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All India Coordinated Rice Improvement Project



Indian Institute of Rice Research
(Indian Council of Agricultural Research)
Rajendranagar, Hyderabad – 500 030, (Telangana)., India

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PREFACE

Multi-disciplinary evaluation of varietal, crop production and crop protection technologies across locations has been continued under the All India Coordinated Research Project on Rice (AICRP on Rice) to strengthen rice farmers with suitable technologies resulting in higher levels of rice production and productivity with input resource optimization. About 400 scientists belonging to ICAR - Indian Institute of Rice Research, 45 funded and more than hundred voluntary centres belonging to State Agricultural Universities, Departments of Agriculture, ICAR Institutes and Private Undertakings work towards progress of rice research work under the umbrella of AICRIP.

This volume reports the salient findings of experimental trials in entomology and plant pathology during 2018. The crop protection programme of AICRIP mainly aims at developing holistic, eco-friendly and cost effective IPM technology which can ensure socio-economic benefits for rice farmers. Focus is on eco-friendly and rational IPM components such as host plant resistance, ecological engineering and biodiversity and use of only safe chemicals.

I compliment the efforts of the entire staff of Entomology and Plant Pathology including Principal Investigators, Cooperating scientists, technical and supporting personnel for their contribution in bringing out this document containing useful and relevant information related to rice IPM.

(S.R. Voleti)

Director (Acting)

May 2019

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SUMMARY

All India Coordinated Entomology Programme was organized and conducted during *kharif* 2018 with seven major trials encompassing various aspects of rice Entomology involving 312 experiments (91.0%) that were conducted at 41 locations (32 funded + 9 voluntary) in 22 states and one Union territory. Details of scientists involved in the program at headquarters, cooperating centres and the performance of centres is provided in Appendices I and II.

2.1 Host plant resistance studies comprised of seven screening experiments involving 1661 entries which included 1425 pre-breeding lines, 94 hybrids, one cultivar and 28 germplasm accessions and 113 check varieties. These entries were evaluated against 12 insect pests in 213 valid tests (46 greenhouse reactions+167 field reactions). The results of these reactions identified 104 entries (6.62%) as promising against various insect pests. Of these promising materials, 15 entries (14.4%) were under retesting.

In **Planthopper Screening Trial (PHS)**, evaluation of 100 entries against the two planthoppers BPH and WBPH in 9 greenhouse and 7 field tests indicated 23 entries (including 16 breeding lines, 4 germplasm and three checks) as promising in 5-14 tests.

Under Gall midge screening trial (GMS) 61 entries evaluated in one greenhouse and 10 field tests against 11 populations of gall midge (five identified biotypes) helped in identification of 9 promising lines 3 of the 11 tests across all the populations. Of these SKL 07-11-117-50-65-60-267, WGL 1164 and Aganni were under retesting. Aganni was promising in 7 tests.

In **Gall midge special screening trial (GMSS)** evaluation of 80 donors against 5 gall midge biotypes in one greenhouse and 8 field tests identified RP 5925 and 13 other pyramided lines as promising in 6-7 tests. Aganni was promising in 8 tests and W1263 in 6 tests. The source of resistance in the promising gene pyramided lines was either *Gm4* or *Gm8* genes or both.

In **Leaf folder screening trial (LFST)**, Augmented field evaluation of 20 entries replicated thrice in a randomised block design against rice leaf folder in Leaf Folder Screening Trial (LFST) during Kharif 2018 at 17 locations in 9 valid field

tests revealed that 11 entries were promising in 3-4 valid field tests. In this second year of testing, HWR 24, MSM 139 and NEG 186 were found promising in 4 out of 9 valid field tests while HPR 2613 and HWR 3 were found promising in 3 valid field tests.

In **Stem borer screening trial (SBST)**, evaluation of entries in 30 field tests identified 16 entries viz., JGL 32467, JGL 32485, BK 39-179, JGL 33080, JGL 33124, JGL 34508, RP 5587-B-B-B-209, RP 5587-B-B-B-253-2, BK 35-155, JGL 34505, KAUPTB 0627-2-11, KAUPTB 0627-2-14, RP 5587-B-B-B-258-1, RP 5587-B-B-B-262, RP 5588-B-B-B-232, JGL 28547 as promising in 9-11 tests of the 30 valid tests in terms of low dead hearts, white ear damage and high grain yield. Recovery resistance and tolerance could be the mechanism in these entries as they showed good grain yield (>15g/hill) despite damage. The mean no. of larvae in the stubbles of these entries ranged from 0.4-2.1/hill.

Evaluation of 23 entries under **Multiple resistance screening trial ((MRST)** in 7 greenhouse and 39 field tests against 7 insect pests helped in identification of 2 entries viz., BPT 2231 and BPT 2611 as promising in 4 and 6 tests, respectively of the 46 valid tests against 2 pests. The multiple resistance index (MRI) varied from 4-8 with a per cent promising reaction (PPR) of 1.242 - 1.863. Of the 3 entries, BPT 2611 was in the second year of testing. The check lines RP 2068-18-3-5 had an MRI of 8 with a PPR of 2.484 and Kavya with an MRI of 6 and PPR of 1.863, respectively.

National Screening Nurseries (NSN) comprised of 4 trials viz., National Screening Nursery 1(NSN1), National Screening Nursery 2 (NSN2), National Screening Nursery – Hills (NSN hills) and National Hybrid Screening Nursery (NHSN).

NSN1 constituted with 408 entries (384 AVT entries along with 10 insect checks and 14 disease checks) was evaluated at 18 locations in 6 greenhouse and 18 field tests against 7 insect pests. Two entries viz., IET nos 27275 and 27284 were promising in 4 tests of the 30 valid tests against 2 pests. Aganni, MO1 and PTB 33 were promising in 4-6 tests of the 24 valid tests.

NSN 2 trial constituted with 692 entries (668 entries from IVT trials, 10 insect and 14 disease checks) was evaluated at 15 locations in 8 greenhouse and 23 field tests against 7 pests in 31 valid tests. Ten entries were identified as promising along with PTB 33 and RP 2068-18-3-5 in 5-7 tests of the 31 valid tests against 3-4 pests.

NSN- Hills trial included evaluation of 111 entries (87 hill entries + 10 insect check lines and 14 disease checks) at 8 locations in 16 tests against 9 insect pests. IET 27480 was identified as promising in 3 of the 16 tests against BPH, GM and WM while PTB 33 and RP 2068-18-3-5 were promising in 6 tests of the total 16 tests.

NHSN trial constituted with 104 entries (94 hybrids + 10 insect checks) was evaluated at 14 locations against 6 insect pests identified IET Nos 27379, 27392 as promising in 3 tests of the 21 valid tests. Aganni, PTB 33 and RP 2068-18-3-5 were promising in 3-4 tests.

2.2 Insect biotype studies comprising of three trials 1) Gall midge biotype monitoring trial (**GMBT**) and 2) Gall midge population monitoring (**GMPM**) and Planthopper special screening trial (**PHSS**) were conducted to monitor the virulence pattern of gall midge and brown planthopper populations. Evaluation of the gene differentials in **GMBT** trial in one greenhouse and 9 field tests against 5 different biotypes and one population of gall midge identified Aganni (*Gm8*), INRC 3021(*Gm8*) and W1263 (*Gm1*) as promising in 5-8 of the 10 tests. The results suggest that the resistance genes *Gm8* and *Gm1* hold promise across gall midge populations.

Evaluation of the gene differentials through single female progeny testing in **GMPM** trial revealed that at Ragolu, Aganni (*Gm8*) holds promise. The study suggests, low virulence on Aganni at Warangal and W 2163 at Pattambi and increase in virulence on RP 2068-18-3-5 at all the three locations is similar to the trend evident in GMBT trial and is a cause of concern.

In **PHSS** trial 16 gene differentials with primary sources of resistance were evaluated against brown planthopper across eleven locations in standard seedbox screening test. Two differentials viz., PTB 33 with bph2+Bph3+unknown factors and RP 2068-18-3-5 with Bph33(t) gene were promising in 8 and 9 locations respectively out of 10 locations. Rathu Heenati with Bph3+Bph17 genes and T 12 with bph7 gene performed better in 5 locations each with a damage score of <5. Babawee with bph 4 gene performed better in 3 locations and two gene differentials viz., Chinsaba with bph 8 gene and Swarnalatha with Bph 6 gene registered promising reaction at two locations.

2.3. Chemical Control Studies consisted of two trials viz., Pesticide Compatibility Trial (PCT) and Botanical Insecticide Evaluation Trial (BIET) carried out during *Kharif* 2018.

Pesticide Compatibility Trial (PCT) was carried out with the objective of evaluating the compatibility of newer insecticide and fungicide formulations as tank mix against major insect pests and diseases of rice and consequent impact on grain yield, at 27 centres during *kharif* 2018. There were no significant differences in their proven efficacy of the two newer insecticide formulations spinetoram+methoxyfenozide and triflumezopyrim when applied alone or in combination with fungicides. Spinetoram+methoxyfenozide performed better against stem borer and leaf folder, while triflumezopyrim showed superiority against plant and leafhoppers. Insecticide treatments applied in combination with fungicides were on par with triflumezopyrim applied alone and superior to remaining treatments including control in terms of yield. Overall, the results revealed that there was no adverse impact on the efficacy of either of the insecticides when applied with fungicides or vice versa confirming the compatibility of the chemicals when used as tank mix in field.

Botanical Insecticide Evaluation Trial (BIET) was carried out at 24 locations across the country to evaluate the efficacy of four essential oils, neemazal and recommended insecticides, dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield during *kharif*, 2018. Based on the performance of the treatments in controlling the pest damage at various locations, the botanicals, eucalyptus oil and neemazal were found effective in reducing damage by stem borer. Cedar wood oil showed efficacy in controlling gall midge damage. Dinotefuran was the most effective treatment in reducing the populations of plant and leaf hoppers, while all the essential oil treatments were moderately effective. However, against leaf folder, all essential oils were found effective in reducing leaf damage. Camphor oil was effective against attack by Gandhi bug. Botanical formulations were found moderately effective in reducing damage by hispa. All essential oils were effective in controlling leaf damage by whorl maggot. Impact of essential oils on natural enemies revealed that treatments were relatively safer to mirid bug than spiders while dinotefuran was unsafe. Highest grain yield of 7768.8 kg/ha was recorded in rynaxypyr treatment. Among botanicals, cedar wood oil recorded highest yield of 6597.9 kg/ha.

Ecological studies consisted of one trial on **Effect of planting dates on insect pest incidence (EPDP)** conducted at 21 locations during Kharif 2018. Incidence of stem borer was reported from 17 locations, of which highest dead heart damage was observed in late planting at Titabar (24.2%) followed by Navasari (15.5%). Highest white ear damage was reported in late planting at

Nawagam (32.3%) followed by early planting at Navasari (24.3%). Gall midge incidence was recorded from 7 locations with highest damage at Sakoli in late planting (17.4%). Among the foliage feeders, leaf folder incidence was reported from 20 locations, highest damage of 22.11% was reported at Titabar in late planting followed by Pusa in early planting (12.6%). Whorl maggot incidence was observed at 7 locations with highest damage in normal planting at Malan (15.8%). Caseworm incidence was recorded at 3 locations and was very high in late planting at Titabar (23.80%). Low incidence of hispa was noticed at 6 locations and thrips at two locations. Sap sucking insects like BPH was reported from 11 locations with highest population at Gangavathi in late planting (80.1/hill) followed by normal planting (65.0/hill). WBPH incidence was higher than BPH and observed at 8 locations with maximum numbers at Nawagam in late planting (181.6/hill) followed by normal planting (115.5/hill). GLH population was observed at 12 locations. Minor pests like horned caterpillar incidence was observed at Navasari, rice skipper and grasshopper incidence at Khudwani, leaf mite damage at Aduthurai and army worm incidence at Sakoli in all the three plantings.

Biocontrol and Biodiversity studies covered i) Ecological Engineering for Planthopper Management (EPPM) ii) Bio-intensive Integrated Pest management (BIPM) and iii) Monitoring of Pest species and their natural enemies (MPNE).

Ecological engineering for pest management was taken up in six locations with a combination of interventions such as organic manuring, alleyways, spacing management, water management and growing of flowering plants on bunds. The results also indicated that water management along with ecological engineering can significantly reduce hopper population. Such interventions increased the natural enemy populations like mirids, spiders and coccinellids and increased egg parasitisation across the locations. The benefit cost ratio was also significantly higher with ecological engineering.

Bio intensive pest management trial was conducted in 10 locations during *Kharif* 2018. The pest incidence was either reduced in BIPM plots as in Chinsurah and Titabar, Raipur and Jagdalpur or on par as in Ludhiana and IIRR compared to Farmers' practice. The natural enemies were higher in BIPM plots in all locations. In Hyderabad after three years of this trial, higher yields were obtained in BIPM plots indicating a period of three years for stabilization of yields in organic practices.

Integrated Pest Management studies included two trials *viz.*, i) Yield loss estimation trial (YLET) and ii) Integrated pest management special (IPMs)

Yield loss estimation trial (YLET) was conducted at 5 locations for stem borer, 3 locations for leaf folder and one location for rice hispa during Kharif 2018. Validation of yield loss estimation model for stem borer was done by regressing observed vs predicted yield losses caused by white ear damage. The linear regression indicates a close fit between observed and predicted yield loss ($R^2 = 0.9762$; $P = 0.00001$) wherein $y = 1.139x - 10.53$. This affirms the yield loss prediction model across the locations which can be utilized for the assessment of actual yield losses caused by stem borer due to white ear damage. A significant negative relationship was observed between leaf folder damaged leaves and grain yield at Coimbatore ($R^2 = 0.5764$) and Ludhiana ($R^2 = 0.4840$). Similarly, a significant negative relationship was observed between hispa damaged leaves and grain yield at Malan ($R^2 = 0.7033$; $P=0.0001$). However, there is only 0.6 g loss in grain yield for every 10% increase in hispa damaged leaves.

Integrated Pest Management special (IPMs) trial was conducted at 15 locations involving 31 farmers' in a participatory mode across the Country with an objective of managing insects, diseases and weeds in a holistic way by providing a basket of options to the farmers. In general, during Kharif 2018 the pest incidence was low across the locations. However, insect pest incidence surpassed ETL at 8 locations and was observed high in farmer practices plots as compared to IPM plots. Implementation of IPM practices resulted in reduction in the population of WBPH (103/ hill to <10/hill) at Gangavathi. BPH population was high in IPM plots initially but got reduced later with the adoption of IPM practices at Gangavathi and Raipur. Similarly, stem borer damage was low in IPM plots than FP plots at 4 locations while dead heart damage was very high in IPM plots at Malan (55.5%), Pusa and Sakoli. Gall midge incidence was low in IPM plots (3.99 – 10.29% SS) compared to FP plots (11.68 – 21.23% SS) at Jagdalpur. Leaf folder incidence was low in IPM at Kurumbapet (16.6%) while it was high at Pusa (17.75%). Hispa incidence was low in IPM (10.2 – 24.8%) compared to FP plots (22.3 – 91.9%) throughout the crop growth period at Malan.

Disease incidence was observed at six locations and among these, leaf blast was recorded from four locations viz., Coimbatore, Jagdalpur, Mandya, and Sakoli while neck blast was found at Sakoli and Mandya. The leaf blast and neck blast disease progress was significantly lower in the experimental plots where IPM practices were followed when compared to the farmer practices. Sheath blight disease was recorded at Jagdalpur, Ludhiana, Sakoli and Titabar while BLB at two locations viz., Sakoli and Titabar. Sheath blight progression was more and rapid at Sakoli in farmer practices (144 -255) compared to other three locations. The brown spot, sheath rot and stem rot diseases were recorded at Sakoli while false smut was observed only at

Ludhiana under both IPM and FP fields. In general, the disease progression was slow in IPM fields compared to farmer practices.

Weed population and weed biomass recorded at all the locations were considerably reduced by two to five times in IPM implemented plots compared to farmer practices resulting in higher grain yields. Grain yields were high in IPM fields compared to farmer practices at all the locations. High returns and low cost of cultivation resulted in high BC ratio in IPM implemented farmer fields.

Assessment of insect populations throughout the year using light traps

revealed that, stem borers and planthoppers continued to be the most important pests in terms of numbers as well as spread across the locations. However, the catches during peak activity were smaller as compared to previous year except gall midge. Leaf folder, and GLH were also found across the country but their numbers and distribution along with the remaining pests continues to be moderate. But, there is a need for continuous monitoring of their populations along with those of major pests to understand the spatial and temporal distribution and shifts in pest profiles if any, in different rice ecosystems in the country.

ENTOMOLOGY

INTRODUCTION

Insect pests continue to be prime constraints in rice production. Climate change and its concomitant effect on shifts in cropping patterns influence the changes in pest profile scenarios in diverse rice ecosystems of the country. The national pests *viz.*, stem borer, gall midge, planthoppers and leaf folder have consistently maintained their pest status in rice cultivation, while pests of regional significance like hispa, caseworm, swarming caterpillar, cutworms etc. have inflicted serious crop losses in certain parts of the country. It is sometimes an uphill task for the farmers to tackle the pest menace in the context of socio-economic and ecological constraints.

All India Coordinated Rice Improvement Project (AICRIP) Entomology programme continues to focus on the theme of rice pest management holistically encompassing different components to ensure economic gains and ecological benefits for the farmers. Pest Survey Reports (PSR) generated with the information collected across locations at fortnightly interval includes real time information on insect pest incidence in farmers' fields. During 2018, the PSR reports revealed severe incidence of planthoppers from Kawardha District of Chhattisgarh in the month of September and Coimbatore region in Tamil Nadu during October, while high infestation was observed on hybrid rice cultivars at Nagrota, in Himachal Pradesh. Hopper burn was also reported from different areas in Punjab. Gall midge was in severe form on ADT 46 and CR 1009 at Karaikal. At Pantnagar, panicle mite and ear head bug infestation was very high. Severe incidence of black beetle was observed in Kangra District of Himachal Pradesh in the month of July and grass hoppers in the month of November at Khudwani in Jammu and Kashmir.

Host plant resistance programme is one of the main pillars of the biointensive IPM efforts being carried out at different centres and targets planthoppers, gall midge, stem borer and leaf folder. The promising lines with desirable resistance traits will be carried forward to crossing programmes involving elite entries with higher yield potential or utilized for advanced genetic analysis studies.

Evaluation of newer insecticide molecules for bio-efficacy and safety along with their compatibility with other pesticides is a continuous process so that we are ready with the information to help the farmers in situations of sudden pest outbreaks. Concurrently, performance of botanicals is being assessed for their potential role as green pesticides with supplementary benefits as components of organic means of managing insect pests.

Ecological studies on insect pests help in understanding the impact of globally changing climatic scenario on rice based cropping systems and resultant

alterations in agronomic practices on insect pest population dynamics. Field trials on yield losses generate reliable data on extent of damage due to two key pests, stem borer and leaf folder.

The rice ecosystem richly endowed with natural enemy diversity can be suitably manipulated through ecological engineering strategy towards the goal of eco-friendly and cost effective rice IPM. Biointensive pest management efforts are aimed at exploring the possible benefits of eco-friendly components of IPM to strengthen organic farming in rice.

All said and done, farmers will readily adopt integrated pest management only when they are convinced that it provides an all round solution to their multi pest problem scenario along with increase in their profits by enhancing yields or reducing involved costs. Under AICRIP, the trials conducted in multidisciplinary approach with involvement of Entomology, Plant Pathology and Agronomy researchers in a farmers' participatory mode can be a model path to reap effective results in validating location specific IPM practices *vis a vis* farmers practices.

Short and long term assessment of pest populations through light trap catches have contributed towards understanding of changing pest population scenario as pre-requisites for pest forecasting.

The following report highlights the significant findings from the greenhouse evaluations and field trials carried out at IIRR and its cooperating centres under AICRIP during 2018.

2.1 HOST PLANT RESISTANCE STUDIES

The prime objective of host plant resistance studies is identification and delineation of new sources of resistance to major insect pests, and multilocal evaluation of breeding lines from various National Screening Nurseries against insect pests to identify lines with tolerance/resistance. These include multi-location evaluations under both greenhouse and field conditions to evaluate the performance of germplasm accessions, breeding lines as well as characterization of insect pest populations from various hot spots. Seven trials *viz.*, i) Planthopper Screening trial (PHS), ii) Gall Midge Screening trial (GMS), iii) Gall Midge Special Screening trial (GMSS), iv) Leaf Folder Screening Trial (LFST), v) Stem Borer Screening Trial (SBST) vi) Multiple Resistance Screening Trial (MRST) and vii) National Screening Nurseries (NSN) were constituted and conducted during *Kharif* 2018. In all, 1661 entries were evaluated at 40 locations against 12 insect pests and 104 entries (6.62%) were identified as promising. **The detailed pest reaction of all the entries in each trial is presented in a separate volume “Screening Nurseries: – Diseases & Insect Pests”.**

i) Planthopper Screening Trial (PHS)

The planthopper screening trial was constituted with 100 entries comprising of 7 breeding lines developed at RRU, ANGRAU, Bapatla; 14 breeding lines developed at TNAU, Coimbatore; 14 breeding lines developed at RARS, PJTSAU, Jagtiyal; 10 breeding lines developed at APRRI, ANGRAU, Maruteru; 14 breeding lines developed at ARI, PJTSAU; Rajendranagar, 14 breeding lines developed at RARS, PJTSAU; Warangal, 3 breeding lines, 7 introgression lines and 5 germplasm accessions developed at IIRR Hyderabad, along with three resistant checks PTB 33(BPH), RP 2068-18-3-5(BPH) and MO1 (WBPH) as well as one susceptible check TN1. Of these, six entries were under retesting. The entries were evaluated at 13 locations in 16 tests against brown planthopper (BPH), whitebacked planthopper (WBPH) and mixed populations of planthoppers under both field and greenhouse conditions.

Evaluation of entries in 7 greenhouse and 3 field tests against brown planthopper, 2 greenhouse tests against whitebacked planthopper and 4 field tests against mixed populations of planthoppers revealed 16 breeding lines *viz.*, BPT 2601, CB 15569, CB 15144, MTU 1303, MTU 1305, MTU 1306, MTU 1307, MTU 1308, MTU 1309, WGL 1250, WGL 1319, WGL 1320, RNR 19416, RP 5995 Bphk17-5, IR 73382-80-9-3-13-2-2-1-3-B (HWR-16) and RP 5690-20-6-3-2-1 as promising in 5-9 tests (**Table 2.1**). Four germplasm accessions *viz.*, IC 216735, IC 76013, IC 75975 and IC 76057 performed better in 7-12 tests. Three breeding lines *viz.*, RP 5995 Bphk17-5, IR 73382-80-9-3-13-2-2-1-3-B (HWR-16) and RP 5690-20-6-3-2-1 performed better in the second year of retesting. The susceptible check TN1 recorded damage score in the range of 8.2-9.0 in these valid tests. The universal checks *viz.*, PTB 33 and MO1

performed well in 14 and 11 tests respectively. The breeding line, RP 2068-18-3-5 carrying gall midge resistant *gm3* gene and identified as a new donor check line for BPH performed better in 13 tests.

Mixed populations of brown planthopper and whitebacked planthopper were present in Gangavathi, Maruteru, Nawagam, Pantnagar and Warangal. Data on BPH and WBPH populations during the field evaluation at Gangavathi (WBPH:BPH in 1.0:0.67 ratio) and Nawagam (WBPH:BPH in 2.5:1 ratio) revealed predominance of WBPH over BPH. BPH was predominant throughout the crop season at Pantnagar (BPH 5-30 times more), while at Warangal, BPH and WBPH were in the equal ratio. At Aduthurai, Jagityal and Rajendranagar, only BPH population was present.

Evaluation of the entries against the two planthoppers BPH and WBPH in 9 greenhouse and 7 field tests indicated 23 entries (including 16 breeding lines, 4 germplasm and three checks) as promising in 5-14 tests.

ii) Gall midge screening trial (GMS)

Gall midge trial was constituted with 61 entries (58 breeding lines + 3 checks). Forty five nominations from 4 research stations *viz.*, Jagtial, Kunaram, Warangal and Sindewahi along with 14 entries under retesting were evaluated at 13 locations across the country against 5 identified biotypes of gall midge. The valid data from 11 locations for various biotypes/populations were considered for analysis and the salient findings are discussed as under:

Ten entries recorded nil damage in 2 of the 3 tests against GMB 1. Aganni was promising in all the three tests. At Cuttack, only JGL 24267 recorded nil damage for GMB 2. JGL 34594 recorded <5 % DP and SKL 07-08-720-63-147-182-276 had < 10 % DP at both Jagtial and Ranchi for biotype 3. JGL 34594 and Aganni recorded nil damage for biotype 4 at both Ragolu and Sakoli. At Warangal, Aganni was the only entry reported to have nil damage against biotype 4M. At Pattambi, 7 entries *viz.*, JGL 34505, JGL 34564, KNM 6854, KNM 6869, KNM 6871, KNM 6873, SKL 07-11-117-50-65-60-267* recorded nil damage against GMB 5, while at Maruteru, WGL 1151, was the only entry under retesting that recorded nil damage.

Overall reaction: Evaluation of 61 entries in one greenhouse and 10 field tests against 11 populations of gall midge (five identified biotypes) helped in identification of 9 lines that were promising in 3 of the 11 tests across all the populations (**Table 2.2**). Of these SKL 07-11-117-50-65-60-267, WGL 1164 and Aganni were under retesting. Aganni was promising in 7 tests.

Table 2.1 Performance of most promising entries in Panthopper Screening Trial (PHS) *kharif* 2018

Entry No.	Designation	Cross combination	BPH									WBPH		Planthoppers				No. of Promissing Tests					
			Greenhouse reaction						Field reaction			GR		Field reaction									
			Damage Score						No/10h		%DT	DS		DS	DS	No./10h							
			IIRR	CBT	CTC	LDN	MND	PNT	WGL	ADT	RNR	JGT	IIRR	CBT	MTU	GVT	NWG	PNT	GH(7)	FR(3)	GH(2)	FR(4)	TOTAL
1	BPT 2601	MTU1001/N22	7.7	5.7	9	8.1	7.0	5.6	6.3	10	20	17.3	8.1	7.5	3.0	5.0	177	133	0	2	0	4	6
5	IC 216735	IIRR Gemplasm	1.8	4.1	3	2.5	9.0	4.0	3.0	25	17	10.3	5.9	4.8	9.0	3.0	83	133	6	2	0	4	12
11	IC 76013	IIRR Gemplasm	0.0	5.2	3	2.5	9.0	3.0	4.6	23	14	12.2	5.5	5.8	9.0	9.0	370	145	5	2	0	0	7
12	CB 15569	JGL 1798/ IET 21601	7.4	7.5	3	8.7	9.0	5.4	5.0	26	26	25.0	9	6.6	3.0	3.0	102	142	2	1	0	3	6
21	CB 15144	CO 05 022/ CB 09 123	8.1	7.4	5	6.7	9.0	8.8	9.0	38	26	4.3	6.5	7.5	3.0	3.0	336	133	1	1	0	3	5
22	IC 75975	IIRR Gemplasm	2.5	6.1	1	2.7	9.0	0.6	6.1	NG	14	1.1	8.2	7.5	5.0	3.0	284	142	4	2	0	1	7
32	MTU 1303	MTU 1075/MTU 1001	9.0	NG	3	6.8	9.0	6.8	NG	52	16	10.3	9	NG	3.0	5.0	84	NG	1	1	0	3	5
34	MTU 1305	(MTU 1075/MTU 1081)/ MTU 1121	5.7	6.6	5	2.9	9.0	7.6	3.1	59	25	8.9	9	7.4	3.0	5.0	72	124	3	0	0	4	7
35	IC 76057	IIRR Gemplasm	2.7	6.7	3	3.8	9.0	5.5	5.5	21	18	4.2	5.5	7.6	1.0	3.0	308	126	3	3	0	3	9
36	MTU 1306	MTU 1121/MTU 1010	7.4	6.6	5	9.0	9.0	4.5	9.0	NG	30	5.4	9	8.5	1.0	3.0	97	139	2	0	0	3	5
37	MTU 1307	MTU 1001/KMP 150	7.5	6.7	7	8.3	9.0	5.5	4.2	20	31	5.1	5.2	7.5	1.0	3.0	169	133	1	1	0	4	6
38	MTU 1308	(MTU 1010/MTU 1081) /MTU 1121/JGL18047	6.3	7.6	7	8.3	9.0	5.8	6.6	23	21	3.1	7.1	7.9	3.0	3.0	75	130	0	2	0	4	6
39	MTU 1309	(MTU 1075/MTU 1081) MTU 1121	6.4	6.3	5	3.7	9.0	6.5	3.1	NG	28	5.1	5.9	7.7	3.0	5.0	119	123	3	0	0	4	7
62	WGL- 1250	KMP 150/JGL 17025	6.3	7.8	9	8.5	9.0	6.8	9.0	28	19	2.4	9	7.5	3.0	9.0	144	137	0	3	0	2	5
64	WGL- 1319	IR 42/1005	3.2	8	7	8.5	9.0	7.8	7.4	30	20	13.2	5.2	7.2	7.0	1.0	200	134	1	2	0	3	6
65	WGL- 1320	IR 42/1005	NG	8.5	5	NG	9.0	6.8	7.8	34	20	20.6	NG	8.2	3.0	5.0	472	135	1	2	0	3	6
73	RNR 19416	MTU 1010/JGL 3844	4.1	7.5	5	4.7	9.0	6.5	8.5	30	27	18.0	5.4	6.5	9.0	3.0	515	137	3	1	0	1	5
87	RP 5995 Bphk17-5*	RPHR-1005/BPH-18	5.9	6.1	9	1.8	9.0	1.4	3.1	36	41	21.4	4.8	7	NG	5.0	394	146	3	0	1	1	5
88	IR 73382-80-9-3- 13-2-2-1-3-B (HMR-16)*		4.8	6.4	9	2.9	9.0	3.4	3.9	175	26	16.1	4.7	9	NG	9.0	601	139	4	0	1	0	5
89	RP 5690-20-6-3- 2-1*	Sonamahsuri/SR 26-B	2.8	6.2	9	3.6	9.0	4.5	1.4	230	18	13.6	3.9	6.3	3.0	3.0	74	143	4	1	1	3	9
60	PTB33	R check	1.3	3	1	1.6	1.0	7.6	1.4	30	6	0.9	4.2	4.2	1.0	5.0	38	143	6	3	2	3	14
40	RP 2068-18-3-5	R check	1.8	3.6	3	2.2	7.0	6.8	3.5	32	18	3.0	5.2	4.7	3.0	5.0	145	135	5	3	1	4	13
30	MO1	R check	4.2	4.9	5	9.0	3.0	NG	3.9	38	1	12.0	1.6	2.7	7.0	3.0	81	134	5	1	2	3	11
Promising level			5	5	5	5	5	5	5	35	20	5	5	5	3	5	200	135					
No. of Promising entries			16	10	21	23	7	12	22	36	26	14	10	11	33	36	36	36					

*Entry under retesting

Table 2.2 Reaction of promising breeding lines against gall midge populations in GMS, *kharif* 2018.

Entry No.	Designation	Per cent plant damage											Overall NPT
		GMB1		GMB?	GMB2	GMB3		GMB4		GMB4M	GMB5	GMB?	
		IIRR	CHP	JDP	CTC\$	JGT	RNC	RGL	SKL	WGL	PTB	MTU\$	
		GR	50DT	50DT	30DT	50DT	50DT	50DT	50DT	50DT	50DT	50DT	
28	JGL 34594	100.0	20.0	0.0	50.0	10.0	15.0	0.0	0.0	75.0	4.8	2.0	3
29	KNM 6854	NT	0.0	0.0	50.0	65.0	30.0	75.0	15.0	95.0	0.0	1.9	3
31	KNM 6869	NT	30.0	0.0	55.6	55.0	25.0	80.0	0.0	95.0	0.0	2.0	3
32	KNM 6871	NT	30.0	0.0	55.6	25.0	0.0	80.0	15.0	100.0	0.0	1.0	3
45	SKL 07-11-117-50-65-60-267*	0.0	60.0	0.0	76.9	90.0	10.0	100.0	80.0	100.0	0.0	3.1	3
49	SKL 07-08-720-63-147-182-276	75.0	0.0	0.0	16.7	5.0	10.0	0.0	30.0	25.0	4.8	2.1	3
50	SKL 06-02-27-13-54-239-34	0.0	10.0	0.0	13.3	25.0	10.0	0.0	25.0	20.0	38.1	4.1	3
53	WGL-1164*	0.0	0.0	10.0	88.9	65.0	0.0	100.0	10.0	100.0	4.8	2.2	3
40	Aganni (R. Check)	0.0	0.0	0.0	5.6	0.0	25.0	0.0	0.0	0.0	4.8	3.5	7
Total Tested		56.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	
Ave. damage in the trial		17.7	57.7	31.8	53.4	79.7	17.6	79.0	59.7	89.1	16.9	15.6	
Damage in TN1		71.4	100.0	65.0	97.2	100.0	60.0	82.5	100.0	100.0	33.3	30.4	
Promising Level		0	0	0	0	0	0	0	0	0	0	0	
No. promising		29	5	19	1	1	6	4	5	1	7	1	

*. Entry under retesting. \$-Silver shoots

iii) Gall midge special screening trial (GMSS)

This trial constituted with 80 donors (including 48 gene pyramided lines nominated from IBT, PJTSAU along with check varieties) was carried out in 11 locations to identify new sources of resistance to gall midge biotypes/populations. Of these, 20 lines were under retesting. The valid data from the nine locations were analysed and discussed biotype/population wise as under:

Evaluation of the entries for GMB1 identified W1263, Aganni, RP 5925 and 19 gene pyramided lines (IBT GM 1, IBT GM 2, IBT GM 3, IBT GM 8, IBT GM 9, IBT GM 11, IBT GM 12, IBT GM17, IBT GM18, IBT GM19, IBT GM20 and IBT GM23) as promising with nil damage at IIRR, CHP and JDP.

Against biotype 3, ARC 6626, KOLLIMALAISAMBA, GEB24, PTB 32, IC 332045, IBT GM14, IBT GM24, Kavya, W1263, Aganni had nil damage at both Jagtial and Ranchi.

For biotype 4, , RP 5925, Aganni, IBT GM1 to IBT GM29, IBT GM 34 to 37, IBT GM 42, IBT GM 43, WGL-1127, WGL-1147 and IBT R4 recorded nil damage at Ragolu and Sakoli .

IC 330695, Aganni, RP 5925, IBT GM 1, IBT GM 2, IBT GM 3, IBT GM14 recorded nil damage against biotype 4 M at Warangal.

ARC 5913 and W1263 recorded nil damage for biotype 5, at Pattambi.

Overall reaction: Evaluation of 80 donors against 5 gall midge biotypes in one greenhouse and 8 field tests identified 14 lines as promising in 6-7 tests. Aganni was promising in 8 tests and W1263 in 6 tests (**Table 2.3**).

Table 2.3 Reaction of donors against gall midge populations in GMSS, kharif 2018

Entry No.	Designation	GMB1		GMB?	GMB3	GMB3	GMB4		GMB4M	GMB5	Overall NPT
		IIRR	CHP	JDP	JGT	RNC	RGL	SKL	WGL	PTB	
		GH	30DT	50DT	50DT	30DT	50DT	50DT	50DT	50DT	
		%DP	%DP	%DP	%DP	%DP	%DP	%DP	%DP	%DP	9
26	RP 5925	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	23.8	7.0
27	IBT GM 1	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0	47.6	7.0
41	IBT GM14	NT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.6	7.0
28	IBT GM 2	0.0	0.0	0.0	15.0	15.0	0.0	0.0	0.0	NT	6.0
29	IBT GM 3	0.0	0.0	0.0	20.0	30.0	0.0	0.0	0.0	14.3	6.0
34	IBT GM 8	0.0	0.0	0.0	0.0	20.0	0.0	0.0	25.0	47.6	6.0
35	IBT GM 9	0.0	0.0	0.0	0.0	25.0	0.0	0.0	10.0	23.8	6.0
37	IBT GM 11	0.0	0.0	0.0	0.0	25.0	0.0	0.0	5.0	33.3	6.0
38	IBT GM 12	0.0	0.0	0.0	0.0	20.0	0.0	0.0	5.0	28.6	6.0
44	IBT GM17	0.0	0.0	0.0	0.0	10.0	0.0	0.0	15.0	52.4	6.0
45	IBT GM18	0.0	0.0	0.0	0.0	15.0	0.0	0.0	20.0	57.1	6.0
46	IBT GM19	0.0	0.0	0.0	0.0	15.0	0.0	0.0	10.0	57.1	6.0
51	IBT GM24	0.0	10.0	0.0	0.0	0.0	0.0	0.0	5.0	57.1	6.0
52	IBT GM25	0.0	0.0	0.0	0.0	10.0	0.0	0.0	70.0	52.4	6.0
	R. Checks										
25	Aganni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	8.0
20	W1263	0.0	0.0	0.0	0.0	0.0	55.0	10.0	95.0	0.0	6.0

Data was not received from NRRI, Cuttack. Data from Moncompu was not considered due to low pest pressure

Leaf Folder Screening Trial (LFST)

Leaf folder screening trial was constituted with the main aim of identifying new sources of resistance to rice leaf folder, *Cnaphalocrocis medinalis*. This trial comprised of 20 entries with two nominations from Main Rice Research Station, Anand Agricultural University, Nawagam; six nominations from Rice & Wheat Research station, CSK HP Agricultural University, Malan; two elite high yielding introgression lines derived from tropical japonicas; two mutants lines of samba mahsuri; two RILs of wild rices from IRRI; two northeast germplasm entries; one RIL of IR 64/ *O. glaberrima* derivative; one RIL of TN1/W1263 along with susceptible check (TN1) and resistant check (W1263). During *Kharif* 2018, the trial was conducted at 17 locations with 20 entries replicated thrice in a randomised block design. This is the second year testing of these entries. Data analysis revealed 11 entries as promising in 3-4 tests out of 9 valid tests (**Table 2.4**). The average damage in the susceptible check, TN1 varied from 10.9 to 81.8%. The average damage in the trial ranged between 8.2 and 46.9% while the maximum damage varied from 26.5 to 77.8%. In this second year of testing, three entries viz., HWR 24, MSM 139 and NEG 186 were found promising in 4 of the 9 valid tests while resistant check, W 1263 was found promising in all the 9 valid tests. Seven nominations viz., NWGR 12048, HPR 2613, HWR 3, MSM 127, NEG 37, JBB 622 and JBB 618 were found promising in 3 valid field tests.

Table 2.4 Reaction of promising entries against leaf folder in LFST, *Kharif* 2018

Designation	Parentage	PTB	NVS	NLR	MLN	CHT	KRK	LDN	NWG	RNR	NPT (9)
		60	80	80	98	78	80	80	60	104	
		DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	
% Damaged Leaves											
W1263	Resistant check	19.4	6.7	2.9	18.7	18.8	8.1	17.7	15.7	10.5	9
HWR 24	IR 73382-7-12-1-1-3-B	37.0	2.7	10.8	18.6	20.8	29.7	30.2	22.4	10.1	4
MSM 139	Mutant of Samba Mahsuri	41.8	7.8	6.5	22.4	19.8	33.8	21.5	30.1	16.3	4
NEG 186	PhoutumMah	42.9	9.6	9.4	19.7	20.9	38.3	21.8	27.9	10.3	4
NWGR 12048	Gurjari x IR-38/4-1-1-1-1-1	71.5	14.4	18.5	21.6	20.5	38.3	14.6	17.9	20.8	3
HPR 2613	MLN2098-1-6 216/HPR 2362	32.9	1.8	19.0	20.0	25.5	28.5	18.9	35.8	8.5	3
HWR 3	IR 71037-9-7-B	40.0	10.9	15.4	20.5	24.4	46.5	21.8	22.2	18.0	3
MSM 127	Mutant of Samba Mahsuri	49.0	1.6	11.1	18.0	21.5	42.1	24.3	24.1	25.1	3
NEG 37	Niphuthokpi	24.2	0.0	10.6	20.4	22.5	23.3	25.7	25.8	4.7	3
JBB 622	Swarna/IRGC 63248//DSB 3	63.9	10.7	11.9	19.7	29.6	41.3	18.7	30.0	24.3	3
JBB 618	Swarna/IRGC 63248//DSB 3	62.1	0.0	10.6	20.1	23.2	61.7	18.7	26.8	17.9	3
Minimum damage		19.4	0.0	2.9	18.0	18.8	8.1	14.6	15.7	4.7	
Maximum damage		77.8	27.3	26.5	23.0	29.6	61.7	30.2	55.2	30.2	
Average damage in trial		46.9	8.2	14.5	20.6	22.1	33.8	21.8	28.2	18.1	
Average damage in TN 1		81.8	27.2	10.9	18.1	21.1	33.4	43.3	81.1	15.5	
Promising level		25	15	10	20	20	15	20	25	20	
No. Promising		2	15	3	6	3	1	7	7	10	
Total entries tested		20	20	20	20	20	20	20	20	20	

Data from Arundhuthinagar, Bapatla, Chinsurah, Ganagavathi, Jagdalpur, Khudwari, Karjat and Masodha was not considered for analysis due to low pest pressure

Augmented field evaluation of 20 entries replicated thrice in a randomised block design against rice leaf folder in Leaf Folder Screening Trial (LFST) during *Kharif* 2018 at 17 locations in 9 valid field tests revealed that 11 entries were promising in 3-4 valid field tests. In this second year of testing, HWR 24, MSM 139 and NEG 186 were found

promising in 4 out of 9 valid field tests while HPR 2613 and HWR 3 were found promising in 3 valid field tests.

v) Stem borer screening trial (SBST)

The Stem borer Screening trial (SBST), was constituted with 62 entries with nominations from IIRR, Jagtial, and Pattambi which were specifically bred for stem borer tolerance. During *kharif* 2018, these entries were evaluated at 12 locations. To ensure effective screening of the material two plantings were taken up as per the technical programme. To identify the tolerant lines, observations were recorded on dead heart at vegetative phase and white ear damage, grain yield in the infested plant and the larval survival in the stubbles at harvest. Two locations *viz.*, Pattambi and Malan reported the damage for white stem borer, *S.fusciiflua* while in 10 locations yellow stem borer damage was recorded. The results of the evaluation from the valid tests are discussed below.

Dead heart damage: The dead heart damage in the trial varied from 0-48.1% with an average damage of 17.4% DH across the 6 locations in 8 valid tests. Evaluation of entries for dead heart damage at six locations in two staggered sowings identified RP 5587-B-B-B-253-2 as promising in 2 tests. JGL 32467, JGL 32485, JGL 33430, JGL 33440, JGL 34560, KAUPTB 0627-2-11, RP 5587-B-B-B-262, RP 5588-B-B-B-B-232, BK 39-179, BK 35-155 and JGL 28547 showed nil damage in one of the 8 tests.

White ear damage:

The white ear damage across 8 locations in 11 valid tests varied from 0 to 82% with a mean of 9.7% WE. Evaluation of entries identified, JGL 28547 in 4 tests, RP 5588-B-B-B-B-232, BK 39-179 and JGL 32467 in 3 tests and RP 5587-B-B-B-253-2, JGL 33080, JGL 33440, KAUPTB 0627-2-11, RP 5587-B-B-B-253-2, RP 5587-B-B-B-258-1, BK 35-155 as promising in two of the 11 valid tests with nil WE damage. The larval survival per entry across 7 locations in 10 tests varied from 0-8.3 larvae/hill in the stubbles with a mean of one larvae/hill. At Rajendranagar, pink stem borer larvae were observed in very few entries. Slight dominance of pink stem borer over yellow stem borer was reported from Aduthurai.

Grain yield: JGL 33124, RP 5587-B-B-B-209, JGL 34505 and JGL 34508 were found promising with >15g/hill in 9-10 of the 11 valid tests for grain yield /hill despite stem borer damage. However, JGL 32467, BK 39-179, RP 5587-B-B-B-258-1, BK 35-155 and RP 5587-B-B-B-262 which were promising in 2-4 tests for stem borer damage were also promising in 7 tests for grain yield.

Overall reaction: Evaluation of entries in 30 field tests identified 16 entries as promising in 9-11 tests of the 30 tests in terms of low dead hearts, white ear damage and high grain yield. Recovery resistance and tolerance could be the mechanism in these entries as they showed good grain yield despite damage **Table (2.5)**. The mean no. of larvae in the stubbles of these entries ranged from 0.4-2.1/hill.

Table 2.5 Reaction of promising entries against stemborer in SBST, *kharif* 2018.

S.No.	Designation	No. of promising tests(NPT)				Overall NPT	Mean no of larvae/hill
		DH	WE	DH + WE	Grain yield		
		8	11	8+11=19	11	19+11=30	10 tests
4	JGL 32467	1	3	4	7	11	1.4
5	JGL 32485	1	2	3	8	11	1.0
58	BK 39-179*	1	3	4	7	11	0.4
11	JGL 33080	0	2	2	8	10	1.1
13	JGL 33124	0	0	0	10	10	1.3
24	JGL 34508	0	1	1	9	10	0.7
37	RP 5587-B-B-B-209*	0	0	0	10	10	2.1
38	RP 5587-B-B-B-253-2*	2	2	4	6	10	1.2
61	BK 35-155*	1	2	3	7	10	0.7
23	JGL 34505	0	0	0	9	9	1.0
31	KAUPTB 0627-2-11	1	2	3	6	9	0.7
32	KAUPTB 0627-2-14	0	1	1	8	9	0.6
41	RP 5587-B-B-B-258-1*	0	2	2	7	9	0.5
42	RP 5587-B-B-B-262*	1	1	2	7	9	1.1
55	RP 5588-B-B-B-232*	1	3	4	5	9	0.5
2	JGL 28547	1	4	5	4	9	0.9

*-Entry under retesting

Data from MLN for DH and WE; WE from IIRR was not considered due to low pest pressure. Data not received from GVT

.Valid data considered for analysis in SBST trial

Pest damage	Locations									
DH(%)	CHN	IIRR-1	IIRR-2	MSD	NVS-1	PNT-1	PNT-2	PTB		
WE(%)	PNT	ADT	CHN	CBT	NVS-1	NVS-2	PTB	RNR-1	RNR-2	RPR
Grain yield	ADT	CBT	CHN	PTB	RNR-1	RNR-2	NVS-1	NVS-2	PNT-1	PNT-2
Larvae per hill	IIRR-1	IIRR-2	NVS-1	NVS-2	PNT-1	PNT-2	RNR-1	RNR-2	RPR	MLN

1& 2- indicate staggered sowings at same location

vi) Multiple resistance screening trial (MRST)

This trial was constituted with a view to identify the reaction of entries promising in pest specific trials to other pests and also to evaluate the reaction of advanced breeding lines to insect pests. The trial included evaluation of 23 entries consisting of two entries from retesting, 2 lines from Nawagam, three BPT mutant lines, two lines from Warangal, two germplasm lines promising in gall midge trials, 3 lines from Kerala and 4 lines from Bapatla along with 4 insect resistant and one susceptible check against 7 insect pests at 31 locations. The details of the reaction of entries is available in **Screening Nurseries-Diseases and Insect pests Vol II**. The valid data from various locations are discussed pest wise.

BPB: Only RP 2068-13-5 was promising (DS<3.0) in 2 of the 4 greenhouse tests.

WBPH: None of the entries were promising

Mixed population of planthoppers: KAUPTB 0627-2-11 and KAUPTB 0627-2-15 exhibited field tolerance with a DS ≤ 3.0 in 2 tests at GGV and MTU for mixed population of planthoppers.

Gall midge: Sinnasivappu and Kavya had nil damage in 2 of the 9 tests for gall midge.

Stem borer: Evaluation of entries against stem borer at vegetative phase for dead heart damage in 8 valid tests and at reproductive phase for white ear damage in 7 valid tests identified MTU 1245 (MTU 2139-7-1-1-1*) an entry under retesting, as promising in 3 of the 15 tests.

Foliage feeders: Incidence of leaf folder, whorl maggot and rice hispa were observed in 7, 5 and 2 valid tests respectively, but none of the entries were found promising.

Overall reaction: Evaluation of 23 entries in 7 greenhouse and 39 field tests against 7 insect pests helped in identification of 2 entries *viz.*, BPT 2231 and BPT 2611 as promising in 4 and 6 tests respectively of the 46 valid tests against 2 pests. The MRI varied from 4-8 with a PPR of 1.242 -1.863. **(Table 2.6)**. Of the 3 entries, BPT 2611 was in the second year of testing. The check lines RP 2068-18-3-5 had an MRI of 8 with a PPR of 2.484 and Kavya with an MRI of 6 and PPR of 1.863, respectively.

Table 2.6 Performance of breeding lines against insect pests in MRST, kharif 2018

Entry No.	Designation	BPH	WBPH	BPH+WBPH [@]	GMB	SBDH	SBWE	LF	RH	WM	Total No. of promising		MRI	PPR
											Tests	Pests		
											(T)	(P)	P X T	
		4	2	2	9	8	7	7	2	5	46	7	322	
1	BPT 2231	0	0	0	1	0	1	0	0	0	2	2	4	1.242
22	BPT 2611*	1	0	1	0	1	0	0	0	0	3	2	6	1.863
	Checks													
5	RP 2068-18-3-5	2	0	1	1	0	0	0	0	0	4	2	8	2.484
20	Kavya	0	0	0	2	0	1	0	0	0	3	2	6	1.863

@ - Mixed Population of Planthoppers' *-Entry under retesting: $PPR = (MRI \text{ of test entry} \times 100) / \text{total MRI}$

Data from JDP, RPR, PNT, WGL for BPH; from PNT for WBPH; from JDP for GLH; From CHN, JDP, GVT, CHP, LDN, RNR, NWG, RGL, KJT for BDH; from Pus, chp, GVT, LDN, MSD, RGL, IIRR < KJT, RNR, WGL for SBWE, NVS, NWG, PTB, and RNR for LF; From PTB for CW were not considered for analysis.

Valid data from locations considered for analysis in MRST, kharif 2018

Pest	Locations								
BPH	IIRR	LDN	CBT	MND					
WBPH	IIRR	CBT							
PH	GVT	MTU							
GM	IIRR	CHP	RCI	RGL	PTB	ADT	MTU	SKL	WGL
SBDH	IIRR	MSD	MTU	NVS	PNT	PTB	PUS	RCI	
SBWE	RCI	NLR	NWG	PNT	ADT	SKL	RPR		
LF	CHT	LDN	NLR	NVS	NWG	PTB	PUS		
RH	MLN	RPR							
WM	CHN	PTB	ADT	JDP	MLN				

vii) National Screening Nurseries

National Screening Nurseries (NSN) comprised of 4 trials, National Screening Nursery 1 (NSN1), National Screening Nursery 2 (NSN2), National Screening Nursery – Hills (NSN hills) and National Hybrid Screening Nursery (NHSN). **NSN1**

constituted with 408 entries (384 AVT entries along with 10 insect checks and 14 disease checks) was evaluated at 18 locations. **NSN 2** trial constituted with 692 entries (668 entries from IVT trials, 10 insect and 14 disease checks) was evaluated at 15 locations against 7 insect pests. **NSN-Hills** trial constituted with 111 entries (87 hill entries + 10 insect check lines and 14 disease checks) was evaluated at 8 locations in 16 tests against 9 insect pests. **NHSN** trial constituted with 104 entries (94 hybrids + 10 insect checks) was evaluated at 14 locations against 6 insect pests. The valid data in each trial are discussed pest wise:

Brown planthopper:

NSN1: IR 64 (RP) 27275 and RP 2068-18-3-5 were promising in 2 of the 3 tests as against PTB-33 which was resistant in all the 3 tests.

NSN2: IET Nos 27537, 27547, 27990, 27997, 27657, 27858, 27679, MTU 1291 (DST36-108-1), 28071 were promising in 2 of the 5 tests. PTB 33 and RP 2068-18-3-5 were promising in 3 and 2 tests, respectively.

NSN hills: IET Nos 27479, 27485 and 26565 were promising in 2 of the 4 greenhouse tests with a $DS \leq 3.0$.

NHSN: IET No 227358 and 27389 were promising in 2 greenhouse reactions of the 4 tests with a $DS \leq 3.0$ of the 5 tests. PTB 33 was promising in 4 tests and RP2068-18-3-5 in 2 tests.

White- backed planthopper:

NSN1: None of the test entries were promising for WBPH.

NSN2 : None of the entries were tolerant to WBPH.

NSN hills: All the entries were susceptible.

NHSN: All the entries were susceptible, while MO1 was promising in both tests with a DS of ≤ 3.0 .

Planthoppers:

NSN1: Field tolerance for mixed populations of planthoppers was exhibited by IET Nos 26843, 26956, 26721, 27281, 28017, 28018, 28014, 28015, HRI 174 (HC), Swarna (NC) Sarala (RP), 26751(R) in 2 tests with a $DS \leq 3.0$. The ratio of BPH to WBPH was 9:1 at Maruteru, 1: 1.8 at Gangavathi.

NSN2 : Field tolerance to mixed population of planthoppers was identified in 66 entries at both Gangavathi and Maruteru with a DS of 3.0.

NSN hills: IET Nos 26575, 26564, 27499, Shalimar rice (ZC), Swarnadhan, PTB33 and RP 2068-18-3-5 had a $DS \leq 3.0$.

NHSN: IET Nos 27350, 27374, 27379, 27392 and the regional check varieties IHRT-ME-3215, IHRT-M-3306 and IHRT-M- were promising against planthoppers (DS of 1.0) in the field evaluation at Maruteru.

Gall midge:

NSN1: IET Nos 27284 and Karma Mahsuri (RP), recorded nil damage against gall midge in 2-3 tests of the 6 tests. Kavya and Aganni were promising in 3 and 5 tests, respectively.

NSN2: 13 test entries were promising in 2 of the 4 valid tests along with RP 2068 and W1263.

NSN hills: Twelve test entries along with NC (Vivekdhan 62), 3 yield checks (CH 45, Benibhog and Ajaya) recorded nil damage against GMB1.

NHSN: None of the test entries were promising except the resistant checks Aganni and RP2068-18-3-5.

Stem borer (SB):

NSN1: IET Nos 25219, 25856, 26692 and Pooja(RP) recorded nil white ear in 2 of the 4 tests at reproductive phase at Masodha and Raipur.

NSN2: IET Nos 27570 and 27975 were promising at vegetative phase for dead heart damage in 2 of the 6 tests. IET Nos. 27570, 27610, 27622, 27640, 27645, 27652, 27842, 27682, IR-52 were promising in 2 of the 10 tests for stem borer damage.

NSN hills: IET 25832 and Abhaya (YC) had 5% WE damage despite high dead heart damage at Pantnagar. This needs to be verified under infested conditions at appropriate stage.

NHSN: IET 27379 had <10% DH damage at PTB and PNT. IET 27398 was promising in 2 of the 6 tests.

However, these lines need to be further tested under greenhouse conditions for validation of the reactions and to check that they are not escapes.

Leaf folder:

NSN1: IET No26477 was the only entry with nil damage in 1 test of the 3 valid tests.

NSN2: IET Nos. 27597 and 27537 had nil damage in 3 of the 6 tests.

NSN hills: All the entries were susceptible at Ludhiana and Chatha though RP2068-18-3-5 and W1263 had <11% DL.

NHSN: None of the entries were promising.

Whorl maggot:

NSN2: None of the entries were promising.

NSN hills: IET 27480 and Tetep had <10% damage at Malan.

NHSN: None of the entries were promising.

Rice hispa :

NSN1: High natural incidence of hispa was recorded at Raipur. The average damage by grubs was 39%DL. IET Nos 27296, 28016 and Improved Samba.. Mahsuri recorded <5% DL at 22 DT.

NSN 2: None of the entries were promising for rice hispa at Malan

NSN Hills: At Malan, efforts were made to evaluate the hill entries for hispa damage. Only PTB 33 at Malan had <10 % DL. In the second round of screening, Surakhsha, PB1 and RP 2068 were not preferred for egg laying despite heavy feeding by the adult on the leaves.

Gundhi bug

NSN hills: IET 26585 had 7% damage grains at Chatha.

Overall reaction

NSN1: Evaluation of 408 entries at 18 locations in 6 greenhouse and 18 field tests against 7 insect pests identified 2 entries viz., IET nos 27275 and 27284 as

promising in 4 tests of the 30 valid tests against 2 pests. Aganni, MO1 and PTB 33 were promising in 4-6 tests of the 24 valid tests. **(Table 2.7).**

NSN2: Evaluation of 692 entries in 8 greenhouse and 23 field tests against 7 pests in 31 valid tests identified ten entries along with PTB-33 and RP 2068-18-3-5 as promising in 5-7 tests of the 31 valid tests against 3-4 pests **(Table 2.8).**

NHSN: Evaluation of 104 hybrids along with checks in 7 greenhouse and 14 field tests against 6 insect pests identified IET Nos 27379, 27392 as promising in 3 tests of the 21 valid tests. Aganni, PTB33 and RP 2068-18-3-5 were promising in 3-4 tests **(Table 2.9).**

NSN(H): Evaluation of 111 entries against 9 insect pests at 8 locations in 7 greenhouse and 9 field reactions identified IET 27480 as promising in 3 of the 16 tests against BPH, GM and WM while PTB33 and RP 2068-18-3-5 were promising in 6 tests of the total 16 tests.

It is pertinent to note that since the breeding lines in these nurseries were not specifically bred for insect resistance, the number of promising tests is very low in all the identified promising entries in the nurseries. These entries hence need to be further tested, verified and validated under suitable pest pressure situations for further use in pest resistance breeding programmes.

Table 2.7 Performance of the most promising cultures against insect pests in NSN1, Kharif 2018

Br. No.	IET No.	Desig- nation	Cross combination	Number of promising tests (NPT)									Overall NPT
				BPH	WBPH	BPH+ WBPH @	GM	SBDH	SBWE	LF	WM	CW	
				3	2	2	6	2	4	3	1	1	
5002	27275	IBTR2	MTU 1010*2 /GPP2// MTU1010*2 /NLR 145	2	0	0	2	0	0	0	0	0	4
5038	27284	R 2454-MAS -1-R1-10	karma Mahsuri/IRBB 59	0	0	0	3	0	1	0	0	0	4
R. Checks													
Aganni				0	0	1	5	0	0	0	0	0	6
MO-1				0	2	1	1	0	0	0	0	0	4
PTB-33				3	0	1	0	0	0	0	0	0	4

@ - Mixed Population of Planthoppers

Data from JDP, WGL, PNT for BPH; PNT for WBPH; WGL for PH; MNC for GM; WGL,MNC,RGL,RPR,LDN,CHIP,MSD, PUS,JDP,GVT for SBDH; CHIP,GVT,RGL, PNT,PUS for SBWE; WGL GVT, MSD, NWG, JDP, PUS & MNC for LF; RPR and JDP for GLH; JDP for WM; RH for RPR not considered for analysis due to low pest pressure.

Valid NSN1 data from locations considered for analysis

Pest	Locations					
BPH	IIRR	LDN	CBT	GVT		
WBPH	IIRR	CBT				
PH	MTU					
Gall midge	IIRR GR	JDP	CHIP	RGL	WGL	SKL
SBDH	PNT	TTB				
SBWE	TTB	MSD	NWG	RPR		
LF	WGL	LDN	NWG			
RH	RPR					
CW	TTB					

Table 2.8 Performance of most promising cultures against insect pests in NSN2, Kharif 2018

Entry No.	Br. No.	IET No.	No. of promising tests (NPT)										OVERALL NPT
			BPH+										
			BPH	WBPH	WBPH@	GM	SBDH	SBWE	LF	WM	RH		
			5	2	2	4	6	4	6	1	1	31	
36	401	27537	2	0	1	0	0	1	3	0	0	7	
17	617	27583	1	0	2	2	0	0	1	0	0	6	
5	605	27574	0	0	2	1	0	0	2	0	0	5	
4	604	27573	0	0	2	1	0	0	2	0	0	5	
8	608	27577	1	0	2	0	0	1	1	0	0	5	
35	635	27598	0	0	2	2	0	0	1	0	0	5	
47	412	27547	2	0	1	0	0	1	1	0	0	5	
79	1913	27800	0	0	1	2	0	0	2	0	0	5	
89	3907	27990	2	0	1	1	0	0	1	0	0	5	
351	2320	27842	0	0	2	1	1	1	0	0	0	5	
R. Checks													
687	PTB-33		3	0	2	0	0	0	0	0	0	5	
689	RP 2068-18-3-5		2	0	1	2	0	0	0	0	0	5	

@- Mixed Population of planthoppers

Data from JDP, PNT, ADT for BPH; PNT for WBPH; MNC for GM; CHP, MNC, JDP, NVS for SBDH; CHP, MNC, CHN, GVT for SBWE; MNC, NVS, JDP for LF; JDP, ADT for GLH; CHN, JDP for VM not

Valid NSN 2 data considered for analysis

Pest	locations					
BPH	IIRR	CBT	LDN	PNT	MND	
WBPH	IIRR	CBT				
PH	GVT	MTU				
GMB	IIRR	CHP	ADT	JDP		
SBDH	CHN	ADT	CHP	GGT	PNT	TTB
SBWE	ADT	TTB	GGT	PNT		
LF	TTB	JDP	GVT	ADT	PNT	GGT
VM	MLN					
RH	MLN					

Table 2.9 Performance of the most promising hybrids against insect pests in NHSN, Kharif 2018.

Entry No.	IHRT No.	IET No.	Name	Number of promising tests(NPT)								Overall NPT
				BPH	WBPH	BPH+ WBPH@*	GM	SBDH	SBWE	LF	RH	
				5	2	1	2	2	6	2	1	
38	IHRT-M-3304	27379	NS-6701	0	0	1	0	2	0	0	0	3
55	IHRT-M-3321	27392	MTUHR-2102	0	0	1	1	0	1	0	0	3
R. Checks												
96	Aganni			1	0	0	2	0	0	0	0	3
99	PTB-33			4	0	0	0	0	0	0	0	4
101	RP 2068-18-3-5			2	0	0	2	0	0	0	0	4

@-Mixed population of Planthoppers

Data from PNT for BPH & WBPH; MNC for GM, CHN, GGT, LDN, RNR, MNC, PNT, RPR, PTB for SBDH; CHN: CHN for SBWE, PTB and CHN for VM, PTB for CW & BB; PTB, GTG, MNC, RNR, RPR & NWG for LF; not considered for analysis due to low pest pressure.

Valid NHSN data considered for analysis

Pest	Locations					
WBPH	IIRR	CBT				
PH	MTU					
GM	IIRR	PTB				
SBDH	PTB	PNT				
SBWE	PTB	CHN	GGT	NWG	PNT	RNR
LF	LDN	NWG				
RH	RPR					

2.2 INSECT BIOTYPE STUDIES

Variation in the response of host plant/gene differentials to different pest populations in endemic areas are monitored for two major pests viz., planthoppers and gall midge through Insect biotype studies comprising of three trials 1) Gall midge biotype monitoring trial (GMBT), 2) Gall midge population monitoring (GMPM) trial and 3) Planthopper Special screening trial (PHSS). The results of the observed virulence pattern of gall midge populations during *kharif* 2018 are discussed below:

a) Gall midge biotype monitoring trial (GMBT)

Gall midge biotype trial was constituted with a set of gene differentials categorized into 5 groups and carried out at 14 locations. The results of the evaluation are summarized in **Table 2.10** and discussed as under.

Biotype 1: This biotype is characterized by the reaction pattern R-R-R-R-S. The populations at IIRR and Jagdalpur followed this pattern of expression while RP 2333-156-8 showed susceptibility at IIRR. But at Chiplima and Jagdalpur most of the differentials were showing susceptibility except for W1263, INRC 3021 and Aganni.

Biotype 3: The reaction of the gall midge populations at Ranchi conformed to the typical pattern of R-S-R-R-S for biotype 3 except for susceptibility of RP 2068-18-3-5, Phalguna, ARC 5984. At Jagtial, only differentials with *Gm8* gene were promising.

Biotype 4: Gall midge populations from Ragolu and Sakoli were designated as biotype 4 from earlier studies. But this year only Aganni and INRC 3021 (both with *Gm8*) showed promise. MR1523 at Ragolu and W1263 at Sakoli recorded nil damage. The trial was taken up in the farmers' field at Sakoli to check the virulence pattern, but there was no pest incidence.

Biotype 4M: Aganni (with *Gm8*) exhibited nil damage and INRC 3021(with *Gm8*) showed <10% plant damage when evaluated at Warangal but both of them exhibited nil damage in the farmer's field

Biotype 5: At Pattambi, low level of susceptibility (<10% DP) was observed in RP 2333-156-8, MADHURI L 9, Aganni, INRC 3021 and RP 2068-18-3-5.

Other populations: All the differentials exhibited susceptibility to gall midge populations though with varying intensity at Maruteru.

Overall reaction: *Evaluation of the gene differentials in one greenhouse and 9 field tests against 5 different biotypes and one population of gall midge identified Aganni (*Gm8*), INRC 3021(*Gm8*) and W1263 (*Gm1*) as promising in 5-8 of the 10 tests. The results suggest that *Gm8* and *Gm1* hold promise across locations. Exploratory studies suggest that these donors still hold promise in farmers' fields though low level of susceptibility is observed in research stations.*

Table 2.10 Reaction of gene differentials to gall midge populations in GMBT, *kharif* 2018

Group	Entry No.	Differential	Gene	GMB1			GMB3		GMB4		GMB4M	GMB5	GMB?	Overall NPT (10)
				IIRR	JDP	CHP	JGT	RNC	RGL	SKL	WGL	PTB	MTU	
				GH	50DT	50DT	50DT	50DT	50DT	50DT	50DT	30/50DT	30DT	
				%DP	%DP	%DP	%DP	%DP	%DP	%DP	%DP	%DP	%DP	
I	1	KAVYA	<i>Gm1</i>	0.0	0.0	30.0	60.0	0.0	95.0	15.0	90.0	14.3	5	3
	2	W1263	<i>Gm1</i>	0.0	0.0	0.0	50.0	0.0	90.0	0.0	95.0	19	5	5
	3	ARC 6605	(?)	0.0	40.0	90.0	100.0	0.0	100.0	100.0	42.1	47.6	25	2
	4	PHALGUNA	<i>Gm2</i>	0.0	20.0	100.0	100.0	25.0	95.0	95.0	60.0	57.1	38.9	1
	5	ARC 5984	<i>Gm5</i>	0.0	20.0	70.0	100.0	45.0	95.0	65.0	70.0	23.8	40	1
II	6	DUKONG 1	<i>Gm6</i>	10.0	80.0	60.0	100.0	0.0	95.0	75.0	90.0	28.6	25	1
	7	RP 2333-156-8	<i>Gm7</i>	22.2	50.0	70.0	70.0	35.0	80.0	65.0	80.0	9.5	20	0
	8	MADHURI L 9	<i>Gm9</i>	0.0	0.0	40.0	95.0	0.0	100.0	35.0	100.0	4.8	15	3
	9	BG 380-2	<i>Gm10</i>	0.0	90.0	90.0	100.0	0.0	100.0	100.0	90.0	52.4	40	2
III	10	MR 1523	<i>Gm11</i>	0.0	20.0	80.0	65.0	0.0	0.0	75.0	70.0	33.3	6.3	3
	11	RP 2068-18-3-5	<i>gm3</i>	0.0	10.0	50.0	35.0	48.0	70.0	45.0	70.0	9.5	5.3	1
IV	12	ABHAYA	<i>Gm4</i>	0.0	30.0	90.0	50.0	0.0	45.0	80.0	45.0	38.1	15.8	2
	13	INRC 3021	<i>Gm8</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	4.8	25	7
	14	AGANNI	<i>Gm8</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	15	8
	15	INRC 15888	<i>Gm8</i>	0.0	10.0	40.0	65.0	25.0	45.0	20.0	90.0	14.3	15	1
V	16	B 95-1	<i>none</i>	10.0	100.0	100.0	100.0	45.0	90.0	100.0	90.0	42.9	25	0
	17	TN1	<i>none</i>	100.0	100.0	100.0	100.0	55.0	90.0	95.0	100.0	28.6	15	0
Total Tested				17	17	17	17	17	17	17	17	17	17	
Average. In the trial				8.8	33.5	59.4	70	16.4	70	56.8	70.1	25.5	19.8	
Damage in TN1				100	100	100	100	55	90	95	100	28.6	15	
Promising level				0	0	0	0	0	0	0	0	0	0	
No. promising				13	5	3	2	10	3	3	1	0	0	

Pest incidence was low at Nellore, Moncompu, Mandya & Raipur (Kanker). Data not received from Cuttack

b) Gall midge population monitoring (GMPM)

The virulence pattern of the gall midge populations is monitored through progeny testing of a single gall midge female in GMPM trial. This year the trial was conducted on three differentials, W1263 (*Gm1*), RP2068-18-3-5 (*gm3*), Aganni (*Gm8*) along with Purple variety at Warangal, Pattambi and Ragolu. The differentials were grown in a single pot with 5-10 seedlings each and labeled appropriately. Each pot was infested with a single mated female collected from light source and covered by a plastic bag placed tightly over the pot. The pots were observed for the gall development and emergence of insects from the gall. Number and sex of the emerging adults was also recorded from each pot. Based on these observations, virulence status was assigned to the parent insect. The results of this year's trial are summarized in **Table 2.11** and discussed below.

Pattambi: All the 65 females tested were virulent. Of these, 46.1% were virulent on purple, 15.4 % on W1263, 73.8% on RP 2068-18-3-5 and 52.3% on Aganni. The sex ratio was highly favourable on all the lines. This corroborates with the low damage observed in W1263 (*Gm1*) in the other gall midge trials at this location

Warangal: From the light source 250 females were collected and infested singly of which only 156 females were virulent. Of these, 61.5% were virulent on purple, 54.5% on W1263, 34.6 % on RP 2068-18-3-5 and 1.9 % on Aganni. Sex ratio was favourable in all the differentials though the percent male progeny varied from 33.3 -42.3%.

Ragolu: From the light source 120 females were collected and released singly. The percent virulent females was 58% was on purple variety, and 53 % on W1263, 58% on RP 2068-18-3-5 and nil damage in Aganni. The sex ratio was skewed towards males in all the test genotypes and the percent male progeny was very high (53.2-57.9%)

Evaluation of the gene differentials through single female progeny testing revealed that at Ragolu, Aganni (Gm8) holds promise. The study suggests low virulence on Aganni at Warangal and W 2163 at Pattambi and increase in virulence on RP 2068-18-3-5 at all the three locations which is similar to the trend evident in GMBT trial and is a cause of concern.

Table 2.11 Virulence Pattern of Gall midge population in GMPM, Kharif 2018

Parameters	Locations											
	Pattambi				Warangal				Ragolu			
	AGANNI	RP 2068-18-3-5	W1263	PURPLE	AGANNI	RP 2068-18-3-5	W1263	PURPLE	AGANNI	RP 2068-18-3-5	W1263	PURPLE
Pots with Infested plants(%)	34	48	10	30	3	54	85	96	0	19	47	19
% of virulent females	52.3	73.8	15.4	46.2	1.9	34.6	54.5	61.5	0	57.9	53.2	57.9
No of plants damaged	85	139	23	76	85	54	85	96	0	27.1	67.1	27.1
% DP	52.3	73.8	15.4	46.2	1.2	21.6	34	38.4	-	-	-	-
SS(%)	58.8	61.9	47.8	61.8	0.5	6.7	12.6	16.8	0	27.1	67.1	27.1
Sex ratio	1M:1.8F	1M:1.08F	1M:2.67F	1M:2.13F	1M:2F	1M:1.41F	1M:1.36F	1M:1.46F	0	1M:0.72F	1M:0.88 F	1M:0.72F
% male progeny	36	53.5	27.3	31.9	33.3	41.5	42.3	40.5	0	57.9	53.2	57.9

Planthopper Special Screening Trial (PHSS)

A set of 16 primary sources of BPH resistance with some sources having known resistance gene(s) was evaluated at eleven locations viz., IIRR, Aduthurai, Coimbatore, Gangavathi, Ludhiana, Mandya, Maruteru, New Delhi, Pantnagar, Rajendranagar and Warangal in the greenhouse in standard seedbox screening test (SSST) with 2-4 replications. The special screening tests viz., days to wilt to know the tolerance mechanism was conducted at Coimbatore and Pantnagar. Feeding preference test by measuring honeydew excretion was carried out at Coimbatore, Maruteru and Pantnagar, while nymphal survival and egg hatching tests were done at Pantnagar.

Two gene differentials viz., PTB 33 with bph2+Bph3+unknown factors and RP 2068-18-3-5 with Bph 33(t) gene were promising in 8 and 9 locations respectively out of 10 locations. Rathu Heenati with Bph3+Bph17 genes and T 12 with bph7 gene performed better in 5 locations each with a damage score of <5. T12 performed better at Aduthurai, Ludhiana, New Delhi, Rajendranagar and Warangal whereas Rathu Heenati was promising at Aduthurai, Coimbatore, Gangavathi, Ludhiana, and Rajendranagar. The gene differential Babawee with bph 4 gene performed better in 3 locations viz., Gangavathi, Rajendranagar and Warangal. Two of the gene differentials registered promising reaction at two locations viz., Chinsaba with bph 8 gene at Coimbatore and Gangavathi; Swarnalatha with Bph 6 gene at IIRR and Gangavathi. Four other gene differentials showed low damage at one location only viz., IR 64 with Bph1+ gene at IIRR, IR 65482-7-216-1-2-B with Bph 18 gene, MUT NS 1 with unknown genetics and Pokkali with bph9 gene at Gangavathi. Five gene differentials viz., ASD 7 with bph2 gene, IR 36 with bph2 gene, IR71033-121-15 with Bph 20/21 gene, Milyang 63 and OM 4498 with unknown genetics, were not effective at any of the test locations (**Table 2.12**).

In Pantnagar, lowest nymphal survival was observed in IR 71033-121-15 and RP 2068-18-3-5 followed by PTB 33 and highest nymphal survival was observed in IR 65482-7-216-1-2-B followed by Chinsaba (ACC 33016). PTB 33 and RP 2068-18-3-5 did not wilt and TN 1 wilted in 9 days. Lowest honeydew excretion was there in PTB 33 followed by RP 2068-18-3-5 and Rathu Heenati and highest honeydew excretion was there in TN1. Unhatched eggs were less in MUT NS 1 followed by TN1 and more in Rathu Heenati followed by T 12 (**Table 2.12a**).

Table 2.12 Reaction of most promising gene differentials against BPH in PHSS, *kharif* 2018

PHSS No.	Designation	Gene	Damage Score (DS)									NPT (9)
			IIRR	ADT	CBT	GVT	LDN	NDL	PNT	RNR	WGL	
2	Babawee (ACC 8978)	<i>bph4</i>	5.6	8.9	6.3	3.0	6.0	6.5	6.3	4.3	3.0	3
3	Chinsaba (ACC 33016)	<i>bph8</i>	5.8	9.2	4.5	1.0	7.1	8.1	7.5	8.9	8.9	2
14	Ptb33	<i>bph2+Bph3+?</i>	1.4	N.G	2.9	3.0	1.3	2.8	1.2	3.1	0.9	8
16	Rathu Heenati (ACC 11730)	<i>Bph3+Bph17</i>	5.4	4.9	3.0	3.0	3.3	6.9	8.6	3.1	8.9	5
17	RP 2068-18-3-5	?	0.8	0.4	3.6	3.0	1.5	3.4	1.3	3.2	0.5	9
18	Swarnalatha (ACC 33964)	<i>Bph6</i>	3.7	5.9	5.5	3.0	5.2	7.3	6.5	8.8	8.9	2
19	T 12 (ACC 56989)	<i>bph7</i>	5.9	3.6	7.0	7.0	1.6	2.8	7.3	4.8	1.0	5
Promising level			5	5	5	3	5	5	5	5	5	
No. promising			3	3	4	9	4	3	2	5	4	

The data from Mandya and Maruteru was not considered.

Table 2.12a Special Screening techniques to know mechanisms of resistance at Pantnagar

PHSS No.	Designation	Nymphal survival (%)	Days to wilting	Honeydew (mm ²)	unhatched eggs (%)
1	ASD 7 (ACC 6303)	72	9.8	809.6	38.41
2	Babawee (ACC 8978)	59	22.4	223.6	27.008
3	Chinsaba (ACC 33016)	87	11.4	1097	40.6
4	IR 36	73	20.4	754.2	32.53
5	TN1	79	17	999.4	21.954
6	IR 64	75	18.6	465.6	36.49
7	IR 65482-7-216-1-2-B	91	17.6	458	46.464
8	IR71033-121-15	45	9.2	519.4	29.464
9	Milyang 63	70	13	1015.2	43.182
10	TN1	47	10	998.6	23.426
11	MUT NS 1	64	9.6	1055.8	18.446
12	OM 4498	75	11	765.6	39.3
13	Pokkali	62	13	594.8	37.3
14	Ptb33	52	not wilted	41	32.84
15	TN1	79	10.4	342.2	25.504
16	Rathu Heenati (ACC 11730)	79	17	127.8	49.494
17	RP 2068-18-3-5	45	not wilted	63.2	44.928
18	Swarnalatha (ACC 33964)	68	13.6	463.4	37.838
19	T 12 (ACC 56989)	59	11.4	307.4	48.48
20	TN1	52	8.8	1247.2	42.18

Chemical Control Studies

Farmers can save time, labour and money if they can apply chemicals in combination to tackle multiple pests and diseases. However, it is essential for the farmer to know about the compatibility of chemicals so that there is no adverse effect of the pesticide mixtures in terms of their efficacy in reducing pest incidence in field. So, there is a need to generate requisite information on the pesticide compatibility in situations when the pesticides are applied as tank mix in field. Similarly, keeping in view the safety to human health and environment, eco-friendly products of plant origin should be assessed as safe alternatives to chemical pesticides for use by the farmers. Hence, chemical control studies included two trials as described under:

Pesticide Compatibility Trial (PCT)

The trial on compatibility of two newer insecticides belonging to different groups *viz.*, spinetoram 6% w/v (5.66% w/w) + methoxyfenozide 30% w/v (28.3% w/w) SC supplied by Dow Agrosiences Ltd and triflumezopyrim (DPX RAB 55 106 SC), a product of Dupont India Ltd.. with fungicides was continued during *Kharif* 2018. Assessment was done based on their efficacy when applied as tank-mix in the field. The fungicides consisted of hexaconazole and tricyclazole supplied by Rallies India Ltd. The trial was carried out at 27 locations *viz.*, Arundhutinagar, Bapatla, Chinsurah, Coimbatore, Chiplima, Cuttack, Gangavathi, Karaikal, Karjat, Ludhiana, Malan, Mandya, Maruteru, Masodha, New Delhi, Navsari, Nawagam, Pantnagar, Pusa, Pattambi, Ragolu, Raipur, Rajendranagar, Ranchi, Sakoli Titabar and Warangal.

Sl. No.	Location	Date of sowing	Date of planting	Date of harvesting	No of applications	Times of application (DAT)
1	Arundhutinagar	18-06-2018	10-07-2018	03-10-2018	2	33 & 50
2	Bapatla	08-06-2018	09-06-2018	01-04-2019	1	90
3	Chinsurah	18-06-2018	23-07-2018		1	15
4	Coimbatore	29-06-2018	20-07-2018	03-11-2018	3	13,38 & 52
5	Cuttack	30-06-2018	04-08-2018	30-11-2018	2	15 & 45
6	Chiplima	09-17-18	08-08-2018	22-11-2018	3	25,50 & 65
7	Gangavathi	10-07-2018	14-08-2018	12-12-2018	4	19,40,59 & 89
8	Karjat	14-06-2018	DSR	23-10-2018	2	36 & 56
9	Karaikal	11-08-2018	15-09-2018	11-12-2018	1	30
10	Ludhiana	21-05-2018	26-06-2018	31-10-2018	3	40,62 & 86
11	Malan	16-06-2018	12-07-2018	05-11-2018	2	21 & 46
12	Mandya	10-07-2018	04-08-2018	17-12-2018	3	25,45 & 70
13	Masodha	06-07-2018	02-08-018	30-11-2018	2	34 & 82
14	Maruteru	27-06-2018	01-08-2018	24-11-2018	2	25 & 48

15	Navsari	03-07-2018	31-08-2018	28-11-2018	2	25 & 31
16	Nawagam	16-07-2018	18-08-2018	12-11-2018	2	45 & 63
17	New Delhi	20-06-2018	19-07-2018	20-11-2018	4	15,52,75 & 90
18	Pantragar	20-06-2018	18-07-2018	10-11-2018	4	15,30,50 & 65
19	Pattambi	04-08-2018	28-08-2018	09-03-2018	3	15,45 & 60
20	Pusa	26-06-2018	21-07-2018	16-11-2018	2	21 & 42
21	Raipur	07-07-2018	04-08-2018	04-12-2018	3	30,55 & 90
22	Ragolu	13-07-2018	13-08-2018	01-12-2018	4	30,40,70 & 80
23	Rajendranagar	18-07-2018	17-08-2018	19-12-2018	2	32 & 53
24	Ranchi	16-07-2018	08-08-2018	21-11-2018	5	15,30,45,60 & 90
25	Sakoli	27-06-2018	24-07-2018	20-11-2018	3	17,35 & 58
26	Warangal	15-06-2018	11-07-2018	24-11-2018	2	35 & 59
27	Titabar	09-07-2018	09-08-2018	28-11-2018	3	15,30 & 45

Treatments

The trial consisted of nine treatments consisting of the spinetoram 6% w/v (5.66% w/w) + methoxyfenozide 30% w/v (28.3% w/w) SC @ 0.75 ml/litre, triflumezopyrim @ 0.48 ml/litre, hexaconazole @ 2.0 ml/litre and tricyclazole @ 0.6 ml/litre applied alone as individual treatments and also in four possible combination treatments. Untreated control without any insecticide or fungicide application was also included for comparison. The nine treatments with three replications were laid out in Randomized Complete Block Design (RCBD).

Observations were recorded on ten randomly selected hills to assess stem borer damage at vegetative and heading stages and expressed as per cent dead hearts or white ears. Similarly, counts of leaf folder damaged leaves were taken on 10 randomly selected hills per plot and the percentage damaged leaves were calculated. Planthopper populations were counted on ten randomly selected hills per plot before and after application of treatments. For assessing the severity of blast, sheath blight and other diseases, percentage disease severity was assessed as the proportion of the leaf area damaged by the disease in relation to the total leaf area of all the plants in a plot before and after application. Towards maturity, the crop was harvested and grain yield/ net plot leaving two border rows on all sides was recorded and expressed as kg/ha.

Results

Insect pest infestation (Table 2.13)

The **stem borer** infestation at vegetative stage across 19 locations was recorded up to a maximum of 40.1% DH, while mean infestation ranged from 5.2 to 11.7% DH across treatments including control. The infestation in insecticides alone and combination treatments (5.2 to 7.2% DH) was lower than that in fungicide alone treatments (7.7 and 7.9% DH %) and control (11.7% DH). The differences in efficacy between the insecticides and

their combinations with fungicides were not significant. At heading stage, the white ear incidence ranged from 00.3 to 37.4% in treatments including control, across locations. The white ear incidence was significantly lower in spinetoram+methoxyfenozide treatment and its combinations (6.6 to 6.7% WE), compared to triflumezopyrim treatment alone and in combination (8.6 to 9.9% WE) and fungicide treatments (11.5 to 11.7% WE). All the treatments were significantly superior to control (16.1% WE). Overall, against stem borer, the performance of spinetoram+methoxyfenozide was superior to that of triflumezopyrim, when applied alone or in combination with fungicides.

The gall midge incidence was recorded up to 38.1% SS across 7 locations. All the insecticide treatments were at par (6.9 to 8.8% SS) and showed less gall midge incidence than fungicide treatments (8.4 to 9.6% SS) and control (13.6 % SS).

Brown planthopper populations were recorded at 12 locations and very high infestation was recorded up to 2719.7 hoppers/10 hills at New Delhi. Across other locations, the maximum population recorded was 116.7 hoppers/10 hills, at Maruteru. The mean infestation across locations ranged from 17.8 to 153.1 hoppers per 10 hills. The hopper population was significantly lower in triflumezopyrim treatment alone and in combination with fungicides (17.8 to 18.9 hoppers/10 hills). The spinetoram+methoxyfenozide treatments (141.9 to 153.1 hoppers/10 hills), were on par with fungicides alone and control treatments (126.5 to 142.0 hoppers/10 hills). The **white backed planthopper** population was recorded in 8 locations and maximum incidence up to 77.0 hoppers/10 hills was observed at New Delhi, Gangavathi and Nawagam. As observed in the case of BPH, application of triflumezopyrim individually as well as in combination with fungicides showed lower mean WBPH population (16.6 to 19.7 hoppers/10 hills) than spinetoram+methoxyfenozide (20.3 to 25.1 hoppers/10 hills), fungicides applied alone (23.4 and 23.7 hoppers/10 hills) and untreated control (29.9 hoppers/10 hills). However, differences were less discernible.

Leaf folder incidence across 12 localtions was recorded upto a maximum of 72.0% DL at Ranchi, while in the remaining locations, the damage ranged between 0.4 and 22.0% DL. The mean infestation across locations varied from 7.9 to 9.2% DL in insecticide treatments, 10.9 in fungicides alone and 13.8% DL in control. Spinetoram+methoxyfenozide treatment performance both alone and in combination with fungicides was superior to that of remaining treatments.

Disease incidence (Table 2.14)

Sheath blight incidence was observed at 5 locations. At Maruteru, disease severity was observed up to 53.7% while at four locations *viz.*, Gangavathi, Masodha, Mandya and Raipur, it was recorded up to a maximum of 45.3%. At all these locations there were significant differences among the treatments including control after application of treatments. Across locations, the hexaconazole treatments in combination with triflumezopyrim or spinetoram+methoxyfenozide and hexaconazole treatment applied alone were at par and superior treatments showing least disease severity of 20.2 to 20.4%. The tricyclazole and insecticide treatments showed a range of 29.7 to 30.8% disease severity on par with control (29.9%).

Blast disease was recorded at three locations. At Gangavathi and Ranchi, leaf blast disease severity was recorded up to 34.9% and 24.0%, respectively and there were significant differences among treatments including control after the application of pesticide treatments. The blast severity was significantly lower in the fungicide applications applied alone as well as in combination with insecticides (10.7 to 18.8%) compared to insecticide treatments alone (20.5 and 23.8%) and control (26.6%). Among the two fungicides, tricyclazole performed significantly superior (10.7 to 11.7%) to hexaconazole (18.1 to 18.9%) both when applied alone and in combination with insecticides, in reducing blast incidence. Neck blast was observed at Rajendranagar. Tricyclazole applied alone was the most superior treatment showing least incidence of 13.3 % followed by hexaconazole applied alone (18.2%). However, higher disease incidence was recorded in insecticide combination treatments with both fungicides (23.7 to 32.0%). All treatments were superior to control (47.4%) in reducing neck blast incidence.

Brown spot incidence was observed at Ranchi ranging from 24.0 to 31.0% before application of treatments. Post application data showed significant reduction in hexaconazole treatments (5.3 to 10.0%) followed by tricyclazole treatments (6.0 to 14.3%) while insecticides applied alone and control treatments showed an increase in disease incidence range (31.3 to 35.3%).

Grain yield (Table 2.15)

There were significant differences in grain yield among different treatments at 27 locations. The mean grain yield data across the locations revealed that the insecticide – fungicide combination treatments were at par with grain yield ranging narrowly from 4559 to 4776 kg/ha (20.5 to 24.1% IOC). However, Triflumezopyrim applied alone treatment was also at par yielding 4625 kg/ha (21.5% IOC). They were significantly superior to fungicide treatments applied alone (4298 and 4315 kg/ha with 15.7 and 16.0% IOC, respectively). All pesticide treatments used alone or in combination yielded significantly higher than control (3625 kg/ha).

Pesticide compatibility trial was carried out with the objective of evaluating the compatibility of newer insecticide and fungicide formulations as tank mix against major insect pests and diseases of rice and consequent impact on

grain yield, at 27 centres during kharif 2018. There were no significant differences in their proven efficacy of the two newer insecticide formulations spinetoram+methoxy-fenozide and triflumezopyrim when applied alone or in combination with fungicides. spinetoram+methoxyfenozide performed better against stem borer and leaf folder, while triflumezopyrim showed superiority against plant and leafhoppers. Insecticide treatments applied in combination with fungicides were on par with triflumezopyrim applied alone and superior to remaining treatments including control in terms of yield. Overall, the results revealed that there was no adverse impact on the efficacy of either of the insecticides when applied with fungicides or vice versa confirming the compatibility of the chemicals when used as tank mix in the field.

Table:2.13 Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	Stem Borer Damage (% Dead hearts)										
					AND		CBT	CHN		CHP		CTC		KJT	
					30DAT	50DAT	48DAT	30DAT	50DAT	56DAT	76DAT	30DAT	60DAT	30DAT	50DAT
1	Spinetoram 6%+methoxy-fenozide 30%	Spinetoram 6% + methoxy-fenozide 30%	36	0.75	6.5c	5.3b	2.7a	2.4a	7.8a	1.2a	0.5a	4.0a	3.3a	7.9a	0.8a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	4.2b	4.8b	5.7b	2.7a	15.2c	2.5a	2.0b	3.5a	3.6a	8.7a	0.7a
3	Contaf Plus	Hexaconazole	5	2.0	4.3b	5.7b	10.7c	11.2c	16.1c	2.5a	2.6b	8.1b	6.4b	8.3a	1.7a
4	Mantis 75 WP	Tricyclazole	75	0.6	6.7c	7.3c	10.6c	4.9b	15.8c	2.9a	3.0b	8.4b	7.3b	10.0a	2.2a
5	Spinetoram 6% + methoxy-fenozide 30%+Contaf	Spinetoram 6% + methoxy-fenozide 30%+ Hexaconazole	-	0.75+2.0	4.3b	3.2a	3.1a	1.6a	10.4b	0.9a	0.5a	4.9a	3.7a	10.1a	1.2a
6	Spinetoram 6% + methoxyfenozide 30%+ Mantis	Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	2.1a	2.0a	2.5a	6.0b	11.3b	1.1a	0.7a	5.2a	4.0a	9.0a	0.8a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	7.0c	4.9b	4.4a	4.3b	17.1c	2.6a	2.5b	4.5a	3.8a	7.9a	1.5a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	6.4c	6.8c	4.8a	9.8c	13.5b	2.4a	3.0b	3.4a	3.2a	7.7a	1.9a
9	Untreated control	Water		Water spray	11.1d	17.7d	11.2c	13.5c	24.5d	5.5b	7.2c	10.4b	8.4b	10.5a	5.2b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd..) Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	Stem Borer Damage (% Dead hearts)												
					LDN								MND		MSD		
					41DAT	46DAT	51DAT	63DAT	68DAT	73DAT	88DAT	93DAT	98DAT	30DAT	50DAT	30DAT	50DAT
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	4.4a	1.7a	2.2a	3.2a	1.7a	1.9a	2.4a	1.6a	1.6a	0.6a	0.8a	10.3a	6.5a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	4.4a	3.8b	4.1b	5.2a	3.9b	4.0b	4.9b	3.5b	4.3c	2.3b	2.6b	8.7a	5.8a
3	Contaf Plus	Hexaconazole	5	2.0	4.9a	4.1b	4.4b	5.1a	4.1b	4.3b	4.8b	3.8b	4.6c	3.9b	3.5b	15.5b	21.7b
4	Mantis 75 WP	Tricyclazole	75	0.6	5.2a	4.3b	4.7b	4.4a	4.4b	4.6b	4.3b	4.1b	4.3c	6.0c	6.1c	15.5b	19.3b
5	Spinetoram 6% + methoxy-fenozide 30%+Contaf	Spinetoram 6%+methoxy-fenozide 30%+ Hexaconazole	-	0.75+2.0	5.0a	2.2a	3.0a	3.6a	2.8a	2.7ab	3.3a	1.9a	2.7b	0.2a	0.4a	10.0a	5.6a
6	Spinetoram 6% + methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxy-fenozide 30%+ Tricyclazole	-	0.75+0.6	4.9a	2.4a	3.3a	4.1a	2.5a	3.2b	3.5ab	2.2a	3.0b	0.4a	0.8a	9.2a	6.0a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	4.4a	4.0b	4.4b	5.1a	4.2b	4.3b	4.8b	3.8b	4.3c	1.8a	1.7a	8.8a	4.8a
8	DPX-RAB 55+ Mantis	Triflumezopyrim+ Tricyclazole	-	0.48+0.6	4.7a	4.1b	4.4b	4.9a	4.2b	4.3b	4.8b	4.1b	4.3c	1.0a	1.5a	9.3a	5.8a
9	Untreated control	Water		Water spray	4.9a	7.1c	6.0c	6.4a	5.0b	7.2c	8.1c	8.7c	9.1d	8.7c	9.4d	27.3c	31.1c

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd..)Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	Stem Borer Damage (% Dead hearts)									
					NVS		NWG		PNT		PSA		PTB	
					30DAT	50DAT	30DAT	50DAT	30DAT	50DAT	30DAT	50DAT	30DAT	50DAT
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	3.5a	4.0ab	1.6a	13.5a	15.1a	17.2a	15.2a	15.6b	11.9a	18.4b
2	DPX-RAB 55	Triflumezopyrim	106	0.48	6.8b	3.1a	3.8b	25.5b	15.7a	22.8a	12.7a	13.0b	9.1a	15.6b
3	Contaf Plus	Hexaconazole	5	2.0	9.5c	5.9b	4.1bc	20.2b	15.3a	20.3a	8.7a	8.3a	15.1a	17.0b
4	Mantis 75 WP	Tricyclazole	75	0.6	10.3c	7.1bc	3.2b	20.9b	12.6a	20.9a	8.5a	7.6a	12.2a	11.2a
5	Spinetoram 6%+ methoxyfenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	4.3a	4.6ab	1.7a	15.4a	9.1a	20.7a	16.5a	18.7b	11.7a	15.6b
6	Spinetoram 6%+ methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	5.8a	2.3a	1.6a	15.9a	17.4a	21.5a	13.6a	16.0b	8.9a	16.5b
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	7.4ab	8.2c	3.1b	26.9b	21.3a	26.7b	11.2a	10.6b	8.0a	10.4a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	8.0ab	9.1c	3.2b	28.2b	13.1a	31.8b	10.4a	9.5a	11.7a	17.0b
9	Untreated control	Water		Water spray	14.3d	18.8d	5.8c	32.7b	10.5a	40.1c	7.8a	5.1a	14.2a	18.5b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd..)Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	Stem Borer Damage (% Dead hearts)									Mean
					RNC	RNR	RPR		SKL			TTB		
					50DAT	74DAT	30DAT	50DAT	72DAT	87DAT	95DAT	30DAT	50DAT	
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6%+ methoxy-fenozide 30%	36	0.75	2.3a	0.8a	5.4a	3.3a	4.7a	6.7a	3.3a	1.4a	1.2a	5.2a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	5.7b	2.4b	8.0a	6.4b	4.2a	6.1a	3.5a	1.3a	1.4a	6.5a
3	Contaf Plus	Hexaconazole	5	2.0	12.1c	3.0b	7.3a	6.3b	5.4a	9.5a	4.2a	1.5a	2.0a	7.9a
4	Mantis 75 WP	Tricyclazole	75	0.6	12.2c	2.1b	7.6a	6.0b	5.2a	7.7a	4.6a	1.1a	1.2a	7.7a
5	Spinetoram 6%+ methoxy-fenozide 30%+Contaf	Spinetoram 6%+ methoxy-fenozide 30%+ Hexaconazole	-	0.75+2.0	2.2a	1.1a	6.1a	2.7a	6.6a	5.2a	2.8a	0.6a	0.6a	5.4a
6	Spinetoram 6%+ methoxy-fenozide 30%+ Mantis	Spinetoram 6%+ methoxy-fenozide 30%+ Tricyclazole	-	0.75+0.6	2.3a	0.4a	6.8a	3.8a	5.7a	8.7a	3.0a	0.8a	0.0a	5.7a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	4.5b	2.5b	9.0a	6.5b	5.9a	6.2a	2.6a	0.9a	0.6a	6.7a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	5.5b	5.0c	9.4a	6.7b	7.5a	6.6a	2.6a	1.0a	0.7a	7.2a
9	Untreated control	Water		Water spray	14.1c	6.5c	9.0a	7.2b	8.1a	5.7a	5.3a	5.8b	7.3b	11.7b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd. .)Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	%a.i. formulation	g or ml per litre of spray fluid	Stem borer Damage (%White Ears)									
					AND	CBT	CHN	CHP	CTC	LDN	MND	MSD	MTU	NVS
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6% + methoxyfenozide 30%	36	0.75	4.0b	2.6a	5.8a	0.6a	4.8a	2.0a	2.1a	2.8a	20.4a	9.6a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	3.7b	6.4b	12.9bc	4.3b	5.4a	4.0a	3.9a	2.1a	11.7a	8.6a
3	Contaf Plus	Hexaconazole	5	2.0	8.5c	10.7c	20.6c	4.7b	11.9b	3.9a	6.0b	12.7b	11.7a	10.5b
4	Mantis 75 WP	Tricyclazole	75	0.6	6.8c	9.4c	19.2c	5.4b	11.3b	4.0a	7.5b	13.8b	13.0a	11.6b
5	Spinetoram 6% + methoxyfenozide 30%+Contaf	Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	1.8a	3.4a	11.4b	0.3a	5.8a	2.2a	0.8a	2.7a	12.7a	9.7a
6	Spinetoram 6% + methoxyfenozide 30%+ Mantis	Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	2.1a	2.8a	10.7b	1.3a	6.5a	2.5a	1.4a	3.0a	12.5a	7.3a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	3.7b	5.7b	17.0c	4.6b	6.4a	4.2a	2.5a	1.0a	17.8a	13.0b
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	3.7b	5.8b	14.4c	4.3b	5.1a	4.0a	3.5a	2.0a	12.7a	14.0b
9	Untreated control	Water		Water spray	16.2d	12.4c	19.4c	7.9c	13.9b	10.4b	15.5c	19.5b	20.8a	18.1c

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd. .)Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	%a.i. formulation	g or ml per litre of spray fluid	Stem Borer Damage(%White ears)								Mean
					NWG	PNT	PTB	RNC	RNR	RPR	SKL	WGL	
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6% + methoxyfenozide 30%	36	0.75	18.2a	7.6a	5.2a	4.7a	1.8a	13.1a	5.2b	10.4a	6.7a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	27.3b	12.9b	10.6b	6.5a	3.4b	17.1a	4.5b	9.9a	8.6a
3	Contaf Plus	Hexaconazole	5	2.0	22.9a	15.0b	18.0c	13.3b	3.9b	18.3a	6.9c	11.1a	11.7b
4	Mantis 75 WP	Tricyclazole	75	0.6	21.7a	13.4b	18.2c	13.0b	4.0b	17.3a	6.1c	10.9a	11.5b
5	Spinetoram 6% + methoxyfenozide 30%+Contaf	Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	20.2a	11.2b	6.5a	3.4a	1.5a	12.6a	2.9a	11.1a	6.7a
6	Spinetoram 6% + methoxyfenozide 30%+ Mantis	Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	17.1a	7.4a	8.8ab	5.0a	1.7a	12.0a	4.5b	11.3a	6.5a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	30.2b	13.3b	18.2c	5.8a	4.8bc	14.8a	4.4b	11.5a	9.9ab
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	29.0b	12.5b	13.6b	6.5a	4.1b	14.1a	4.1b	10.3a	9.1ab
9	Untreated control	Water		Water spray	37.4b	20.0c	18.0c	16.4b	6.8c	20.3a	8.7c	7.8a	16.1c

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd...)Insect pest incidence in different treatments, PCT, *Kharif* 2018

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	Gall midge (% Silver Shoots)								
					CBT 48DAT	CHP		PTB		RGL	RNC	SKL	
						56DAT	76DAT	30DAT	50DAT	70DAT	50DAT	80DAT	103DAT
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	3.1a	26.0a	16.2b	8.7c	8.8a	15.1a	3.5a	10.3a	2.4a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	2.5a	22.9a	10.4b	7.8c	5.5a	15.2a	5.2b	10.4a	5.9b
3	Contaf Plus	Hexaconazole	5	2.0	6.1ab	30.2a	17.2c	7.0c	7.6a	15.9a	10.3c	15.6a	4.0b
4	Mantis 75 WP	Tricyclazole	75	0.6	5.5a	29.2a	23.3c	4.8b	3.8a	13.5a	10.0c	12.8a	2.9ab
5	Spinetoram 6%+ methoxyfenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	3.1a	25.1a	8.1a	4.5b	6.6a	13.3a	2.5a	12.5a	1.7a
6	Spinetoram 6%+ methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	4.1a	20.2a	12.2b	5.9b	6.6a	14.6a	3.0a	7.6a	2.5a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	5.1a	24.5a	13.2b	6.9bc	3.0a	18.5a	5.9b	13.5a	5.5b
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	5.2a	21.9a	16.4bc	2.1a	5.3a	19.5a	6.3b	9.9a	3.0ab
9	Untreated control	Water		Water spray	8.9b	38.1b	33.6d	9.2c	11.8a	18.9a	10.9c	16.1a	6.3b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd...)Insect pest incidence in different treatments, PCT, *Kharif* 2018

Sl. No.	Trade Name	Common Name	% a.i. formula- tion	g or ml per litre of spray fluid	Gall midge Damage (% Silver Shoots)					Mean
					WGL					
					62DAT	80DAT	95DAT	104DAT	111DAT	
1	Spinetoram6%+metho-xyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	6.3a	7.8a	4.9a	1.9a	1.4a	8.3a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	4.9a	6.9a	3.6a	1.9a	1.7a	7.5a
3	Contaf Plus	Hexaconazole	5	2.0	6.2a	7.4a	3.3a	1.3a	3.0a	9.6a
4	Mantis 75 WP	Tricyclazole	75	0.6	9.0a	7.5a	5.5a	2.1a	1.7a	9.4a
5	Spinetoram 6%+methoxy-fenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	5.7a	8.9a	3.6a	2.5a	3.7a	7.3a
6	Spinetoram 6%+methoxy-fenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	6.3a	6.8a	3.2a	1.6a	2.3a	6.9a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	5.8a	8.7a	6.1a	2.8a	3.0a	8.8a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	6.5a	10.3a	4.8a	1.9a	3.0a	8.3a
9	Untreated control	Water		Water spray	6.5a	8.5a	7.4a	7.5b	6.6b	13.6b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd..) Insect pest incidence in different treatments, PCT, *Kharif* 2018

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	Brown Planthopper (No./10hills)													
					BPT	GVT					LDN						MND	
					95DAT	BT	AT	BT1	AT1	41DAT	46DAT	63DAT	68DAT	88DAT	93DAT	50DAT-BT	50DAT-AT	
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	4.3a	9.1a	14.4a	16.5a	17.2a	8.7a	7.3b	14.0b	11.3b	34.0b	20.0b	11.3a	5.0b	
2	DPX-RAB 55	Triflumezopyrim	106	0.48	5.0a	13.7a	15.4a	13.3a	16.1a	8.7a	3.3a	9.7a	4.0a	18.0a	8.0a	14.3a	1.3a	
3	Contaf Plus	Hexaconazole	5	2.0	7.3a	11.6a	17.5a	16.5a	16.5a	9.7a	7.7b	15.7b	12.3b	34.7b	22.4b	11.7a	13.0c	
4	Mantis 75 WP	Tricyclazole	75	0.6	6.0a	14.4a	13.7a	13.7a	15.4a	9.0a	8.3b	15.3b	11.7b	36.0b	24.5b	12.7a	14.0c	
5	Spinetoram 6%+ methoxy-fenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	4.3a	15.1a	16.5a	14.0a	13.0a	9.3a	8.3b	14.7b	11.0b	35.3b	21.9b	15.0a	3.7b	
6	Spinetoram 6%+ methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	5.7a	15.8a	15.4a	18.2a	10.2a	8.7a	8.0b	15.0b	11.3b	35.3b	21.7b	13.7a	4.3b	
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	6.0a	12.3a	13.3a	16.5a	12.3a	9.0a	8.7b	11.0a	7.3a	20.0a	9.5a	10.3a	0.3a	
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	6.7a	14.4a	13.3a	16.5a	13.7a	9.0a	8.0b	10.7a	8.0a	20.3a	9.7a	13.3a	1.0a	
9	Untreated control	Water		Water spray	5.7a	15.4a	11.9a	14.0a	12.6a	9.7a	10.0b	14.7b	18.7b	33.7b	32.3c	12.0a	23.0d	

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd..) Insect pest incidence in different treatments, PCT, *Kharif* 2018

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	Brown Planthopper (No./10hills)										
					MTU		NVS				NDL				
					60DAT	65DAT	50DAT-BT	50DAT-AT	70DAT	75DAT	50DAT	60DAT	70DAT	80DAT	90DAT
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+methoxyfenozide 30%	36	0.75	38.7a	99.7a	9.7a	2.0a	10.7a	3.3b	14.7a	44.3b	295.0b	1420.0b	2317.3b
2	DPX-RAB 55	Triflumezopyrim	106	0.48	58.3a	106.0a	8.3a	2.7ab	10.7a	3.7b	19.3a	8.3a	1.7a	2.7a	0.0a
3	Contaf Plus	Hexaconazole	5	2.0	62.0a	116.7a	9.7a	3.3b	10.7a	4.0b	13.7a	66.7b	209.3b	1021.7b	2227.0b
4	Mantis 75 WP	Tricyclazole	75	0.6	22.0a	67.3a	8.7a	4.3b	11.3a	4.7b	12.7a	123.3c	277.0b	1354.3b	2043.7b
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6%+methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	50.3a	101.0a	8.3a	1.3a	10.3a	2.0a	13.7a	74.7b	330.0b	1314.7b	2719.7b
6	Spinetoram 6%+methoxyfenozide 30%+ Mantis	Spinetoram 6%+methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	35.0a	102.0a	9.3a	0.7a	11.0a	1.7a	18.0a	86.3b	263.7b	1412.0b	2492.3b
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	32.0a	103.0a	9.7a	5.0b	10.3a	5.3b	17.3a	14.3a	4.3a	2.3a	0.0a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	57.0a	109.7a	9.0a	5.7b	11.3a	5.7b	13.0a	19.3a	2.0a	0.0a	1.0a
9	Untreated control	Water		Water spray	39.0a	56.0a	9.0a	11.0c	12.3a	14.3c	14.0a	99.7bc	277.7b	1396.7b	2240.7b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd..) Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	Brown Planthopper (No./10hills)									Mean
					PNT				RGL	RPR		SKL	WGL	
					53DAT	58DAT	69DAT	74DAT	70DAT	50DAT	70DAT	83DAT	51DAT	
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+methoxyfenozide 30%	36	0.75	26.7a	26.0a	29.3a	30.3a	78.0a	18.0b	18.7b	6.3a	1.0a	141.9b
2	DPX-RAB 55	Triflumezopyrim	106	0.48	23.0a	27.7a	29.7a	29.7a	76.7a	10.7a	14.0a	6.3a	1.1a	18.0a
3	Contaf Plus	Hexaconazole	5	2.0	24.3a	23.0a	22.7a	26.7a	72.3a	22.0bc	22.0b	7.5a	1.2a	126.5b
4	Mantis 75 WP	Tricyclazole	75	0.6	22.0a	30.0a	26.7a	27.3a	78.7a	21.3b	20.7b	7.6a	1.0a	132.5b
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6%+methoxyfenozide 30%+Hexaconazole	-	0.75+2.0	24.0a	23.7a	24.3a	24.0a	81.8a	16.7ab	20.0b	5.9a	1.0a	153.1b
6	Spinetoram 6%+methoxyfenozide 30%+Mantis	Spinetoram 6%+methoxyfenozide 30%+Tricyclazole	-	0.75+0.6	23.0a	27.0a	26.3a	23.3a	75.7a	18.0b	22.0b	6.5a	1.5a	147.3b
7	DPX-RAB 55+Contaf	Triflumezopyrim+Hexaconazole	-	0.48+2.0	26.0a	29.7a	28.0a	28.3a	84.8a	10.7a	16.0a	5.5a	1.4a	17.8a
8	DPX-RAB 55+Mantis	Triflumezopyrim+Tricyclazole	-	0.48+0.6	28.0a	31.0a	40.3a	28.7a	64.8a	10.0a	14.0a	5.3a	1.3a	18.9a
9	Untreated control	Water		Water spray	23.3a	35.7a	37.3a	44.7b	77.2a	26.7c	29.3c	7.5a	13.8a	142.0b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd..) Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	White Backed Planthoppers(No./10hills)										
					BPT 95DAT	GVT				LDN					
						60DAT-BT	60DAT-AT	82DAT-BT	82DAT-AT	41DAT	46DAT	63DAT	68DAT	88DAT	35DAT
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+methoxyfenozide 30%	36	0.75	12.0a	62.0a	22.4a	18.6a	21.4a	18.7a	17.0b	26.7b	22.0b	32.0a	28.3b
2	DPX-RAB 55	Triflumezopyrim	106	0.48	9.3a	65.8a	19.3a	15.1a	18.9a	18.3a	9.0a	14.7a	7.7a	21.0a	10.7a
3	Contaf Plus	Hexaconazole	5	2.0	8.7a	54.6a	26.3a	19.3a	16.8a	18.7a	17.3b	26.3b	22.0b	35.3a	31.3b
4	Mantis 75 WP	Tricyclazole	75	0.6	10.0a	64.4a	21.7a	18.6a	17.2a	18.3a	17.3b	27.3b	22.3b	35.0a	30.0b
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6%+methoxyfenozide 30%+Hexaconazole	-	0.75+2.0	13.0a	70.4a	23.1a	15.1a	21.4a	19.3a	18.0b	27.7b	23.7b	32.0a	29.3b
6	Spinetoram 6%+methoxyfenozide 30%+Mantis	Spinetoram 6%+methoxyfenozide 30%+Tricyclazole	-	0.75+0.6	13.7a	58.8a	17.9a	20.3a	19.6a	18.7a	17.3b	28.3b	24.0b	32.3a	28.3b
7	DPX-RAB 55+Contaf	Triflumezopyrim+Hexaconazole	-	0.48+2.0	9.7a	57.4a	23.8a	20.7a	17.5a	18.0a	12.3a	17.7a	10.0a	23.0a	12.3a
8	DPX-RAB 55+Mantis	Triflumezopyrim+Tricyclazole	-	0.48+0.6	11.3a	69.7a	24.2a	14.7a	13.7a	18.0a	13.0a	16.7a	9.7a	24.3a	13.0a
9	Untreated control	Water		Water spray	10.7a	64.8a	16.8a	20.7a	13.7a	18.3a	27.7c	28.7b	36.7c	33.3a	37.7c

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd...)Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	White Backed Planthopper (No. /10hills)								
					MTU		NVS				NDL		
					65DAT	70DAT	50DAT-BT	50DAT-AT	70DAT-BT	70DAT-AT	40DAT	50DAT	60DAT
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	15.0a	6.7a	11.0a	3.7ab	13.0a	5.0ab	4.0a	5.3a	8.3a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	17.3a	4.7a	10.3a	4.3ab	13.7a	5.7b	4.0a	3.3a	2.0a
3	Contaf Plus	Hexaconazole	5	2.0	19.0a	7.0a	10.0a	5.3b	13.0a	7.0b	9.0a	6.3a	92.3b
4	Mantis 75 WP	Tricyclazole	75	0.6	9.7a	4.3a	11.0a	6.0b	12.7a	8.3b	9.0a	6.0a	92.7b
5	Spinetoram 6%+ methoxyfenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	14.3a	8.0a	11.7a	3.0a	13.7a	4.7ab	9.0a	6.0a	61.0b
6	Spinetoram 6%+ methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	20.0a	3.3a	11.0a	1.7a	13.7a	3.7a	9.7a	6.3a	49.7b
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	13.7a	7.0a	10.3a	7.0b	13.0a	8.3b	6.7a	2.0a	4.3a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	16.0a	4.7a	10.3a	7.3b	13.3a	9.7b	6.3a	15.0a	10.7a
9	Untreated control	Water		Water spray	8.7a	7.0a	10.7a	13.3c	16.0a	19.3c	9.0a	9.0a	77.0b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd...)Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	White Backed Planthopper (No. /10hills)					Mean
					NWG				PNT	
					49DAT-BT	49DAT-AT	67DAT-BT	67DAT-AT	74 DAT	
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	34.7a	24.0a	54.7a	37.3b	4.7a	20.3a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	41.3a	21.3a	49.3a	24.0a	4.0a	16.6a
3	Contaf Plus	Hexaconazole	5	2.0	46.7a	17.3a	49.3a	21.3a	4.3a	23.4a
4	Mantis 75 WP	Tricyclazole	75	0.6	42.7a	20.0a	56.0a	26.7a	5.3a	23.7a
5	Spinetoram 6%+ methoxyfenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	56.0a	36.0b	64.0a	42.7b	4.7a	25.1ab
6	Spinetoram 6%+ methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	53.3a	36.0b	66.7a	42.7b	5.7a	24.1a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	52.0a	22.7a	54.7a	24.0a	6.7a	18.2a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	56.0a	21.3a	61.3a	26.7a	4.7a	19.7a
9	Untreated control	Water		Water spray	57.3a	58.7c	73.3a	73.3c	7.0a	29.9b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd..) Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	Leaf folder Damage (% Damaged Leaves)									
					BPT	CBT	LDN							
							41DAT	46DAT	63DAT	68DAT	73DAT	88DAT	93DAT	98DAT
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+methoxyfenozide 30%	36	0.75	4.1a	4.2a	8.6a	4.7a	6.4a	4.6a	5.1a	6.2a	4.3a	4.6a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	6.7a	6.5a	10.0a	6.6a	7.2a	6.8a	7.0a	7.3a	6.3a	6.3a
3	Contaf Plus	Hexaconazole	5	2.0	4.1a	5.5a	10.3a	7.2a	9.0a	6.8a	6.9a	7.7a	6.5a	6.5a
4	Mantis 75 WP	Tricyclazole	75	0.6	4.6a	7.2a	9.4a	7.7a	9.1a	7.2a	7.2a	7.9a	6.5a	6.6a
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6%+methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	3.3a	8.2a	9.4a	5.6a	6.4a	5.2a	5.9a	6.4a	4.4a	4.7a
6	Spinetoram 6%+methoxyfenozide 30%+ Mantis	Spinetoram 6%+methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	5.5a	6.3a	10.2a	5.7a	6.4a	5.2a	6.0a	6.5a	4.4a	5.0a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	3.3a	5.8a	10.0a	7.1a	8.0a	7.0a	7.1a	8.0a	6.6a	7.0a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	3.7a	7.6a	10.0a	7.2a	7.9a	7.1a	7.1a	8.0a	6.9a	7.0a
9	Untreated control	Water		Water spray	5.1a	8.0a	9.9a	10.9b	12.0b	12.8b	14.2b	15.9b	17.1b	18.0b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd..) Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	Leaf folder Damage (% Damaged Leaves)									
					MLN		MND	MSD		NVS		NDL		
					48DAT	68DAT		30DAT	50DAT	30DAT	50DAT	50DAT	60DAT	70DAT
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+methoxyfenozide 30%	36	0.75	0.6a	6.3a	0.7a	2.3a	1.1a	4.5a	4.8a	6.7a	6.1a	5.5a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	1.4a	4.4a	3.4b	1.5a	0.6a	4.0a	4.3a	7.1a	9.0a	8.1a
3	Contaf Plus	Hexaconazole	5	2.0	1.4a	6.6a	4.4b	3.7b	3.9b	4.8a	5.2a	7.3a	8.6a	8.9a
4	Mantis 75 WP	Tricyclazole	75	0.6	0.7a	6.7a	5.3b	4.7b	4.7b	5.5a	6.1a	7.1a	11.1a	10.2a
5	Spinetoram 6%+ methoxyfenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	0.4a	5.9a	0.4a	2.3a	1.0a	4.5a	5.2a	5.7a	7.3a	5.2a
6	Spinetoram 6%+ methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	0.4a	6.5a	0.5a	2.4a	1.0a	3.7a	3.8a	5.9a	7.0a	5.6a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	1.6a	6.1a	2.0a	1.4a	0.6a	6.1a	6.5a	6.8a	8.2a	7.1a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	1.5a	6.0a	2.7a	1.3a	0.7a	6.6a	6.7a	6.5a	11.1a	7.5a
9	Untreated control	Water		Water spray	9.4b	18.2b	10.0c	6.0b	6.5b	8.8a	7.5a	9.0a	11.5a	9.5a

Means in columns followed by different letters are significantly different at P=0.05

Table:2.13 (Contd..) Insect pest incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formula- tion	g or ml per litre of spray fluid	Leaf folder Damage (% damaged Leaves)									Mean
					NDL		MMG			PSA		RNC		
					80DAT	90DAT	30DAT	45DAT	60DAT	30DAT	50DAT	89DAT	98DAT	
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6% + methoxyfenozide 30%	36	0.75	5.5a	3.8a	4.5a	5.7a	5.5a	22.0b	19.7b	59.0a	11.3a	7.9a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	7.0a	6.9a	8.1a	7.2a	7.1a	18.5b	16.1b	65.0a	15.7a	9.2a
3	Contaf Plus	Hexaconazole	5	2.0	6.8a	7.1a	7.1a	6.1a	6.8a	9.4a	10.6a	64.0a	72.0b	10.9ab
4	Mantis 75 WP	Tricyclazole	75	0.6	8.5a	7.0a	7.8a	7.3a	6.6a	9.0a	9.6a	56.0a	67.7b	10.9ab
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	4.9a	4.3a	6.3a	5.9a	6.0a	20.2b	22.0b	55.7a	11.0a	8.1a
6	Spinetoram 6%+methoxyfenozide 30%+ Mantis	Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	5.5a	4.6a	7.1a	5.7a	6.0a	17.0b	19.0b	56.3a	12.0a	8.0a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	6.7a	5.9a	8.7a	7.0a	7.1a	15.2b	14.9b	60.0a	16.0a	8.9a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	7.6a	7.3a	8.1a	7.1a	7.5a	13.2b	16.6b	55.7a	15.0a	9.0a
9	Untreated control	Water		Water spray	6.3a	8.3a	9.7a	9.1a	12.5b	8.8a	7.9a	54.3a	62.7b	13.8b

Means in columns followed by different letters are significantly different at P=0.0

Table:2.14 (Contd..) Disease incidence in different treatments, PCT, Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	Sheath Blight									Mean	
					GVT				MND		MSD	MTU			RPR
					BT	AT	BT1	AT1	BT	AT		45DAT	75DAT		
1	Spinetoram6%+methoxy-fenozide 30%	Spinetoram 6%+ methoxy-fenozide 30%	36	0.75	32.6a	33.2b	31.0a	32.6b	13.9a	3.7a	32.1bc	24.4a	41.9a	38.2b	28.4b
2	DPX-RAB 55	Triflumezopyrim	106	0.48	32.9a	33.0b	33.0a	33.1b	14.7a	3.2a	30.3bc	31.1a	51.9a	39.2b	30.2b
3	Contaf Plus	Hexaconazole	5	2.0	32.4a	15.1a	25.0a	8.0a	17.8a	0.2a	19.3a	27.0a	48.5a	29.7a	22.3a
4	Mantis 75 WP	Tricyclazole	75	0.6	32.2a	31.0b	34.8a	34.2b	17.3a	1.8a	28.8b	30.0a	53.7a	44.5b	30.8b
5	Spinetoram 6%+methoxy-fenozide 30%+Contaf	Spinetoram 6%+ methoxy-fenozide 30%+ Hexaconazole	-	0.75+2.0	31.1a	12.7a	23.0a	6.1a	15.8a	0.0a	18.4a	20.4a	47.8a	26.5a	20.2a
6	Spinetoram 6%+methoxy-fenozide 30%+ Mantis	Spinetoram 6%+ methoxy-fenozide 30%+ Tricyclazole	-	0.75+0.6	33.1a	33.4b	35.5a	34.9b	19.4a	1.3a	23.7b	17.0a	42.6a	45.3b	28.6b
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	33.1a	13.3a	18.9a	5.3a	13.3a	0.2a	15.8a	21.1a	40.4a	42.4b	20.4a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	33.9a	32.8b	34.4a	34.0b	15.2a	0.9a	24.9b	31.1a	47.4a	42.0b	29.7b
9	Untreated control	Water		Water spray	31.7a	36.5b	35.6a	35.5b	18.7a	5.8a	34.0c	18.2a	40.0a	42.7b	29.9b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.14 (Contd..) Disease incidence in different treatments, PCT, *Kharif* 2018

Sl. No.	Trade Name	Common Name	% a.i. formula- tion	g or ml per litre of spray fluid	Blast							Mean	Neck blast		Brown spot	
					GVT				MND		RNC		RNR	RNC		
					BT	AT	BT1	AT1	50DAT	59DAT	68DAT			90DAT	BT	AT
1	Spinetoram6%+methoxy- fenozide 30%	Spinetoram 6% + methoxyfenozide 30%	36	0.75	29.1a	26.5bc	25.2bc	25.9b	4.1b	14.3a	18.3bc	20.5	28.0b	26.3a	31.3c	
2	DPX-RAB 55	Triflumezopyrim	106	0.48	29.1a	30.8c	31.4c	32.3b	5.3b	17.7a	20.3c	23.8	40.4c	29.0a	34.7c	
3	Contaf Plus	Hexaconazole	5	2.0	24.1a	22.9b	26.4bc	22.4b	0.9a	17.3a	12.7d	18.1	18.2a	26.7a	5.3a	
4	Mantis 75 WP	Tricyclazole	75	0.6	25.3a	13.4a	14.0a	6.6a	0.6a	18.0a	4.0a	11.7	13.3a	27.0a	14.0b	
5	Spinetoram 6%+methoxy- fenozide 30%+Contaf	Spinetoram 6%+ methoxy fenozide 30%+ Hexaconazole	-	0.75+2.0	24.5a	23.7b	26.1bc	26.1b	0.7a	20.0a	11.0b	18.9	23.7ab	24.0a	5.7a	
6	Spinetoram 6%+methoxy- fenozide 30%+ Mantis	Spinetoram 6%+ methoxy- fenozide 30%+ Tricyclazole	-	0.75+0.6	22.6a	12.9a	13.9a	5.7a	0.0a	18.7a	5.7a	11.3	25.9ab	26.3a	10.0b	
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	24.1a	23.7b	25.4bc	26.1b	1.3a	20.3a	10.3b	18.8	32.0b	27.0a	6.0a	
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	24.1a	10.4a	11.9a	2.7a	0.4a	20.7a	4.7a	10.7	27.8b	27.7a	14.3b	
9	Untreated control	Water	Water spray		33.4a	34.3c	34.9c	34.1b	6.3b	19.3a	24.0c	26.6	47.4c	31.0a	35.3c	

Means in columns followed by different letters are significantly different at P=0.05

Table 2.15 Grain yield in different treatments, PCT *Kharif* 2018

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	Yield(Kg/ha)									
					AND	BPT	CBT	CHN	CHP	CTC	GVT	KRK	KJT	LDN
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	5207a	7012c	5295b	4133a	4955b	4000b	6685b	2417a	3653a	6568a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	3867e	7087c	7234a	3578b	4505c	4100b	9310a	3417a	3720a	6337b
3	Contaf Plus	Hexaconazole	5	2.0	3783e	7318b	6269ab	3422b	4426d	3600c	6895b	2667a	2967b	6370b
4	Mantis 75 WP	Tricyclazole	75	0.6	4683b	7148c	6067b	3289b	4485cd	3700c	7105b	3333a	2280c	6288c
5	Spinetoram 6%+ methoxy-fenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	4333c	7387b	7455a	3667b	5092ab	4200ab	7805ab	2750a	3447a	6667a
6	Spinetoram 6%+ methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	4083d	8322a	7240a	3867ab	5170a	4300a	7630b	2583a	3520a	6469b
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	4100d	7442b	7197a	3378ab	4583c	4400a	8295ab	3000a	3107b	6568b
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	3750e	8077a	7266a	3511b	4485c	4400a	9030ab	2750a	2600c	6469b
9	Untreated control	Water	Water spray		3350f	6847d	5615b	3356b	3564e	2700d	4830c	2917a	1913d	5597d

Means in columns followed by different letters are significantly different at P=0.05

Table 2.15 (Contd...) Grain yield in different treatments, PCT Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	Yield(Kg/ha)									
					MLN	MND	MSD	MTU	NVS	NDL	NWG	PNT	PSA	PTB
1	Spinetoram 6%+methoxy-fenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	2966a	6107a	2542d	3296a	3884b	2142b	2830a	5191a	5994a	2360b
2	DPX-RAB 55	Triflumezopyrim	106	0.48	2894a	5867a	2758c	2854a	4004a	4083a	2723b	4251a	5787a	2448b
3	Contaf Plus	Hexaconazole	5	2.0	2894a	5613a	2487d	3395a	3747b	2817b	2359b	5148a	5032b	3159a
4	Mantis 75 WP	Tricyclazole	75	0.6	2749a	5667a	2260e	3317a	3669c	2925b	2600b	4719a	4943b	2735b
5	Spinetoram 6%+ methoxy-fenozide 30%+Contaf	Spinetoram 6%+ methoxy-fenozide 30%+ Hexaconazole	-	0.75+2.0	2894a	6587a	2945b	3536a	3832b	2400b	2923a	5584a	6494a	4158a
6	Spinetoram 6%+ methoxy-fenozide 30%+ Mantis	Spinetoram 6%+ methoxy-fenozide 30%+ Tricyclazole	-	0.75+0.6	3038a	6493a	2758c	3322a	4090a	2942b	2972a	5285a	6268a	2797b
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	3038a	6173a	3250a	3084a	3549c	4025a	3096a	5107a	5050b	2897b
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	2604a	6040a	3038b	2935a	3447c	4075a	2636b	4794a	4874b	2935b
9	Untreated control	Water		Water spray	1389b	4613b	1667f	3282a	3366d	2642b	2340b	4106a	4345b	2660b

Means in columns followed by different letters are significantly different at P=0.05

Table 2.15 (Contd...) Grain yield in different treatments, PCT Kharif 2018

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	Yield(Kg/ha)							Yield (Kg/ha)	%dOC
					RGL	RNC	RNR	RPR	SKL	TTB	WGL		
1	Spinetoram 6%+methoxy-fenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	5980a	4533a	4370a	6850a	3228a	4337b	4978a	4500ab	19.4
2	DPX-RAB 55	Triflumezopyrim	106	0.48	5392a	4467a	4445a	6575a	3664a	4100b	5283a	4620a	21.5
3	Contaf Plus	Hexaconazole	5	2.0	4549b	4400a	4438a	6317b	2948b	3987b	5050a	4298b	15.7
4	Mantis 75 WP	Tricyclazole	75	0.6	5453a	4400a	4140a	6467a	2963b	4200b	4914a	4315b	16.0
5	Spinetoram 6%+ methoxy-fenozide 30%+Contaf	Spinetoram 6%+ methoxy-fenozide 30%+ Hexaconazole	-	0.75+2.0	5611a	5044a	4558a	6958a	3277a	4620a	4723a	4776a	24.1
6	Spinetoram 6%+ methoxy-fenozide 30%+ Mantis	Spinetoram 6%+ methoxy-fenozide 30%+ Tricyclazole	-	0.75+0.6	5853a	4867a	4379a	6458a	3262a	4520a	4794a	4714a	23.1
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	5483a	4756a	4462a	6600a	3670a	4303b	5279a	4663a	22.3
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	5581a	4600a	4502a	6392ab	2884b	4195b	5233a	4559ab	20.5
9	Untreated control	Water		Water spray	4512b	3622a	3919a	5500c	2624b	3433c	3173b	3625c	

Means in columns followed by different letters are significantly different at P=0.05

ii) Botanical Insecticides Evaluation Trial (BIET)

Use of plant extracts or botanicals is one of the earliest and traditional practices in control of insect pests of crops. Botanicals can play a key role in management of rice pests as they are environment-friendly, safe, renewable and cost effective. Integration of botanicals in rice IPM will reduce pesticide load in environment, prevent insecticide resistance and help in conserving natural enemy populations. Earlier efforts under AICRIP were mainly focussed on evaluation of efficacy of various insecticides against insect pests. Hence, it was felt necessary to re-look at the efficacy of some of commercially available essential oils against major pests of rice in order to identify the effective oil with an aim to integrate in rice IPM. So, the trial with commercially available essential oils initiated last year was continued during *kharif* 2018 to evaluate their relative efficacy against major insect pests at 24 locations.

Sl. No.	Location	Date of sowing	Date of planting	Date of harvesting	No of applications	Times of application (DAT)
1	Arundhatinagar	02-08-2018	23-08-2018	17-12-2018	3	10,50 & 68
2	Bapatla	06-08-2018	06-09-2108	05-01-2019	2	60 & 70
3	Chinsurah	15-16-2018	13-07-2018	26-11-2018	3	15,30 & 50
4	Coimbatore	29-06-2018	20-07-2018	03-11-2018	3	15,40 & 55
5	Chiplima	09-07-2018	08-08-2018	22-11-2018	3	25,50 & 65
6	Gangavathi	10-07-2018	13-08-2018	12-12-2018	4	30,50,80 &100
7	Jagdulpur	02-07-2018	18-08-2018	25-12-2018	2	37&55
8	Khudwani	11-05-2018	10-06-2018	09-10-2018	1	62
9	Karjat	13-06-2018	25-07-2018	03-11-2018	1	55
10	Karaikal	11-08-2018	14-09-2018	10-12-2018	2	40 & 56
11	Ludhiana	20-05-2018	26-06-2018	29-10-2018	3	37,56 & 81
12	Malan	13-06-2018	12-07-2018	05-11-2018	2	20 & 54
13	Masodha	06-07-2018	02-08-2018	22-11-2018	4	17,30,43 & 53
14	Maruteru	27-06-2018	01-08-2018	24-11-2018	2	20 & 25
15	Navsari	03-07-2018	30-07-2018	15-11-2018	3	30,40 & 45
16	Nellore	24-08-2018	25-09-2018	yet to harvest	1	50
17	New Delhi	20-06-2018	24-07-2018	15-11-2018	7	13,20,30,40,50,60 & 70
18	Pattambi	04-08-2018	28-08-2018	21-11-2018	3	15,45 & 75
19	Pusa	26-06-2018	21-07-2018	16-11-2018	2	20 & 40
20	Raipur	07-07-2018	04-08-2018	12-03-2018	3	43,55 & 75
21	Ranchi	26-07-2018	20-08-2018	06-12-2018	6	25,40,70,80,90 & 105
22	Rewa	14-07-2018	10-08-2018	17-11-2018	0	Not applied
23	Sakoli	27-06-2018	23-07-2018	21-11-2018	4	18,38,70 & 88
24	Titabar	10-07-2018	11-08-2018	16-12-2018	1	15

Treatments:

Four botanicals-essential oils procured from local market *viz.*, Camphor oil, Cedar wood oil, Eucalyptus oil and Lemon grass oil @ 1000 ml/ha were compared with effective neem formulation, Neemazal and

commonly recommended insecticides – dinotefuran 20 SG @ 40 g a.i./ha and rynaxypyr 20 SC @ 30 g a.i./ha along with untreated control (only water spray). There were eight treatments replicated thrice and laid out in Randomized Complete Block Design (RCBD). Adjuvant-Dhanuvit was added to oil spray @ 0.05% to form an emulsion. Spray applications of the treatments were done based on pest incidence exceeding the economic threshold level guidelines at 10-15 days interval. All the treatments were applied as high volume sprays @ 500 litres of spray fluid/ha.

Standard observation procedures were followed to record insect pest incidence at regular intervals throughout the crop growth period. To assess stem borer and gall midge damage, observations were recorded on total tillers (TT), dead hearts (DH) and silver shoots (SS) at 30 and 50 DAT, while stem borer damage at heading stage was expressed as per cent white ears based on counts of panicle bearing tillers (PBT) and white ear heads (WE). In case of sucking pests such as brown plant hopper (BPH), white backed plant hopper (WBPH), green leafhopper (GLH) and natural enemies, number of insects were recorded on 10 randomly selected hills. The damage due to foliage feeders such as leaf folder, whorl maggot, hispa, blue beetle etc., was assessed based on counts of damaged leaves/10 hills. At the time of harvest, the grain yield from net plot leaving 2 border rows on all sides was collected and expressed as kg/ha.

ANOVA test for Random Complete Block Design (RCBD) was applied to analyse data collected for each date of application at each location as well as for yield at harvest to assess the performance of the different treatments. The comparative efficacy of the treatments was worked out based on efficacy at each DAT and pooled means of the pest damages across observations and over locations. Pooled yield data analysis was carried out to assess the impact of each treatment on yield.

Results

Pest Infestation (Table 2.16)

Stem borer infestation during vegetative stage ranged from 0.7 to 11.7% dead hearts (DH) in the insecticide treatments and 1.5-14.4% in essential oil treatments across 15 locations with minimum damage of 4.0- and maximum of 18.6% in untreated control, during 30 to 105 DAT. There were significant differences in stem borer damage (DH) among the treatments at 12 locations. Rynaxypyr treatment recorded the lowest mean damage of 3.5% while essential oil treatments showed mean DH infestation between 5.2-6.5% across the locations compared to 10.5% in untreated control. Botanical insecticide treatments were significantly superior to control at 12 locations. Among essential oils, Eucalyptus oil treatment showed highest efficacy with mean damage of 5.2% compared to other oils.

White ears (WE) damage at heading stage in various treatments ranged from 0.5 to 20.0% compared to 5.0 to 21.9% in control across 16

centres. There were significant differences among treatments in white ear damage at 15 locations. Mean WE infestation ranged from 8.1-8.6% in essential oil treatments as compared to 4.8-7.3% in insecticide treatments and 12.6% in control. Overall, Eucalyptus oil was found to be superior in reducing stem borer damage compared to other essential oils along with neemazal while rynaxypyr was the most effective treatment at both vegetative and reproductive phases.

Gall midge occurrence was reported from 8 centres of which Maruteru recorded highest damage ranging from 27.3 to 34.7% silver shoots (SS) across treatments and 20.7% in control, Chiplima centre also recorded high damage with a range of 21.6-32.1 in treatments as against 39.9% SS in control at 50 DAT. At other locations, the SS damage varied from 1.60 to 17.5% in treatments and 5.0 to 28.0% in control. There were significant differences in the efficacy of essential oils among the treatments at all locations except 30 DAT at Maruteru and 56 DAT at Sakoli. Among essential oil treatments, lowest mean infestation was recorded in cedar wood oil (10.7%) on par with rynaxypyr (10.5%) and significantly superior to control (17.0%).

Brown planthopper incidence was very high at New Delhi centre (718.3-991.0 hoppers/10hills) at 80 DAT followed by same centre with population of 163.7-400.7 hoppers/10 hills at 70 DAT. Across the 8 locations, dinotefuran was found to be the most effective treatment with mean population of 7.9/10 hills and was significantly superior to control (16.5). All essential oil treatments also significantly reduced BPH populations (10.1-11.0 hoppers/10 hills) and were at par.

White-backed planthopper populations were observed at 6 locations, and Gangavathi recorded the highest populations ranging from 57.0-194.6/10 hills across the treatments at 40 and 60 DAT. The populations of hoppers varied from 8.7 to 254.6/10 hills across other centres in control. Dinotefuran was the most effective treatment in reducing WBPH populations with mean of 16.5 hoppers/10 hills. Essential oil treatments also showed significant efficacy against the hoppers with mean population of 30.5-33.5 hoppers/10 hills and significantly superior to that of control (59.5).

Green leafhopper incidence was high at Ranchi (31.3-85.7 hoppers/10hills) during 79-82 DAT among the 7 centres. Dinotefuran was the most effective treatment with mean population of 13.2 hoppers/10 hills and superior to control (27.4). There were significant differences in hopper populations among the treatments at 4 locations as well as populations recorded at 63 DAT and 70 DAT at Navsari and 82 DAT at Ranchi. All the botanical treatments also showed significant efficacy against the hoppers

(mean population of 14.5-17.2 hoppers/10 hills) when compared to control (27.4).

Leaf folder damage was recorded from 14 locations and highest leaf damage was recorded in Ranchi centre (10.7-70.0%) followed by Malan with 13.0-57.4% during 48-88 days after planting. There were significant differences in leaf damage among the treatments at 13 locations. Rynaxypyr was the most effective treatment showing mean leaf damage of 7.5% when compared to other treatments and untreated control (18.0%). The efficacy of essential oils was at par (11.1-11.8% leaf damage).

Whorl maggot infestation was recorded at 6 centres, of which high foliage damage was noticed in Malan ranging from 9.2-20.4% in treatments and 73.5-77.7% in control at 48 and 68 DAT. The lowest mean damage was recorded in rynaxypyr treatment (5.3%). A mean damage range of 6.6-9.5% was noticed in essential oil treatments compared to control (19.7%).

Hispa damage was recorded at 3 centres viz., Ranchi, Malan and Raipur. Highest damage of more than 50% was observed in Ranchi centre. However, none of the treatments were found effective against the pest at 33 DAT and all were at par. Dinotefuran was the most effective treatment with 17.9% mean leaf damage. Essential oil treatments were also found effective showing 19.8-23.8% leaf damage compared to 50.3% in control.

Gandhi bug incidence was observed only in Navsari location. Both essential oil and insecticide treatments were found effective in reducing damage by the bug (5.9-9.7%) when compared to 12.2% in control. Among botanicals, Neemazal recorded the lowest damage of 7.2% followed by camphor oil (7.5%).

Grass hopper infestation was reported from Khudwani centre at 62 and 70 DAT with damage range of 5.0-41.7% in treatments and 40.7-52.7% in control. Cedar wood oil recorded the lowest mean damage of 22.7% which was comparable with Dinotefuran (22.0%) and showed significant efficacy as compared to 46.7% in control.

Natural enemies: The populations of mirid bug, an important natural enemy of BPH, were recorded in 4 centres. High populations of 9.3-38.1 mirid bugs/10 hills was recorded in Gangavathi centre followed by Ludhiana with 5.7-7.7 bugs in treatments as against 14.0-51.8 bugs/10 hills in control. There were no significant differences in mirid populations among botanical treatments in Gangavathi centre during 40-100 DAT. Low mean population of mirid bugs was recorded in dinotefuran treatment (5.7/10hills) indicating that the insecticide is not very safe to predators. Comparatively higher populations of the predator was noticed in essential oil

treatments (13.2-14.8/10hills) and control (19.5) signifying that all botanicals are relatively safe to the mirid bug.

Spider populations were recorded in 6 locations, of which Gangavathi reported more spider numbers (8.5-40.3/10hills) during 40-100 DAT compared to other locations (0.0-23.0/10hills). Mean spider population in essential oil treatments ranged from 10.1-11.0/10 hills as compared to 16.5 in control indicating the relative safety of botanical treatments to spiders. Comparatively lower spider numbers were recorded in insecticide treatments (7.9-8.6/10 hills).

Grain Yield (Table 2.17)

There were significant differences in grain yield among the treatments including control at all locations except Karaikal. Based on mean yield of these locations, rynaxypyr recorded the highest grain yield of 7768.8kg/ha with 41.22% increase over control (IOC) followed by dinotefuran with 7018.6kg/ha (27.58% IOC). Among the botanicals, neemazal recorded the highest yield 6961.4kg/ha (26.54% IOC) followed by cedar wood oil with yield of 6597.9 kg/ha (19.93% IOC). The control plot showed an yield of 5501.1kg/ha.

Botanical Insecticide Evaluation Trial (BIET) was carried out at 24 locations across the country to evaluate the efficacy of four essential oils, neemazal and recommended insecticides, dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield during kharif, 2018. Based on the performance of the treatments in controlling the pest damage at various locations, the botanicals-eucalyptus oil and neemazal were found effective in reducing damage by stem borer. Cedar wood oil showed efficacy in controlling gall midge damage. Dinotefuran was the most effective treatment in reducing the populations of plant and leaf hoppers, while all the essential oil treatments were moderately effective. However, against leaf folder, all essential oils were found effective in reducing leaf damage. Camphor oil was effective against attack by Gandhi bug. Botanical formulations were found moderately effective in reducing damage by hispa. All essential oils were effective in controlling leaf damage by whorl maggot. Impact of essential oils on natural enemies revealed that treatments were relatively safer to mirid bug than spiders while dinotefuran was unsafe. Highest grain yield of 7768.8kg/ha was recorded in rynaxypyr treatment. Among botanicals, cedar wood oil recorded highest yield of 6597.9kg/ha.

Table 2.16 Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula-tion/ha	Stem Borer Damage (%Dead Hearts)										
			AND		CBT		CHN		CHP		GVT	KJT	
			30DAT	50DAT	31DAT	47DAT	30DAT	50DAT	56DAT	75DAT	50DAT	30DAT	50DAT
1	Camphor oil	1000	5.2bc	7.8ab	4.4a	4.5de	11.9bc	10.8b	2.3bc	2.1b	1.5b	11.2a	2.9bc
2	Cedar wood oil	1000	4.9bc	5.7bac	4.7a	7.4bcd	14.4b	9.5bc	2.6b	2.4b	2.2b	9.8a	2.3de
3	Eucalyptus oil	1000	4.5bc	4.1bc	4.5a	6.0bcd	8.5de	6.8cd	1.5cd	1.8bc	2.2b	8.2a	3.2b
4	Lemon grass oil	1000	9.2a	5.4abc	4.6a	4.7cde	10.7cd	9.7b	2.1bc	2.4b	1.7b	7.4a	2.6cd
5	Neem azal	1000	4.1c	3.9bc	4.6a	7.7abc	7.5e	6.4d	2.2bc	2.3b	1.8b	11.4a	2.2dg
6	Dinotefuran	200	6.9abc	5.3abc	4.4a	8.8ab	6.0ef	6.2d	2.0bc	1.8bc	2.6b	11.7a	1.9ef
7	Rynaxypyr	150	5.7bc	3.3c	2.2b	2.6e	4.6f	1.9e	0.7d	0.7c	1.5b	9.0a	1.6f
8	Untreated Control	Water	7.3ab	9.0a	5.5a	10.5a	18.6a	16.7a	5.8a	7.6a	4.8a	9.2a	4.2a

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Stem Borer Damage (%Dead Hearts)													
		LDN									MSD		NVS		
		36DAT	41DAT	46DAT	56DAT	61DAT	66DAT	82DAT	87DAT	91DAT	30DAT	50DAT	30DAT	50DAT	
1	Camphor oil	3.9a	2.8bcd	3.6bc	4.1b	3.5bc	4.1bc	4.3bc	3.2bc	3.5b	4.6a	7.8b	6.0c	6.0c	
2	Cedar wood oil	4.1a	3.1bc	3.3cd	3.8bc	3.0bcd	3.2cd	3.7cde	2.8bc	3.0bc	3.9a	6.6bc	7.9b	7.9b	
3	Eucalyptus oil	5.0a	1.9de	2.2ef	3.0c	2.7cd	3.0cd	3.2de	2.4cd	2.5cd	3.3a	5.0cd	5.5c	5.5c	
4	Lemon grass oil	4.9a	2.8bcd	3.1cd	3.8bc	3.2bcd	4.0bc	4.4bc	3.0bc	3.3bc	3.2a	4.5de	9.3b	9.3b	
5	Neem azal	4.1a	2.2cde	2.7de	3.8bc	3.2bcd	3.5bc	3.8bcd	2.9bc	3.3bc	4.4a	3.2def	5.1cd	5.1cd	
6	Dinotefuran	4.9a	3.8b	4.2b	4.3b	4.3b	4.6b	4.9b	3.5b	3.8b	3.2a	2.5ef	3.7de	3.7de	
7	Rynaxypyr	4.8a	1.4e	1.6f	3.0c	1.9d	2.1d	2.7e	1.6d	1.9d	3.1a	1.9f	2.7e	2.7e	
8	Untreated Control	4.7a	5.0a	6.8a	7.2a	8.0a	8.5a	8.6a	8.8a	9.1a	4.0a	11.1a	16.9a	16.9a	

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd...) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Stem Borer Damage (%Dead Hearts)										Mean
		PSA		PTB		RCI	RPR		SKL	TTB		
		30DAT	50DAT	30DAT	50DAT	50DAT	30DAT	50DAT	105DAT	30DAT	50DAT	
1	Camphor oil	10.0b	10.7b	10.8ab	9.8abc	9.1abc	22.6a	5.9	4.7a	3.1d	3.6de	6.5
2	Cedar wood oil	10.5b	9.8b	7.8b	9.8abc	9.1abc	10.9bc	5.3a	4.4ab	7.7b	8.0b	6.3
3	Eucalyptus oil	9.2bc	10.5b	12ab	8.3abc	8.1bcd	10.4bc	5.0a	3.3ab	5.3c	5.7c	5.2
4	Lemon grass oil	9.7bc	9.3b	7.5b	13.0a	10.1ab	3.9e	5.2a	3.6ab	7.6b	6.5c	6.0
5	Neem azal	10.1b	9.2b	7.8b	10.1abc	6.1cd	4.3de	6.3a	3.6ab	3.5d	3.7d	5.0
6	Dinotefuran	9.5bc	9.6b	6.4b	5.6bc	5.8cd	5.5de	4.1a	3.3ab	6.3bc	5.6c	5.2
7	Rynaxypyr	8.1c	6.5c	7.5b	3.9c	5.1d	7.7cd	8.2a	2.5b	2.2d	2.4e	3.5
8	Untreated Control	13.7a	17.9a	16.4a	12.5ab	12.5a	11.5b	9.4a	4.9a	12.5a	13.4a	10.5

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd...) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Stem Borer Damage (% White Ears)																Mean
			Pre-harvest																
			AND	CBT	CHN	CHP	GVT	KRK	LDN	MSD	MTU	NVS	PSA	PTB	RCI	RPR	SKL	TTB	
1	Camphor oil	1000	4.6b	6.0cd	9.0cd	3.4bc	2.3cd	4.7c	4.1bc	15.3b	18.0a	10.5cde	10.2b	10.4b	8.5ab	15.6bc	6.1ab	3.0d	8.2
2	Cedar wood oil	1000	3.1bc	9.7ab	9.6b	3.8b	2.7bc	7.8a	2.9cd	14.3b	14.0a	13.4cb	9.4bc	13.6ab	8.3b	13.8cd	5.9abc	5.1c	8.6
3	Eucalyptus oil	1000	2.6c	7.7bc	7.2c	2.3c	1.7cd	3.8c	3.2bcd	10.4c	16.7a	12.1cd	9.3bc	15.7a	7.2bc	17.9b	4.9abc	2.0b	8.1
4	Lemon grass oil	1000	3.0cb	5.6cd	9.8b	3.2bc	2.9bc	5.5bc	3.4bcd	9.5c	15.0a	15.9b	9.7b	14.7ab	9.1ab	17.2bc	5.3abc	2.0b	8.5
5	Neem azal	1000	3.4cb	0.0abc	7.1c	4.5b	2.6bcd	5.7abc	3.7bc	6.8d	15.0a	9.1def	8.9bc	15.0ab	6.6bc	17.5b	4.9abc	2.0d	7.1
6	Dinotefuran	200	2.2c	7.4bc	4.9d	2.3c	3.8ab	7.3ab	4.3b	7.1d	10.0a	7.5ef	10.1b	17.3a	4.9c	17.4bc	4.2bc	2.0b	7.3
7	Rynaxypyr	150	2.1c	2.7d	2.7d	0.5d	1.2b	3.6c	2.3d	2.6e	20.0a	6.3f	6.5c	3.3c	4.7c	11.5d	3.9c	2.3d	5.3
8	Untreated Control	Water	7.3a	11.3a	16.9a	7.5a	5.0a	7.1ab	9.8a	19.7a	15.7a	20.3f	18.5a	13.5ab	11.1a	21.9a	6.8a	9.7a	12.6

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd...) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Gall midge Damage(%Silver Shoots)														Mean
			BPT	CHP		JDP		MTU		PTB		RCI	SKL		TTB		
				56DAT	75DAT	30DAT	50DAT	30DAT	50DAT	30DAT	50DAT		50DAT	56DAT	85DAT	30DAT	
1	Camphor oil	1000	2.4bc	31.1b	25.7bc	6.7ab	15.6b	7.3a	29.7ab	11.6ab	11.3ab	8.6ab	10.1a	6.4a	2.6cd	2.5f	12.3
2	Cedar wood oil	1000	3.3bc	23.7c	17.6d	7.6ab	12.0b	3.0a	34.7a	8.4ab	4.0b	8.6ab	7.4a	6.2b	6.2b	7.5b	10.7
3	Eucalyptus oil	1000	3.8bc	32.1b	26.0b	5.6b	18ab	4.3a	31.0ab	6.3b	11.3ab	7.3b	12.6a	8.3ab	3.6c	4.5de	12.5
4	Lemon grass oil	1000	3.5bc	32.1b	26.9bc	6.9ab	15.1b	6.0a	31.3ab	7.0b	6.2ab	10.2a	13.3a	7.9ab	5.8b	4.8cd	12.6
5	Neem azal	1000	4.2ab	32.0b	28.4b	4.9b	17.5b	6.7a	31.7ab	11.4ab	5.8ab	5.9c	13.2a	7.3ab	3.1cd	3.7e	12.5
6	Dinotefuran	200	4.6ab	32.1b	23.7c	3.8b	11.5b	3.7a	27.3ab	14.3ab	8.5ab	4.3c	12.8a	8.6ab	6.6b	5.6c	12.0
7	Rynaxypyr	150	1.6c	21.6c	16.1d	4.1b	10.9b	7.7a	32.7ab	10.5ab	16.6a	3.9c	10.3a	7.2ab	1.9d	2.4f	10.5
8	Untreated Control	Water	6.4a	39.9a	39.1a	9.9a	28.0a	5.0a	20.7b	17.3a	15.7a	11.1a	13.3a	9.0a	11.0a	12.2a	17.0

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd...) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Brown Planthopper(No./10hills)																
			BPT				GVT				LDN								
			DAT	DAT1	DAT2	DAT3	40DAT	60DAT	80DAT	100DAT	36DAT	41DAT	46DAT	56DAT	61DAT	66DAT	82DAT	87DAT	91DAT
1	Camphor oil	1000	4.3b	7.3a	5.0a	6.0ba	52.9bc	67.7bc	52.5c	33.3c	8.7a	3.7c	3.7de	5.7b	4.3c	5.0d	16.0b	9.0bc	9.7c
2	Cedar wood oil	1000	5.3b	5.3a	8.0a	6.6ba	57.3b	62.1bcd	54.8bc	31.8c	8.0a	4.0c	5.0bc	6.3b	6.0b	6.7bc	18.3b	11.0b	12.3b
3	Eucalyptus oil	1000	5.0b	6.0a	8.6a	4.6ba	60.6b	60.6bcd	47.0c	31.8c	8.3a	4.7bc	5.3bc	6.7b	5.7bc	6.0c	17.7b	11.7b	12.7b
4	Lemon grass oil	1000	3.3b	6.6a	7.6a	4.3ba	55.5bc	61.4cd	48.1c	29.0c	8.3a	4.0c	4.7cd	5.7b	6.3b	6.7bc	18.0b	10.7b	11.3b
5	Neem azal	1000	5.0b	7.3a	8.6a	7.0a	36.2cd	52.5d	45.9c	28.1cd	8.7a	3.7c	4.3cde	6.0b	6.7b	7.0b	17.3b	10.3b	10.7bc
6	Dinotefuran	200	4.3b	6.6a	8.6a	5.6ba	19.6d	24.0e	14.1d	13.6d	9.0a	2.3d	3.3e	6.3b	2.7d	3.7e	11.0c	5.7c	6.3d
7	Rynaxypyr	150	4.6b	6.0a	6.3a	6.3ba	61.4b	75.1b	72.5b	74.0b	8.3a	5.3b	6.0b	6.7b	6.0b	6.0c	16.7b	12.0b	12.3b
8	Untreated Control	Water	7.6a	7.3a	8.0a	4.0b	98.0a	97.3a	102.5a	106.5a	8.7a	10.0a	11.3a	14.0a	19.0a	25.0a	38.3a	46.7a	56.7a

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd...) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Brown Planthopper(No./10hills)																Mean
			MTU				NDL				NVS				RPR		SKL		
			45DAT	55DAT	65DAT	75DAT	50DAT	60DAT	70DAT	80DAT	90DAT	60DAT	63DAT	70DAT	73DAT	50DAT	70DAT	93DAT	
1	Camphor oil	1000	7.0a	53.0ab	99.3a	80.0a	22.3a	226.7a	230.3ab	718.3a	200.0b	9.7a	4.3d	11.7a	6.0de	14.0bc	12.7abc	5.6b	10.8
2	Cedar wood oil	1000	10.0a	64.7ab	121.3a	96.3a	21.3a	273.7a	267.3ab	991.0a	292.3ab	9.3a	7.3b	12.0a	8.7bc	14.0bc	8.7c	6.0b	11.0
3	Eucalyptus oil	1000	8.7a	93.7a	110.3a	82.7a	31.0a	252.7a	241.0ab	918.7a	263.7ab	10.0a	6.0c	11.7a	7.3cd	14.0bc	12.7abc	5.9b	10.8
4	Lemon grass oil	1000	12.3a	61.3ab	131.3a	113.0a	24.7a	285.3a	260.7ab	744.3a	230.0b	9.7a	8.0b	12.3a	9.3b	16.7ab	10.0bc	6.6ab	10.1
5	Neem azal	1000	9.7a	89.3a	110.7a	93.0a	30.0a	313.0a	301.7ab	897.3a	271.3ab	9.3a	3.7de	12.3a	5.0e	10.7bc	12.7abc	7.0ab	10.9
6	Dinotefuran	200	4.7a	17.3b	43.3b	66.7a	15.7a	98.7b	163.7b	735.7a	207.0b	10.0a	2.7ef	11.3a	3.3f	9.3c	8.0c	5.9b	7.9
7	Rynaxypyr	150	12.3a	103.7a	104.0a	91.0a	25.0a	214.7a	400.7a	795.3a	298.3ab	9.0a	2.0f	11.0a	2.3f	14.7bc	14.7ab	6.3ab	8.6
8	Untreated Control	Water	12.7a	87.7a	122.3a	110.7a	17.3a	224.0a	319.3ab	912.3a	364.0a	9.7a	11.3a	13.3a	14.3a	22.0a	17.3a	7.7a	16.5

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd...) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	White-backed Planthopper(No./10 hills)												
			BPT				GVT				LDN				
			DAT	DAT1	DAT2	DAT3	40DAT	60DAT	80DAT	100DAT	36DAT	41DAT	46DAT	56DAT	61DAT
1	Camphor oil	1000	11.3b	11.6a	18.0ab	15.6bc	183.2b	163.2bc	112.5c	66.6c	21.7a	8.7c	9.3c	15.0b	7.7d
2	Cedar wood oil	1000	16.0ab	16.0a	11.6c	12.3c	194.6b	165.0bc	124.3c	79.2c	21.7a	11.3b	12.3b	17.3b	11.0bc
3	Eucalyptus oil	1000	14.3ab	12.3a	19.6ab	14.6bc	173.2b	149.5bc	114.7c	89.5c	19.3a	10.7bc	11.0bc	17.0b	11.3bc
4	Lemon grass oil	1000	13.3ab	13.6a	21.0a	15.3bc	187.6b	137.6c	98.1c	85.1c	23.3a	10.3bc	10.7bc	16.3b	12.7b
5	Neem azal	1000	11.0b	14.6a	15.0bc	17.6ab	119.5c	130.6c	95.5d	65.9c	20.0a	10.7bc	11.0bc	16.0b	11.7bc
6	Dinotefuran	200	13.6ab	14.6a	21.3a	15.0bc	81.4d	57.0d	40.0b	22.9d	20.7a	5.3d	6.0d	16.7b	5.0e
7	Rynaxypyr	150	12.0b	15.0a	20.0a	16.3bc	172.8b	186.5d	183.9	138.4b	20.7a	12.0b	12.7b	17.3b	10.0c
8	Untreated Control	Water	21.0a	13.0a	18.3ba	21.3a	239.8a	254.6a	250.9a	220.2a	18.3a	26.7a	46.7a	26.7a	36.7a

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd...) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	White-backed Planthopper(No./10 hills)											Mean
			LDN				MTU		NDL	NVS				
			66DAT	82DAT	87DAT	91DAT	55DAT	65DAT	50DAT	60DAT	63DAT	70DAT	73DAT	
1	Camphor oil	1000	8.7c	13.0b	7.3bc	8.0bc	7.7ab	3.3c	10.0b	9.3a	4.3de	11.7a	5.3cd	30.5
2	Cedar wood oil	1000	12.0b	14.0b	10.3b	11.0b	8.0ab	13.0a	6.3b	10.7a	6.3c	12.0a	7.3b	33.5
3	Eucalyptus oil	1000	12.3b	13.3b	10.0b	10.7b	11.3a	5.7bc	5.0b	9.7a	5.0d	11.7a	6.7bc	31.6
4	Lemon grass oil	1000	13.0b	13.3b	10.0b	11.0b	5.3ab	10.0ab	13.8ab	10.3a	7.7b	12.3a	8.3b	31.7
5	Neem azal	1000	12.0b	12.7b	9.7b	10.0bc	12.7a	10.0ab	5.7b	10.7a	3.7e	12.0a	4.7d	26.8
6	Dinotefuran	200	6.3c	9.0c	3.7c	4.7c	2.0b	9.0abc	14.5ab	10.3a	2.3f	11.7a	3.7de	16.5
7	Rynaxypyr	150	12.3b	13.7b	11.0b	11.7b	14.3a	7.7abc	48.8a	9.0a	1.7f	12.0a	2.0e	40.1
8	Untreated Control	Water	50.0a	30.0a	35.0a	40.0a	10.0ab	10.3ab	8.7b	10.0a	11.3a	13.7a	15.0a	59.5

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd...) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Leaf Folder damage (% damaged leaves)												
			BPT			CBT	CHN		GVT	KRK		LDN			
			DAT1	DAT2	DAT3	47DAT	30DAT	50DAT	60DAT	30DAT	50DAT	36DAT	41DAT	46DAT	56DAT
1	Camphor oil	1000	5.3a	3.6ab	3.0bc	10.2cd	4.1c	4.3bc	1.6b	13.1abc	33.5ab	9.7b	6.9bc	6.9bc	8.0b
2	Cedar wood oil	1000	4.9ba	3.8ab	2.3cd	11.8bc	5.0b	5.2b	1.3b	16.5a	33.3ab	11.6a	6.7bc	6.9bc	7.7b
3	Eucalyptus oil	1000	4.0ba	1.0c	3.5b	13.3b	3.1d	3.3de	1.2b	15ab	31.2ab	10.7ab	6.8bc	6.8bc	7.1bc
4	Lemon grass oil	1000	4.6ab	3.0b	1.8d	8.7d	4.7bc	4.7bc	1.6b	14.5abc	34.6ab	9.2b	5.2d	5.8d	6.2c
5	Neem azal	1000	3.4ab	3.3b	2.4cd	12.0b	3.3d	3.9cd	1.1b	14abc	38.2a	9.5b	5.8cd	6.3cd	7.0bc
6	Dinotefuran	200	5.4a	2.3bc	3.3cb	9.7d	1.8e	2.8ef	1.5b	14.4abc	37.3a	9.5b	7.3b	7.5b	7.8b
7	Rynaxypyr	150	2.9b	3.2b	1.4d	6.5e	1.5e	1.9f	0.7b	9.4bc	38.6a	10ab	3.3e	3.8e	4.0d
8	Untreated Control	Water	5.4a	5.3a	6.2a	16.0a	7.0a	7.2a	6.8a	8.5c	26.3b	9.6b	10.8a	12.3a	13.3a

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd...) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Leaf Folder damage (% damaged leaves)												
			LDN					MLN		MSD		NDL			
			61DAT	66DAT	82DAT	87DAT	91DAT	48DAT	68DAT	30DAT	50DAT	50DAT	60DAT	70DAT	80DAT
1	Camphor oil	1000	6.1bc	6.6b	7.0bc	6.2c	6.5b	19.0b	21.9b	9.8b	8.5b	7.2ab	6.0a	4.9a	5.0ab
2	Cedar wood oil	1000	6.2bc	6.7b	6.9bc	6.1c	6.2bc	14.8bc	19.6b	9.6b	7.1c	5.6b	4.5ab	5.1a	4.7ab
3	Eucalyptus oil	1000	6.1bc	6.6b	6.8bc	6.3c	6.5b	11.1bc	20.2b	10.9b	6.4c	7.4ab	3.4b	4.8a	3.6b
4	Lemon grass oil	1000	4.9c	5.1c	5.5d	5.1d	5.2c	14.93c	18.1b	10.5b	5.0d	8.3ab	5.3ab	4.7a	5.0ab
5	Neem azal	1000	6.2bc	6.2bc	6.3cd	5.9cd	6.0bc	13.0c	18.3b	10.1b	4.2de	10.1a	5.8ab	5.6a	4.3b
6	Dinotefuran	200	7.6b	7.2b	7.3b	7.0b	7.1b	15.2c	19.4b	9.7b	3.4ef	9.6a	5.6ab	5.4a	6.3ab
7	Rynaxypyr	150	3.0d	3.5b	3.8e	2.7e	3.0d	15.2bc	18.4b	10.0b	2.4f	1.2c	0.6c	0.8b	2.0c
8	Untreated Control	Water	14.2a	14.6a	15.9a	17.1a	18.0a	47.6a	57.4a	15.5a	21.3a	6.9ab	4.4ab	5.8a	4.1b

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Leaf Folder damage (% damaged leaves)									Mean
			NVS		PSA		PTB	RCI		TTB		
			30DAT	50DAT	30DAT	50DAT	45DAT	78DAT	88DAT	30DAT	50DAT	
1	Camphor oil	1000	4.4d	4.5d	9.4bc	8.9b	27.7abc	68.0a	39.0bc	2.1cd	1.8d	11.2
2	Cedar wood oil	1000	6.1c	6.9b	9.7bc	10.0b	39.9ab	67.0a	43.7b	4.8b	4.1c	11.8
3	Eucalyptus oil	1000	5.3cd	5.7c	8.9bc	10.0b	48.1a	67.3a	36.0c	4.7b	5.1b	11.4
4	Lemon grass oil	1000	7.1b	7.6b	10.1b	8.7b	31.7abc	67.3a	43.7b	5.0b	5.0b	11.1
5	Neem azal	1000	3.2e	3.6e	10.1b	8.6b	14.8bc	70.7a	20.0d	3.0c	3.3c	10.0
6	Dinotefuran	200	2.7e	3.0ef	8.8bc	8.9b	36.1ab	70.7a	10.7e	5.0b	6.2a	10.7
7	Rynaxypyr	150	2.3e	2.5f	7.6c	5.7c	3.5c	70.7a	14.3e	1.7d	1.7d	7.5
8	Untreated Control	Water	10.2a	14.0a	13.4a	15.5a	37.4ab	70.0a	77.7a	7.2a	6.0a	18.0

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Whorl Maggot (%Damages Leaves)											Mean
			CHN		JDP		MLN		NDL	PTB		TTB		
			30DAT	50DAT	30DAT	55DAT	48DAT	68DAT	50DAT	25DAT	45DAT	30DAT	50DAT	
1	Camphor oil	1000	5.8bc	3.4b	7.4a	3.8ab	19.6b	11.9bc	7.7ab	2.5b	5.5a	3.2c	3.2cd	6.7
2	Cedar wood oil	1000	7.0b	4.0b	7.8a	5.6a	17.7b	11.5bc	7.5ab	2.4b	6.1a	3.2c	3.8bc	7.0
3	Eucalyptus oil	1000	3.7d	2.5c	7.3a	3.9ab	19.6b	12.6bc	7.9ab	3.1b	5.3a	3.4c	3.7bc	6.6
4	Lemon grass oil	1000	5.1c	3.8b	6.5ab	3.6ab	20.4b	36.9b	8.3a	4.5b	8.2a	3.6c	4.2b	9.5
5	Neem azal	1000	3.1de	1.8cd	6.3ab	4.9a	13.6b	10.3bc	5.9bc	3.2b	5.9a	1.9d	4.3b	5.6
6	Dinotefuran	200	1.9e	1.0d	4.0c	2.6b	19.3b	9.2c	4.6c	4.1b	6.4a	5.0b	2.8d	5.5
7	Rynaxypyr	150	3.2de	2.1c	4.7bc	2.4b	18.1b	10.8bc	5.0c	3.9b	5.6a	1.8d	1.2f	5.3
8	Untreated Control	Water	9.2a	5.5a	8.0a	4.8a	73.5a	77.7a	7.9ab	10.5a	6.2a	7.0a	6.5a	19.7

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Green Leafhopper (No./10hills)							
			CBT	GVT				JDP		NVS
			47DAT	40DAT	60DAT	80DAT	100DAT	60DAT	70DAT	60DAT 63DAT
1	Camphor oil	1000	4.0ab	18.9abc	16.3c	13.0c	8.1c	14.0ab	17.0ab	9a 4.3d
2	Cedar wood oil	1000	2.6bc	17.4bc	18.1c	13.7c	10.4c	17.0ab	16.0ab	9.7a 7.3b
3	Eucalyptus oil	1000	2.0bc	18.5bc	17.4c	11.8c	9.3c	16.0ab	17.3ab	10.0a 6.0c
4	Lemon grass oil	1000	1.3c	17.4bc	14.1c	12.6c	7.4cd	18.7ab	17.3ab	9.7a 8.0b
5	Neem azal	1000	1.6c	20.7ab	16.3c	11.5c	10.0c	14.3ab	14.3ab	9.3a 3.7de
6	Dinotefuran	200	1.3c	11.5c	12.6c	5.9c	3.0d	9.7b	9.7b	10.0a 2.7e
7	Rynaxypyr	150	1.3c	20.4ab	31.1b	42.6b	24.4b	8.7b	8.3b	9.3a 1.3f
8	Untreated Control	Water	5.3a	27.0a	41.8a	54.4a	31.1a	22.0a	23.7a	9.3a 11.7a

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Green Leafhopper (No./10hills)								Mean
			NVS		RCI		RPR		TTB		
			70DAT	73DAT	79DAT	82DAT	50DAT	70DAT	30DAT	50DAT	
1	Camphor oil	1000	12a	5.7c	68a	50.3bc	6a	7.3a	4.3cde	4cd	15.4
2	Cedar wood oil	1000	12.3a	8.7b	76.7a	57.7b	4.7a	7.3a	7.3b	6.3b	17.2
3	Eucalyptus oil	1000	12.3a	6.7c	68.7a	48.7bcd	6.7a	8.0a	6.0bc	5.3bc	15.9
4	Lemon grass oil	1000	12.3a	9.3b	72.3a	49.7bcd	7.3a	7.3a	6.0bc	5.3bc	16.2
5	Neem azal	1000	12.0a	4.3d	76.7a	31.3e	4.7a	8.0a	4.0de	3.7cd	14.5
6	Dinotefuran	200	11.7a	2.7e	79.0a	39.0e	5.7a	7.3a	5.7bcd	6.3b	13.2
7	Rynaxypyr	150	11.7a	1.3f	78.0a	43cd	5.3a	12a	3.7e	3.3d	18.0
8	Untreated Control	Water	13.7a	16a	77.3a	85.7a	8.7a	12a	12.3a	14.7a	27.4

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Hispa damage (% Damaged leaves)					Mean
			RCI		MLN		RPR	
			33DAT	40DAT	48DAT	68DAT		
1	Camphor oil	1000	60.7a	24.7c	8.2b	6.6b	5.2a	21.0
2	Cedar wood oil	1000	61.3a	26.3c	3.6d	3.3b	4.5a	19.8
3	Eucalyptus oil	1000	65.3a	19.3cd	5.1bcd	3.4b	5.8a	19.8
4	Lemon grass oil	1000	63.7a	40.0b	7.4bcd	2.7b	5.1a	23.8
5	Neem azal	1000	60.3a	22.3d	4.4cd	2.9b	4.1a	18.8
6	Dinotefuran	200	62.0a	10.7d	5.4bcd	6.5b	4.7a	17.9
7	Rynaxypyr	150	61.0a	16.3cd	7.8bc	6.8b	4.4a	19.3
8	Untreated Control	Water	65.3a	72.3a	51.9a	57.0a	5.1a	50.3

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Insect pest incidence in different treatments, BIET, Kharif 2018

Table 2: (Contd.) Effect of different treatments on Gundhi bug incidence in different treatments, 2021, Peshawar							
S. No.	Common Name	Rate g or ml of formula tion/ha	Gundhi Bug (%Damage)				Mean
			NVS				
			70DAT	73DAT	80DAT	83DAT	
1	Camphor oil	1000	9.0a	4.3e	11.7a	5.0ed	7.5
2	Cedar wood oil	1000	9.7a	7.0c	12.0a	7.3c	9.0
3	Eucalyptus oil	1000	9.3a	5.7d	11.7a	6.3cd	8.3
4	Lemon grass oil	1000	9.7a	8.3b	12.0a	9.0b	9.7
5	Neem azal	1000	9.3a	3.3ef	11.7a	4.3e	7.2
6	Dinotefuran	200	8.3a	3.0f	11.7a	3.7e	6.7
7	Rynaxypyr	150	8.7a	1.7g	11.3a	2.0f	5.9
8	Untreated Control	Water	9.3a	11.3a	13.3a	15a	12.2

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formulation/ha	Blue beetle (% Damaged leaves)		Mean
			PTB		
			25DAT	45DAT	
1	Camphor oil	1000	31.7a	15.4ab	23.5
2	Cedar wood oil	1000	18.5b	17.5ab	18.0
3	Eucalyptus oil	1000	27.4ab	20.7a	24.0
4	Lemon grass oil	1000	21.6ab	17.4ab	19.5
5	Neem azal	1000	22.1ab	23.2a	22.6
6	Dinotefuran	200	18.1b	11.9b	15.0
7	Rynaxypyr	150	19.1b	16.6ab	17.8
8	Untreated Control	Water	23.2ab	23.1a	23.2

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Insect pest incidence in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	Grasshopper (% Damage)		Mean
			KHD		
			62DAT	70DAT	
1	Camphor oil	1000	37.7a	10.7b	24.2
2	Cedar wood oil	1000	36.0a	9.3bc	22.7
3	Eucalyptus oil	1000	40.3a	9.0bcd	24.7
4	Lemon grass oil	1000	38.7a	8.3bcde	23.5
5	Neem azal	1000	35.0a	7.0cde	21.0
6	Dinotefuran	200	39.0a	5.0e	22.0
7	Rynaxypyr	150	41.7a	5.7de	23.7
8	Untreated Control	Water	40.7a	52.7a	46.7

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Incidence of natural enemies in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formulation/ha	No of spiders/10hills						
			CBT	CHP		GVT			LDN
			47DAT	56DAT	76DAT	40DAT	60DAT	80DAT	36DAT
1	Camphor oil	1000	4.6a	5.3b	3.3cd	33.7ab	28.1ab	20.7b	24.0b
2	Cedar wood oil	1000	6.3a	4.3bc	4.0cd	29.6abc	27.8b	22.9b	22.9b
3	Eucalyptus oil	1000	5.3a	4.6bc	3.3cd	27.4abc	21.1bc	22.2b	27.4b
4	Lemon grass oil	1000	6.0a	3.3cd	3.0de	23.3bc	24.4b	19.2bc	23.3b
5	Neem azal	1000	6.3a	5.3b	4.3bc	29.2abc	22.2bc	17.4bc	22.2b
6	Dinotefuran	200	0.3b	2.6d	2.0e	20.7c	14.8c	11.1c	10.0c
7	Rynaxypyr	150	0.0b	5.0b	5.3b	25.2abc	14.8c	9.3d	8.5c
8	Untreated Control	Water	6.3a	9.6a	11.3a	34.4a	36.3a	40.3a	39.2a

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Incidence of natural enemies in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	No. of spiders/10hills												Mean	
			LDN					NDL								RPR
			41DAT	46DAT	56DAT	61DAT	66DAT	30DAT	40DAT	50DAT	60DAT	70DAT	80DAT	70DAT		
1	Camphor oil	1000	6.7de	7.3cd	11.3b	7.7cd	8.3bcd	6.0ab	4.7a	8.7a	9.3a	3.0a	6.3ab	6.7a	10.8	
2	Cedar wood oil	1000	7.3cd	8.0bcd	11.0b	7.7cd	9.0bc	5.0ab	6.3a	7.0a	13.0a	6.3a	6.7ab	4.0ab	11.0	
3	Eucalyptus oil	1000	8.0bc	8.3bc	11.7b	8.7bc	9.3bc	6.7a	7.0a	7.0a	11.3a	4.3a	7.0ab	5.3ab	10.8	
4	Lemon grass oil	1000	8.0bc	8.3bc	11.0b	8.3c	8.7bc	4.0ab	6.0a	7.3a	10.3a	5.7a	6.7ab	4.0ab	10.1	
5	Neem azal	1000	8.7b	9.3b	12.0b	9.7b	10.0b	2.0b	8.7a	5.7a	11.7a	6.3a	9.7a	5.3ab	10.9	
6	Dinotefuran	200	7.0cd	7.7cd	12.0b	7.0d	7.7cd	3.5ab	6.7a	8.7a	7.0a	8.0a	6.3ab	2.7b	7.9	
7	Rynaxypyr	150	5.7e	6.7d	11.3b	5.7e	6.7d	6.0ab	7.3a	11.0a	12.3a	5.7a	6.7ab	6.0a	8.6	
8	Untreated Control	Water	14.0a	15.3a	17.0a	19.7a	23.0a	6.0ab	7.3a	8.7a	13.0a	4.0a	4.3b	6.7a	16.5	

Means in columns followed by different letters are significantly different at P=0.05

Table 2.16 (Contd..) Incidence of natural enemies in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formula tion/ha	No. of mirids/10 Hills								Mean
			CBT	GVT				LDN	SKL		
			47DAT	40DAT	60DAT	80DAT	100DAT	41DAT	80DAT	100 DAT	
1	Camphor oil	1000	2.6b	28.5a	27.8ab	38.1ab	37.0ab	6.0cd	1.5b	3.3a	14.8
2	Cedar wood oil	1000	1.3bc	28.5a	24.4b	29.2b	33.3b	7.0bc	1.6b	2.9ab	13.2
3	Eucalyptus oil	1000	0.3c	23.7a	29.2ab	33.3b	32.9b	6.7bcd	1.7b	3.3ab	13.5
4	Lemon grass oil	1000	2.3b	25.9a	28.1ab	37.7b	32.2b	6.7bcd	1.8b	2.9ab	14.1
5	Neem azal	1000	2.3b	22.6a	25.9b	32.2b	32.6b	7.3b	1.9ab	2.5b	13.1
6	Dinotefuran	200	0	10.0b	9.3c	13.0c	10.4c	5.7d	2.3a	2.6ab	5.7
7	Rynaxypyr	150	0.3c	21.8ab	31.1ab	30.7b	24.4b	7.7b	1.9ab	2.7ab	12.4
8	Untreated Control	Water	7.3a	27.4a	38.1a	51.8a	46.6a	14.0a	2.2a	3.3a	19.5

Means in columns followed by different letters are significantly different at P=0.05

Table 2.17 Grain Yield in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formulation/ha	Yield kg/ha											
			RNR	BPT	CBT	CHN	CHP	GVT	JDP	KHD	KJT	KRK	LDN	MLN
1	Camphor oil	1000	4893.3bc	5306.7cd	4818.3abc	5383.3d	4386.9c	8510.0ab	3168.3abc	10044.4b	13466.7de	1650.0a	5958.8d	2929.7a
2	Cedar wood oil	1000	4686.6c	5633.3abc	4283.3bc	5000.0d	4484.9bc	8556.25ab	3270.0abc	10355.6ab	16933.3c	2058.3a	6107.1bcd	3095.5a
3	Eucalyptus oil	1000	5120.0ab	5280.0cd	4278.3bc	6850.0c	4563.2b	8787.5a	3033.3bc	10488.9ab	12600.0e	1775.0a	6041.2cd	2699.1a
4	Lemon grass oil	1000	4800.0c	5491.6bc	4411.7abc	4933.3d	4347.8c	8972.5a	3171.7abc	10466.7ab	15066.7d	1983.3a	6074.1cd	2893.7a
5	Neem azal	1000	5260.0a	5590.0abc	4266.5bc	6566.6c	4171.5d	8741.25a	3066.7bc	10688.9ab	18100.0bc	1816.7a	6222.2bc	3009.0a
6	Dinotefuran	200	5100.0b	6215.0ab	5073.6ab	7583.3b	4563.2b	10313.75a	3761.7ab	11400a	18733.3ab	2350.0a	6353.9ab	2810.8a
7	Rynaxypyr	150	4913.3bc	6425.0a	5218.3a	8600.0a	5189.9a	9481.25a	3863.3a	11244.4a	19800.0a	2100.0a	6485.6a	2785.6a
8	Untreated Control	Water	4180.0d	4461.7d	4025.8c	3900.0e	3427.3e	6752.5b	2763.3c	9644.4b	9466.7f	1436.7a	5316.9e	1704.5b

Means in columns followed by different letters are significantly different at P=0.05

Table 2.17 Grain Yield in different treatments, BIET, Kharif 2018

S. No.	Common Name	Rate g or ml of formulation/ha	Yield kg/ha										Mean	IOC(%)
			MSD	MTU	NDL	NVS	PSA	PTB	RCI	RPR	SKL	TTB		
1	Camphor oil	1000	2929.7e	38459.3ab	2963.3ab	3712.0cd	5194.0ab	2291.7ab	3599.7ab	6433.3ab	3025.0de	5170.7b	6527.5	18.7
2	Cedar wood oil	1000	3095.5d	36744.0ab	2890.0ab	3541.0de	5040.7b	2388.9ab	3800.0ab	6796.7ab	3130.0cd	3817.3d	6597.9	19.9
3	Eucalyptus oil	1000	2699.1d	37014.0b	2548.3a	3618.0de	4973.7bc	2152.8b	3800.0ab	6100.0bc	3060.0cde	4714.7c	6458.6	17.4
4	Lemon grass oil	1000	2893.7d	35779.4b	2481.7b	3343.7ef	5799.0ab	2069.4b	3577.7ab	6433.3ab	2788.3de	3916.0dab	6428.9	16.9
5	Neem azal	1000	3009.0c	38383.5ab	2815.0ab	3935.3bc	5807.0ab	2430.6ab	4111.3a	6425.0ab	3480.0bc	5402.7d	6961.4	26.5
6	Dinotefuran	200	2810.8b	32911.9b	3481.7a	4038.0b	5776.0ab	2027.8b	4244.3a	6566.7ab	3586.7b	4493.3c	7018.6	27.6
7	Rynaxypyr	150	2785.6a	44424.7a	2778.3ab	4355.3a	5978.0a	3097.2a	4355.3a	6916.7a	4113.3a	5512.0a	7768.8	41.2
8	Untreated Control	Water	1704.5f	35455.1b	2815.0ab	3163.7f	4097.0c	2180.6b	2866.7b	5616.7c	2691.7e	3402.7e	5501.1	

Means in columns followed by different letters are significantly different at P=0.05

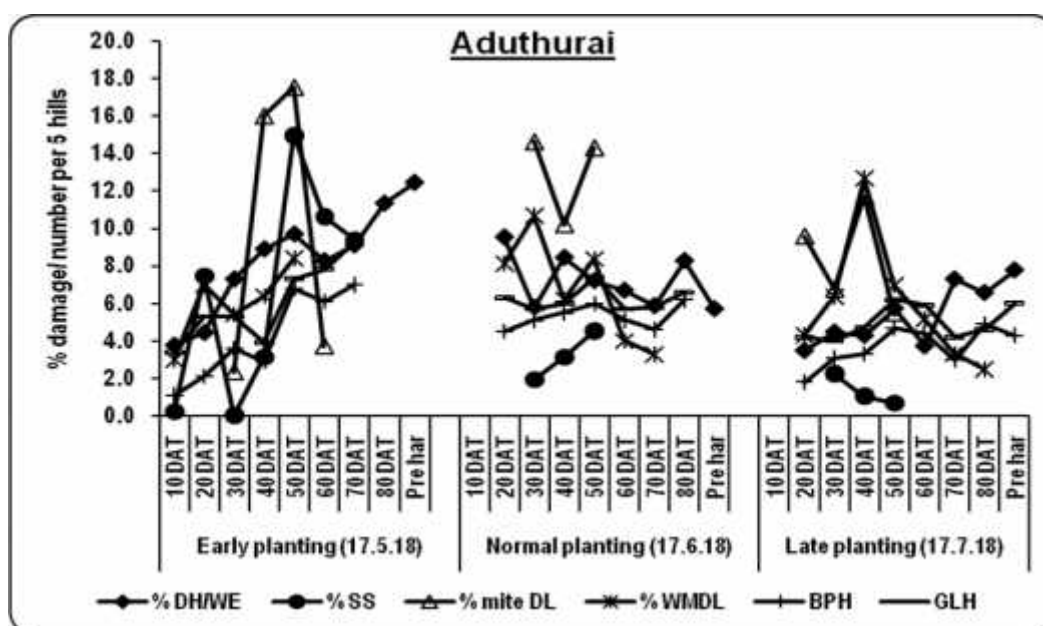
ECOLOGICAL STUDIES

In India, climate change effects are becoming more visible every year through temperature and rainfall fluctuations affecting the farming systems by disrupting the normal planting schedule. Consequently, alternative planting and harvesting dates are suggested as potential farm-level adaptations to climate variability. It is vital to have the knowledge of population dynamics of insect pests in relation to planting dates and crop phenology for their efficient management. Hence, the trial on effect of planting dates on insect pest incidence was continued and the results are presented below.

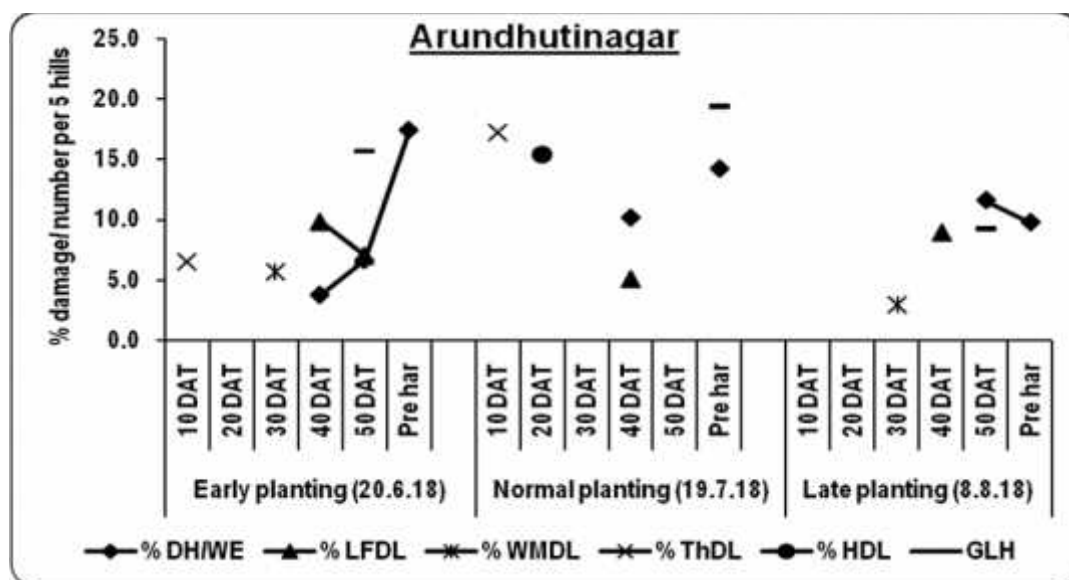
Effect of Planting Dates on Insect Pest Incidence (EPDP)

During *Kharif* 2018, effect of planting dates on insect pest incidence trial was conducted at 21 locations. At each location, most popular variety of that region was planted at three dates *viz.*, normal planting as per the recommended package of practices of that region, 20 days earlier to normal planting, designated as 'early planting' and 20 days later than the normal planting, designated as 'late planting'. Each time, sowing of the nursery and planting was done separately in 500 sq. m area. Observations on insect pest incidence were recorded on ten randomly selected hills at 10 day interval starting from the first appearance of the pest. Location wise pest incidence at different dates of planting is discussed here.

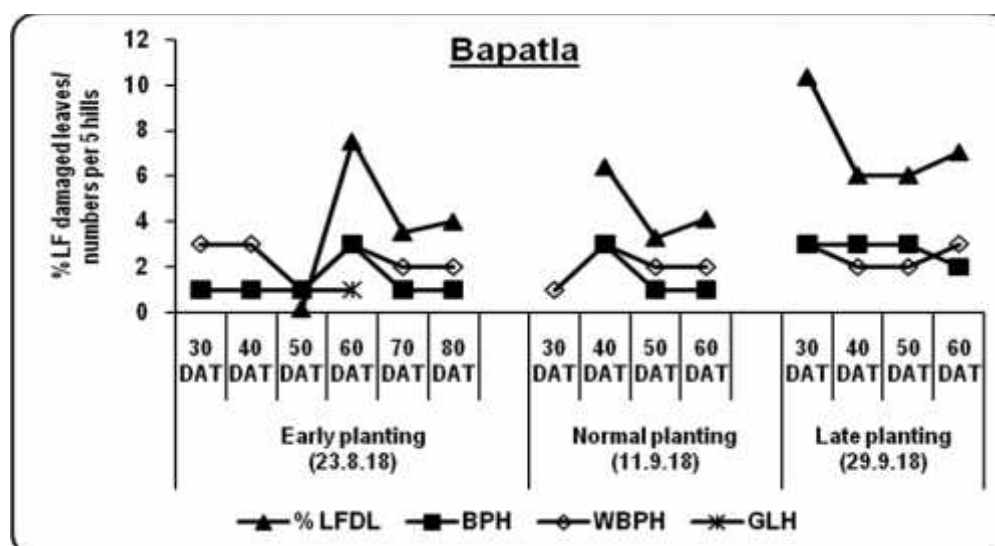
1) Aduthurai (11° 02' N & 79° 48' E): Leaf mite incidence was observed for the first time in different plantings. Low incidence of yellow stem borer (3.5 – 12.4%), gall midge (0 – 15%), leaf mite (2.3-17.5%), whorl maggot (2.5 – 12.7%), leaf folder (<5%), thrips (<6%), hispa (<10%), brown planthopper (< 1/hill) and green leafhopper (<1/hill) were observed in all the plantings on ADT 43 variety grown in this trial. Grain yield of 60.0, 85.0 and 57.5 q/ ha was recorded from early, normal and late plantings, respectively.



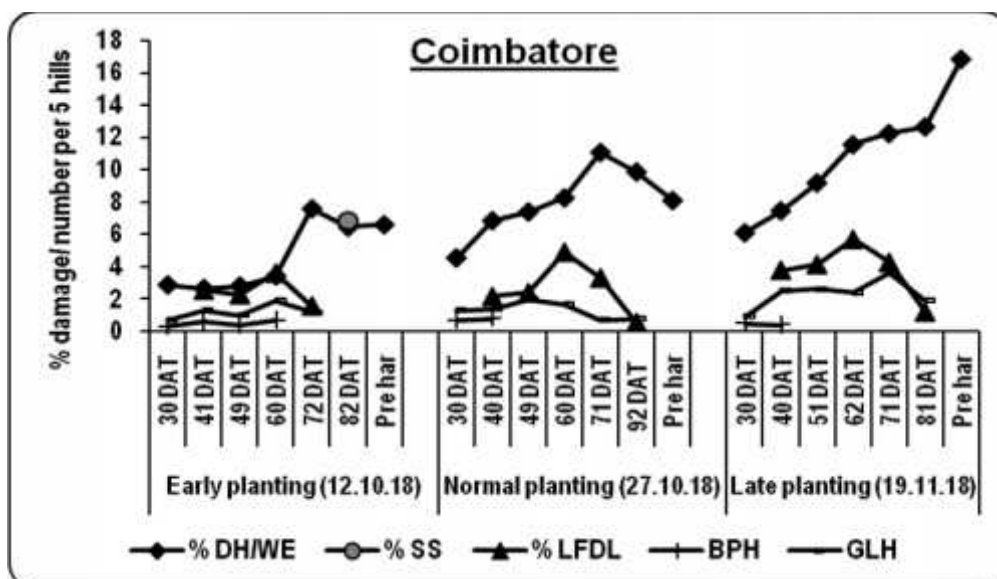
2) Arundhuthinagar (24° 16' N & 92° 13' E): Swarna (MTU 7029) variety was grown in this trial in all the three plantings. Low incidence of stem borer (3.8 -17.4%), leaf folder (5.1-9.9%), whorl maggot (<6%), green leafhopper (<5/hill) was observed in all the plantings. However, moderate incidence of thrips (17.2%) and hispa (15.4%) was observed in normal planting alone. Grain yield varied from 31.0 to 37.4 q/ ha in different plantings.



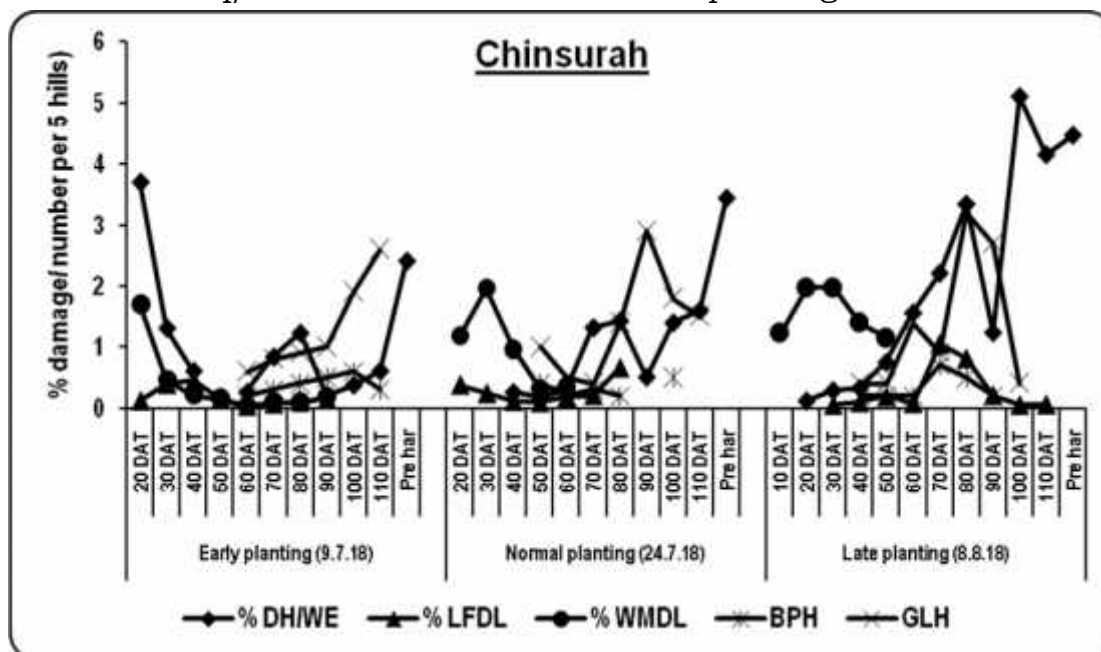
3) Bapatla (15° 90' N & 80° 47' E): Very low incidence of leaf folder, BPH, WBPH and GLH was observed in all the three plantings starting from 30 DAT onwards in BPT 5204. Grain yield of 45.2, 52.6 and 42.9 q/ ha was recorded in early, normal and late plantings, respectively.



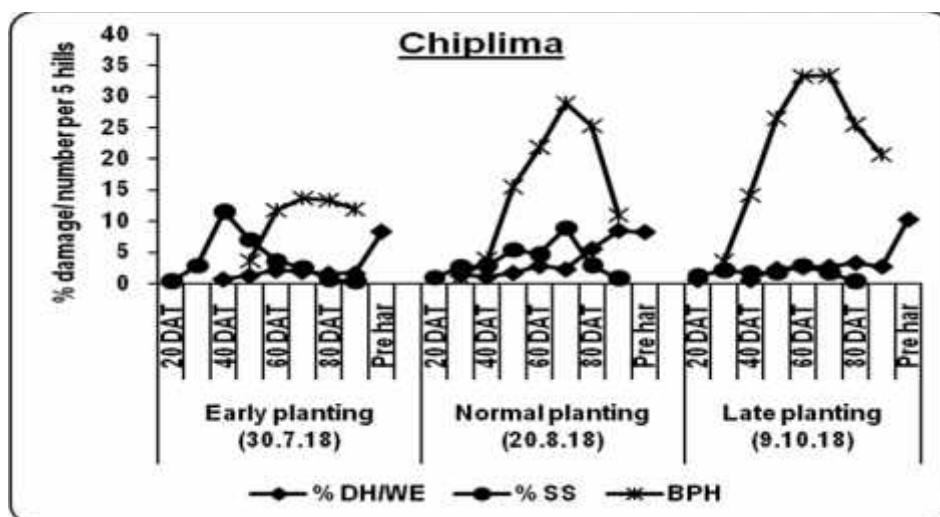
4) Coimbatore (11° 02' N & 76° 95' E): Low incidence of stem borer (2.7 – 16.8%), gall midge (<7%), leaf folder (<6%), BPH (<1/hill) and GLH (<1/hill) incidence was reported on CO 51 grown in all the plantings at this location. Grain yield varied from 46.8 to 49.0 q/ ha in all the three plantings.



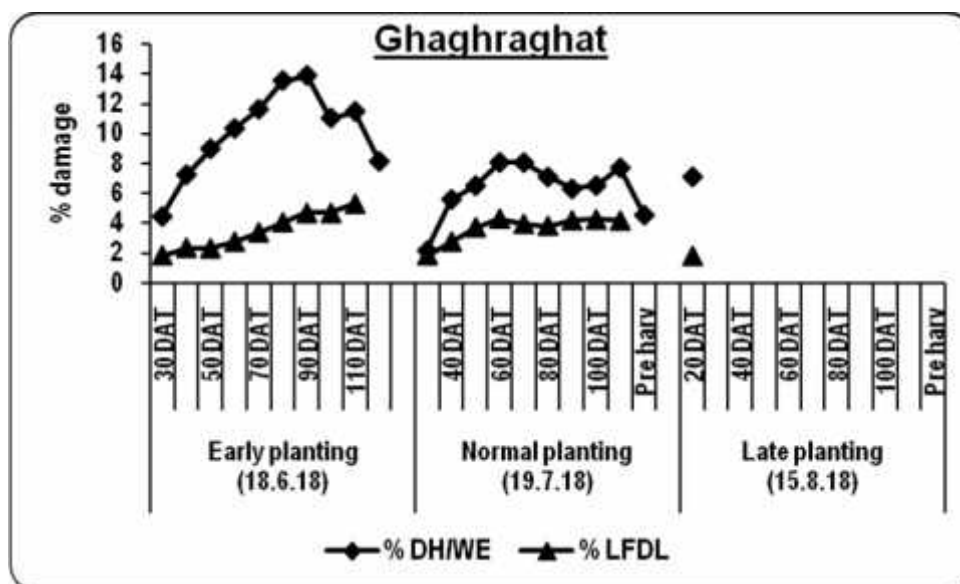
5) Chinsurah (22° 88' N & 88° 39' E): Very low incidence of stem borer (< 5%), leaf folder (< 2%), whorl maggot (2%), hispa (<2%), BPH, WBPH and GLH (<1/hill) was observed in Swarna (MTU 7209) variety grown in all the plantings. Grain yield of 39.2 – 44.2 q/ ha was recorded in different plantings.



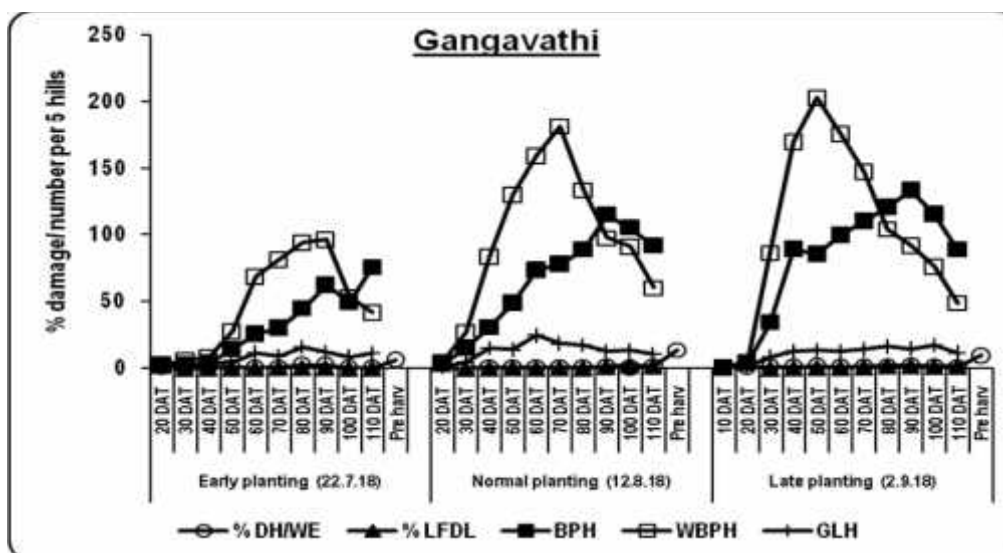
6) Chiplima (21° 46'N & 83° 98'E): Incidence of stem borer (0.5 – 10.2%), gall midge (0.3-11.5%) and BPH (< 6/hill) was observed in Jaya variety grown in all the three plantings. Grain yield of 35.5, 28.0 and 18.0 q/ ha was recorded in early, normal and late plantings, respectively.



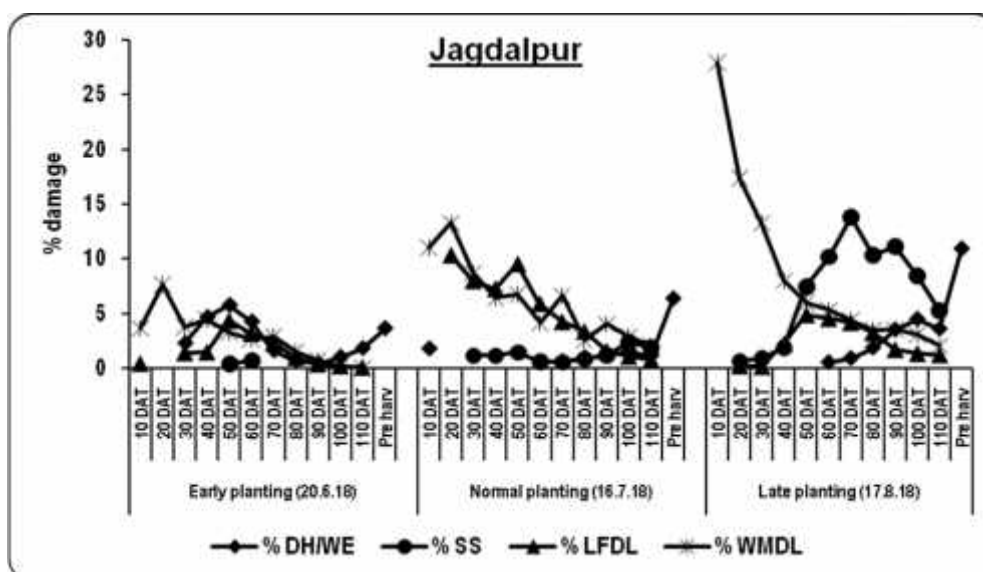
7) Ghaghraghat (28° 63'N & 77° 22'E): Incidence of stem borer (2.2 – 13.8%) and leaf folder (< 6%) was low in NDGR 201 variety grown in all the plantings at this location. Grain yields of 36.0 – 38.0 q/ ha were recorded from the three plantings.



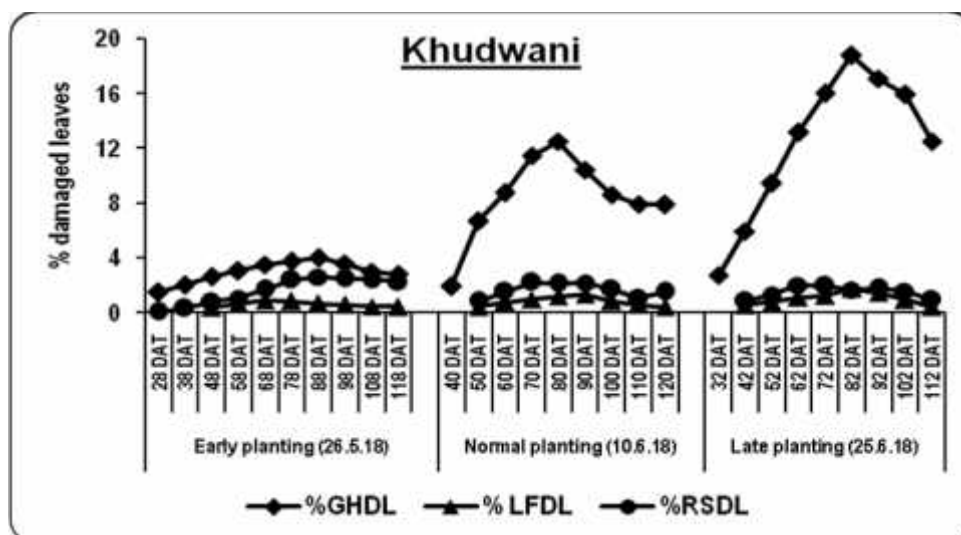
8) Gangavathi (15° 43' N & 76° 53' E): Planthopper population was high in all the three plantings on BPT 5204 grown in this trial. BPH and WBPH population was high in normal and late plantings as compared to early planting. BPH population crossed ETL in normal planting at 90 DAT onwards and in late planting, 70 DAT onwards. WBPH numbers crossed ETL from 50 DAT onwards in normal planting and 40 DAT onwards in late planting. WBPH population was high (48 – 101 per hill) as compared to BPH population (31 – 80) in all the three plantings. Low incidence of stem borer (0.3-13.5%), leaf folder (<5%) and GLH (<6/hill) was recorded. Grain yield of 75.0, 62.5 and 50.0 q/ ha was recorded in early, normal and late plantings, respectively.



9) Jagdalpur (19° 4' N & 82° 0' E): Swarna variety was grown in all the three plantings at this location. Whorl maggot incidence was high in late planting from 10 to 30 DAT (13.3 – 27.9%). Incidence of other pests like stem borer (0.5 – 10.9%), gall midge (0.4 – 14%), leaf folder (0.1-10.3%), BPH (<1/hill), WBPH (<1/hill) and GLH (<3/hill) was observed in all the plantings. Grain yield varied from 28.8 – 49.0 q/ ha in all the three plantings.

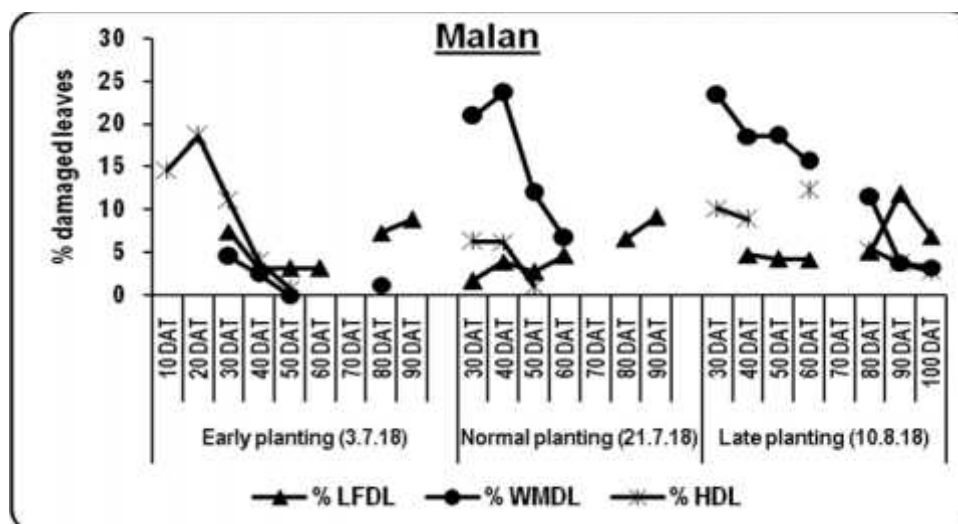


10) Khudwani (33° 71' N & 75° 10' E): Incidence of grasshopper, leaf folder and rice skipper was observed in Jhelum variety grown in all the plantings. Damage by grasshopper was high in late planting from 62 to 112 DAT (12.5 – 18.8%) and low ($\leq 12\%$) in early and normal plantings., Very low incidence of leaf folder (<2%) and rice skipper (<3%) was also reported under all the three plantings.



11) Karjat (18° 92' N & 73° 33' E): Very low incidence of stem borer (< 6%), leaf folder (< 2%) and case worm (< 2%) was reported from all the three plantings in Karjat 3 variety grown in this trial. Yield of 19.7 – 22.1 q/ ha was recorded in various plantings.

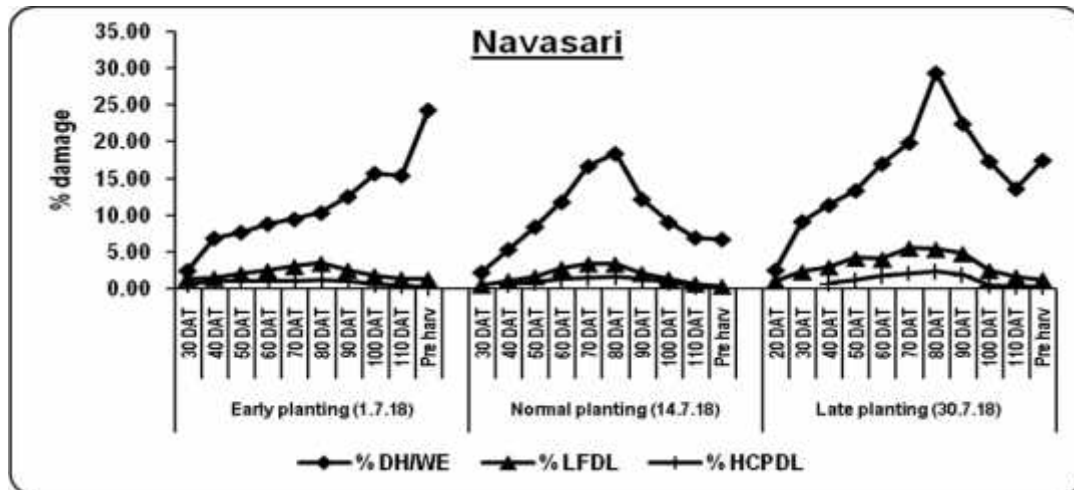
12) Malan (32° 11' N & 76° 25' E): Kasturi variety was grown in all the three plantings at this location. Incidence of whorl maggot was found high starting from 30 – 50 DAT (12.0 – 23.6%) in normal planting and at 30 – 60 DAT (15.6 – 23.3%) in late planting. Hispa damage was found high in early planting starting from 10 DAT to 30 DAT (11.0 – 18.6%) followed by late planting during 30 – 60 DAT (8.8 – 12.2%).



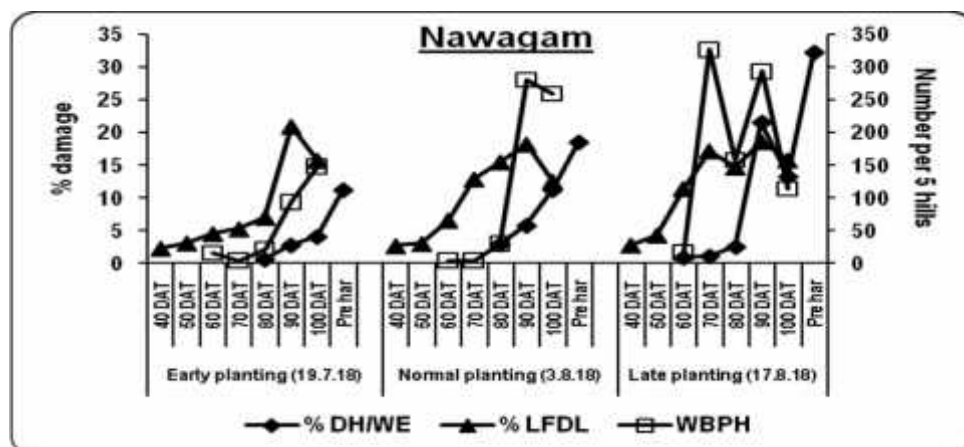
13) Masodha (26°77' N & 82° 14'E): Very low incidence of stem borer (<7%) and leaf folder (< 4%) was observed in Pusa Basmati variety grown in this trial. Yield ranged from 24.4 to 28.6 q/ ha in all the three plantings.

14) Navasari (20° 94' N & 72° 95' E): Stem borer incidence was high in all the three plantings in GR 11 variety. Stem borer damage crossed ETL at 80

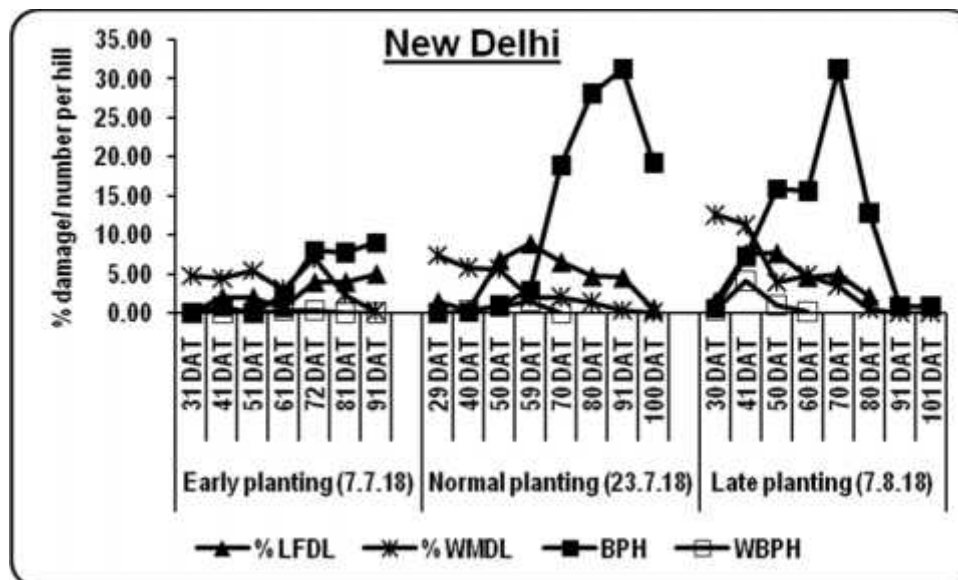
DAT onwards up to pre harvest in early planting (10.2 - 24.3%), at 60-90 DAT in normal planting (11.7-18.3%) and during 40 DAT to pre harvest in late planting (11.3 - 29.3%) with highest damage in late planting. Low incidence of leaf folder (<6%), horned caterpillar (<3%), BPH, WBPH and GLH with less than 4/ hill were recorded. Grain yield of 36.6 to 49.9 q/ ha was recorded in all the three plantings.



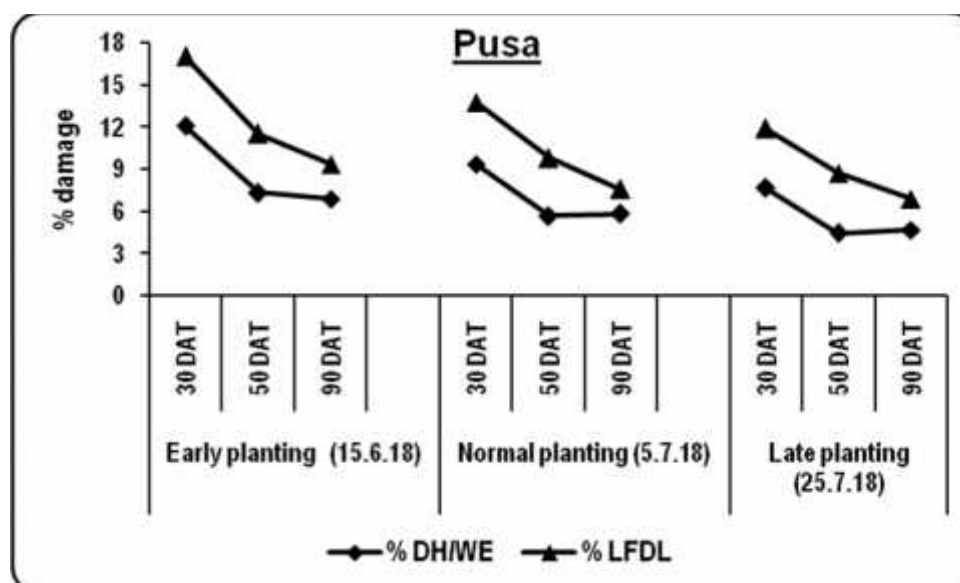
15) Nawagam (23° 26' N & 71° 95' E): White ears caused by stem borer were very high, in late planting (32.3%) followed by normal planting (18.5%) and early planting (11.2%) in GR 11 variety grown at this location. However, dead heart damage was low in all the three plantings (2.5 – 7.9%). WBPH incidence was very high in late planting starting from 70 DAT till harvest (23 -64/ hill) followed by normal planting at 90 DAT and 100 DAT (52 – 56/hill) and at 100 DAT in early planting (29/hill). Damage by leaf folder crossed ETL in late planting (11.4 – 18.6%) at 60 to 100 DAT followed by normal planting (12.6 – 18.2%) at 70 to 100 DAT and at 90 – 100 DAT in early planting (15.7 – 21.0%). Yield varied between 46.3 and 63.5 q/ ha in different plantings.



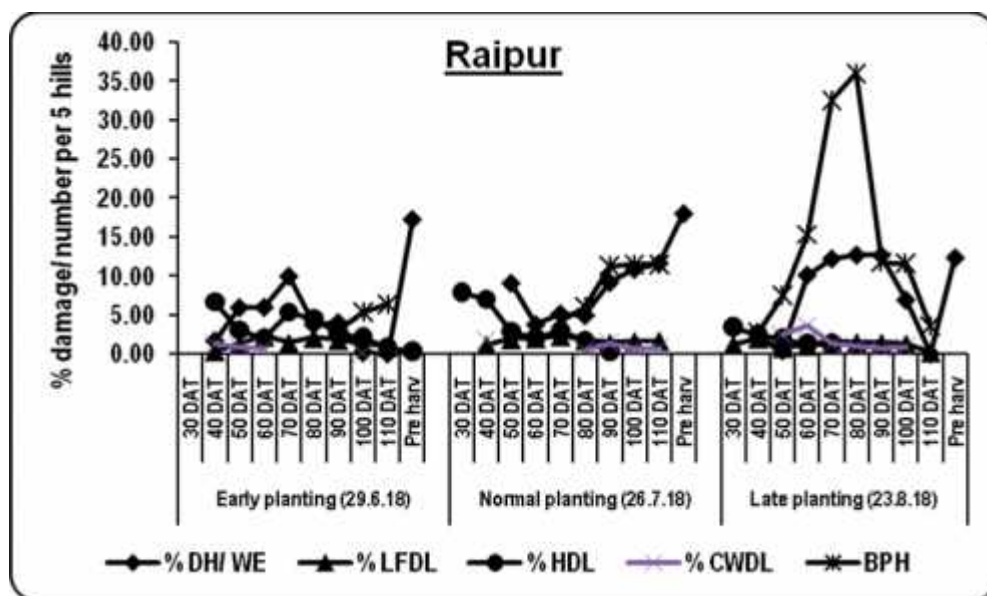
16) New Delhi (28° 61' N & 77° 20' E): BPH incidence crossed ETL from 70 DAT till harvest in normal planting (19 – 31/hill) followed by late planting between 50 DAT and 80 DAT (12.8 – 31.2/hill). Low incidence of other pests like leaf folder (<9%), whorl maggot (<13%) and WBPH (< 5/hill) was noticed. Spiders (<3/hill) and rove beetles (<1/hill) were also recorded in all the three plantings in Pusa 1121 and Pusa 1637 varieties grown in this trial.



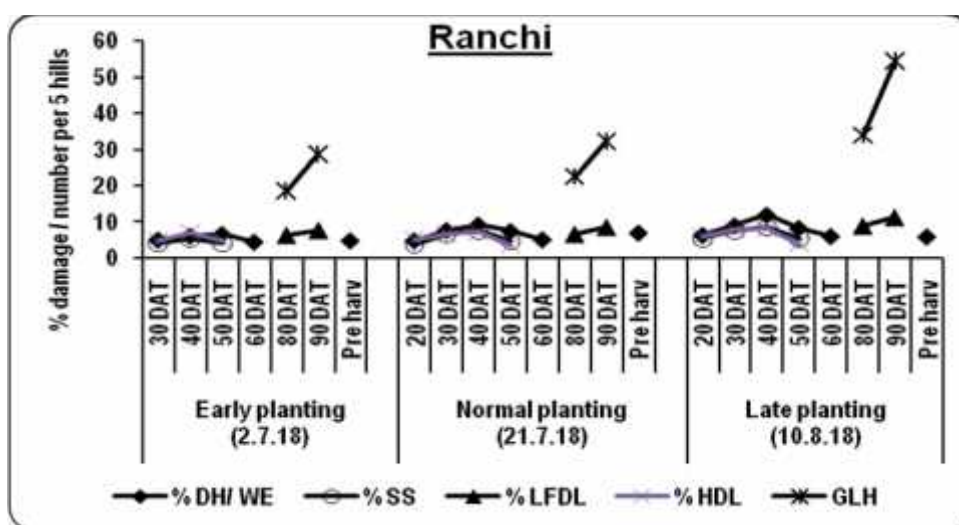
17) Pusa (25°98'N & 85°64' E): Only stem borer and leaf folder incidence was observed in Rajendra mansuri variety grown in this trial. Dead heart damage was found high in early planting at 30 DAT (12.1%) whereas it was low in other two plantings (6.0 – 7.5%). Leaf folder incidence was found high at 30 DAT in early planting (17.0%) followed by normal planting (13.8%) and late planting (11.9%). Grain yield of 39.9 – 56.1 q/ ha was recorded in all the three plantings.



18) Raipur (21° 25'N & 81° 63'E): Swarna variety was grown in all the three plantings at this location. Low incidence of dead heart damage by stem borer (<9%), leaf folder (<3%), hispa (< 8%), caseworm (<4%), BPH (<7/hill) and GLH (<2/hill) was observed in different plantings. However, at pre-harvest, white ears were found high in normal planting (17.9%) followed by early planting (17.2%) and late planting (12.3%). Grain yield of 68.7, 78.9 and 42.5 q/ ha was recorded in early, normal and late plantings, respectively.

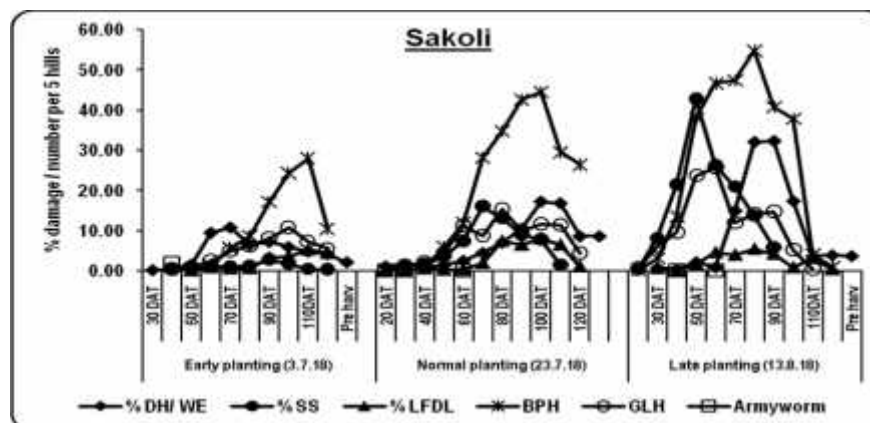


19) Ranchi (23° 34'N & 85° 31'E): Low incidence of stem borer (4.5 – 11.9%), gall midge (3.7 – 8.4%), leaf folder (6.3 – 11.3%), hispa (3.6 – 8.1%) and GLH (3.1 – 10/hill) was noticed in all the three plantings on Birsa Vikas Sugandha 1 variety grown in this trial. Grain yield varied between 32.7 and 43.7 q/ ha in three plantings.

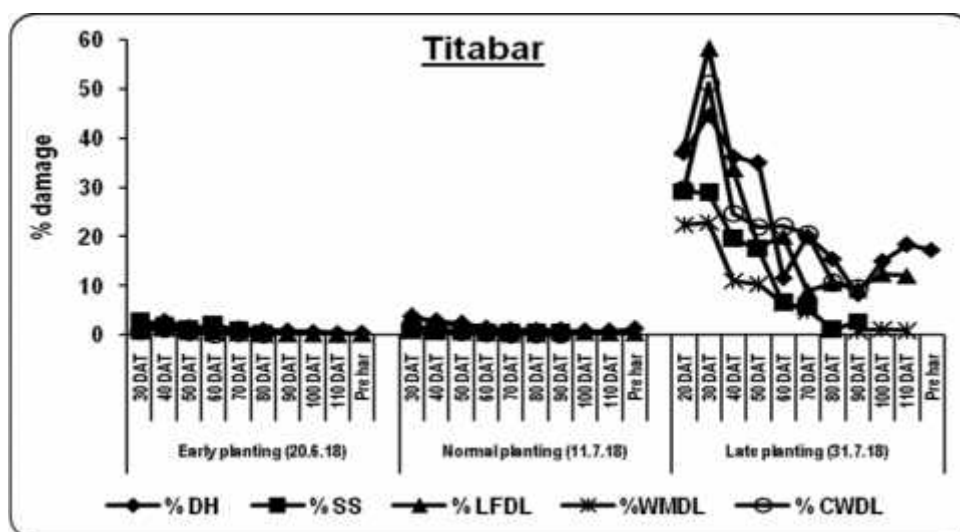


20) Sakoli (21° 08'N & 79° 99'E): Incidence of stem borer, gall midge, leaf folder, BPH, WBPH, GLH and armyworm was observed in PKV HMT variety grown in this trial in all the three plantings. In general pest incidence was high

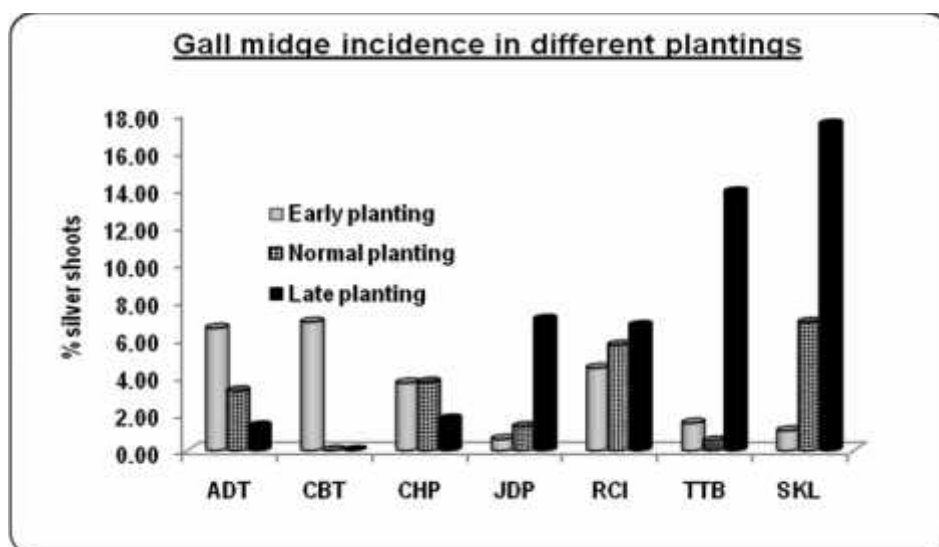
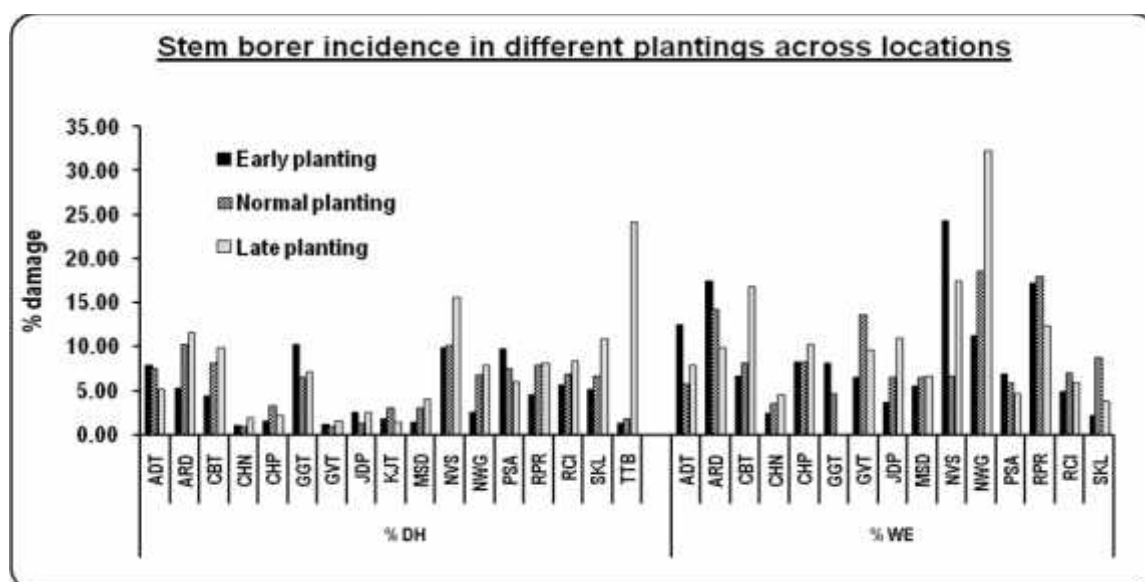
in late planting as compared to normal and early plantings. Gall midge incidence was very high in late planting from 40 DAT to 80 DAT (13.7 – 42.9%) followed by 70 and 80 DAT in normal planting (13.2 – 16.0%). Dead heart damage crossed ETL and was very high in late planting starting from 70 DAT to 100 DAT (14.9 – 32.4%) followed by normal planting from 90 to 100 DAT (10.5 – 17.3%) and early planting at 70 DAT alone (10.8%). Low incidence of leaf folder (<9%), BPH (<11/hill), WBPH (<4/hill) and GLH (<5/hill) was noticed. Army worm incidence was noticed for the first time and number of larvae ranged from 0.1 – 2.0 per hill. Grain yield of 53.5, 36.4 and 16.5 q/ ha was recorded in early, normal and late plantings, respectively.



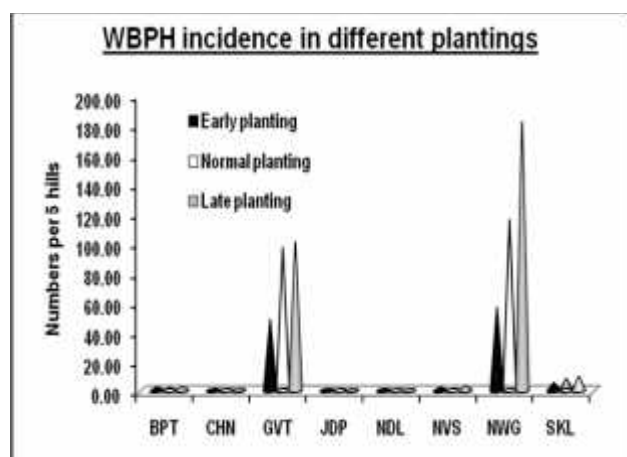
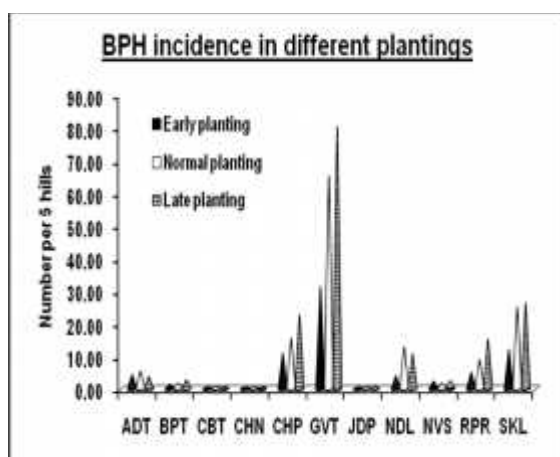
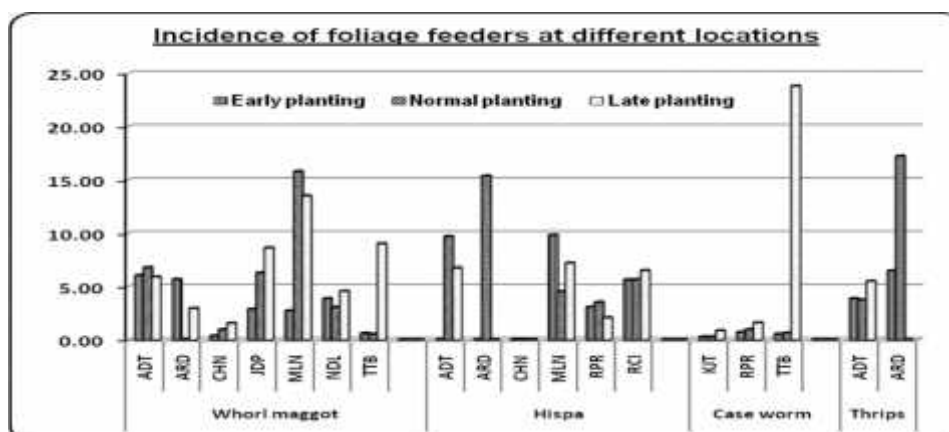
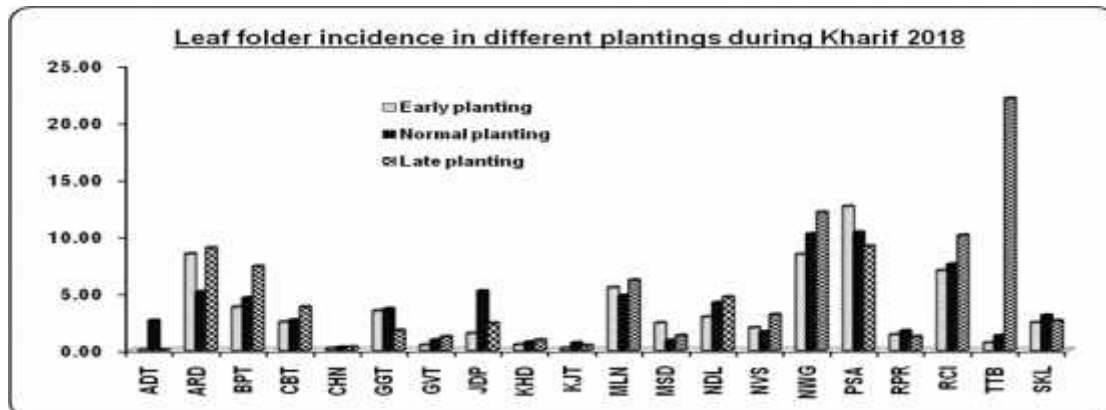
15) Titabar (26° 58'N & 94° 19'E): Among the three plantings, incidence of stem borer, gall midge, leaf folder and caseworm was very high in late planting in Ranjit variety as compared to early and late plantings. Stem borer damage was very high in late planting and crossed ETL starting from 20 DAT onwards till harvest (11.60 – 44.69% DH & 17.29% WE). Similarly, gall midge incidence also crossed ETL from 20 – 50 DAT (17.38 – 29.14%). Highest leaf folder damage of 58.28% was observed at 30 DAT in late planting and it exceeded ETL from 20 DAT to harvest stage (10.56-58.28%) excluding 70 (8.86%) and 90 DAT (9.27%). Caseworm damage was also high in late planting from 20 to 80 DAT (10.65-51.12%). Grain yield varied from 48.8 to 95.0 q/ ha in all plantings.



During *Kharif* 2018, insect pest incidence was low in all the plantings across locations. Incidence of stem borer was reported from 17 locations, of which highest dead heart damage was observed in late planting at Titabar (24.2%) followed by Navasari (15.5%). Highest white ear damage was reported in late planting at Nawagam (32.3%) followed by early planting at Navasari (24.3%). Gall midge incidence was recorded from 7 locations with highest damage at Sakoli in late planting (17.4%). Among the foliage feeders, leaf folder incidence was observed from 20 locations, highest damage of 22.11% was reported at Titabar in late planting followed by Pusa in early planting (12.6%). Whorl maggot incidence was observed at 7 locations with highest damage in normal planting at Malan (15.8%). Low incidence of hispa was noticed at 6 locations and thrips at two locations. Caseworm incidence was recorded at 3 locations and was very high in late planting at Titabar (23.80%).



Sap sucking insects like BPH was reported from 11 locations with highest population at Gangavathi in late planting (80.1/hill) followed by normal planting (65.0/ hill). WBPH incidence was higher than BPH and observed at 8 locations with maximum numbers at Nawagam in late planting (181.6/hill) followed by normal planting (115.5/hill). GLH population was observed at 12 locations with highest numbers in late planting at Ranchi (44.3/hill). Army worm was noticed only at Sakoli in all the three plantings and leaf mite damage at Aduthurai.



Overall, the pest incidence was low in different dates of planting across locations during *Kharif* 2018. Incidence of stem borer, gall midge, leaf folder, caseworm, whorl maggot, BPH, WBPH, and GLH was high in late planting compared to early and normal plantings. Hispa and thrips were found high in normal planting compared to early and late plantings.

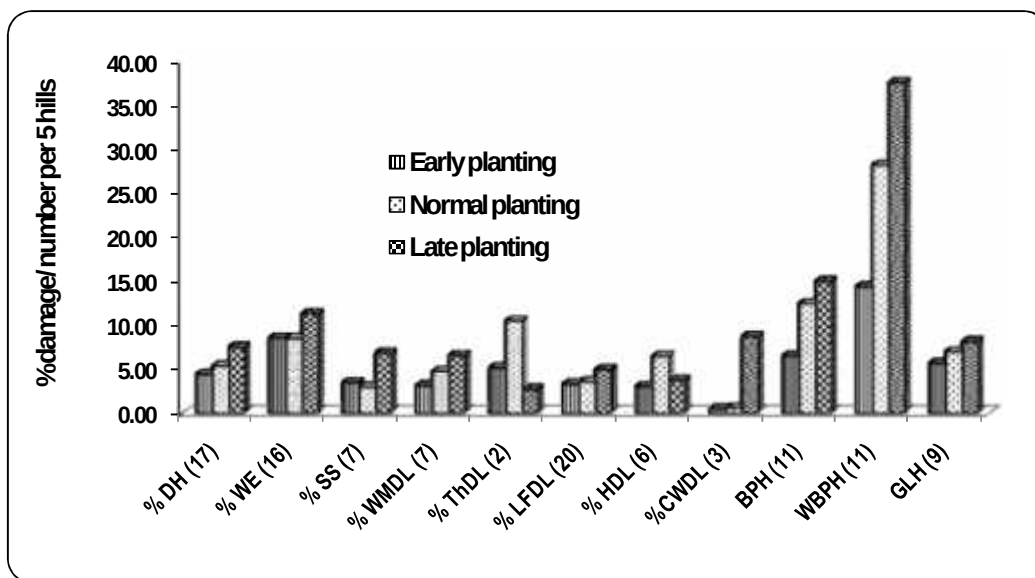


Fig...Insect pest incidence in different dates of planting during *Kharif* 2018

A trial on Effect of planting dates on insect pest incidence (EPDP) was conducted at 21 locations during *Kharif* 2018. Incidence of stem borer was reported from 17 locations, of which highest dead heart damage was observed in late planting at Titabar (24.2%) followed by Navasari (15.5%). Highest white ear damage was reported in late planting at Nawagam (32.3%) followed by early planting at Navasari (24.3%). Gall midge incidence was recorded from 7 locations with highest damage at Sakoli in late planting (17.4%). Among the foliage feeders, leaf folder incidence was reported from 20 locations, highest damage of 22.11% was reported at Titabar in late planting followed by Pusa in early planting (12.6%). Whorl maggot incidence was observed at 7 locations with highest damage in normal planting at Malan (15.8%). Caseworm incidence was recorded at 3 locations and was very high in late planting at Titabar (23.80%). Low incidence of hispa was noticed at 6 locations and thrips at two locations. Sap sucking insects like BPH was reported from 11 locations with highest population at Gangavathi in late planting (80.1/hill) followed by normal planting (65.0/hill). WBPH incidence was higher than BPH and observed at 8 locations with maximum numbers at Nawagam in late planting (181.6/hill) followed by normal planting (115.5/hill). GLH population was observed at 12 locations. Minor pests like horned caterpillar incidence was observed at Navasari, rice skipper and grasshopper incidence at Khudwani, leaf mite damage at Aduthurai and army worm incidence at Sakoli in all the three plantings.

2.5 BIOCONTROL AND BIODIVERSITY STUDIES

These studies covered i) Ecological Engineering for Planthopper Management (EEPM) ii) Bio-intensive Integrated pest management (BIPM) and iii) Monitoring of pest species and their natural enemies (MPNE)

i) Ecological Engineering for Planthopper Management (EEPM)

This trial has the objective of habitat management through cultural and non-pesticidal methods along with floral diversity to increase natural biological control and to augment egg predators of hoppers and thereby manage planthopper pests by enhancing natural enemy fitness. Data were recorded on hoppers and their natural enemies and analyses was done using the independent 't' test. The trial was conducted at ten locations during kharif 2018 viz., Aduthurai, Bapatla, Gangavathi, Ludhiana, Moncompu, Mandya, Maruteru, Ragolu, Rajendranagar and Warangal.

1. Aduthurai

Four observations were recorded on planthoppers and their natural enemies throughout the crop period. In the ecological engineering plots the hopper population was significantly lower ranging from 0.96/hill to a maximum of 11.83/hill. The mean hopper numbers over the crop period were significantly lower in EE plots (5.02/hill) in comparison to farmers' practices (FP) (13.11/hill, **(Table 2.18)**).

The population of green mirids, spiders and coccinellids were also significantly higher in EE plots @ 7.5, 9.45 and 9.6 per ten hills **(Table 2.18)**.

Table 2.18 Effect of ecological engineering on populations of hoppers and their natural enemies at **Aduthurai**, EEPM, *kharif* 2018

A. Hoppers and its predators

Parameters	BPH (No./ hills)		Green mirids (No./ 10 hills)		Spiders (No./hills)		Coccinellids (No./hills)	
	EE		FP		EE		FP	
	EE	FP	EE	FP	EE	FP	EE	FP
Mean	5.01	13.11	7.50	4.00	9.45	5.15	9.60	4.95
t value	9.24 **		4.73		5.97**		5.13**	
df	398		398		398		398	
P - value	<0.01		<0.01		<0.01		<0.01	

2. Bapatla

The population of hoppers and their natural enemies were on par **(Table 2.19)**.

Table 2.19 Effect of ecological engineering on populations of hoppers and their natural enemies at **Bapatla**, EEPM, *kharif* 2018

Parameters	BPH (No./ hills)		WBPH (No./ hill)		Spiders (No./hills)		Coccinellids (No./hills)	
	EE		FP		EE		FP	
	EE	FP	EE	FP	EE	FP	EE	FP
Mean	2.13	1.98	2.83	2.95	9.25	10.00	4.50	4.75
t value	0.38		0.28		0.40		0.18	
df	78		78		78		78	
P - value	NS		NS		NS		NS	

3. Gangavathi

Two interventions *viz.*, alleyways and growing border crop of cowpea were undertaken in the ecological engineering (EE) plots.

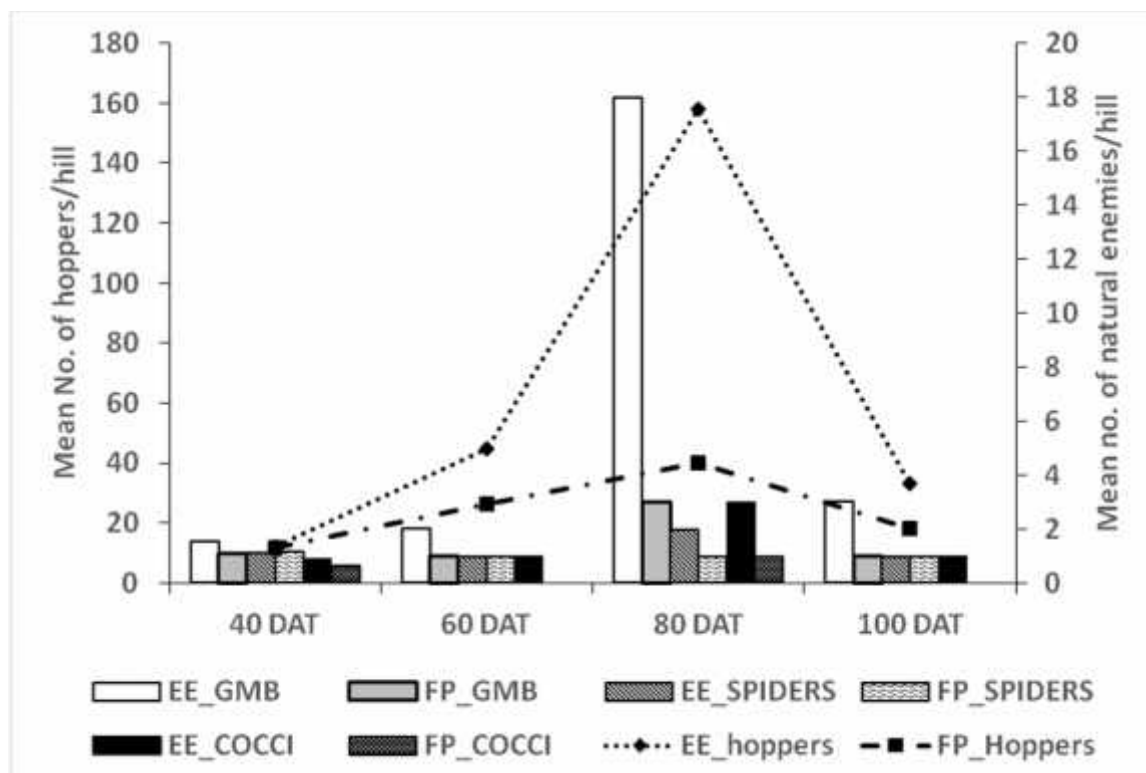


Fig.2.2 Abundance of hoppers and its natural enemies at Gangavathi, EEPM, kharif 2018

Four observations were recorded on planthoppers and their natural enemies throughout the crop period. In the ecological engineering plots the hopper population was higher ranging from 11.96/hill at 40 DAT to a maximum of 157.60/hill at 80 DAT (**Fig.2.2**). The mean hopper numbers over the crop period were also significantly higher in EE plots (59.17/hill) in comparison to farmers' practices (FP) (29.41/hill, (**Table 2.20A**).

But, the higher population of green mirids, spiders and coccinellids in EE plots indicated a positive trend for these practices in conservation of natural enemies. The green mirid number in the ecological engineering plots (5.91/hill) was 5 times higher than that of the farmers practice (1.21/hill). Four observations on egg parasitisation by egg baiting method were also done under the two practices. Mean parasitisation by three species of parasitoids in the EE plots was significantly higher (31.15%; $t = 7.01$; $P < 0.01$) compared to 12.53 % under farmers practice. The highest parasitisation of 49.04 per cent was observed at 60 DAT in the ecological engineering plots while the lowest parasitisation of 5.08 % was observed at 75 DAT in Farmer' practice plots. 61.96 per cent of parasitisation was by *Anagrus* sp followed by *Oligosita* (23.9403%) and least by *Gonatocerus* (14.10%) in EE plots while a similar

trend was also observed in FP plots with 62.16 per cent by *Anagrus* sp followed by *Oligosita* (27.03%) and *Gonatocerus* (10.81%)(**Table 2.20B**).

Table 2.20 Effect of ecological engineering on populations of hoppers and their natural enemies at **Gangavathi, EEPM, kharif 2018**

A. Hoppers and its predators

Parameters	BPH		Green mirids		Spiders		Coccinellids		Drynids	
	(No./ hills)		(No./hills)		(No./hills)		(No./hills)		(No./hills)	
	EE	FP	EE	FP	EE	FP	EE	FP	EE	FP
Mean	59.17	29.41	5.91	1.55	1.21	0.81	1.47	0.29	0.06	0.05
t value	7.52 **		7.38		3.77**		8.36**		0.38	
df	398		398		398		398		398	
P - value	<0.01		NS		<0.01		<0.01		NS	

B. Parasitoids

Parameters	Egg Parasitisation % at								Mean	
	30 DAT		40 DAT		60 DAT		75 DAT		parasitisation %	
	EE	FP	EE	FP	EE	FP	EE	FP	EE	FP
Mean	32.44	18.17	43.24	15.36	49.04	10.81	11.88	5.80	34.15	12.53
t value	2.28*		4.89**		6.67**		1.59		7.01	
df	48		48		48		48		198	
P - value	0.02		<0.01		<0.01		NS		<0.01	

4. Ludhiana

The EE interventions followed at **Ludhiana** included alleyways, water management, bund flora of flowering plants like cosmos, sesame, soybean and marigold. The populations of hoppers were very low though significantly lower in EE plots (**Table 2.21A**). Similarly, population of spiders, mirids and coccinellids were significantly higher in EE practice stressing the positive effect of flowering plants on predator abundance. But the level of population was very low.

Drynid parasitisation was also significantly higher in EE plots (8.3/10 hills). Mean parasitisation by three species of parasitoids in the EE plots was significantly higher on all four dates of observation (31.75%; $t = 4.99$; $P = <0.01$) compared to 20.00 % under farmers practice (**Table 2.21B**). Similar trends in relative composition of parasitoids were observed in both practices with 60.97% of the parasitisation of hopper eggs by *Anagrus* followed by *Oligosita* (25.47%) and *Gonatocerus* (13.56%).

Table 2.21 Effect of ecological engineering on hoppers and their natural enemies at **Ludhiana, EEPM, Kharif 2018****A. Hoppers and its predators**

Parameters	BPH (No./hill)		WBPH (No./hill)		Green mirids (No./hill)		Spiders (No./hill)		Coccinellids (No./hill)	
	EE	FP	EE	FP	EE	FP	EE	FP	EE	FP
Mean	2.97	4.65	2.27	2.97	1.18	0.80	2.27	1.80	1.35	0.80
t value	7.28**		0.31**		4.26**		4.96**		6.32**	
df	298		298		298		298		298	
P - value	<0.01		NS		<0.01		<0.01		<0.01	

B. Parasitoids

Para- meters	Drynid parasitisa- tion		Egg Parasitisation % at								Mean Parasitisation %	
			75 DAT		90 DAT		105 DAT		120 DAT			
	EE	FP	EE	FP	EE	FP	EE	FP	EE	FP	EE	FP
Mean	0.83	0.64	24.94	18.26	25.61	21.67	31.17	18.22	39.22	18.39	31.75	20.00
t value	2.45**		1.42 ^{NS}		2.58 ^{NS}		2.57*		4.54**		4.99**	
df	298		28		28		28		28		118	
P - value	0.01		0.45		0.45		0.05		<0.01		<0.01	

5. Mandya

The floral diversity was increased in EE plots by growing cowpea on the bunds and other practices of keeping alleyways and application of vermicompost. Hoppers were higher in EE plots (7.56/hill) compared to that of FP plots (5.48/10 hills) (**Table 2.22**). The population of spiders (3.86/hill) and coccinellids (2.67/hill) was significantly higher in the ecological engineering plots as compared to farmers' practice plots. The mirid population was very low and was on par in both treatments.

Table 2.22 Effect of ecological engineering on hoppers and their natural enemies at **Mandya, EEPM, kharif 2018**

Parameters	Hoppers (No./ hill)		Mirid (No./ 10 hills)		Spiders (No./ hill)		Coccinellids (No./ hill)	
	EE	FP	EE	FP	EE	FP	EE	FP
Mean	7.56	5.48	3.9	1.45	3.86	2.33	2.67	1.62
t value	4.83*		0.14 ^{NS}		9.35**		6.20**	
df	398		398		398		398	
P - value	0.05		0.89		<0.01		<0.01	

6. Maruteru

The EE interventions tested were alleyways, organic manuring and bund flora. The observations on hoppers and their natural enemies were taken four times over the crop period. The hopper population was observed from 45 DAT and reached a peak at 75 DAT (30.87 and 8.02/hill in ecological engineered and farmers' practice plots respectively). The pooled data analysis showed that the population of hoppers in plots with farmers' practices was significantly lower than EE plots (**Table 2.23**). The population of mirids and spiders were on the other hand significantly higher in EE plots (4.84 and 2.49/hill respectively) as compared to the FP plots (2.99 and 1.28/ hill respectively). The yield was on par in EE (4550.40 kg/ha) and FP (5048.2 kg/ ha) plots.

Table 2.23 Effect of ecological engineering on hoppers and its natural enemies at **Maruteru, EEPM, kharif 2018**

Para- meters	Hoppers (No./ hill)		Mirids (No./ hill)		Spiders (No./ hill)		Coccinellids (No./ hill)	
	EE	FP	EE	FP	EE	FP	EE	FP
Mean	12.57	6.75	4.84	2.99	2.49	1.28	0.62	0.56
t value	5.21**		4.46**		2.3*		1.29 ^{NS}	
df	498		298		398		198	
P - value	0.01		0.01		0.05		0.20	

7. Moncompu

Bund planting of marigold was taken up in EE plots. The pooled analysis of the data on hopper population and its natural enemies revealed that number of hoppers was very low and did not differ significantly in EE and FP plots (**Table 2.24**). Similar trend was observed for natural enemies.

Table 2.24 Effect of ecological engineering on hoppers and their natural enemies at **Moncompu, EEPM, kharif 2018**

Parameters	Hoppers (No./10 hills)		Green mirids (No./10 hills)		Spiders (No./10 hills)	
	EE	FP	EE	FP	EE	FP
Mean	5.84	6.01	1.60	2.13	1.26	1.09
t value	0.40NS		0.98NS		1.41NS	
df	298		298		298	
P - value	0.68		0.33		0.64	

8. Ragolu

The EE interventions tested were alleyways, organic manuring and bund flora. The mean hopper population was very low, but higher in FP plots (5.64/hill) as compared to EE (1.10/hill) (**Table 2.25**). The percent dead hearts / white ears caused by stem borer and incidence of leaffolder were low in both treatments though a little higher in EE plots. The yield in EE plots was higher (4960.50 kg/ha) when compared to FP (4001.4 kg/ ha).

Table 2.25 Effect of ecological engineering on insect pests of rice **Ragolu, EEPM, kharif 2018**

Parameters	Hoppers (No./10 hills)		Stem borer (% Dead hearts)		Stem borer (%white ears)		Leaffolder (% damaged leaves)	
	EE	FP	EE	FP	EE	FP	EE	FP
Mean	1.10	5.64	1.39	3.11	2.16	4.23	1.37	0.84
t value	10.36**		2.23*		3.27*		1.75NS	
df	298		48		8		8	
P - value	0.01		0.02		0.05		0.24	

9. Rajendranagar

The EE interventions tested were alley ways, bund flora of marigold - yellow flower hybrid Thai 999 and alternate wetting and drying. Pest population was very low in both treatments with a mean hopper population of 1.11/ hill, spiders 1.15/ hill and 2.35 % damage by stem borer. The yield was a higher in EE plots (6605 kg /ha) as compared to FP plots (5621 kg /ha) though not statistically significant. An additional benefit of Rs 7850.00/ acre could be accrued from sale of marigold flowers.

10. Warangal

Three treatments were tested- Farmers practice plots with chemical interventions (FP), Ecological engineering plots with and without alternate wetting and drying (EEP 1 and EEP 2 respectively). Practices followed in EE plots were, alleyways, alternate wetting and draining of water, increase in floral diversity on bunds by planting marigold in addition to no chemical plant protection measures. Five observations were recorded on hoppers and their

natural enemies through the crop period. A mixed population of BPH and WBPH was observed. The BPH numbers were on par in all three treatments until 81 DAT. At 96 DAT the brown planthopper population was significantly higher in farmers practice (29.33/hill) and lowest in EEP I (9.07/hill). Thereafter the population declined in all treatments and its natural enemies were on par in all three treatments, **(Table 2.26)**. The population of hoppers reached a peak at 78 DAT and ranged from 3.16 to 154.37/hill in different treatments. The highest BPH number was observed in Farmers' practice plots (154.37/hill) and the lowest in the ecological engineering plots with alternate wetting and drying (7.45/hill). Similar trend was observed for White backed planthopper at 96 DAT, with the highest population recorded in Farmers practice (31.13 /hill) compared to EEP I and II. Population in EEP I and II were on par **(Table 2.27)**. The hopper numbers were consistently lowest in the EEP-I treatment plots indicating that alternate wetting and drying along with ecological engineering can reduce hopper population. The populations of coccinellids were significantly higher in EEP I and II plots while the number of spiders was on par in the three treatments. Mirid bugs were significantly higher on 52 and 96 DAT in EEP I and II plots. EE plots yielded higher, with the highest being in EEP-I (6237.97 kg /ha) and the least in FP plots (5929.59 kg/ha), however there were no significant differences. The B: C ratio was higher in the ecological engineering plots with the highest of 2.60 being observed in EEP-I plots with alternate wetting and drying along with ecological engineering followed by EEP II (2.54). The lowest B: C ratio was observed in FP plots (2.25).

Table 2.26 Effect of ecological engineering on populations of hoppers and their natural enemies at **Warangal, EEPM, kharif 2018****A. Hoppers**

Treatment	BPH (No./ hill)					WBPH (No. /hill)				
	52 DAT	66 DAT	81 DAT	96 DAT	110 DAT	52 DAT	66 DAT	81 DAT	96 DAT	110 DAT
EEP-I	21.80	18.73	10.73	9.07	18.47	8.20	19.80	8.00	18.80	10.20
EEP-II	23.47	17.80	13.80	17.13	16.87	7.40	29.07	12.73	17.73	9.80
FP	18.60	19.13	10.53	29.33	18.20	7.47	19.47	11.87	31.13	9.00
CD(0.05)	NS	NS	NS	4.69	NS	NS	5.91	NS	4.99	NS

B. Natural enemies of hoppers

Treatment	Spiders No. / 10 hills					Coccinellids No. / 10 hills					Mirids No. / 10 hills				
	52 DAT	66 DAT	81 DAT	96 DAT	110 DAT	52 DAT	66 DAT	81 DAT	96 DAT	110 DAT	52 DAT	66 DAT	81 DAT	96 DAT	110 DAT
EEP –I	17.80	20.07	20.73	18.07	22.47	7.27	7.60	4.00	5.40	7.53	6.07	7.13	5.00	4.80	7.27
EEP- II	16.20	24.67	24.07	22.40	25.20	9.00	4.40	7.33	3.33	9.87	8.60	5.47	6.40	3.60	8.53
FP	17.73	22.07	21.40	27.53	26.13	7.93	4.53	2.53	2.60	10.20	4.47	4.67	4.73	1.87	9.47
CD (0.05)	NS	NS	NS	NS	NS	NS	1.91	1.93	1.76	1.53	0.96	NS	NS	1.23	NS

Table 2.26A. Grain Yield and Benefit cost ratio of Ecological engineering at Warangal, EEPM, *kharif* 2018

Treatment	Grain yield (Kg/ha)	B:C ratio
EEP-I	6237.967	2.60
EEP-II	6107.212	2.54
FP	5929.59	2.25
CD(0.05)	NS	0.10

Table 2.27 Natural enemy population on marigold planted on bunds in EEP plots*

Treatments	Mirids *	Coccinellids	Spiders
EEP- I	0.236	0.156	1.08
EEP-II	0.22	0.216	0.892

*Mean of 50 marigold plants on five dates of observation

Populations of mirids, coccinellids and spiders were also observed on the marigold plants grown on the bunds indicating a sharing of natural enemies (**Table 2.27**).

Ecological engineering for pest management was taken up in ten locations with a combination of interventions such as organic manuring, alleyways, spacing management, water management and growing of flowering plants on bunds. Such interventions increased the natural enemy populations like mirids, spiders and coccinellids and increased egg parasitisation across the locations and reduced hopper numbers in some. The results also indicated that water management along with ecological engineering can significantly reduce hopper population. The benefit cost was also significantly higher with ecological engineering.

ii) Bio-intensive pest management trial (BIPM)

This trial was initiated, to generate comprehensive plant protection and soil health data to validate adoption of pest management practices for organic rice cultivation. The trial was taken up at ten centres *viz.*, Chinsurah, Jagdalpur, Karjat, Kurumbapet, Ludhiana, Pattambi, Ranchi, Raipur, Titabar and IIRR, Hyderabad.

The trial involved mainly two treatment blocks *viz.*, i) Bio-intensive pest management and ii) Input intensive pest management or Farmers Practice block spread over an area of a minimum of half acre for each block, planted

with a local popular variety of the region. The results of the trials at various locations are given below

1. Bapatla

Incidence of leaffolder was observed. The per cent leaves damaged by leaffolder were on par in the two treatments (4.40 and 4.30 % respectively). Similarly there was no difference in the beneficial insects and yield between BIPM and FP plots (**Table 2.28**).

Table 2.28 Pest incidence under Bio-intensive pest management trial at Bapatla, *kharif* 2018

Parameters	LF		Spiders		Coccinellids		Mirids		Yield	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	4.40	4.30	0.97	0.97	0.48	0.62	5.48	4.75	4500	4566
t value	0.21NS		0.00 NS		1.69NS		3.52*		NS	
df	398		398		398		398		4	
P - value	0.10		0.1		0.36		0.05			

* LF- leaffolder

2. Chinsurah

Observations were recorded on the damage by whorl maggot, stem borer, and natural enemies like spiders, coccinellids and staphylinids. Whorl maggot incidence observed in the early crop growth ranged from 0.00 to 10.00 per cent of leaves damaged in the two treatments. The incidence was on par in BIPM and FP plots. The dead heart damage by stem borer was significantly higher in FP plots (15.48%) compared to that of BIPM plots (6.70%). A similar trend was observed with white ear damage in the reproductive phase with 5.57 % damage recorded in BIPM plots as compared to 20.57% in FP plots (**Table 2.29**). The populations of other pests were low.

Table 2.29 Pest incidence under Bio-intensive pest management trial at Chinsurah, *kharif* 2018

Parameters	WM		DH		WE	
	(% damage)		(% damage)		(% damage)	
	BIPM	FP	BIPM	FP	BIPM	FP
Mean	3.29	3.56	6.70	15.48	5.57	20.57
t value	0.44 ^{NS}		4.75 ^{**}		6.07 ^{**}	
df	118		238		238	
P - value	0.40		<0.01		<0.01	

*WM- whorl maggot; DH – Dead heart; WE- white ears

The spider population in general was significantly higher in the BIPM plots (**Table 2.30**) at 2.83/ 10 hills and 1.50/10 hills in FP plots. Coccinellids (6.00/ 10 hills) were also significantly higher than that of Farmers' practice plots. Due to lower stem borer damage in the vegetative and reproductive phase, the yield was also significantly higher in BIPM plots (5195 kg/ha) than that of FP plots (4430 kg/ha).

Table 2.30 Population of natural enemies and yield under Bio-intensive pest management trial at **Chinsurah, kharif 2018**

Parameters	Coccinellids		Spiders		Yield*	
	(No./ 10 hills)		(No./ 10 hills)		(kg/ha)	
	BIPM	FP	BIPM	FP		
Mean	6.0	1.83	2.83	1.50	5195	4430
t value	3.60**		1.5**		3.46**	
df	118		118		38	
P - value	<0.01		0.80		<0.01	

*projected yield

3. Jagdalpur

Incidence of whorl maggot, thrips, leaffolder, caseworm, stem borer, BPH, GLH and predators like spiders, coccinellids and others was observed. The per cent leaves damaged by whorl maggot were significantly higher in farmer's practice plots (11.40%) compared to BIPM plots (13.40%). Similarly damage by thrips was also higher in farmers practice plots (17.89%) as compared to BIPM (19.83%) (**Table 2.31**). Very low numbers of spiders and coccinellids were recorded in both treatments. The yield was higher in BIPM plots (3483 kg/ha) than that of FP plots (2729 kg/ha).

Table 2.31 Pest incidence under Bio-intensive pest management trial at **Jagdalpur, kharif 2018**

Para-meters	Per cent leaves damaged by							
	WM		Thrips		Caseworm		LF	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	11.40	13.40	17.89	19.83	1.40	0.57	1.67	1.87
t value	4.89*		2.26*		5.22 ^{NS}		9.01 ^{NS}	
df	38		38		38		38	
P - value	0.05		0.05		0.08		0.10	

*WM- whorl maggot; LF- leaffolder

4. Karjat

Incidence of stem borer and leaffolder was observed over seven dates of observation. The incidence was very low for both pests.

5. Ludhiana

The treatments were planted with variety PR 121, in six replications. The practices followed in BIPM plots were application of vermicompost @ 500 g/ m² and rice husk ash @ 100 g/ m² of nursery bed, seed dressing with phosphorus

solubilizing microorganisms (PSM) (@ 10 g/ kg seed and *Pseudomonas subtilis* and *P. argentinensis* (@ 10 g / kg seed at the time of sowing; root dipping with PSM and *Pseudomonas spp* before transplanting; Field ploughing thoroughly to incorporate weed and straw into soil; 2.5 tonnes/ ha of vermicompost as basal + 400 kg neem cake/ ha half as basal and half as top dressing at active tillering stage; Clipping of leaf tips before field transplanting; Pheromone traps for mass trapping of stem borers @ 20/ha; Flower plants of marigold, soybean, cosmos, sesame on bunds for natural enemies; Spray of *P. fluorescens* on the foliage @ 20 g / litre of water, need based application of nimbecidine @ 5 ml/L; proper plant spacing and water management for planthoppers. The practices followed in the FP treatment included application of Neem coated Urea 90 kg/ acre in 2 splits; 1 at puddling and 2nd after 6 weeks after transplanting; spraying chlorpyrifos @ 1.0 l/ acre at 60 DAT and imidacloprid (Confidor 17.8 SL) @ 40 ml / acre at 60 DAT.

Incidence of whorl maggot, stem borer, leaf folder, BPH, WBPH and natural enemies including predators like spiders, coccinellids and the parasitoids like ichneumonids and braconids was observed. White ears at reproductive phase (4.4%) were significantly lower than that of FP plots (5.46%). Leaf folder, whorl maggot and dead hearts damage were on par in both the treatments (**Table 2.32**). Similarly, the population of BPH and WBPH per hill did not differ significantly in BIPM plots and FP plots.

The populations of beneficials though higher in BIPM plots were statistically on par in both treatments. The Ichneumonid number (10.69/ 10 hills) was significantly higher in the BIPM plots compared to that of Farmers' practice plots (9.07/10 hills) (**Table 2.33**). The yield however was on par in both FP plots (7601kg/ha) and BIPM plots (7634kg/ha).

Table 2.32 Pest incidence under Bio-intensive pest management trial at Ludhiana, *kharif* 2018

Parameters	WM		DH		LF		WE		BPH		WBPH	
	% damage		%damage		%damage		%damage		(No./hill)		(No./hill)	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	1.17	2.31	2.60	2.75	6.49	6.65	4.44	5.46	16.98	20.71	31.23	31.40
t value	2.99NS		0.37 ^{NS}		0.53 ^{NS}		0.65NS*		0.57 ^{NS}		0.11 ^{NS}	
df	82		82		82		10		82		82	
P - value	0.07		0.22		0.60		0.10		0.10		0.91	

*WM- whorl maggot; DH – Dead heart; LF- leaffolder; BPH –brown planthopper; WBPH – white backed planthopper

Table 2.33 Population of natural enemies and yield under Bio-intensive pest management trial at Ludhiana, *kharif* 2018

Parameters	Spiders		Coccinellids		Ichneumonid		Braconid		Yield*	
	(No./ 10 hills)		(No./ 10 hills)		(No./ 10 hills)		(No./ 10 hills)		(kg/ha)	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	9.95	8.88	2.71	2.14	10.69	8.83	9.78	9.07	7634.53	7601.79
t value	1.46 ^{NS}		1.53 ^{NS}		2.58*		1.07 ^{NS}		0.45NS	
df	82		82		82		82		10	
P - value	0.50		0.89		0.05		0.80		0.52	

*projected yield

6. Pattambi

The practices followed in BIPM plots were application of Neem cake + Vermicompost as per recommended dosage; growing cowpea on bunds and application of Azadirachtin 0.003% at 15, 30, 45, 60 and 75 DAT. Incidence of whorl maggot, blue beetle, silver shoots, leaffolder, caseworm, stem borer and predators like spiders, coccinellids and mirids was observed over four dates of observation and the mean analysed data is being presented below. The per cent leaves damaged by leaffolder were significantly lower in BIPM plots (2.40%) compared to farmer's practice plots (11.50%). On the other hand, incidence of stemborer, caseworm, gall midge was on par in both treatments (**Table 2.34A**).

The beneficials such as spiders and coccinellids recorded in BIPM plots were higher in numbers in BIPM plots. The spider population (29.00/10 hills) was significantly higher in the BIPM plots compared to that of Farmers' practice plots. (**Table 2. 34B**). The yield though higher in BIPM plots (1465 kg/ha) was statistically on par with that of FP plots (1312 kg/ha).

7. Raipur

Three modules were tested at Raipur. BIPM I consisted of *Psuedomonas* seed treatment while BIPM II consisted of *Trichoderma* seed treatment. Incidence of stem borer, leaffolder, hispa, caseworm BPH, and predators like spiders, coccinellids were recorded on eight dates of observation throughout the crop growth period. The per cent leaves damaged by hispa, leaffolder and caseworms in BIPM plots were on par with that of Farmers practice (**Table 2.35**). Hispa damage ranged from 9.83 -12.56 % leaves while deadhearts caused by stemborer ranged from 7.74 -9.95 % among the three modules. The beneficial insects in BIPM plots were statistically on par in both treatments. The yield though higher in BIPM plots (7655.83 and 7827.08 kg/ha) than that of EE plots (7392.50kg/ha), they were statistically on par.

Table 2.34A Pest incidence under Bio-intensive pest management trial at Pattambi, kharif 2018

Parameters	Per cent damage by									
	Leaffolder		Case worm		Blue beetle		Stemborer		Gall midge	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	2.40	11.50	10.96	9.95	11.20	12.89	1.42	1.43	9.83	10.52
t value	8.90**		0.52NS		0.43		0.01NS		0.51NS	
df	538		538		478		538		538	
P - value	<0.01		0.89		0.90		0.90		0.90	

Table 2.34B Population of natural enemies and yield under Bio-intensive pest management trial at Pattambi, kharif 2018

Parameters	Spiders		Coccinellids		Mirid		Yield*	
	(No./10 hills)		(No./10 hills)		(No./10 hills)		(kg/ha)	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	29.00	8.10	15.90	8.80	10.22	6.27	1465.27	1312.5
t value	12.26**		7.75*		4.50*		0.90NS	
df	336		336		336		10	
P - value	<0.01		0.05		0.05		0.90	

*projected yield

Table 2.35 Pest incidence under Bio-intensive pest management trial at **Raipur, kharif 2018**

Practice	Hispa % damage	DH % damage	BPH (No./10 hills)	WE / m2	Spiders (No./10 hills)	Coccinellids (No. /10 hills)	Yield
BIPM I	9.83 (17.57)	9.65 (17.43)	24.77 (29.85)	0.92	3.2	5.77	7655.83
BIPM II	11.06 (18.77)	8.00 (15.99)	29.8 (33.10)	1.01	3.3	6.17	7827.08
FP	12.56 (20.31)	7.74 (15.65)	30.83 (33.73)	0.92	4.1	4.83	7392.50
CD (0.05)	NS	NS	NS	NS	NS	NS	NS

* DH – Dead heart; LF- leaffolder; BPH –brown planthopper; CW – caseworm; WE- white ear

Table 2.36 Pest incidence under Bio-intensive pest management trial at **Ranchi, kharif 2018**

Para- meters	Hispa % damage		LF % damage		DH % damage		SS (No./10 hills)		WE % damage		Yield Kg/ha	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	3.71	2.98	3.92	3.28	4.46	3.6	4.00	2.01	4.48	3.88	3329.63	3940.74
t value	1.95 ^{NS}		2.07 ^{NS}		1.35 ^{NS}		1.63 ^{NS}		0.93 ^{NS}		2.07	
df	358		358		358		358		238		10	
P - value	0.25		0.22		0.20		0.20		0.35		0.06	

* DH – Dead heart; LF- leaffolder; SS –silver shoots; WE – white ears

8. Ranchi

Incidence of hispa, stem borer, leaffolder and gall midge were recorded on seven dates of observation throughout the crop growth period. The per cent damage by hispa, leaffolder stemborer and gall midge was on par in BIPM and FP plots (**Table 2.36**). The yield in FP plots (3940kg/ha) though higher, was on par with that of BIPM plots (3329 kg/ha).

9. Titabar

The treatments were planted with Keteki Joha variety, in six replications of plot size 600 m². The practices followed in BIPM plots were wet seed treatment with *Pseudomonas fluorescens* prepared @10g/litre of water per kg of seed or *Trichoderma* sp., Seedling root dip treatment with *Azospirillum* and Phosphorous solubilizing bacteria (PSB) @ 600g culture for 1 ha, application of vermicompost @500g/ sq m and rice husk ash @100g/ sqm of the nursery bed; application of vermicompost @ 2.5ton/ ha + green manure crop @ 2.5t/ ha Half as basal and half at active tillering stage, clipping of rice seedlings before transplanting, mass trapping of stem borer with pheromone trap @ 20 numbers per ha (2 in 600 sqm); *Trichogramma japonicum* for stem borer and *T. chilonis* for leaf folder @5cc egg/ ha Neem oil @ 5 ml/liter of water was done when the insect pest incidences was observed.

Table 2.37 Pest incidence under Bio-intensive pest management trial at Titabar, *kharif* 2018

Practice	Gall midge % damage	DH % damage	LF % damage	WM % damage
BIPM I	0.31 (2.72)	0.47 (3.39)	0.27 (2.50)	0.13 (1.17)
BIPM II	0.37 (2.46)	0.66 (4.00)	0.38 (3.27)	0.13 (1.04)
FP	6.98 (13.10)	11.87 (19.20)	6.02 (3.14)	4.21 (10.25)
CD (0.05)	5.09	3.28	3.31	3.82

WM- whorl maggot; DH- Dead heart; WE- white ears; LF- leaffolder;
GLH- green leafhopper; GM- Gall midge

Table 2.38 Yield under Bio-intensive pest management trial at Titabar, *kharif* 2018

Parameters	Grain Yield*		Straw Yield*	
	(kg/ha)		(kg/ha)	
	BIPM	FP	BIPM	FP
Mean	5222.67	3520.00	8733.33	6266.33
t value	5.27		4.02**	
df	10		10	
P - value	<0.01		<0.01	

*projected yield

The flowering plant marigold was grown in the border of the BIPM I and II plots. The practices followed in the FP treatment were no seed treatment; no fertilizer in nursery, application of N- 60kg, P₂O₅ -20kg and K₂O -40 kg/ha and no application of insecticides.

The silver shoot damage, 0.31 and 0.37 % in BIPM I and BIPM II modules were significantly lower in BIPM plots (**Table 2.37**) as compared to FP plots (6.98%). Similarly dead hearts caused by stem borer were also significantly less (< 1 %) compared to 11.87 % in FP plots. BIPM plots also yielded significantly higher (5222.67kg/ha) than that of FP plots (3520 kg/ha) (**Table 2.38**).

10. IIRR, Hyderabad

At IIRR, Hyderabad, two BIPM modules tested which varied in the seed treatment with *Triochotherma asperellum* IIRRCK1 and treatment with *Pseudomonas fluorescens*. Nine replications with variety BPT5204 were followed. Under the Farmers' practice all recommended agronomic practices were followed. Only stem borer damage was observed and the Dead hearts at vegetative phase was on par in the BIPM plots and FP plots (11.09-14.67) but significantly lower than the untreated control (18.65%). White ear damage was also least in FP plots (11.09%) compared to other treatments. The egg parasitization varied between 18.88 and 22.32%, while the range of spiders was 5.67 to 7.50/10 hills across the treatments. The population of coccinellids was negligible. The yield was on par in BIPM and FP plots compared to that of untreated control (5000 kg/ha) (**Table 2.39**). The crop in organic manuring BIPM plots has been showing a steady increase in yields in the past three years (**Fig. 2.3**).

Table 2.39 Pest incidence and yield under Bio-intensive pest management trial at IIRR, Hyderabad, *kharif* 2018

Treatment	Dead Heart (%)	White Ears (%)	% Egg parasitisation	Spiders (No./ 10hills)	Coccinelids (No./ 10hills)
BIPM 1	14.67 (22.45)	14.67 (22.45)	22.32	5.67	0.33
BIPM 2	14.69 (22.33)	17.48 (24.64)	21.56	7.50	1.50
Farmers Practice	11.09 (19.16)	11.09 (19.16)	18.88	6.17	2.67
Untreated Control	18.65 (25.26)	21.61 (27.47)	22.32	6.67	0.83
CD (P=0.05)	2.02	2.13		NS	NS

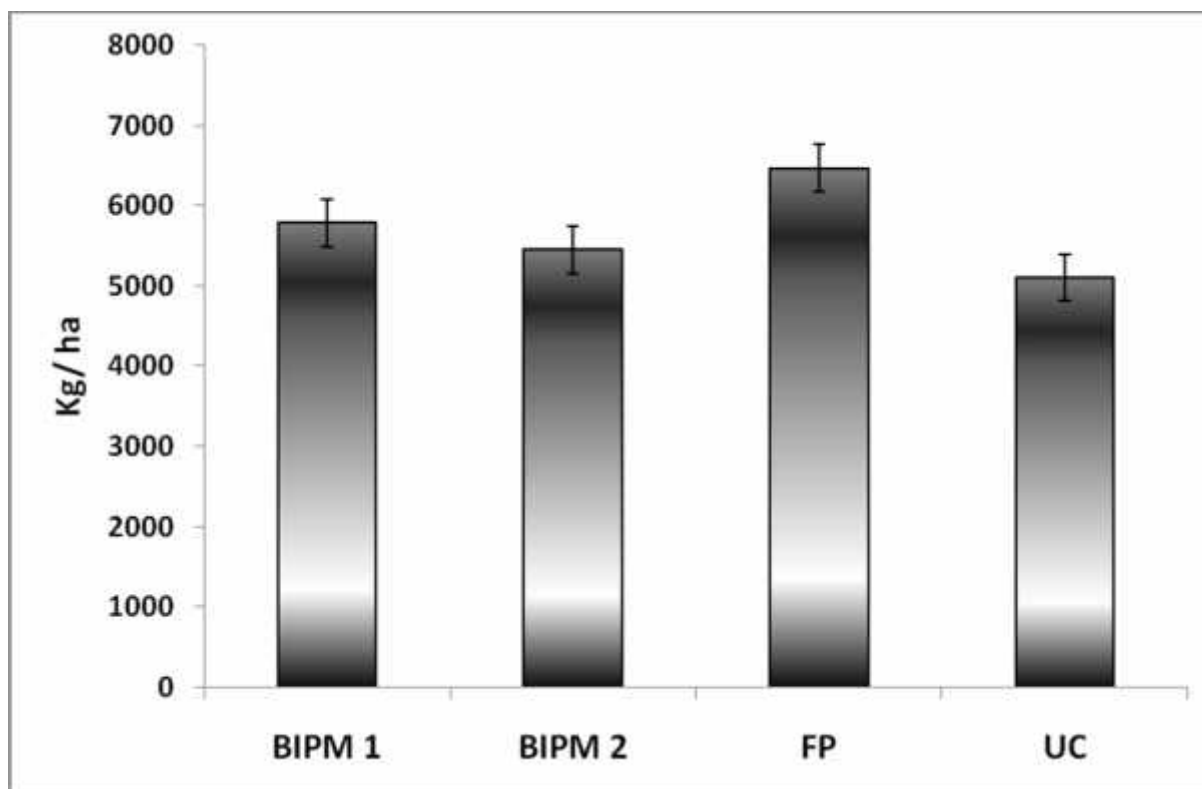


Fig 2.3 Yield under Bio-intensive pest management trial at **IIRR, Hyderabad, Kharif 2018**

Bio intensive pest management trial was conducted in 10 locations during Kharif 2018. The pest incidence was either reduced in BIPM plots as in Chinsurah and Titabar, Raipur and Jagdalpur or on par as in Ludhiana and IIRR compared to Farmers' practice. The natural enemies were higher in BIPM plots in all locations. In Hyderabad after three years of this trial, higher yields were obtained in BIPM plots indicating a period of three years for stabilization of yields in organic practices.

iii) Monitoring of pest species and their natural enemies (MPNE)

This trial has been closed since 2017. However data was received from two locations *viz.*, Navsari and Moncompu.

At Navsari, only three species of stem borer were observed *viz.*, yellow stemborer (YSB), *Scirpophaga incertulas*, pink stemborer (PSB) and White stem borer (WSB) *Scirpophaga fusciflua*. YSB and WSB were observed at the early stages while in later stage of crop all three species were observed. YSB was the dominant species accounting for 61.63 per cent of the stem borer population followed by PSB (29.07%) and WSB (29.08%). The egg mass parasitisation ranged from 29.16-84.00% while the egg parasitisation varied from 15.00 to 51.29 %. Three species of parasitoids were recorded with an average composition of *Trichogramma japonicum* (46.54%), *Tetrastichus schoenobii* (27.75%) and *Telenomus* spp (25.70 %).

At Moncompu, four species of stem borer were observed. In addition to YSB, WSB and PSB, Striped stem borer (SSB) was also observed. YSB was the dominant species accounting for 53.30 to 73.30 per cent of the stem borer population followed by WSB (19.20%), SSB (13.30%) and PSB (6.70%). The egg mass parasitisation ranged from 40.00 - 72.00% while the egg parasitisation varied from 31.50 to 67.15 %. Three species of parasitoids were recorded with an average composition of *T. japonicum* (21.42%), *T. schoenobii* (17.38%) and *Telenomus* spp (61.19 %).

Information on the hoppers species composition was received from Coimbatore. A mixed population of two planthoppers BPH, WBPH (12.05 and 14.52/ 10 hills respectively) and green leafhopper (11.52/ 10 hills) was observed at low levels at this centre. The predators observed were green mirids (7.92/10hills) spiders (19.80/10hills) and coccinellids (15.92/10hills). Drynid parasitoids were also observed at 6.2/10 hills. Hopper egg parasitisation was observed to the extent of 23.59 percent of eggs observed with three species *Anagrus* (62.07%), *Oligosita* (44.83%) and *Gonatocerus* (37.93%) parasitizing the eggs.

Gall midge parasitisation was reported from Moncompu centre. A total of 82 galls were observed of which 74.4 per cent were parasitized by *Platygaster* sp.

Observations on species composition of stem borer revealed the presence of four species in two locations with YSB being dominant in both locations. Three parasitoids were observed on the eggs of stem boprer and Telenomus sp. was the dominant parasitoid in both locations. Anagrus, Oligosita and Gonatocerus were the parasitoids reported on hopper eggs. Mirids, spiders and coccinellids were the commonly prevalent predators of hoppers.

INTEGRATED PEST MANAGEMENT STUDIES

These studies included two trials viz., i) Yield loss estimation trial (YLET) and ii) Integrated pest management special (IPMs) trial. The results of these two trials are presented below:

i) Yield Loss Estimation Trial (YLET)

Many biotic and abiotic factors play a major role in causing yield loss in rice in the field. These factors, either individually or in combination with other factors result in the reduction in grain yield. Actual yield losses due to insect pests in rice field are indistinguishable due to involvement of many complex factors. The main objective of this trial is to quantify the actual yield losses caused by insect pests at different stages of crop growth. Stem borer and leaf folder are the target pests. Quantification was done by creating varying levels of pest damage through the augmentation of egg masses or larvae at various crop growth stages and their impact on yield was assessed.

At each location, experimental field was divided into two equal sized plots (250 m² each) and designated as natural infestation plot and augmentation plot. Each of these plots was again sub divided into 3 equal sized plots (80 m² each) and designated as Range 1, Range 2 and Range 3. In each range of natural infestation plot, 35 hills were marked and data on insect damage and grain yield was recorded. Thus, from natural infestation plot, data from 105 hills were recorded. In augmentation plot, four hills at nine spots were covered with a mylar cage in each range. Target pest was augmented by pinning egg masses in case of stem borer or releasing larvae in case of both pests. Data were recorded on these 36 hills in each range and total of 108 hills from augmentation plot.

During *Kharif* 2018, the trial was conducted at 8 locations. Yield data at different damage levels was obtained from 5 locations for YSB and from 3 locations for leaf folder.

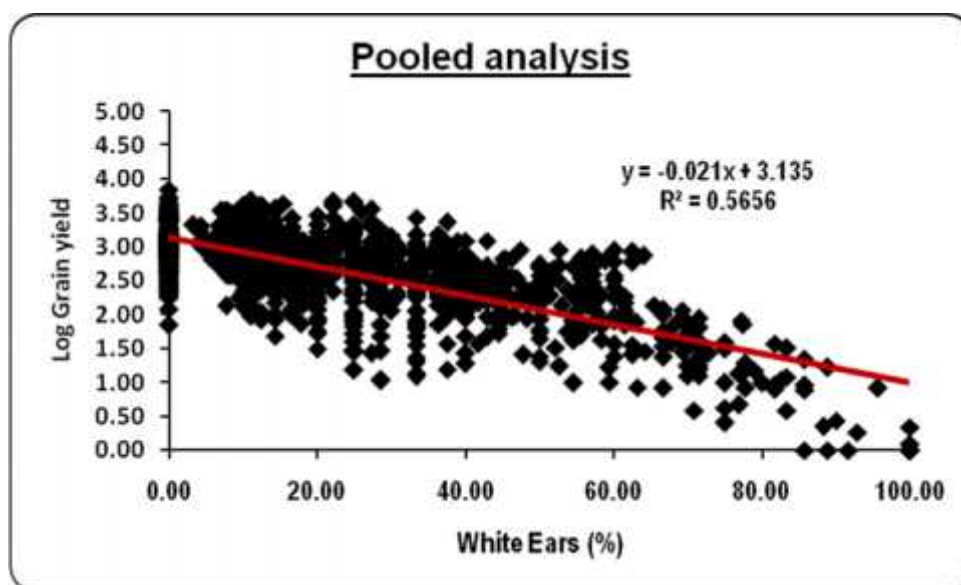
TARGET PEST: STEM BORER

Yield loss estimation trial for stem borer was being carried out for the last three years from 2015 onwards. The data of these three years was used to build a model to predict yield loss and validated with 2018 observed yield data.

Model development and Validation

Three years (2015, 2016 & 2017) data from Ludhiana, Chinsurah, Raipur, Pantnagar, IIRR and Coimbatore comprising of 1283 data points was considered to build the model. Grain yields were transformed into natural logarithm values

$\ln(\text{GY})$ prior to analysis. Regression model yielded the equation as $\ln(\text{GY}) = 3.135 - 0.021x$, where $x = \% \text{ white ears}$. The coefficient of determination (R^2) for this model was 0.5656 ($p < 0.00001$). Based on this model, loss in grain yield was predicted as 18.9% at 10% white ears, 34.3% at 20% white ears and so on.



Yield data of 480 hills from Coimbatore, Chinsurah, Pantnagar and Raipur recorded during *Kharif* 2018 was considered to validate the model. The observed grain yield for different levels of white ear damage was found to be 4.29% for 10% white ears, 23.24% for 20% white ears, 41.72% for 30% white ears and so on (**Fig. 2.4**).

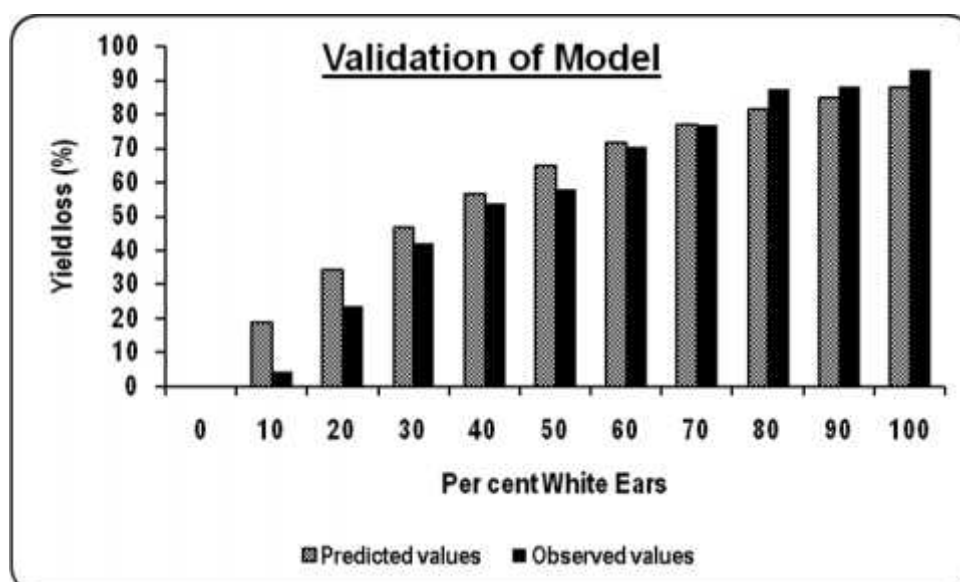


Fig.2.4 Predicted and observed data on yield loss at different levels of white ear damage

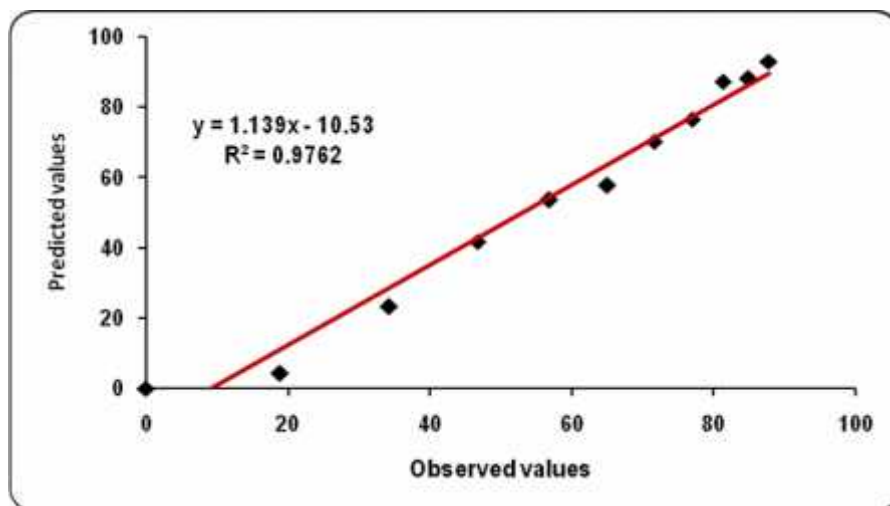


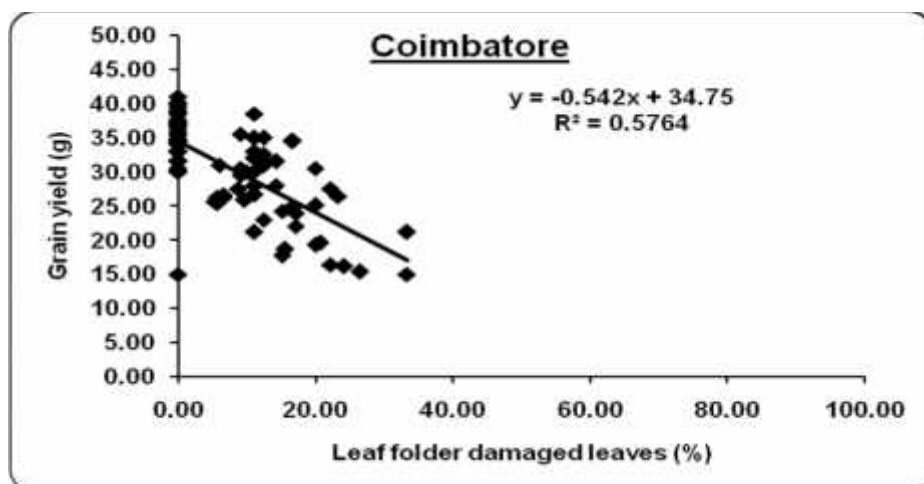
Fig.2.5 Observed Vs Predicted yield loss

Validation of yield loss estimation model for stem borer was done by regressing observed vs predicted yield loss due to white ear damage. The linear regression indicates a close fit between observed and predicted yield loss ($R^2 = 0.9762$; $P = 0.00001$) wherein $y = 1.139x - 10.53$. This affirms the yield loss prediction model across the locations (**Fig. 2.5**).

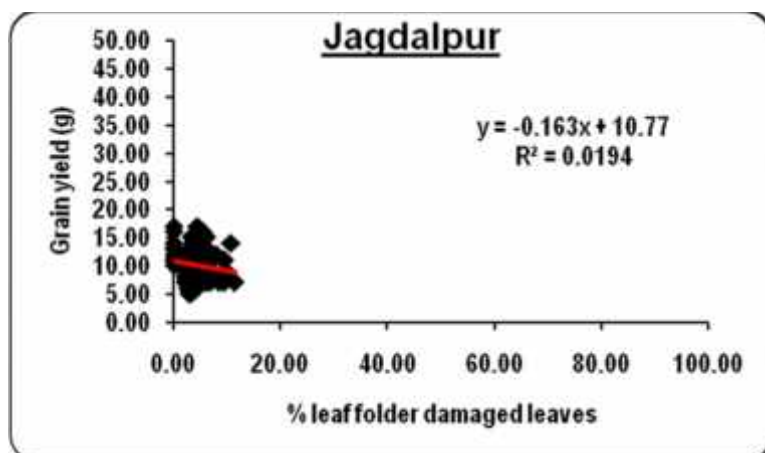
TARGET PEST: LEAF FOLDER

Yield loss estimation trial for leaf folder was conducted at three locations i.e., Coimbatore, Jagdalpur and Ludhiana.

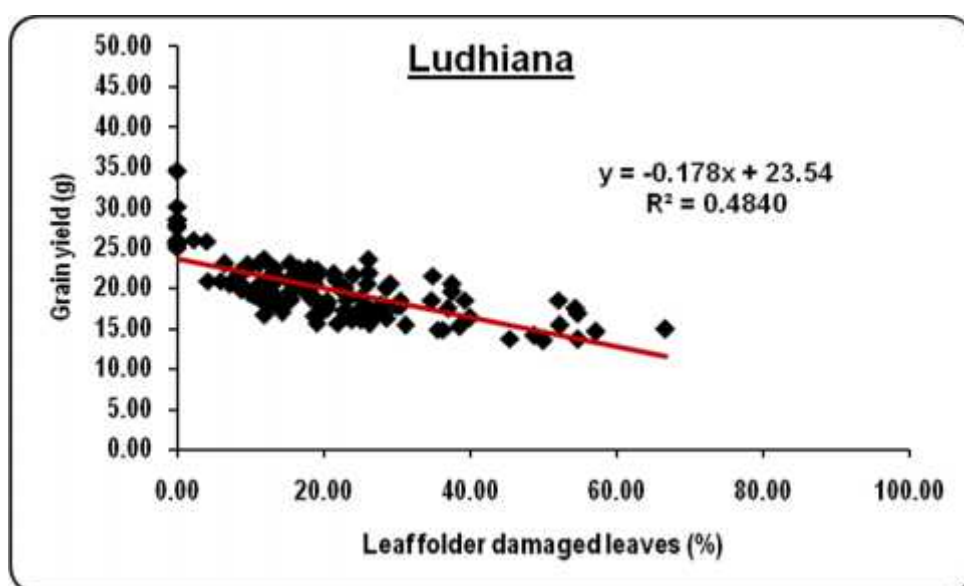
At **Coimbatore**, leaf folder damage ranged from 0 to 33.33% with grain yield of 15.0 to 41.0 g per hill in CO 51 variety. Regression analysis revealed a significant negative relationship between leaf folder damaged leaves and grain yield ($R^2=0.5764$). For every 10% increase in leaf folder damage, reduction of 5.42 g in grain yield was observed.



Leaf folder damage was very low at **Jagdarpur** (0 – 11.43%) resulting in grain yield of 5.0 to 17.0g/ hill in Swarna variety. Regression analysis revealed a non-significant negative relationship between leaf folder damaged leaves and grain yield ($R^2 = 0.0190$)

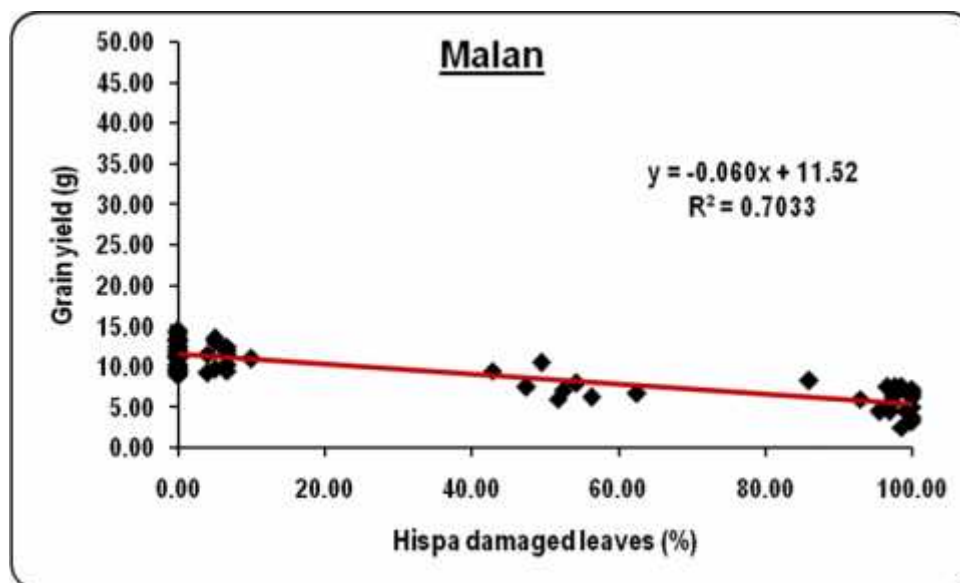


At **Ludhiana**, a significant negative relationship was observed between leaf folder damaged leaves and grain yield ($R^2 = 0.4840$) resulting in 1.78g yield reduction for every 10% increase in leaf folder damage. At this location, leaf folder damage varied from 0.00 to 66.67% with a grain yield of 13.50 to 34.50 g per hill in PR 121 variety.



TARGET PEST: HISPA

Yield loss estimation trial for hispa was conducted only at one location, i.e., Malan. At **Malan**, hispa damage varied between 0 and 100% and grain yield ranged from 2.5 to 14.5 g per hill in Kasturi variety grown in this trial. Regression analysis revealed a significant negative relationship ($R^2 = 0.7033$) between hispa damaged leaves and grain yield resulting in 0.6 g loss in grain yield for every 10% increase in hispa damaged leaves.



Yield loss estimation trial was conducted at 5 locations for stem borer, 3 locations for leaf folder and one location for rice hispa during Kharif 2018. Validation of yield loss estimation model for stem borer was done by regressing observed vs predicted yield losses caused by white ear damage. The linear regression indicates a close fit between observed and predicted yield loss ($R^2 = 0.9762$; $P = 0.00001$) wherein $y = 1.139x - 10.53$. This affirms the yield loss prediction model across the locations which can be utilized for the assessment of actual yield losses caused by stem borer due to white ear damage. A significant negative relationship was observed between leaf folder damaged leaves and grain yield at Coimbatore ($R^2 = 0.5764$) and Ludhiana ($R^2 = 0.4840$). Similarly, a significant negative relationship was observed between hispa damaged leaves and grain yield at Malan ($R^2 = 0.7033$; $P=0.0001$). However, there is only 0.6 g loss in grain yield for every 10% increase in hispa damaged leaves.

Integrated pest management special trial (IPMs)

Biotic stresses are major constraints in rice production and their integrated management is crucial at different stages of crop growth. Implementation of IPM at farmers' level is limited due to the knowledge and certain skills required for taking decisions and selecting IPM options for long term management of pests in a sustainable way. In order to overcome these limitations, participatory IPMs trial was continued in collaboration with agronomists and plant pathologists with an objective to validate IPM practices from a basket of options available and demonstrate to farmers the management of pests (including insects, diseases and weeds) in a holistic way.

During *Kharif* 2018, IPMs trial was conducted at 15 locations. At 7 locations *viz.*, Coimbatore, Karjat, Kurumbapet, Mandya, Pusa, Raipur and Sakoli, the trial was carried out in three farmers' fields. At 2 locations, Pantnagar and Jagdalpur, the trial was conducted in two farmers' fields while in the rest of 6 locations, i.e., Chinsurah, Chiplima, Gangavathi, Ludhiana, Malan and Titabar, the trial was carried out in one farmer field. Details of farmers, villages, pest incidence and management practices followed were discussed below location wise:

Coimbatore: IPMs trial was conducted at Pattiyarkovilpathi, Narasipuram village, Thondamuthur block, Coimbatore district, Tamilnadu in 3 farmers' fields. BPT 5204 was grown in both IPM and farmer practices plots of one acre each. Practices followed in IPM and FP plots are given in a table below. Low incidence of stem borer (<10%) and leaf folder (<10%) was observed in both IPM and farmer practice plots (**Table 2.40**). Area under disease progress curve (AUDPC) for leaf blast revealed that the disease progress was significantly lower in the experimental plots where IPM practices were followed when compared to the farmer's practices.

Table 2.40 Pest incidence and grain yield in IPMs trial at Coimbatore, kharif 2018

Farmer	Treatment	%DH		%LFDL		Leaf blast	Yield kg/ha
		60 DAT	80 DAT	45 DAT	100 DAT	AUDPC	
Sri L Kathiseran	IPM	2.6 ± 0.9	2.7 ± 0.6	5.1 ± 2.8	1.0 ± 1.0	24	6680 ± 177
Sri L Kathiseran	FP	8.3 ± 0.9	8.9 ± 0.9	8.7 ± 2.9	8.8 ± 4.3	92	5712 ± 2231
Sri K Rajamani	IPM	1.4 ± 0.7	1.2 ± 0.5	2.2 ± 1.3	1.2 ± 1.2	21	6592 ± 93
Sri L Moorthi	IPM	1.0 ± 0.4	2.1 ± 0.7	1.3 ± 0.4	1.9 ± 1.2	56	6648 ± 178

Table 2.41 Returns and BC ratio in IPMs trial at Coimbatore, kharif 2018

Name of the Farmer	Treatments	Yield (q/ha)	Gross Returns (Rs.)	Cost of Cultivation (Rs.)	Net Returns (Rs.)	BC ratio
Sri L Kathiseran	IPM	66.80	90180	26125	64055	3.45
Sri L Kathiseran	FP	57.12	77112	26750	50362	2.88
Sri K Rajamani	IPM	65.92	88992	24750	64242	3.60
Sri L Moorthi	IPM	66.48	89748	25625	64123	3.50

Price of paddy = Rs1350/ q

Practices followed in IPMs trial at Coimbatore, Kharif 2018

LOCATION: COIMBATORE		
Village: Narsipuram; Mandal/district: Thondamuthur block, Coimbatore district, Tamilnadu State Farmer 1: Sri L Kathirasan; Farmer 2: Sri K Rajamani; Farmer 3: Sri L Moorthy		
	Practices followed in IPM	Farmers practices
Area & variety	1.0 acre; BPT 5204	1.0 acre; BPT 5204
Fertilizers applied	80:64.5:60:38 kg NPKS/ha Urea, DAP, Complex fertilizer	100:64.5:0:20 kg NPKS/ha Urea, Complex fertilizers
Nursery	Seed treatment with Pseudomonas 10g/kg seed	No seed treatment
Main field	• Basal application of Pseudomonas 1kg/ac • Pre-emergence herbicide application Butachlor 500 ml/acre • Post emergence herbicide application Nominee gold @ 70 ml/acre • Installation of YSB pheromone trap @ 5/acre • Inundative release of <i>Trichogramma chilonis</i> 2 cc/acre two times @ 50 & 65 DAT • Application of Neem formulation Azadirachtin 10000 ppm (Neemazal @ 200ml/acre) • Application of Cartap hydrochloride @ 400g/ac • Application of fungicide tricyclazole @ 250g/acre	• Application of Lamda Cyhalothrin @ 400 ml/ acre • Application of Monocrotophos @ 500ml/ac • Application of Profenophos @ 300 ml/ac

Grain yield was highest in IPM plots varying from 65.92 to 66.80 Q/ ha as compared to farmers practices (57.12q/ ha). BC ratio was highest in IPM plots and ranged between 3.45 and 3.60 as against farmers' practices (2.88) because of high grain yield and low cost of cultivation (**Table 2.41**).

Chinsurah: IPM trial was conducted in Sri Narayan Chandra Mondal's field at Bele Village, Pandua in Hooghly district, West Bengal. Low incidence of stem borer, leaf folder, whorl maggot, hispa, BPH, WBPH and GLH was observed in IPM and farmer practices plots. None of the pests recorded crossed ETL (**Table 2.42**). Significant decrease in weed population and biomass in IPM implemented plots resulted in higher grain yield in Swarna variety grown in this trial (**Table 2.43**). High BC ratio of 1.82 was obtained in IPM plot as compared to FP plot (1.45) mainly due to higher grain yield that resulted in increased returns (**Table 2.44**).

Practices followed in IPMs trial at Chinsurah, Kharif 2018		
LOCATION: CHINSURAH		
	IPM practices followed	Farmers practices followed
Area/ variety	1 acre; Swarna	1 acre; Swarna
Nursery	• Application of 8 kg of 10:26:28	
Main field	• Field preparation with power tiller, cutting of bunds and leveling the field • Application of 105:100:27 kg urea, SSP & MOP • Application of Butachlor + hand weeding • Application of Ferterra @ 4 kg/ acre • Application of Coragen @ 60 ml/ acre • Application of carbendazim • Installation of pheromone traps @ 8/acre for stem borer mass trapping	• Field preparation with power tiller, cutting of bunds and leveling the field • Application of 80 kg 10-26-26; Urea 40 KG • Hand weeding two times • Application of Phorate @ 4.5 kg/ acre • Triazophos @ 750 ml/ acre two times

Table 2.42 Pest incidence and grain yield in IPMs trial at Chinsurah, kharif 2018

Treatments	%DH		%WE	% VMDL	%LFDL	%HDL	BPH	GLH
	64 DAT	92 DAT	Pre har	36 DAT	43 DAT	36 DAT	99 DAT	99 DAT
IPM	0.48 ± 0.22	0.37 ± 0.25	1.06 ± 0.46	0.98 ± 0.71	0.04 ± 0.04	0.12 ± 0.12	0.40 ± 0.24	1.60 ± 1.03
FP	3.37 ± 0.58	6.74 ± 0.73	9.20 ± 0.72	1.56 ± 0.35	0.32 ± 0.13	0.23 ± 0.16	5.40 ± 2.48	48.4 ± 7.61

Table 2.43 Weed population and weed biomass at Chinsurah, kharif 2018

Treatments	Weed population (No/ m2)		Weed biomass (g/ m2)	
	30 DAT	60 DAT	30 DAT	60 DAT
IPM	41.8 ± 5.1	77.2 ± 6.3	5.3 ± 0.6	9.6 ± 0.8
FP	72.6 ± 4.8	114.2 ± 10.9	10.4 ± 0.5	17.2 ± 1.4

Table 2.44 Returns and BC ratio in IPMs trial at Chinsurah, kharif 2018

Treatments	Yield (q/ha)	Gross Returns (Rs.)	Cost of Cultivation (Rs)	Net Returns (Rs.)	BC Ratio
IPM	54.16	94780	51993	42787	1.82
FP	41.31	72293	49870	22423	1.45

Price of paddy = 1750 Rs/ q

Chiplima: Incidence of stem borer, gall midge and BPH was observed in Swarna variety grown at research farm but found low damage and hence valid conclusions could not be drawn from this location (**Table 2.45**).

Practices followed in IPMs trial at Chiplima, Kharif 2018

Details	IPM block	FP block
Variety	Swarna	Swarna
Practices followed in main field	- Transplanted seedlings at 20 x15 cm. - Left alleyways of 30 cm after every 2 m. - Fertilizers (NPK) applied 100:50:50 - Application of Carbofuran 3 G @ 25 kg / ha, 20 days after transplanting. - Spraying of Rynaxypyr 20 SC @ 150 ml/ ha at 45 DAT - Spraying of Strptomycin sulphate 9% + tetracycline hydrochloride 1% SP @ 50 g/ ha at 55 DAT - Spraying of Flonicamid 50 WG @ 150 g/ ha at 65 DAT	- Fertilizers (NPK) applied- 120:60:60 - Application of Cartap hydrochloride 4 G @ 20 kg/ ha at 20 DAT - Spraying of acephate 75 SP @ 1000 g /ha at 40 DAT - Spraying of Strptomycin sulphate 9%+ tetracycline hydrochloride 1% 75 SP @ 50 g/ ha at 50 DAT - Spraying of Strptomycin sulphate 9%+ tetracycline hydrochloride 1% 75 SP @ 50 g/ ha at 60 DAT - Sprayed Fipronil 5 SC @ 1500 ml/ ha at 65 DAT - Sprayed Dinotefuran 20 SG @ 250 g/ ha at 70 DAT

Table 2.45 Pest incidence, grain yield & BC ratio in IPMs trial at Chiplima, kharif 2018

Treat-ments	%DH	%WE	%SS	BPH/ hill	Yield (Q/ ha)	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
	60 DAT	Pre har	45 DAT	75 DAT					
IPM	0.45 ± 0.28	0.97 ± 0.40	1.24 ± 0.39	19.60 ± 1.75	51.0	89250	480000	41250	1.86
FP	2.47 ± 0.41	2.96 ± 0.47	12.69 ± 1.27	26.00 ± 1.50	45.5	79625	49930	29695	1.59

Price of Paddy =Rs.1750/q

Gangavathi: IPMs trial was conducted in Sri Rudrappa's field at Kesaratti village, Gangavathi district of Karnataka state. BPT 5204 was grown in both IPM and FP plots. Low incidence of stem borer and leaf folder (<2%) was observed in both the treatments (**Table 2.46**). Incidence of planthoppers *i.e.*, BPH and WBPH started at 15 DAT in both IPM and FP plots. WBPH population was higher than BPH population (**Fig 2.6**). Highest population of WBPH was found in IPM plot at 43 and 50 DAT (567 & 553/5 hills) followed by 78 DAT (328/ 5 hills) and 71 DAT (269/ 5 hills). In FP plot, WBPH population was high from 43 DAT to 78 DAT (170 – 276/ 5 hills). Similarly, BPH numbers were high at 43 and 50 DAT in IPM plot (319 & 340/ 5 hills) while the population was high at 71 DAT (328/ 5 hills) and 57 DAT (259/5 hills) in farmers practices plots. Weed population and weed biomass was comparatively low in IPM adopted plots as compared to FP plots. Low grain yield of 61.54 q/ ha was recorded in IPM plot compared to FP plot (71.98 q/ ha) resulting in higher gross returns. However, BC ratio was similar in both IPM and FP plots mainly due to high cost of cultivation in FP plot (**Table 2.46**).

Practices followed in IPMs trial at Gangavathi, Kharif 2018	
IPM practices	Farmers Practices
Variety – BPT 5204	Variety – BPT 5204
- Seed treatment with Carbandezim @ 2g / kg seed - Application of carbofuran @ 1.1 kg/ ha in nursery bed, 5 days before pulling the seedlings - Transplanting @ 20X15 Cm - Leaving alleyways of 30 cm - Installation of pheromone traps @ 8 traps/ ha - Application of Rynaxypyr @ 4kg/ac - Application of cartap hydrochloride 50 WP @ 600 g/ ha at 60 DAT	- No seed treatment - Application of weedicide, Butachlor @ 400 ml/ac - Transplanting @15X10 cm - Leaving alleyways - Fertilizer application @ 300:125:125 kg/ha - Application phorate 10 G @ 12 kg/ha - Application of hexaconazole @2 ml/l+ Streptocycline @ 0.06g/l + chlorpyrifos & cypermethrin (Hamla 505) + Acephate - Application of carbendiazim@ 1gm/l + Dinotefuran - Application of Pymetrozine @ 0.6 g/l + Hexaconazole @ 2 ml/l + Acephate @ 2 gm/l - Application of Acephate 95 SG @ 1.5 g/l trifloxystrobin & tebuconazole (Nativo) @ 0.4 gm/l - Spray of tricyadazole @ 0.6 gm/l - Application of propiconazole @ 1 ml/l + Buprofezine 25SC @ 1 ml/l

Table 2.46 Pest incidence and BC ratio in IPMs trial at Gangavathi, kharif 2018

Treatments	%DH	% LFDL	GLH	Weed numbers/ m ²		Weed biomass g/m ²		Yield (q/ha)	Gross Returns (Rs.)	Cost of Cultivation (Rs.)	Net Returns (Rs.)	BC ratio
	64 DAT	85 DAT	43 DAT	30 DAT	60 DAT	30 DAT	60 DAT					
IPM	0.82 ± 0.20	0.51 ± 0.09	110.2 0 ± 8.73	32.0 ± 2.1	27.6 ± 2.3	15.6 ± 0.6	12.7 ± 0.8	61.54	110772	54215	56557	2.04
FP	0.29 ± 0.13	1.35 ± 0.18	19.00 ± 3.02	44.8 ± 2.1	36.0 ± 4.0	21.9 ± 1.2	18.3 ± 1.8	71.98	129564	62368	67196	2.08

Price of paddy = 1800 Rs/ q

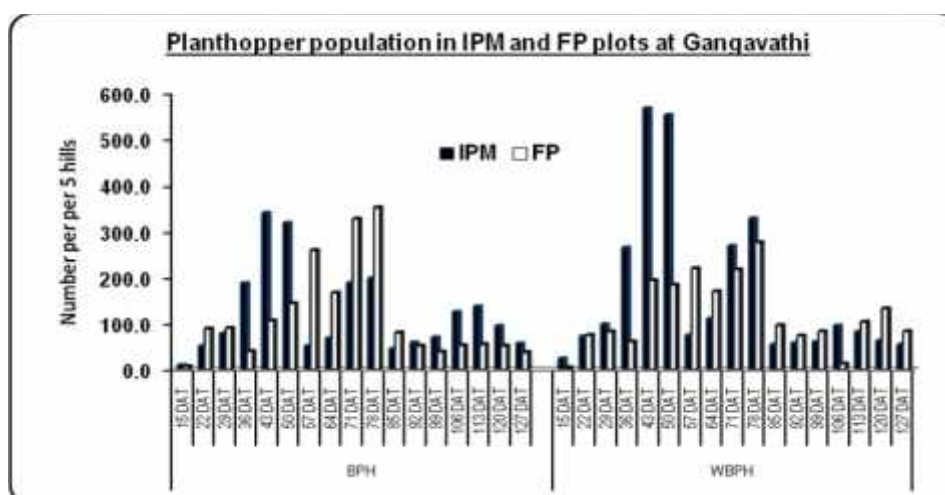


Fig 2.6 Planthopper population in IPM and FP plots at Gangavathi

Jagdalpur: At this location, IPMs trial was conducted in two farmers fields viz., Sri Kirtu Ram Nag and Sri Babulal of Dharmaur village, Jagdalpur district of Bastar. Incidence of stem borer, leaf folder, gall midge, whorl maggot and hispa was observed in both IPM and FP plots. Caseworm and thrips incidence was noticed only in farmers' practices plots.

White ear damage crossed ETL in both the farmers' fields in FP plots (**Table 2.47**). White ear damage was significantly lower in IPM plots (5.64%) than FP plots (24.16%). Among the farmer's, white ear damage was high in FP plot of Sri Babulal's field (28.05%) compared to FP plot of Sri Kirtu Ram Nag's field (20.31%).

Practices followed in IPMs trial at Jagdalpur, Kharif 2018		
	IPM Practices followed	Farmers Practices followed
Area	1 acre	1 acre
Variety	Safri	Safri-17
Nursery	Application of 3.2 kg N, 2 kg P, 1.2 kg K / 400m²nursery	Application of 2 kg N, 1kg P, 1 kg K / 400m² nursery
Main field	- Application of 80:50:30 kg NPK per hectare - Seedlings transplanted at spacing of 20/15 cm; Left alleyways of 30 cm after 10 rows. - Applied Butachlor 1.5 kg ai/ha at 4 DAT+ 1 hand weeding - Applied chlorpyrifos @ 1 lit/acre at 20 DAT - Applied weedicide metsulfurom methyl @ 20 DAT + One hand weeding at 40 DAT - Nitrogen top dressing at 45 DAT - Sprayed Tricyclazole 300 g/ha against blast - Sprayed cartap hydrochloride 50WP @ 600g/ha at 60 DAT	- Application of 80 kg N, 50 kg P & 30 Kg K/ acre - Applied phorate 10 G @ 5kg/ha - Hand weeding twice - Sprayed Carbendazim @ 200 g/ha against blast

Table 2.47 Pest incidence and grain yield in IPMs trial at Jagdalpur, kharif 2018

Treatments		% WE	% SS		% LFDL	% WMDL	Yield kg/ ha
		Pre harv	45 DAT	60 DAT	60 DAT	60 DAT	
IPM		5.64 (2.37)	10.29 (3.04)	3.99 (1.71)	6.42(2.61)	0.97(1.16)	3504
FP		24.16(4.86)	21.23(4.57)	11.68(3.37)	10.69(3.33)	9.00 (2.85)	2788
LSD		0.46	0.36	0.38	0.16	0.26	82.27
Sri Kirtu Ram Nag		12.86(3.38)	17.06(3.96)	9.74(2.83)	8.60(2.98)	1.97(1.47)	3204
Sri Babulal		16.94 (3.86)	14.46(3.64)	5.93(2.26)	8.50(2.96)	8.00 (2.54)	3088
LSD		0.37	0.33	0.19	0.15	0.17	60.47
Sri Kirtu Ram Nag	IPM	5.41 (2.26)	10.23(3.03)	3.94(1.71)	6.53(2.63)	1.04(1.16)	3592
	FP	20.31 (5.00)	23.90(4.89)	15.5(3.94)	10.67(3.33)	2.90(1.70)	2816
Sri Babulal	IPM	5.86 (2.49)	10.35(3.04)	4.04(1.72)	6.30(2.59)	0.90(1.15)	3416
	FP	28.02(5.23)	18.57(4.25)	7.83(2.80)	10.71(3.33)	15.12(3.93)	2760
LSD		5.08	0.51	0.54	0.23	0.37	116.34

Gall midge incidence was noticed from 30 DAT onwards in both IPM and FP plots, however, damage was high at 45 DAT in FP plot of Sri Kirtu Ram Nag's field (23.90%SS) and was significantly different from FP plot damage of SR Babulal's field (18.57%). Similarly, at 60 DAT also, silver shoots were significantly high in FP plots (11.63%) as against IPM plots (3.99%) of both the farmers together. Damage by leaf folder and whorl maggot was low in both the treatments and in both the farmers' fields. Among the diseases, leaf blast was observed in both IPM and FP plots whereas sheath blight was recorded only in IPM plots. Grain yields were significantly high in both the IPM plots (34.16 – 35.92 kg/ ha) compared to FP plots (27.60 – 28.16 kg/ ha). BC ratio was high in IPM plots (2.94 – 3.09) compared to FP plots (2.68 – 2.70) in both the farmer's fields due to high gross returns and low cost of cultivation in IPM plots.

Karjat: IPMs trial was conducted in three farmers' fields' viz., Mr Shiwaji Sudhakar Patil of Bhaliwadi village, Mr Amrut Shinde of Kadav village, Mr Gopal Sonawale of Tambus village in Karjat taluq of Raigad district, Maharashtra State. Practices followed in both IPM and FP plots were given below:

Practices followed in IPMs trial at Karjat, Kharif 2018		
Practices adopted	IPM block	Farmers practices
Area	1 acre	1 acre
Varieties	1) Sri Shiwaji Sudhakar Patil, Bhaliwadi village - Karjat-7 2) Sri Amrut Shinde, Kadav village- Karjat 7 3) Sri Gopal Sonawale, Tambus village - Karjat 6	Karjat 7 Karjat 7 Karjat 6
Nursery	Seed treatment with carbendazim @ 10 g/ 10 kg seed Raised bed 3x1m treated with rice husk (hull) ash @3kg/bed	Land burned with waste materials Application of Phorate 1 kg
Main field	• Deep ploughing • Application of FYM 4 T, Suphala 215 Kg, Urea 87 Kg • 2-3 seedlings transplanted at a spacing 20 x15 cm. • Alleyways of 40cm left after every 10 rows • Bipyribasodium 250ml/ha (Nomini gold). • Pheromone traps @8/ acre • Use of bird perches in the field • Use Vaibhav sickle for harvesting • Application of Fipronil 0.3% G @ 20 kg/ ha	• Deep ploughing • Application of FYM 2 T, Urea 145 kg, Suphala 75 kg • 4-5 seedlings transplanted randomly • Hand weeding once • Phorate 10 kg/ha (two applications)

Very low incidence of stem borer (<9%) and leaf folder (<2%) was observed in both IPM and FP plots in all the three farmers fields (**Table 2.48**). However, grain yield was low in FP plots compared to IPM plots due to low gross returns and high cost of cultivation resulting in negative net returns (**Table 2.49**).

Table 2.48 Pest incidence in IPMs trial at Karjat, *kharif* 2018

Farmer details	%DH 36 DAT		%LFDL 43 DAT	
	IPM	FP	IPM	FP
F1 - Mr. Shivaji Sudhakar Patil	2.53 ± 0.42	8.69 ± 0.37	0.07 ± 0.04	0.57 ± 0.07
F2 - Mr. AmrutShinde	2.05 ± 0.19	7.71 ± 0.51	1.02 ± 0.03	1.98 ± 0.09
F3 - Mr. Gopal Sonavale	0.32 ± 0.24	1.62 ± 0.67	0.02 ± 0.01	0.29 ± 0.11

Table 2.49 Returns and BC ratio in IPMs trial at Karjat, *kharif* 2018

Farmer name	Treatments	Grain Yield (q/ ha)	Straw yield (q/ ha)	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	BC ratio
F1 - Mr. Shivaji Sudhakar Patil	IPM	28.89	33.18	57194	41770	15424	1.37
	FP	19.30	22.56	38287	39550	-1263	0.97
F2 - Mr. AmrutShinde	IPM	25.50	30.31	50687	40870	9817	1.24
	FP	15.01	20.64	30378	38950	-8572	0.78
F3 - Mr. Gopal Sonavale	IPM	25.29	32.25	50690	41770	8920	1.21
	FP	14.89	20.51	30160	39550	-9390	0.76

Rate of Paddy : 1550/Q; Rate of straw = Rs. 200/ bundle

Kurumbapet: IPMs trial was carried out in three farmers fields in three villages at this location. These include F1-Sri Perumal of Kudapakkam village, Villianur Commune; Sri A Rathakrishnan of Embalam-Nathamedu village, Nettapakkam commune and Sri A Subramani of Sorapet village, Mannadipet commune in Puducherry State. IPM practices followed and varieties grown were given below:

Practices followed in IPMs trial at Kurumbapet, <i>Kharif</i> 2018		
Practices adopted	IPM block	Farmers practices
Area	1 acre	1 acre
Varieties	1) Sri S Perumal, Kudapakkam village, Villianur commune - BPT 5204 2) Sri A Rathakrishnan, Embalam- Nathamedu village, Nettapakkam commune - White Ponni 3) Sri A Subramani, Sorapet village, Mannadipet commune Co 50	F1 - BPT 5204 F2 - White Ponni F3 - CO 50
Nursery	- Seed treatment with Pseudomonas @ 10 g/kg seed - DAP 2 kg/ cent nursery	
Main field	- Basal application of 120 kg Super, 35 kg urea and 25 kg Potash - Application of Pendimethalin @ 1 liter/ acre, 2-4 days after transplantation - Installation of pheromone traps @ 3 traps/ acre at 25 DAT - Top dressing urea 25 kg and Potash 20 kg - Placed <i>Trichogramma japonicum</i> egg cards at 25,33 and 40 DAT - Also placed <i>T. chilonis</i> egg cards at 30,37 and 45 DAT - Placed solar light trap - Application of cartap hydrochloride @ 250 g/ acre - Foliar spray of 19:19:19 @ 0.5 kg/ acre	- Application of DAP 50 kg and Potash 50 kg 3 hand weedings at 15,30 and 60 DAT - Application of complex fertilizer 50 kg and neem cake 25 kg. - Top dressing urea 50 kg - Sprayed Fame (Profenophos) @ 250 ml/ acre + Bavistin @ 100 g - Application of Ammonium sulphate @ 50 kg

Incidence of stem borer and leaf folder was observed starting from 15 DAT onwards till harvest in both IPM and FP plots at all the three locations. Dead heart incidence was significantly high at Sri Perumal's (F1) field in both IPM and FP plots (**Table 2.50**) as compared to other two farmers. Incidence of dead hearts was significantly high in IPM plot (27.3%) as against FP plot (6.0%) at 29 DAT. However, stem borer damage was low in Sri. A Subramani's field in both IPM and FP plots. Similarly, white ears were significantly high (17.8%) in FP plot of Sri S Perumal (F1) compared to FP plot (8.0%). Leaf folder damage was significantly low in IPM plots as compared to FP plots at 22 DAT in all the farmers' fields but slowly increased and found at par with FP plot at 36 DAT. Highest leaf folder damage of 33.1% was recorded in Sri Permal's FP plot at Kudapakkam village. Weed population and weed dry mass was low in IPM plots as compared to FP plots in all the three farmers' fields (**Table 2.51**). Grain yield was significantly high in IPM plots across the farmers/ villages compared to FP plots. BC ratio was high in IPM plots (2.07 – 2.67) compared to FP plots (1.30 – 1.60) which is mainly due to high gross returns and low cost of cultivation (**Table 2.52**).

Table 2.50 Pest incidence and grain yield in IPMs trial at Kurumbapet, *kharif* 2018

Treatments		%DH			%WE	%LFDL		Yield
		29 DAT	36 DAT	43 DAT	Pre har	22 DAT	36 DAT	kg/ ha
IPM		21.0 (4.2)a	13.9 (3.4)a	19.4 (4.2)a	9.5 (3.1)a	5.2 (2.0)b	17.5 (4.1)a	5428.5a
FP		14.9 (3.2)b	11.8 (3.0) a	10.6 (2.9)b	11.8 (3.4)a	16.6 (3.6)a	13.3 (3.6)b	4588.8b
LSD (0.05)		0.31	0.43	0.44	0.18	0.34	0.21	46.1
F1- Sri S Perumal		34.5 (5.8)a	20.2 (4.3)a	24.6 (4.9)a	12.9 (3.6)a	23.4 (4.7)a	18.3 (4.3)a	5350.4a
F2- Sri A. Rathakrishnan		16.6 (3.7)b	15.5 (3.8)a	16.6 (3.8)b	9.1 (3.1)b	8.1 (2.4)b	18.9 (4.3)a	4151.2b
F3-Sri A Subramani		2.7(1.6)c	2.7 (1.5)b	3.9 (1.8)c	10.1 (3.2)ab	1.3 (1.2)b	8.9 (3.0)b	5524.4a
LSD (0.05)		0.73	0.38	0.37	0.22	0.58	0.34	107.6
F1- Sri S Perumal	IPM	32.7 (5.7)a	15.1 (3.5)ab	25.9 (5.1)a	8.0 (2.9)c	13.7 (3.6)b	18.8 (4.4)ab	5613.6b
	FP	36.4 (5.9)a	25.3 (5.1)a	23.2 (4.7)a	17.8 (4.2)a	33.1 (5.7)a	17.8 (4.3)ab	5087.2c
F2 - Sri A. Rathakrishnan	IPM	27.3 (5.1)a	22.0 (4.7)a	26.5(5.2)a	7.5 (2.8)c	1.4 (1.3)c	23.3 (4.8)a	4652.0d
	FP	6.0 (2.2)b	9.0 (2.8)bc	6.6 (2.5)b	10.6 (3.3)bc	14.9 (3.5)b	14.6 (3.9)bc	3650.4e
F3-Sri A Subramani	IPM	3.2 (1.7)b	4.4 (1.9)cd	5.8 (2.2)b	13.0 (3.7)ab	0.6 (1.0)c	10.4 (3.3)cd	6020.0a
	FP	2.3 (1.5)b	1.0(1.1)d	2.0 (1.5)b	7.1 (2.8)c	1.9 (1.4)c	7.4 (2.8)d	5028.8c
LSD (0.05)		0.54	0.74	0.76	0.31	0.59	0.36	79.9

Table 2.51 Weed population and dry mass in IPM and FP plots in farmers fields at Kurumbapet, *Kharif* 2018

Farmer name	Treatments	Weed Population (No/m ²)		Weed Dry Biomass (g/m ²)	
		29 DAT	57 DAT	30 DAT	60 DAT
F1 - Sri S Perumal, Kudupakkam village	IPM	48.40 ± 3.49	56.20 ± 3.65	34.80 ± 2.82	43.40 ± 3.17
	FP	58.80 ± 3.77	62.60 ± 3.92	45.40 ± 4.06	55.00 ± 4.01
F2 - Sri A. Rathakrishnan, Emabalam Nathamedu village	IPM	40.80 ± 3.69	41.20 ± 3.64	27.40 ± 2.98	25.60 ± 0.98
	FP	58.80 ± 3.70	51.40 ± 3.53	45.40 ± 4.06	36.20 ± 2.85
F3-Sri A Subramani, Sorapet village	IPM	32.20 ± 2.52	42.60 ± 4.26	24.00 ± 2.55	30.60 ± 2.50
	FP	45.20 ± 2.20	50.80 ± 2.80	37.20 ± 2.15	24.30 ± 1.80

Table 2.52 Returns and BC ratio in IPMs trial at Kurumbapet, Kharif 2018

Farmer name	Treatments	Yield (Q/ha)	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
F1 - Sri S Perumal, Kudupakkam village	IPM	56.14	90498	42125	48373	2.15
	FP	50.87	82002	55125	26877	1.49
F2 - Sri A. Rathakrishnan, Emabalam Nathamedu village	IPM	46.52	101600	38000	63600	2.67
	FP	36.50	79716	49875	29841	1.60
F3-Sri A Subramani, Sorapet village	IPM	60.20	84280	40750	43530	2.07
	FP	50.28	70392	54125	16267	1.30

Price of Paddy = Rs.1612/q(F1); Rs. 2184/q (F2); Rs.1400/q (F3)

Ludhiana: PR 121 variety was grown in IPMs trial conducted at Sri Iqbal Singh's field of Tugal village, Ludhiana district, Punjab State. Very low incidence of stem borer, leaf folder, whorl maggot, BPH and WBPH was observed in both the treatments (**Table 2.53**). Observations on natural enemies like spiders, coccinellids, ichneumonids and braconids were also taken in both IPM and FP plots. Sheath blight and false smut diseases recorded at Ludhiana revealed that the disease progression was more under farmers practices compared to IPM practices. Grain yield was relatively high in IPM (75.80 q/ ha) as compared to FP plot (72.60) resulting in higher BC ratio (3.28) due to high gross returns and low cost of cultivation (**Table 2.54**).

Practices followed in IPMs trial at Ludhiana, Kharif 2018		
	IPM Practices followed	Farmers Practices followed
Variety	PR 121	PR 121
Nursery	- Seed treatment with 20 g Bavistin 50 WP and 1 g Streptocycline - Application of urea @ 1.0 kg and Zinc sulphate @ 1 kg/ acre nursery	Application of urea @ 1.0 kg/ acre nursery and Zinc sulphate @ 1 kg/ acre nursery
Main field	- Alley ways of 30 cm after every 2 m - Application of Butachlor @ 1.2 L/ acre - Sprayed Fame 480 SC @ 20 ml/acre - Sprayed Confidor 17.8SL @ 40 ml/ acre & Tilt @ 200ml/ acre - Recommended dose of neem coated urea- 90 kg/ acre - Installation of pheromone traps @ 8 traps / ha - Water management for planthoppers	- Applied urea 120 kg and zinc sulphate 25 kg/ acre - Application of Butachlor @ 1.2 L/ acre - Application of Mortar @ 170 g/ acre - Sprayed Confidor 17.8 SL @ 40 ml/ acre - Sprayed Tilt @ 200ml/ acre

Table 2.53 Insect pests and disease incidence in IPMs trial at Ludhiana, kharif 2018

Treatments	%DH	%WE	%LFDL	% WMDL	BPH	WBPH	AUDPC	
	58 DAT	Pre harv	58 DAT	37 DAT	93 DAT	72 DAT	Sheath blight	False smut
IPM	3.87 ± 1.58	5.34 ± 0.67	7.26 ± 1.19	4.33 ± 0.47	18 ± 1.4	31 ± 1.9	104	13
FP	4.78 ± 1.33	4.79 ± 0.61	10.55 ± 0.52	6.26 ± 0.49	28.0 ± 2.6	12 ± 2.1	131	25

Table 2.54 Grain yield & BC ratio in IPMs trial at Ludhiana, kharif 2018

Treatments	Yield (q/ha)	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	BC ratio
IPM	75.80	134166	40955	93211	3.28
FP	72.60	128502	41988	86514	3.06

Price of paddy = Rs 1770/ Q

Malan: The trial was conducted in Sri Ramesh Kumar's field of Jia Haar block, Bharwana, Kangra district, Himachal Pradesh. HPR 2880 was grown in both IPM and FP plots. Incidence of stem borer and hispa was observed starting from 15 DAT onwards. Dead heart damage was high in FP plot (37.4 – 55.5%) compared to IPM plot (16.9 – 24.7%) from 15 DAT to 50 DAT. Hispa damage was also observed from 15 DAT onwards and the damage increased with increase in crop growth and after 57 DAT got reduced (**Table 2.55**). Hispa damage was very high in FP plot as compared to IPM plot with maximum damage at 57 DAT (91.9%). The weed population was 50% lower in IPM adopted field compared to FP plot. The relative grain yield advantage was 82.69%, emphasizing the necessity of adopting IPM practices (**Table 2.56**). Grain yield was low in FP plot (26.00 q/ ha) compared to IPM plot (47.49 q/ha). BC ratio was relatively high in IPM plot (1.88) due to higher grain yield and low cost of cultivation compared to FP plot (1.37).

Table 2.55 Pest incidence in IPMs trial at Malan, kharif 2018

Treatments	%DH				%HDL						
	15 DAT	29 DAT	36 DAT	50 DAT	15 DAT	22 DAT	29 DAT	36 DAT	43 DAT	50 DAT	57 DAT
IPM	18.0 ± 1.6	22.1 ± 2.3	16.9 ± 5.9	24.7 ± 3.7	14.9 ± 0.5	10.2 ± 2.0	11.1 ± 1.6	20.2 ± 1.0	20.1 ± 1.3	17.2 ± 2.9	24.8 ± 3.1
FP	55.5 ± 4.4	46.5 ± 5.6	37.4 ± 5.2	38.8 ± 6.8	26.3 ± 0.8	22.3 ± 0.8	38.5 ± 4.8	43.0 ± 5.4	56.6 ± 1.0	62.7 ± 5.7	91.9 ± 2.8

Table 2.56 Weed dynamics, returns and BC ratio in IPMs trial at Malan, Kharif 2018

Treatments	Weed Population (No./m ²)		Weed biomass (g/m ²)		Yield (q/ha)	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	BC ratio
	29DAT	57 DAT	29DAT	57 DAT					
IPM	12.80 ± 2.33	5.76 ± 0.37	16.00 ± 2.19	18.84 ± 2.53	47.49	85482	45361	40121	1.88
FP	38.00 ± 2.81	15.22 ± 0.90	80.40 ± 8.93	49.28 ± 4.86	26.00	46800	34186	12614	1.37

Price of Paddy = RS. 1800/Q

Mandya: IPMs trial was conducted in three farmers' fields i.e., in the fields of Sri Mahadevu, Sri Jayaramu and Sri Girish at Ganadalu village of Mandya district in Karnataka State.

Practices followed in IPMs trial at Mandya, *Kharif 2018*

Practices adopted	IPM practices	Farmers practices		
		Sri Mahadevu	Sri Jayaramu	Sri Girish
Area	1 ac	1 ac	1ac	1ac
Variety	KRH 4/ BR 2655/MTU 1001	KRH 4	BR 2655	MTU 1001
Fertilizers applied	Urea 45 kg/ acre, SSP 125 kg/ acre, MOP 35 kg/ acre. Top dressing 45 kg urea	Urea 50 kg/ acre, 10:26:26 complex fertilizer 100 kg/ acre, MOP 25 kg/ acre	70 kg - 10:26:26 complex fertilizer; 100Kg Urea	100Kg - 10:26:26 complex fertilizer; 120Kg Urea
Nursery	Seed treatment with Carbendazim @ 4g/kg of seeds			
Main field	- Alley ways of 30cm after every 2m - Londex power @ 4kg/ac - herbicide at 3 days after transplanting + one hand weeding - Installation of pheromone traps for monitoring stem borer @ 8 traps / ha - Application of Fipronil 5 SC @ 1.5 ml/l - Tricyclazole 75WP @ 0.6g/lit	- Randomly transplanted - Pretilachlor @ 400 ml/ acre + two hand weeding - Carbofuran 4G application @ 8 kg/ acre - Chlorantriliprole (Coragen) @ 60 ml/ acre - Tricyclazole 75WP @ 0.6g/lit	- Randomly transplanted - Londex power @ 4kg/ac - herbicide at 3 days after transplanting + two hand weeding - Carbofuran 4G application @ 8 kg/ acre - Flubendiamide 48 SC @ 0.1 ml/l - Imidacloprid 17.8 SL @ 0.3 ml/l - Propiconazole 25 EC @ 1 ml/l	- Randomly transplanted - Pretilachlor @ 400 ml/ acre + two hand weeding - Carbofuran 4G application @ 8 kg/ acre - one spray of Chloropyrifos 20EC @ 2ml/lit - Tricyclazole 75WP @ 0.6g/lit - Chlorantriliprole (Coragen) @ 60 ml/ acre

Table 2.57 Insect pest incidence in IPMs trial at Mandya, *kharif 2018*

Farmer Name	Treat ments	% DH	% WE	% LFDL	% CWDL	BPH	WBPH
		71 DAT	Pre har	29 DAT	43 DAT	113 DAT	106 DAT
F1- Sri Mahadevu	IPM	1.9 ± 0.7	1.6 ± 0.5	1.1 ± 0.3	1.0 ± 0.2	3.4 ± 0.5	2.8 ± 0.4
	FP	2.5 ± 0.5	6.7 ± 1.3	5.2 ± 0.5	3.3 ± 0.5	13.2 ± 1.5	5.0 ± 0.7
F2 - Sri Jayaramu	IPM	2.1 ± 0.8	2.3 ± 1.1	1.2 ± 0.2	1.1 ± 0.3	3.2 ± 0.6	2.4 ± 0.8
	FP	2.7 ± 0.4	8.3 ± 1.8	4.4 ± 0.6	3.6 ± 0.6	10.4 ± 1.0	3.8 ± 1.2
F3- Sri Girish	IPM	1.4 ± 0.6	2.3 ± 0.9	0.8 ± 0.3	0.8 ± 0.2	3.0 ± 0.1	2.6 ± 0.8
	FP	1.9 ± 0.7	5.2 ± 1.1	5.0 ± 0.6	3.8 ± 0.4	10.8 ± 1.9	5.0 ± 1.0

Incidence of stem borer, leaf folder, caseworm, BPH and WBPH was observed in both IPM and FP plots in all the three farmers' fields. In general, pest damage was very low across the farmers' fields (**Table 2.57**). Weed population and weed

biomass was low in both IPM and FP plots in all the three farmers' fields (**Table 2.58**). Leaf blast and neck blast incidence was recorded in both IPM and FP plots in all the three farmers' fields at Mandya. Disease progression was low in IPM plots as compared to FP plots due to the adoption of IPM practices.

Table 2.58 Weed population, biomass, disease incidence in IPMs trial at Mandya, Kharif 2018

Farmer name	Treatments	Weed population (No./m ²)		Weed biomass (g/m ²)		AUDPC	
		36 DAT	64 DAT	36 DAT	64 DAT	Leaf blast	Neck blast
F1- Sri Mahadevu	IPM	1.60 ± 0.75	2.60 ± 1.17	0.20 ± 0.10	1.00 ± 0.48	64	64
	FP	2.20 ± 0.66	3.80 ± 1.07	0.51 ± 0.26	1.52 ± 0.46	166	104
F2- Sri Jayaramu	IPM	1.80 ± 0.58	4.00 ± 0.84	0.27 ± 0.09	1.55 ± 0.34	58	30
	FP	4.00 ± 0.71	4.40 ± 0.51	1.20 ± 0.25	1.98 ± 0.28	112	61
F3- Sri Girish	IPM	1.80 ± 0.80	2.60 ± 0.98	0.43 ± 0.21	0.86 ± 0.41	70	52
	FP	2.80 ± 0.86	2.68 ± 0.87	0.86 ± 0.28	0.60 ± 0.25	172	103

AUDPC = Area under disease progress curve

Table 2.59 Returns and BC ratio in IPMs trial at Mandya, kharif 2018

Farmer name	Treatments	Yield (q/ha)	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
F1- Sri Mahadevu	IPM	76.24	121984	47175	74809	2.59
	FP	68.16	109056	51750	57306	2.11
F2- Sri Jayaramu	IPM	68.80	106640	46550	60090	2.29
	FP	56.00	86800	54750	32050	1.59
F3- Sri Girish	IPM	52.64	76328	46800	29528	1.63
	FP	47.12	68324	54125	14199	1.26

Price of Paddy = Rs. 1600 (F1); Rs.1550 (F2); Rs. 1450 (F3)

High grain yield was recorded in IPM plots compared to FP plots with maximum yield in IPM plot of Sri Mahadevu's field followed by IPM plot of Sri Jayaramu's field. High BC ratios were obtained in IPM plots compared to FP plots in all the farmers' fields (**Table 2.59**).

Pantnagar: IPM trial was conducted in one village in two farmers' fields' viz., Sri Satnam singh and Sri Prabhash singh of Panchananpur village, Dineshpur, U.S Nagar mandal of Uttarakhand State. Varieties grown and practices followed in IPM and FP plots are given below in a Table. Low incidence of stem borer, leaf folder, whorl maggot, hispa, BPH and GLH was observed in both IPM and FP plots (**Table 2.60**). Stem borer damage crossed ETL only in IPM plot from 43 DAT to 57 DAT and BPH crossed ETL in Sri Satnam singh's field in both IPM and FP plots. Grain yield ranged from 52.48 to 56.12 q/ha in both the treatments.

Table 2.60 Pest incidence in IPMs trial at Pantnagar, *kharif* 2018

Farmer name	Treatments	%DH			%LFDL	%WMDL	%HDL	BPH	Yield
		43 DAT	50 DAT	57 DAT					
F1- Sri Satnam Singh	IPM	9.95 ± 2.69	13.02 ± 2.66	9.49 ± 2.10	1.71 ± 0.32	4.22 ± 1.58	1.51 ± 0.49	55.60 ± 1.2	5321 ± 82
	FP	5.54 ± 1.70	7.60 ± 3.04	9.16 ± 1.87	0.98 ± 0.53	3.01 ± 0.51	1.71 ± 0.56	60.60 ± 1.8	5612 ± 43
F2 - Prabhash Sarkar	IPM	15.98 ± 1.66	8.50 ± 1.01	12.52 ± 3.01	0.56 ± 0.22	0.71 ± 0.44	2.44 ± 0.55	15.60 ± 1.4	5248 ± 69
	FP	10.30 ± 2.06	6.56 ± 1.55	7.81 ± 1.37	0.62 ± 0.33	4.48 ± 1.01	2.15 ± 0.55	7.4 ± 1.6	5481 ± 52

Practices followed in IPMs trial at Pantnagar, *Kharif* 2018

	Sri Satnam Singh		Sri Prabhaskar	
	IPM	FP	IPM	FP
Area	3000 sq.m	300 sq.m	2500 sq.m	2500 sq.m
Variety	PR 113	PR 113	HKR 47	HKR 47
Main Field	• Application of NPK 40 kg/ acre, Zinc 25 kg and urea 100 kg. • Application of Butachlor @ 1.5 L/ ha • Sprayed Cartap hydrochloride @ 600g/ha- two times • Applied streptocycline@15 g/ha + copper oxyclozide@ 500 g/ha • Installed pheromone traps for YSB @ 8/ ha	• Application of NPK 40 kg/ acre, Zinc 25 kg and urea 100 kg. • Application of Pretilachlor 50 EC @ 1500 ml/ ha • Application of Fertera @ 10kg/ha, Fipronil 5SC @ 1000ml/ha, Thiamethoxam 25% WG @ 100g/ ha • Applied Streptocycline@15g/ha + copper oxyclozide @ 500g/ha, Propiconazole 25% EC @ 1000ml/ ha	• Application of NPK 100 kg/ ha, Zinc 25 kg and Urea 100 kg • Application of Butachlor @ 3.0 L/ ha • Sprayed Cartap hydrochloride @ 600g/ha- two times • Applied streptocycline @15 g/ha + copper oxyclozide @ 500g/ha	• Application of NPK 100 kg/ ha, Zinc 25 kg and Urea 100 kg • Applied Pretilachlor 50 EC @ 1500 ml/ ha (Refit) • Application of Cartap hydrochloride 4.0G @ 19 kg/ ha, Coragen @ 150 ml/ ha, Buprofezin @ 800 ml/ ha • Applied Streptocycline @15g/ha + copper oxyclozide @ 500g/ha And Propiconazole 25 Ec @ 1000ml/ ha

Pusa: IPM trial was conducted involving three farmers, i.e., two farmers Samastipur area viz., Sri Sushil Kumar Rhakur and Smt Sukhsagar Devi from Ratras, Warisnagar, Samastipur and one from Darbhanga area, Sri Ram Sevak Rai from Khutwara, Kabariya, Darbhanga in Bihar State. Varieties grown and practices followed in IPM and FP plots are given below in a Table. Incidence of stem borer and leaf folder only was observed in both treatments. Damage was relatively high in IPM plot as compared to FP plots (**Table 2.61**). Grain yield varied from 50.88 to 61.54 q/ ha and resulted in high BC ratio in all the treatments (2.52 – 2.97).

Practices followed in IPMs trial at Pusa, <i>Kharif</i> 2018				
	Sri Sushil Kumar Rhakur		Smt Sukhsagar Devi	Sri Ram Sevak Rai
	IPM	FP1 -	FP2	FP3
Area	1 acre	1 acre	1 acre	1 acre
Variety	Rajendra Mansuri	Rajendra Mansuri	Rajendra Mansuri	Rajendra Mansuri
Main Field	- Seed treatment with Carbendazim @ 2 g/ kg seed - Transplanting at 20 x 15 cm spacing - Application of Butachlor @ 1.5 kg ai/ ha after one week of transplantation - Installed pheromone traps for YSB @ 3/ acre - Application of Bispyribac sodium 20 g ai/ ha at 20 DAT	- Seed treatment with Carbendazim @ 2 g/ kg seed - Transplanting at 20 x 15 cm spacing - Application of Pretilachlor 50 EC @ 1500 ml/ ha - Sprayed Chlorpyrifos 20 EC @ 500 ml ai/ ha at 20 DAT	- Transplanting at 20 x 15 cm spacing - Hand weeding at 30 DAT - Application of Carbaryl 50 WP @ 30 kg/ ha	- Transplanting at 20 x 15 cm spacing - Hand weeding at 30 DAT

Table 2.61 Insect pest incidence, grain yield & BC ratio in IPMs trial at Pusa, *Kharif* 2018

Treatments	%DH		%WE	%LFDL		Yield Q/ ha	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
	30 DAT	50 DAT	Pre har	30 DAT	50 DAT					
IPM	14.06 ± 1.03	15.93 ± 1.37	13.05 ± 1.24	15.18 ± 0.74	17.75 ± 1.00	61.54	95387	32133	63254	2.97
FP1	10.98 ± 0.57	12.40 ± 1.13	9.29 ± 0.67	12.36 ± 0.25	13.81 ± 0.63	52.08	80724	30155	50569	2.68
FP2	10.78 ± 0.87	13.05 ± 1.25	9.82 ± 0.84	11.93 ± 0.19	14.20 ± 0.67	51.16	79298	30950	48348	2.56
FP3	11.28 ± 0.90	13.79 ± 0.41	9.35 ± 0.63	11.55 ± 0.41	13.07 ± 0.57	50.88	78864	31320	47544	2.52

Price of paddy = Rs.1550/q

Raipur: IPM trial was carried out in three farmers fields, i.e, Sri Bhagwat Yadaw, Sri Yogendra Yadaw, Sri Ved Prakash Yadaw and data for farmers practices was taken from Sri Govardhan Sahu's field in Bhothle village, Arang block, Raipur district of Chattisgarh State. Practices followed in both IPM and farmers practices were given in the table below.

Low incidence of stem borer, leaf folder, hispa, BPH and WBPH was noticed in both the treatments in all the farmers' fields which may be mainly due to dry spell resulting in delayed planting (**Table 2.62**). Grain yield ranged between 45.16 and 51.42 q/ ha. High BC ratio was obtained in both IPM and FP fields which are largely because of high sale price of paddy (Rs.2050/Q).

Practices followed in IPMs trial at Raipur, Kharif 2018		
	IPM Practices followed	Farmers Practices followed
Variety	Swarna	Swarna
Nursery	- Seed treatment with Carbendazim @ 2 g/ kg seed and nursery application of carbofuran - Application of 10 kg urea	Application of 10 kg urea
Main field	- Application of 50 kg DAP, 15 kg MOP & 50 kg Urea - Planting at 25 x 25 cm spacing - Alley ways of 30 cm after every 2 m - Application of Butachlor - Regular monitoring - Installation of pheromone traps - Application of cartap hydrochloride	- Application of 70 kg DAP, 50 kg Urea and 150 Zinc/ acre - Random planting - Application of Triazophos + Deltamethrin @ 200ml/ acre - Application of Nativo @ 150g/ acre - Spraying of thiamethoxym @ 150 g/ acre – two times

Table 2.62 Pest incidence, Returns and BC ratio in IPMs trial at Raipur, Kharif 2018

Farmer name	Treatment	%DH	BPH		Yield (q/ ha)	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
		36 DAT	113 DAT	120 DAT					
F1 - Bhagwat yadaw	IPM	3.50 ± 1.43	12.20 ± 6.23	30.20 ± 5.97	51.42	105411	17988	87423	5.86
F2 - Yogendra yadaw	IPM	2.00 ± 1.36	4.60 ± 1.40	32.00 ± 10.34					
F3 - Vedprakash Yadaw	IPM	3.07 ± 1.40	11.40 ± 2.50	25.60 ± 2.84					
F4 - Govardhan Sahu	FP	3.73 ± 1.53	43.40 ± 5.97	55.60 ± 2.84	45.16	92578	22700	69878	4.08

Price of Paddy = Rs. 2050/q

Sakoli: The trial was carried out in three farmers' field's viz., Sri Devram Rushi Fande and Sri Timaji Govinda Waghmare of Dharmapuri village, Sri Yadaorao Ramaji Kapgate of Sakoli village, Sakoli tehsil in Bhandara district of Maharashtra State. Details of farmers and practices followed were given below.

Incidence of stem borer, gall midge, leaf folder, BPH, WBPH and GLH was observed in both IPM and FP plots of all the three farmers. Dead heart damage was high in both IPM field (25.73%) and FP plot of Sri Fande. Damage in other two farmers fields was low (<10%). White ear damage was low in all the fields except FP plot of Sri Waghmare which recorded 17.9% damage (**Table 2.623**). BPH and WBPH population was observed in both the treatments from 50 DAT onwards but did not cross ETL in any of the farmers' fields. Army worm incidence was observed in both the treatments only in Sri Fande and Sri Kapgate's fields.

Practices followed in IPMs trial at Sakoli, Kharif 2018		
Name of the farmer: Sri Devram Rushi Fande; Village: Dharmapuri, Tahsil: Sakoli; Bhandara district		
	IPM Practices followed	Farmers Practices followed
Variety	Kesar	Kesar
Nursery	- Seed treatment with Carbandezim @ 2 g/ kg seed - Application of 20:20:0:13 – 8 kg - Application of Carbofuran @ 1.1 kg ai/ ha, 5 days before pulling seedlings	Application of 20:20:0:13 – 8 kg
Main field	- Application of 20:20:0:13 - 250 kg - Seedlings planted at spacing of 20 x 15 cm - Left alleyways of 30 cm after every 2 m or 10 rows. - Application of Butachlor @ 1.5 kg a.i./ ha on 3rd day after transplanting + 1 manual weeding - Application of Cartap hydrochloride 50 WP @ 600 g / ha - Installation of pheromone traps with 5 mg lure @ 8 traps/ ha for stem borer monitoring - Application of Propiconazole 0.1% at 65 DAT - Mid season drainage for BPH management - Soil application of Ferterra @ 10 kg/ ha at 67 DAT - Application of Streptocycline @ 50 g/ ha at 85 DAT	- Application of 20:20:0:13 - 250 kg - Seedlings were planted randomly - Applied Erase @ 1 L/ ha at 3rd day after transplantation + 1 manual weeding - Application of Imidacloprid 17.8 SL @ 500 ml/ ha + Acephate @ 500 g/ ha at 94 DAT
Name of the farmer: Sri. Yadaorao Ramaji Kappate; Village: Sakoli; Tahsil: Sakoli; Bhandara district		
	IPM Practices followed	Farmers Practices followed
Variety	Yashoda 1312	Yashoda 1312
Nursery	- Seed treatment with Carbandezim @ 2 g/ kg - Application of Carbofuran @ 1.1kg ai/ ha, 5 days before pulling seedlings	Applied 20:20:00:13- 12 kg
Main field	- Application of 20:20:0:13 – 375 kg/ ha - Seedlings transplanted at spacing of 20 x 15 cm - Alleyways of 30 cm after every 2 m or 10 rows. - Application of Butachlor @ 1.5 kg a.i./ ha on 4th day after transplanting + 1 manual weeding - Installation of pheromone traps with 5 mg lure @ 8 traps/ ha for stem borer monitoring - Application of Cartap hydrochloride 50 WP @ 600 g / ha at 56 DAT. - Application of Propiconazole 0.1% at 62 DAT - Mid season drainage for BPH management - Application of carbendazim @ 500 g/ ha at 106 DAT	- Application of 20:20:0:13 – 375 kg/ ha - Seedlings were transplanted randomly - Applied Check weedicide @ 833 ml/ ha at 4th day after transplantation + 1 manual weeding - Application of Imidacloprid 17.8 SL @ 416 ml/ ha at 73 DAT - Spraying of Chlorpyrifos 50% + Cypermethrin 5% EC @ 833 ml/ ha and Acephate @ 833 g/ ha at 100 DAT.
Name of the farmer: Sri. Timaji Govinda Waghmare; Village: Dharmapuri; Tahsil: Sakoli, Bhandara district		
	IPM Practices followed	Farmers Practices followed
Variety	Yashoda 1312	Yashoda 1312
Nursery	- Seed treatment with Carbandezim @ 2 g/ kg seed - Applied 20:20:00:13 complex fertilizer @ 12 kg - Application of Carbofuran @ 1.1kg ai/ ha 4 days before pulling seedlings	- Applied 20:20:00:13 @ 12 kg - Applied Phorate 10G @ 1 kg, 4 days before pulling the seedlings
Main field	- Application of 20:20:00:13 @ 188 kg/ha - Seedlings transplanted at spacing of 20 x 15 cm - Alleyways of 30 cm after every 2 m or 10 rows. - Application of Butachlor @ 1.5 kg a.i./ ha on 3rd day after transplanting + 2 manual weedings - Installation of pheromone traps with 5 mg lure @ 8 traps/ ha for stem borer monitoring - Application of Cartap 50 WP @ 600 g / ha 60 DAT. - Application of Propiconazole 0.1% at 65 DAT - Imidacloprid 17.8 SL @ 416 ml/ ha at 95 DAT - Mid season drainage for BPH management	- Application of 20:20:00:18 @ 125 kg/ha + Urea 125 kg - Seedlings were transplanted randomly - Application of Erase @ 1 liter/ ha on 5th day after transplantation - Manual weeding was done

Incidence of leaf blast, sheath blight, bacterial leaf blight, brown spot, sheath rot and stem rot was observed in both IPM and FP plots in all the three farmer fields. However, neck blast was reported from two farmer fields and absent in Sri Fande's field in both IPM and FP treatments. The AUDPC values of diseases in general were high in all the three farmers' fields in both IPM and FP plots (**Table 2.64**).

Table 2.63 Disease incidence and progression in IPMs trial at Sakoli, *kharif* 2018

Farmer Name	Treatments	Area Under Disease Progress Curve (AUDPC)						
		Leaf blast	Neck blast	Sheath blight	Bacterial leaf blight	Brown spot	Sheath rot	Stem rot
F1- Sri Devram Rushi Fande	IPM	241	0	199	2318	228	39	180
	FP	195	0	195	2289	161	90	216
F2 - Shri. Yadaorao Ramaji Kapgate	IPM	612	8	146	2476	1311	105	288
	FP	498	9	141	2778	735	56	237
F3- Sri Timaji Govinda Waghmare	IPM	372	14	162	1487	363	197	211
	FP	309	50	255	1208	379	435	143

Weed population and weed dry mass data recorded at 30 DAT and 60 DAT revealed that IPM implemented plots had low population and biomass as compared to farmer practices plots (**Table 2.65**). Weed dry mass was very high in FP plots of all the three farmers (30.52 – 36.26 g/ m²) at 60 DAT.

Table 2.64 Insect pest incidence in IPMs trial at Sakoli, *kharif* 2018

Farmer Name	Treatments	%DH	%WE	BPH	WBPH	GLH	Army worm
		64 DAT	Pre har	85 DAT	85 DAT	85 DAT	57 DAT
F1- Sri Devram Rushi Fande	IPM	25.73 ± 2.27	2.63 ± 0.71	28.40 ± 1.50	10.20 ± 0.86	10.60 ± 1.21	1.20 ± 0.37
	FP	18.78 ± 2.15	6.12 ± 1.37	20.40 ± 1.81	8.00 ± 1.22	10.00 ± 0.71	0.8 ± 0.49
F2 - Shri. Yadaorao Ramaji Kapgate	IPM	10.03 ± 1.51	3.65 ± 0.83	33.60 ± 1.91	11.80 ± 0.86	11.00 ± 1.30	0.40 ± 0.24
	FP	8.14 ± 2.19	6.13 ± 0.99	31.40 ± 1.86	9.60 ± 0.51	10.80 ± 0.92	1.00 ± 0.01
F3- Sri Timaji Govinda Waghmare	IPM	7.16 ± 1.60	8.73 ± 1.89	37.40 ± 3.41	12.80 ± 1.07	10.80 ± 1.20	0
	FP	4.04 ± 0.69	17.92 ± 2.34	42.20 ± 1.69	15.20 ± 1.02	10.40 ± 0.87	0

Table 2.65 Weed Population and weed biomass in IPMs trial at Sakoli, *kharif* 2018

Farmer Name	Treatments	Weed Population (No./m ²)		Weed dry mass (g/m ²)	
		30 DAT	60 DAT	30 DAT	60 DAT
F1- Sri Devram Rushi Fande	IPM	6.80 ± 0.49	8.40 ± 0.81	12.46 ± 2.28	18.70 ± 2.30
	FP	10.60 ± 1.08	11.00 ± 1.22	27.98 ± 2.14	36.26 ± 6.80
F2 - Shri. Yadaorao Ramaji Kapgate	IPM	7.80 ± 0.58	8.60 ± 0.75	8.30 ± 1.16	19.84 ± 0.99
	FP	12.00 ± 1.61	11.60 ± 1.29	21.90 ± 4.38	32.82 ± 3.16
F3- Sri Timaji Govinda Waghmare	IPM	7.40 ± 0.81	9.60 ± 0.81	12.04 ± 1.43	16.70 ± 1.42
	FP	9.80 ± 1.07	13.20 ± 1.66	21.48 ± 2.37	30.52 ± 6.92

Grain yield was relatively high in IPM practiced plots compared to FP plots in all the three farmers' fields. High gross returns and low cost of cultivation in IPM plots resulted in high BC ratio (**Table 2.66**). BC ratio ranged from 2.28 to 2.78 in IPM plots and between 1.95 and 2.43 in FP plots.

Table 2.66 Returns and BC ratio in IPMs trial at Sakoli, Kharif 2018

Farmer Name	Treatments	Yield (Q/ ha)	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
F1- Sri Devram Rushi Fande	IPM	53.98	110659	40463	70196	2.73
	FP	42.39	86900	35690	51210	2.43
F2 - Shri. Yadaorao Ramaji Kapgate	IPM	51.98	98762	43372	55390	2.28
	FP	47.59	90421	41313	49108	2.19
F3- Sri Timaji Govinda Waghmare	IPM	47.62	90478	37513	52965	2.41
	FP	34.89	66291	34045	32246	1.95

Price of Paddy = Rs. 2050 (F1); Rs.1900 (F2 & F3)

Titabar: The trial was conducted at Sri ratul Lekhok's field at Mazgoan village, Titabar mandal, Jorhat district of Assam. Ranjit variety was grown in both IPM and FP blocks. Practices followed were given in the table below. Incidence of stem borer was observed from 22 DAT onwards and crossed ETL from 36 DAT to 50 DAT that later got reduced (**Table 2.67**). Low incidence of gall midge, leaf folder and whorl maggot was noticed in both IPM and FP plots. Weed dry mass was considerably high in farmer practices (70.80 g/ m²) compared to IPM field (28.97 g/m²). The severity of bacterial leaf blight and sheath blight was low in IPM plots compared to FP plots. Grain yield was high in IPM plot than FP plot resulting in high BC ratio of 2.08(**Table 2.68**).

Practices followed in IPMs trial at Titabar, Kharif 2018		
	IPM Practices followed	Farmers Practices
Variety	Ranjit	Ranjit
Nursery	• Seed treatment with Bavistin @ 2 g/ kg seed	
Main field	• Fertilizer application @ 30:20:40 kg NPK/ha • Application of pretilachlor within a week of transplanting • Application of paddy weeder to lessen weeds • Installation of pheromone traps @ 8/ ha for stem borer monitoring • At 45 DAT, applied chlorpyriphos 20EC @ 2ml/L for stem borer management • Placement of tricho cards for stem borer and leaf folder management • Sprayed fresh cowdung solution @250g/L at mid tillering stage against BLB	• Fertilizer application @20:10:10 kg NPK/ha • Manual weeding two times • Application of chlorpyriphos

Table 2.67- Insect pests, diseases and weed incidence in IPMs trial at Titabar, kharif 2018

Treatments	% DH			% SS	% LFDL	% WMDL	Weed dry mass	Disease severity (%)	
	36DAT	43DAT	50DAT	50DAT	36DAT	64DAT	g/m ²	BLB	Sheath blight
IPM	1.36 ± 0.5	1.85 ± 0.5	1.23 ± 0.8	1.14 ± 0.5	0.88 ± 0.4	0.40 ± 0.2	28.97 ± 5.40	23.19	11.50
FP	11.44 ± 2.5	12.30 ± 1.9	13.79 ± 1.3	8.18 ± 0.5	4.02 ± 0.7	3.15 ± 0.3	70.80 ± 9.19	35.37	31.05

Table 2.68 Returns and BC ratio in IPMs trial at Titabar, kharif 2018

Treatments	Yield (Q/ha)	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
IPM	50.04	82566	39740	42826	2.08
FP	38.04	62766	35742	27024	1.76

Price of paddy = Rs. 1650/q

Integrated Pest Management special (IPMs) trial was conducted at 15 locations involving 31 farmers' in a participatory mode across the Country with an objective of managing insects, diseases and weeds in a holistic way by providing a basket of options to the farmers. In general, during Kharif 2018 the pest incidence was low across the locations. However, insect pest incidence surpassed ETL at 8 locations and was observed high in farmer practices plots as compared to IPM plots. Implementation of IPM practices resulted in reduction in the population of WBPH (103/ hill to <10/hill) at Gangavathi. BPH population was high in IPM plots initially but got reduced later with the adoption of IPM practices at Gangavathi and Raipur. Similarly, stem borer damage was low in IPM plots than FP plots at 4 locations while dead heart damage was very high in IPM plots at Malan (55.5%), Pusa and Sakoli. Gall midge incidence was low in IPM plots (3.99 – 10.29% SS) compared to FP plots (11.68 – 21.23% SS) at Jagdalpur. Leaf folder incidence was low in IPM at Kurumbapet (16.6%) while it was high at Pusa (17.75%). Hispa incidence was low in IPM (10.2 – 24.8%) compared to FP plots (22.3 – 91.9%) throughout the crop growth period at Malan.

Disease incidence was observed at six locations and among these, leaf blast was recorded from four locations viz., Coimbatore, Jagdalpur, Mandya, and Sakoli while neck blast was found at Sakoli and Mandya. The leaf blast and neck blast disease progress was significantly lower in the experimental plots where IPM practices were followed when compared to the farmer practices. Sheath blight disease was recorded at Jagdalpur, Ludhiana, Sakoli and Titabar while BLB at two locations viz., Sakoli and Titabar. Sheath blight progression was more and rapid at Sakoli in farmer practices (144 -255) compared to other three locations. The brown spot, sheath rot and stem rot diseases were recorded at Sakoli while false smut was observed only at Ludhiana under both IPM and FP fields. In general, the disease progression was slow in IPM fields compared to farmer practices.

Weed population and weed biomass recorded at all the locations were considerably reduced by two to five times in IPM implemented plots compared to farmer practices resulting in higher grain yields. Grain yields were high in IPM fields compared to farmer practices at all the locations. High returns and low cost of cultivation resulted in high BC ratio in IPM implemented farmer fields.

2.7 POPULATION DYNAMICS OF RICE INSECT PESTS ASSESSED THROUGH LIGHT TRAP CATCHES

The population dynamics of insect pests and their natural enemies vary with the geographic location and cropping system. Insect pest populations, during the crop season are always a function of abiotic and biotic factors. Besides biotic potential, to a large extent, abiotic factors like temperature, rainfall, relative humidity, sun shine hours, etc. and biotic factors such as predators, parasitoids, entomopathogenic organisms, etc. determine the abundance of insect pests in a crop ecosystem. Therefore, to design any effective location specific pest management strategies, knowledge of population dynamics of insect pests in relation to abiotic and biotic factors becomes vital. Since rice is grown in diverse agro-climatic zones in India, concerted efforts are being made under AICRIP to study the population dynamics of insect pests of rice at different locations across the country to understand short- and long term changes in rice pest scenario.

During 2018, insect populations in rice ecosystems were recorded daily, throughout the year using light traps (Chinsurah/Robinson type) in 24 locations. Corresponding weather data on temperature, rainfall, relative humidity, sunshine hours, etc. were also collected. Weekly cumulative catches of insects and weekly averages of weather parameters were worked out and are presented on standard week (SW) basis. Highlights and trends of the data collected during the year 2018 are presented zone-wise hereunder:

Zone I- Hills

- 1. Himachal Pradesh-Malan (22-44 SW):** WSB, CW, LF, BPH, WBPH, GLH, and black beetle were recorded. LF was found active during 33-38 standard weeks (SWs). Catches were highest during 37 SW (1100 moths). With respect to WSB, it occurred continuously from 34 SW onwards. Catches were maximum (71) in 34 SW. Black beetle was recorded continuously from 25 SW onwards, but the numbers were considerable during 36-42 SWs with a highest weekly catch in 41 SW (81). On the other hand catches of remaining insects were not considerable.
- 2. Jammu Kashmir-Khudwani (14-44 SW):** GRH, skippers, LF, scarabaeids, and cutworms were recorded at this centre. Gr.H and LF appeared continuously from 29 to 40 SW with maximum catch of 27 and 15 respectively in 40 and 39 SWs. Whereas, skipper population was recorded during 27 to 39 SW with a maximum catch (15) in 34 SW. Scarabaeids were active from 19 to 25 SW and highest numbers were observed in 22 SW (48). Cutworms showed staggered occurrence with moderate catches. in 14-15, 25-26, and 34-36 SWs,

Zone II- Northern

- 3. Uttarakhand-Pantnagar (22-48 SW):** YSB, LF, GLH, BPH, WBPH, and RGB were recorded at this location. YSB started appearing early from 22 SW and catches consisted of mostly females and the maximum count (1439) was recorded in 37 SW followed by gradual decline in numbers. LF, GLH, BPH, and WBPH were active mostly during the crop growth period, 28-43 SWs. LF showed two peaks, one in 32 SW (128) and the other in 41 SW (126). BPH and WBPH were highest in 39 SW (7480 and 725 respectively). RGB was found active during 35-46 SW with a peak catch of 725 in 39 SW.
- 4. Punjab-Ludhiana (1-51 SW):** Three species of SBs namely, YSB, PSB and WSB were recorded at this location. However, YSB and PSB catches were low (56 and 70 respectively). PSB showed two distinct periods of activity during the crop growth seasons and highest catches (364) were found in 44 SW. LF catches were recorded continuously from 24-47 SWs and the peak numbers (336) were observed in 40 SW. Sucking pests and mirid bugs were found only during the *Kharif* season. BPH and WBPH were caught in considerable numbers (6699 and 5215) during 44 SW. Population of mirid bugs reached peak (518) in 45 SW.
- 5. Jammu&Kashmir-Chatha (1-52 SW):** White grub, GSB, Gr.H, LF, GLH, ZZLH and *Cofana* sp. were recorded. White grub appeared continuously from 14-50 SWs. There were two peaks, one at 27 SW (483) and another at 39 SW (164). GSB started appearing continuously from 17 to 51 SW but the catches were highest during 27 SW (44). LF activity was recorded during 34-46 SWs and was highest in the 39 SW (53). GLH was observed throughout the year except in 26- 33 SWs. Largest catch was found during 11 SW (377). GRH were recorded from 23 SW onwards with an exception of 41 SW and peak activity was in 27 SW (29). ZZLH and *Cofana* sp. were recorded only in 42 and 43 SWs in small numbers (22 and 34 respectively).

Zone III-Eastern

- 5. Odisha- Chiplima (27-52 SW):** SB, GM, LF, GLH, BPH, WBPH and CW were reported from this centre. Pest activity was found only during 35-48 SWs. Data reveals a continuous rainfall in the preceding weeks of the season. YSB first appeared in 35 SW and gradually reached the maximum (37+39 female+male) in 43 SW followed by a decline. GM showed two peaks of activity one in 40 SW (160) and another in 43 SW (137). Both the species of GLH, *Nephotettix virescens* and *N. nigropictus* were recorded, however the former was predominant. The combined catch was largest (996) in 43 SW. BPH and WBPH populations were found active only during 42-48 SWs. Peak

catches of BPH (2511) in 44 SW and WBPH (2193) in 43 SW were observed. CW was found most active in 39-43 SWs with catch size of 22-30.

- 6. West Bengal-Chinsurah (1-52 SW):** Rice pests namely, SBs, LF, GLH, BPH, WBPH, and WLH were found active throughout the year. However, temporal distribution of the insect populations revealed two distinct peaks coinciding with *Kharif* and *Rabi* seasons. Insect catches in *Kharif* were larger as compared to *Rabi*, particularly that of YSB and planthoppers. In case of YSB, males were more abundant as compared to females and maximum moths were trapped in 21 SW (381+929). GLH (*N. virescens*) catch was largest (79) in 40 SW and *N. nigropictus* in 41 SW (25). BPH and WBPH were most active (1535 and 223 respectively) in 42 and 41 SWs. WLH were found in considerable numbers and highest catch was recorded in 41 SW (223).

Zone V- Central

- 7. Chhattisgarh-Raipur (1-52 SW):** SBs, LF, GLH, BPH, ZZLH, CW, RGB and blue beetle and *Spodoptera* sp. were recorded at this location. Among the SBs; YSB and PSB were found almost throughout the year. YSB catches were highest (41+13) in 40 SW. LF was found active in *Kharif* season for a limited period i.e. 40-50 SW and catches were small, up to a maximum of 23 moths per trap.. BPH was found most active during 11-21 SW in *Rabi* and 39-50 SW in *Kharif* and their catches were highest (4288) in 45 SW. ZZLH was also observed all round the year with maximum catches (2928) in 45 SW. CW was found in moderate numbers during the cropping seasons. RGB and blue beetle were also trapped during the monsoon season in small numbers. Occasionally *Spodoptera* moths were also attracted in small numbers. Generalist predators namely, coccinellids, spiders, staphylinids, rove beetles, and earwigs were recorded round the year. Rove beetle catches were considerable and highest count of 169 was recorded in 11 SW.
- 8. Chattisgarh-Jagdalpur (1-52 SW):** YSB, GM, LF, GLH, BPH, WBPH, ZZLH, RGB, and Gr.H were recorded at this location. Light trap catches at this location were characterised by the large size of GLH catches. The pest was more active during the *Kharif* season and combined catch of *N. virescens* and *N. nigropictus* was up to 14455, in 39 SW. BPH was present throughout the year, but was most active between 38 and 49 SWs with a highest count of 129 in 43 SW. WBPH numbers were not considerable. ZZLH number was high during the *Kharif* season and 597 hoppers were observed in 46 SW. YSB peak population (53+54 and 79 respectively) was recorded in 39 SW. GM was present in 35-45 SW up to a maximum of 32 adults in 41 SW. LF also was found throughout the year, but was most active during 34 to 50 SWs and catch was largest with 108 moths per trap in 42 SW. Grasshopper activity

picked up during 43-50 SW and was highest during 48 SW (67). Among the natural enemies, coccinellid and ground beetles were recorded round the year with a maximum of 730 and 430 respectively in 45 SW.

- 9. Maharashtra-Sakoli (1-52 SW):** YSB, GM, LF, GLH, BPH, WBPH and rice moth were recorded at this location in light trap catches. YSB was found active throughout the year, while the remaining species showed distinct seasonal activity coinciding with major cropping seasons. In *Rabi*, YSB was most active (387+90) in 16 SW whereas, in *Kharif* the catches were highest during 40 SW (104+27). GM was found exclusively in 36-46 SWs and the highest catch was recorded in 40 SW (600). LF was present in maximum numbers (40) during in 41 SW. Hoppers showed distinct seasonal activity during the crop growth period. In *Rabi* season GLH, BPH, and WBPH catches were maximum in 16 SW whereas, in *Kharif* GLH catch was highest in 42 SW (501) and BPH (1069) and WBPH (608) in 44 and 40 SWs respectively.

Zone VI- Western

- 10. Maharashtra-Karjat (1-52 SW):** YSB, LF, and GLH were recorded at this centre, but numbers were less.
- 11. Gujarat-Nawagam (1-52 SW):** YSB, LF, BPH, and WBPH were recorded. Insect activity was predominant late in the year. Peak populations of YSB, LF, BPH and WBPH (24, 113, 68, and 141 respectively) were recorded in 43, 41, 42, and 41 SWs respectively.
- 12. Gujarat-Navsari (1-52 SW):** SBs, LF, GLH, BPH, WBPH, RGB, and paddy skipper were found in light trap catches. All the pests were recorded only after 22 SW. After first appearance in 22 SW, YSB numbers increased gradually and along with other SBs the catches were at peak (410+205 and 71 respectively) during 37 SW followed by a decline. Maximum numbers of LF (446) were found in 36 SW. Sucking pests appeared late and hoppers were observed in 31 SW while RGB catches were recorded in 37 SW. GLH (*Nephotettix virescens* and *N.nigropictus*) catches were highest (76 and 68) in 44 SW. BPH and WBPH were found in highest numbers during 41 SW but the catches were moderate (97 and 132 respectively).

VII-Southern

- 13. Andhra Pradesh-Maruteru (22-52 SW):** YSB, GM, LF, GLH, BPH, WBPH, ZZLH, black bug, coccinellids and mirid bug were reported from this centre. Except LF and WBPH remaining species showed continuous activity. YSB catches were highest (941+902) in 40 SW. GM was most active (5185) in 40 SW. GLH, BPH and Mirid bugs showed similar trends. GLH catches were maximum (821) in 43 SW and BPH (11665) in 40 SW. WBPH started appearing after 35 SW and reached peak population (5952) in 42 SW. Mirid

bugs were recorded throughout the year and largest catch (43110) was in 40 SW. ZZLH also was found in considerable numbers, up to a maximum of 3582 in 49 SW. Black bug was found throughout year and was most active in 48 SW (711).

- 14. Andhra Pradesh-Bapatla (31-52 SW):** YSB, GM, LF, GLH, BPH, WBPH, ZZLH, Gr.H and natural enemies were reported from this centre. Except GM, WBPH, and GLH all the reported pests were active throughout the season. YSB catches were highest (196) in 41 SW. GM started appearing from 40 SW and was active till 48 SW. Peak activity (3248) was in 41 SW. Leaf folder maximum catches (896) were in 46 SW. In 47 SW BPH catch was the largest (8617). Catches of WBPH and ZZLH also were considerable. *The striking feature of light trap data from this centre is high incidence of GH. During 40-48 SWs a spurt in the GH population was recorded and it was as high as 68880 in 45 SW.* Mirid bug catches were considerable and in 52 SW 14688 bugs were trapped.
- 15. Telangana-RajendraNagar (1-52 SW):** Insect seasonality coincided with the cropping seasons. YSB, PSB, LF, GLH, BPH, WBPH, blue beetle, GLH, coccinellids and mirid bugs were recorded at this centre. Overall insect counts were small. Highest count of YSB (48+48) was recorded in 5 SW. GLH was most active during 43 SW and BPH in 46 SW (218 and 313 respectively).
- 16. Telangana-Warangal (1-52 SW):** YSB, GM, LF, BPH, WBPH, and GLH were recorded at this centre. YSB was found throughout the year. However, the numbers were small in summer months. The catches were maximum (12+28) in 45 SW. GM was found during 39-47 SWs with a peak population of (414+96) in 41 SW. BPH showed two distinct periods of activity corresponding to the crop growth seasons with maximum catch of 675 in 15 SW. Maximum number of GLH was recorded (217) in 16 SW.
- 17. Tamil Nadu-Aduthurai (1-52 SW):** YSB, LF, GLH, BPH, GSB, black bug, blue beetle, crickets, coccinellids, ground beetles and rove beetles were recorded at this location. Except LF, insects were active throughout the year. LF activity was limited to 44-52 SWs. However, YSB, GLH, BPH, and WBPH were more active during the initial SWs. The largest catch of YSB was 232 in third SW. GLH population was maximum in second SW (834), while BPH was most active (65722) in the first SW and afterwards catches decreased gradually. WBPH numbers were moderate and less (up to 23) beyond 7 SW. Black bug population showed a sharp spike in the population during 34 SW with a catch size of 103542. Blue beetle also was found continuously from 9 SW onwards and highest count (471) was in 38 SW. Ground and rove beetles were considerable with maximum counts of 214 (8 SW) and 3333 (39 SW) respectively.

- 18. TamilNadu-Coimbatore (1-52 SW):** YSB, PSB, CW, LF, GLH, BPH, WBPH, WLH, RGB, and mirid bugs were recorded. However, catches were too small. Mirid bugs showed a maximum population of 125 in 51 SW.
- 19. Kerala-Moncompu (1-27 and 40 – 52 SW):** SBs, LF, GLH, BPH, and natural enemies were recorded. However, data could not be recorded during 28-39 SWs, due to floods. YSB was active till 19 SW with a peak population of (76+62) in 7 SW. LF catches were small. GLH was found more active up to 18 SW with an highest count of 341 during first SW. Hoppers were active till 17 SW. GLH gained peak activity (65) by 12 SW. BPH showed similar trend and was most abundant (39) during 10 SW. Post flooding, pest activity did not pick up .
- 20. Kerala-Pattambi (1-52 SW):** YSB, WSB, GM, LF, GLH, BPH, WLH, and CW were recorded in light trap catches. In the initial four SWs, YSB was most active and highest population of 3651 was recorded in third SW. WSB catches ranged between nil to 57 (44 SW). GM was absent during 6-24 SWs, but there was an increase in catches from 30 SW reaching a maximum of 71 in 38 SW. Among the two GLH species *N. virescens* catches were maximum (1173) in 40 SW whereas, *N. nigropictus* counts were highest (880) in the first SW. WLH catches also showed similar trend with maximum numbers (212) in the first SW. BPH catches were higher in *Kharif* season, with a peak population of 19300 in 40 SW. CW was less active during summer months and reached maximum (127) in 29 SW. Ground beetle and mirid bugs were found throughout the year. Maximum mirids (1910) were caught in 7 SW whereas; rice bug catches were highest (454) in 52 SW.
- 21. Karnataka-Mandya (1-52 SW):** YSB, LF, GLH, and BPH were recorded at this centre. Overall, pest activity was less. YSB was found between 1-14 SW and 34-51 SW. Catches were largest in 41 SW (166+82). LF was active during 39-49 SWs with a maximum population of 181 in 43 SW. GLH and BPH activity was low and limited to 36-43 SWs and 42-50 SWs respectively.
- 22. Karnataka-Gangavati (1-52 SW):** YSB, LF, GLH, BPH and WBPH were recorded at this centre. YSB catches showed an increasing trend from first SW onwards reaching peak numbers in 17 SW (309+231) followed by a decline. The catches again picked up reaching a high (221+162) in 47 SW. LF catches were highest (335) in 49 SW. GLH (*N. virescens* and *N. nigropictus*) catches were maximum (721 and 782 respectively) in 48 SW. BPH and WBPH populations constituted in equal proportions of planthopper composition. WBPH catches reached peak level (17487) earlier in the season (44 SW) as compared to peak BPH population (15685) in 50 SW.

23. Puducherry-Karaikal (1-52 SW): SBs, GLH, BPH, WBPH, WLH, RGB, and natural enemies were recorded at this centre. Hoppers showed moderate activity during January and February months. GLH reached maximum numbers (78) in 10 SW, BPH and WBPH (90 and 67 respectively) in 6 SW. Staphylinids catches were considerable and were found throughout the year. Largest catch of staphylinids (1022) was observed in 15 SW.

Pest-wise analysis of light trap catches:

During 2018, in light trap trial, maximum number of insect species were recorded at Rajendra Nagar (16) followed by Aduthurai (15), and Raipur (13). Twelve species were recorded at Pattambi and Jagdalpur.

In terms of occurrence and distribution, brown planthopper was recorded in 21 locations. Highest population was recorded at Aduthurai (64722) followed by Pattambi (19300), Gangavathi (17487) and Maruteru (11665). In the year 2017, BPH population was maximum at Pantnagar (70357) followed by Maruteru (51547), and Pattambi (43710).

White backed planthopper was recorded at 18 locations in all the zones except Hills. Highest population was recorded at Gangavathi (15685) followed by Maruteru (5952), Ludhiana (5215) and Chiplima (2193). In 2017, WBPH catches were highest at Maruteru (29455), followed by Gangavathi (16752), and Ludhiana (5215).

Yellow stem borer was recorded in 22 locations. Highest catches were recorded at Pattambi (3651) followed by Maruteru (1843), Pant Nagar (1439) and Chinsurah (1310). In the previous year maximum population was recorded at Maruteru (5760).

Gall midge was found in 13 locations. It is not recorded from Hills, Northern and Western Zones. It was most abundant in Maruteru (5185) followed by Bapatla (3248), and Sakoli (600). In 2017, this pest was reported from 12 centres with a maximum population of 1062 at Nellore.

Leaf folder was recorded in all the 24 locations. Highest population was recorded at Malan (1100) followed by Bapatla (896), Navsari (446), Ludhiana (336) and Ganagavathi (335). During 2017, also leaf folder was found in all the zones, while highest population (710) was recorded in Masodha.

Green leafhopper was recorded in 22 locations spread over all the zones. Maximum catches were recorded at Jagdalpur (14455) followed by Pattambi (2053), Gangavathi (1503) and Chiplima (996). The trend was similar in the previous year.

In addition to the insect pests of national significance, insect pests of regional importance also were recorded. Rice gundhi bug was recorded at 9 locations and highest catches (725) were recorded at Pantnagar during 39 SW. Bapatla centre reported a spurt in grass hoppers population during 40-48 SW and highest catch of 68880 was recorded in 45 SW. White grubs were

recorded in Chatha and Khudwani and at Chatha, numbers were considerable (483) in 27 SW. Zigzag leaf hopper was recorded at 7 locations and highest catch was at Raipur (2928) during 45 SW. At Ludhiana, pink stem borer was in considerable proportions (364) in 44 SW. Paddy skipper was reported from Khudwani and Navsari centres.

Overall, stem borers and planthoppers continued to be the most important pests in terms of numbers as well as spread across the locations. However, the catches during peak activity were smaller as compared to previous year except gall midge. LF and GLH were also found across the country. Numbers and distribution of the remaining pests continues to be moderate. However, there is a need for continuous monitoring of their populations along with those of major pests to understand the spatial and temporal distribution and shifts in pest profiles if any, in different rice ecosystems in the country.

SUMMARY

2.1 Host Plant Resistance Studies

Four trials *viz.*, **Stem borer screening trial (SBST)**, **Leaf Folder Screening Trial (LFST)**, **National Screening Nursery (NSN2)** and **Multiple pest resistance Screening Trial (MRST)** were conducted during Rabi 17-18.

In **SBST**, out of the evaluated 56 entries, five entries *viz.*, JGL 23746, IIRR-BIO-SB-9, IIRR-BIO-SB-3, IIRR-BIO-SB-2 and RP 5587-B-B-B-209 recorded nil white ear damage at Maruteru. All the lines were under retesting.

Field evaluation of 20 entries replicated thrice in **LFST** trial Aduthurai revealed 2 entries *viz.*, Varun Dhan and HPR 2617, showing low leaf folder damage on par with resistant check.

In **NSN 2 trial** conducted at Aduthurai, no valid conclusions could be drawn due to low pest pressure.

In **MRST** trial at Maruteru, none of the entries were found promising for brown planthopper.

2.2 Chemical Control studies

Pesticide compatibility trial (PCT) was carried out with the objective of evaluating the compatibility of newer insecticide and fungicide formulations as tank mix against major insect pests and diseases of rice and consequent impact on grain yield, at 11 centres during rabi 2017-18. There were no significant differences in the efficacy of the two newer insecticide formulations spinetoram+methoxy-fenozide and triflumezopyrim when applied alone or in combination with fungicides. Spinetoram+methoxyfenozide performed better against stem borer, while triflumezopyrim showed superiority against plant hoppers. Triflumezopyrim treatments in combination with fungicides yielded highest and were significantly superior to remaining treatments.

Botanical Insecticides Evaluation Trial (BIET) was carried out at 7 locations to evaluate the efficacy of four essential oils and neemazal along with recommended insecticides, dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield during Rabi, 2017-18. Based on the performance of the treatments in reducing the pest incidence at various locations, the insecticide-rynaxypyr and eucalyptus oil were found effective against stem borer damage. Eucalyptus oil was found effective against planthoppers. Regarding the efficacy of treatments against leaf folder and whorl maggot all oils were found effective and their efficacy was superior to control while they were not so effective against gall midge and blue

beetle. Highest grain yield of 5793.1kg/ha was recorded in rynaxypyr and among botanicals, eucalyptus oil gave highest yield (4826.2kg/ha).

Monitoring of pest species and natural enemies (MPNE) trial was carried out at only one location, Coimbatore. The stem borer species observed were YSB, PSB and DHB. Three egg parasitoids of stem borer were observed with *Telenomus* spp being dominant.

Ecological engineering for planthopper management (EPPM) was taken up in Maruteru and Moncompu with a combination of interventions such as organic manuring, and growing of flowering plants on bunds. Such interventions increased the natural enemy populations like mirids, coccinellids and spiders. The BPH population was on par in both treatments indicating the potential of ecological engineering for pest suppression.

Bio intensive pest management trial (BIPM) was taken up at Chinsurah during Rabi 2018. The pest incidence was reduced and natural enemy population was higher in BIPM plots. Subsequently the lower pest incidence also reflected in higher yields in BIPM plots.

Effect of planting dates on insect pest incidence (EPDP) trial was conducted at two locations, i.e., at Aduthurai during samba season and at Maruteru during Rabi season of 2017-18. At Aduthurai, incidence of white ears caused by stem borer was high in late planting (16.3%) whereas incidence of leaf folder was high in early planting from 60 DAT to harvest (17.8 – 25.6%) and in late planting from 60 to 90 DAT (16.1 – 29.1%). At Maruteru, very high incidence of BPH was noticed in late planting from 40 DAT to 60 DAT (62.3 – 704/ hill) and high in early planting from 70 DAT to 90 DAT (45.6 – 76.3/ hill).

Yield loss estimation trial (YLET) was conducted at three locations viz, Aduthurai, Chinsurah and Pattambi during Rabi 2017-18. Regression analysis revealed a significant negative relationship between white ears and grain yield at Chinsurah ($R^2 = 0.6498$) resulting in 2.1 g reduction in grain yield for every 10% increase in white ear damage. At Aduthurai and Pattambi, relationship between white ears and grain yield was negative but not significant. Similarly, a negative relationship was observed between leaf folder damaged leaves and grain yield at Aduthurai.

Integrated Pest Management special (IPMs) trial was conducted at two locations, Aduthurai and Pattambi during Rabi 2017-18. Incidence of stem borer (2.00 – 5.37%), gall midge (2.76 – 6.33%) and leaf folder (1.28 – 9.21%) was low in IPM plots as compared to FP plots (4.98 – 32.47%DH; 4.22 – 17.75% SS & 4.43 – 28.06% LFDL) in five villages at Aduthurai. Similarly, incidence of dead hearts (5.72 – 8.48%) and leaf folder (1.04%) was low in IPM plots

compared to FP plots (20.28 – 27.34% DH & 14.86% LFDL) at Pattambi. However, incidence of whorl maggot and case worm was high in IPM plots (37.13% WMDL & 75.83% CWDL) as compared to FP plots (26.15% WMDL & 52.29% CWDL) indicating that the spray of econeem alone was not effective in managing these pests. Net returns were high in IPM plots at both the locations due to high grain yield and low cost of cultivation resulting in higher BC ratio in IPM plots (1.95 – 2.51) than farmer practice plots (1.11-2.07).

2.1 Host Plant Resistance Studies

Stem Borer Screening Trial (SBST):

The Stem borer Screening trial (SBST), was constituted with 56 entries with nominations from IIRR, and Chinsurah of which 22 entries were under retesting. The trial was conducted at Aduthurai, Chinsurah, Maruteru and two plantings at Rajendranagar. JGL 23746, IIRR-BIO-SB-9, IIRR-BIO-SB-3, IIRR-BIO-SB-2 and RP 5587-B-B-B-209 recorded nil white ear damage at Maruteru when the average damage was 14.2 % WE in the trial. At other locations the pest pressure was low and no valid conclusions could be drawn.

Leaf folder Screening Trial (LFST)

Leaf folder Screening Trial (LFST) was conducted at Aduthurai during Rabi 2017-18. This field evaluation trial comprised of 20 entries with six nominations from Rice & Wheat Research station, CSK HP Agricultural University, Malan, four nominations from Main Rice Research Station, Anand Agricultural University, Nawagam, three RILs of IR 64/ *O.glaberrima* derivatives, two RILs of wild rices from IRRI, one elite high yielding introgression line derived from tropical japonicas and two RILs of TN1/W1263 along with susceptible check (TN1) and resistant check (W 1263). Leaf folder damage varied from 13.01 to 38.04 % in different entries (Fig.). Two entries from Malan i.e., Varun Dhan and HPR 2617 recorded low damage (<15%) by rice leaf folder on par with resistant check.

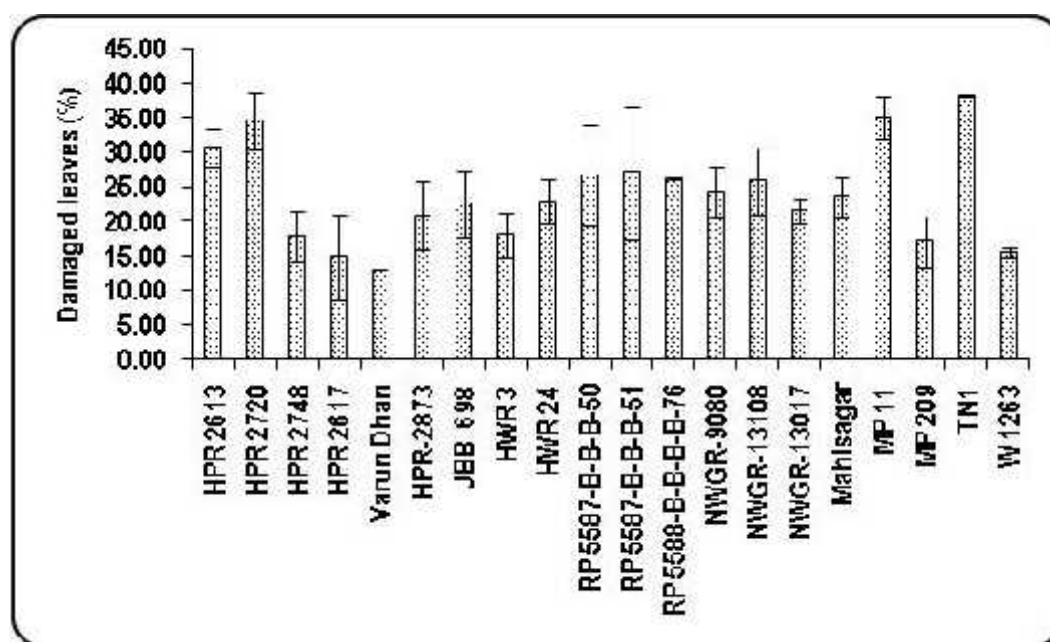


Fig 2.7 Leaf folder damage at Aduthurai in LFST, Rabi 2017-18

Field evaluation of 20 entries replicated thrice in **LFST** trial during Rabi 2017-18 at Aduthurai revealed 2 entries viz., Varun Dhan and HPR 2617, showing low leaf folder damage on par with resistant check.

Pesticide Compatibility Trial (PCT)

The trial was continued during Rabi 2017-18 at 11 locations viz., Aduthurai, Chinsurah, Coimbatore, Chiplima, Karjat, Maruteru, Kurumbapet (Puducherry), Pattambi, Raipur, Rajendranagar and Warangal.

Sl. No.	Location	Date of sowing	Date of planting	Date of harvesting	No. of applications	Times of application (DAT)
1	Aduthurai	03-10-2017	03-11-2017	07-02-2018	3	35,55 & 70
2	Chinsurah	02-01-2018	13-02-2018	-	2	15 & 30
3	Coimbatore	17-12-2017	06-01-2018	02-04-2018	3	17,31 & 46
4	Chiplima	05-01-2018	16-02-2018	08-06-2018	3	20,45 & 60
5	Karjat	06-01-2018	04-02-2018	23-05-2018	1	72
6	Maruteru	15-12-2017	12-01-2018	20-04-2018	3	18,45 & 60
7	Kurumba pet	08-02-2018	15-03-2018	26-05-2018	-	-
8	Pattambi	10-11-2017	30-11-2017	09-03-2018	3	15,45 & 60
9	Raipur	20-01-2018	13-02-2018	07-06-2018	4	20,39,48 & 70
10	Rajendranagar	18-12-2017	27-01-2018	22-05-2018	2	20 & 55
11	Warangal	01-12-2017	03-01-2018	09-05-2018	2	31 & 73

Treatments

The trial consisted of nine treatments viz., spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC @ 0.75 ml/litre, triflumezopyrim @ 0.48 ml/litre, hexaconazole @ 2.0 ml/litre and tricyclazole @ 0.6 ml/litre applied alone as individual treatments and also in four possible combination treatments. Untreated control without any insecticide or fungicide application was also included for comparison. The nine treatments with three replications were laid out in Randomized Complete Block Design (RCBD).

Observations were recorded on ten randomly selected hills to assess stem borer damage at vegetative and heading stages and expressed as per cent dead hearts or white ears. Similarly, counts of leaf folder damaged leaves were taken on 10 randomly selected hills per plot and the percentage damaged leaves were calculated. Planthopper populations were counted on ten randomly selected hills per plot before and after application of treatments. For assessing the severity of blast, sheath blight and bacterial leaf blight diseases, percentage disease severity was assessed as the proportion of the leaf area damaged by the disease in relation to the total leaf area of all the plants in a plot before and after application. Towards maturity, the crop was harvested and grain yield/ net plot leaving two border rows on all sides was recorded and expressed as kg/ha.

Results

Insect pest infestation (Table 2.69)

The **stem borer** infestation at vegetative stage across 10 locations was recorded up to a maximum of 25.5% DH, while mean infestation ranged from 7.0 to 12.6% DH across treatments including control. There were no discernible differences among the treatments including control. At heading stage, there were significant differences among the treatments at 8 locations. The white ear incidence was significantly lower in spinetoram+methoxyfenozide treatment and its combinations (9.6 to 12.4% WE), compared to triflumezopyrim treatment alone and in combination (13.8 to 15.2% WE) and fungicide treatments (16.9 to 17.1% WE). The control plot showed 19.2% WE. Overall, against stem borer, the performance of spinetoram+methoxyfenozide was superior to that of triflumezopyrim, when applied alone or in combination with fungicides.

Brown planthopper populations were recorded at 4 locations and very high infestation was recorded up to 13366.7 hoppers/10 hills at Maruteru. Across other locations, the maximum population recorded was 74.0 hoppers/10 hills, at Chiplima. The mean infestation across locations ranged from 16.0 to 1246.4 hoppers per 10 hills. The hopper population was significantly lower in triflumezopyrim treatment alone and in combination with fungicides (16.0 to 77.1 hoppers/10 hills). The spinetoram+methoxyfenozide treatments were on par with fungicides alone and control treatments (384.4 to 1246.4 hoppers/10 hills). The **white backed planthopper** population was recorded up to 225.0 hoppers/10 hills Maruteru, during 75 to 85 DAT. As observed in the case of BPH, application of triflumezopyrim individually as well as in combination with fungicides showed significantly lower mean WBPH population (3.2 to 10.5 hoppers/10 hills) than all the remaining treatments including control (54.3 to 154.3 hoppers/10 hills).

Disease incidence (Table 2.70)

Sheath blight incidence was observed at 3 locations. At Pattambi, disease severity was observed up to 66.7% while at Maruteru, it was recorded up to a maximum of 49.7%. At all these locations there were significant differences among the treatments including control after application of treatments. At Pattambhi, the pre treatment disease severity range of 45.0 to 55.0% significantly declined to 13.3 to 18.3% in fungicide alone and their combination treatments, after application. Across locations, the hexaconazole treatments in combination with triflumezopyrim or spinetoram + methoxyfenozide and hexaconazole treatment applied alone were at par and superior treatments showing least disease severity of 17.6 to 23.0%. The fungicides alone treatments were at par showing incidence of 23.2 and 23.6% severity, respectively. Insecticides alone treatments showed disease severity on par with control (31.0 to 35.6%).

Grain yield (Table 2.71)

There were significant differences in grain yield among different treatments at 9 locations. The mean grain yield data across the locations revealed that the triflumezopyrim – fungicide combination treatments were at par yielding 5060 to 5112 kg/ha (38.6 to 40.0% IOC) and significantly superior to the remaining treatments. Triflumezopyrim applied alone treatment was the next best treatment yielding 4617 kg/ha (26.5% IOC) followed by hexaconazole alone treatment (4497 kg/ha & 23.2% IOC). Spinetoram+methoxyfenozide and fungicide combination treatments yielded 4386 and 4407 kg/ha (20.1 & 20.7 % IOC, respectively) and were at par. Spinetoram+methoxyfenozide applied alone yielded 4247 kg/ha with 16.0% IOC, while tricyclazole applied alone showed yield of 4026 kg/ha(10.3% IOC). All pesticide treatments used alone or in combination yielded significantly higher than control (3651 kg/ha).

Pesticide compatibility trial was carried out with the objective of evaluating the compatibility of newer insecticide and fungicide formulations as tank mix against major insect pests and diseases of rice and consequent impact on grain yield, at 11 centres during rabi 2017-18. There were no significant differences in the efficacy of the two newer insecticide formulations spinetoram+methoxy-fenozide and triflumezopyrim when applied alone or in combination with fungicides. Spinetoram+methoxyfenozide performed better against stem borer, while triflumezopyrim showed superiority against plant hoppers. Triflumezopyrim treatments in combination with fungicides yielded highest and significantly superior to remaining treatments.

Table:2.69 Insect pest incidence in different treatments, PCT, *Rabi* 2017-18

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	Stem borer Damage (% Dead hearts)										
					ADT		CBT		CHN		CHP	KBP		KJT	
					30DAT	50DAT	28DAT	45DAT	30DAT	50DAT	76DAT	30DAT	50DAT	30DAT	50DAT
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	2.8a	3.2b	7.0a	4.3a	1.4a	4.3a	0.5a	11.5b	9.3a	8.8a	3.6a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	4.2b	4.4c	5.9a	6.1b	3.9b	13.4c	2.6b	8.4a	11.5a	10.0c	3.6a
3	Contaf Plus	Hexaconazole	5	2.0	7.9d	7.8e	8.4a	8.7c	10.0e	23.3e	3.0b	7.2a	8.3a	10.3c	4.0a
4	Mantis 75 WP	Tricyclazole	75	0.6	7.3d	8.0e	9.1a	7.3c	5.8c	23.3e	2.7b	10.3b	12.1a	9.8b	3.4a
5	Spinetoram 6%+ methoxyfenozide 30%+Contaf	Spinetoram 6%+ methoxy fenozide 30%+ Hexaconazole	-	0.75+2.0	5.8c	2.7a	7.1a	4.8a	1.8a	11.5b	0.7a	13.3c	12.7a	10.2c	3.8a
6	Spinetoram 6%+methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxy-fenozide 30%+ Tricyclazole	-	0.75+0.6	5.1c	3.4b	5.9a	4.5a	8.1d	10.8b	0.2a	23.0e	12.5a	10.6c	3.8a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	5.9c	5.0d	4.9a	7.8c	4.7b	17.4d	3.3b	15.7d	12.6a	8.8a	3.7a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	5.6c	4.8d	5.3a	8.5c	11.9e	22.0e	4.1b	15.2d	11.1a	9.9b	3.8a
9	Untreated control	Water		Water spray	9.6e	10.5f	6.5a	12.7d	15.3e	25.5e	6.6c	24.8e	12.2a	11.5d	7.1b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.69 (Contd..) Insect pest incidence in different treatments, PCT, *Rabi* 2017-18

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	Stem borer Damage (% Dead hearts)						Mean	
					MTU	PTB		RPR		WGL		
						50DAT	30DAT	50DAT	30DAT	50DAT		63DAT
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6% + methoxyfenozide 30%	36	0.75	6.0a	11.9a	10.4a	12.5a	15.8a	7.0a	5.7a	7.0a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	3.9a	14.1a	13.1a	18.9b	20.4b	7.9a	6.0a	8.8a
3	Contaf Plus	Hexaconazole	5	2.0	7.2a	10.3a	9.7a	18.9b	20.4b	6.5a	5.6a	9.9a
4	Mantis 75 WP	Tricyclazole	75	0.6	5.9a	13.7a	12.2a	21.3c	20.4b	8.9a	9.3a	10.6a
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	5.6a	8.3a	9.5a	12.5a	15.3a	7.5a	5.8a	7.7a
6	Spinetoram 6%+methoxyfenozide 30%+ Mantis	Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	6.2a	11.9a	6.3a	12.9a	15.5a	4.5a	8.5a	8.5a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	8.3a	11.3a	11.4a	18.5b	19.0b	6.5a	5.5a	9.5a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	6.7a	14.6a	11.3a	19.8b	18.5b	6.3a	6.4a	10.3a
9	Untreated control	Water		Water spray	6.5a	11.5a	9.4a	18.9b	25.1c	6.7a	5.8a	12.6a

Means in columns followed by different letters are significantly different at P=0.05

Table:2.69 (Contd..) Insect pest incidence in different treatments, PCT, *Rabi* 2017-18

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	Stem borer (% White ears)								Mean
					ADT	CBT	CHN	CHP	MTU	PTB	RPR	WGL	
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	4.9a	4.9a	5.1a	0.8a	32.0b	14.0a	12.5a	2.8a	9.6a
2	DPX-RAB 55	Triflumezopyrim	106	0.48	4.1a	7.8b	21.4c	3.2b	25.2a	28.0b	14.6a	5.9b	13.8ab
3	Contaf Plus	Hexaconazole	5	2.0	10.7c	11.0c	23.3c	3.0b	29.3ab	33.9c	15.6a	8.1c	16.9b
4	Mantis 75 WP	Tricyclazole	75	0.6	9.9c	9.1c	30.0d	3.7b	31.6b	24.9b	15.1a	12.7d	17.1b
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	6.1b	5.1a	11.1b	0.5a	28.5ab	30.2c	12.6a	5.3b	12.4a
6	Spinetoram 6%+methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	6.2b	5.7a	8.7a	0.3a	33.0b	24.8b	12.8a	1.8a	11.7ab
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	6.8b	11.5c	19.3c	3.6b	24.4a	35.9c	15.5a	4.8b	15.2b
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	5.2a	12.2c	20.3c	4.5c	27.1a	24.2b	15.4a	8.8c	14.7b
9	Untreated control	Water		Water spray	12.4d	13.4c	26.9d	6.5d	35.5b	28.0b	15.7a	15.1d	19.2b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.69 (Contd..) Insect pest incidence in different treatments, PCT, *Rabi* 2017-18

Sl. No.	Trade Name	Common Name	% a.i. formulation	g or ml per litre of spray fluid	Brown Planthoppers(No./10hills)							
					ADT				CHP			
					30DAT BT	30DAT AT	50DAT BT	50DAT AT	50DAT BT	50DAT AT	65DAT BT	65DAT AT
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+ methoxyfenozide 30%	36	0.75	9.0a	6.0c	4.0a	2.0a	21.7a	18.3b	31.0b	29.3b
2	DPX-RAB 55	Triflumezopyrim	106	0.48	8.7a	2.0a	4.3a	1.7a	20.7a	9.7a	12.7a	8.3a
3	Contaf Plus	Hexaconazole	5	2.0	11.0a	14.3d	4.3a	7.0b	22.0a	25.3c	41.7c	45.3c
4	Mantis 75 WP	Tricyclazole	75	0.6	11.7a	14.7d	6.7b	8.3b	25.7b	28.3c	42.3c	51.0c
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	10.0a	6.3c	6.3b	1.7a	20.7a	25.7c	34.0b	30.7b
6	Spinetoram 6%+methoxyfenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	12.0a	7.3c	7.3ba	3.0a	24.0b	26.3c	33.3b	29.3b
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	10.3a	4.0b	4.7a	1.7a	20.7a	9.7a	13.0a	8.7a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	11.0a	4.0b	5.7b	2.0a	21.0a	10.7a	13.7a	8.7a
9	Untreated control	Water		Water spray	10.0a	14.0d	14.0c	20.3c	32.3c	42.3d	56.7d	74.0d

Means in columns followed by different letters are significantly different at P=0.05

2.69 (Contd..) Insect pest incidence in different treatments, PCT, Rabi 2017-18

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	Brown Planthoppers(No./10hills)				Mean	White backed Planthopper (No./10hills)		Mean
					MTU		RPR			MTU		
					75DAT	85DAT	BPH 1	BPH 2			75DAT	
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6% + methoxyfenozide 30%	36	0.75	1756.3d	6930.0d	5.7a	6.3b	735.0b	67.7c	129.7c	98.7c
2	DPX-RAB 55	Triflumezopyrim	106	0.48	20.3a	199.0a	4.0a	3.0a	24.5a	3.3a	3.0a	3.2a
3	Contaf Plus	Hexaconazole	5	2.0	458.7b	3967.3c	7.7a	8.0c	384.4b	22.3b	86.3b	54.3b
4	Mantis 75 WP	Tricyclazole	75	0.6	1303.3d	10433.3e	7.3a	7.7c	995.0b	85.7c	153.0c	119.3a
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	1443.3d	13366.7e	4.0a	7.3c	1246.4b	83.7c	225.0d	154.3c
6	Spinetoram 6%+methoxyfenozide 30%+ Mantis	Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	894.0c	8900.0d	4.3a	8.0c	829.1b	59.0c	155.0c	107.0c
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	22.7a	87.7a	4.0a	4.7b	16.0a	1.0a	6.3a	3.7a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	63.0a	776.7b	3.7a	5.0b	77.1a	4.3a	16.7a	10.5a
9	Untreated control	Water		Water spray	774.0c	8666.7d	13.7b	11.0d	810.8b	44.7c	168.3c	106.5c

Means in columns followed by different letters are significantly different at P=0.05

Table:2.70 Disease incidence in different treatments, PCT, Rabi 2017-18

Sl. No.	Trade Name	Common Name	% a.i. formula-tion	g or ml per litre of spray fluid	Sheath Blight						Mean
					ADT		MTU		PTB		
					50DAT	60DAT	45DAT	75DAT	65DAT	80DAT	
1	Spinetoram6%+methoxyfenozide 30%	Spinetoram 6% + methoxyfenozide 30%	36	0.75	11.3a	10.0b	41.3d	49.7d	36.7a	61.7b	35.1b
2	DPX-RAB 55	Triflumezopyrim	106	0.48	14.3a	10.7b	43.7d	25.3b	35.0a	66.7b	32.6b
3	Contaf Plus	Hexaconazole	5	2.0	11.0a	3.3a	24.7bc	36.7c	45.0a	18.3a	23.2a
4	Mantis 75 WP	Tricyclazole	75	0.6	11.3a	3.3a	21.0b	41.0d	48.3a	16.7a	23.6a
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6%+ methoxyfenozide 30%+ Hexaconazole	-	0.75+2.0	11.3a	4.3a	15.7b	37.7c	51.7a	15.0a	22.6a
6	Spinetoram 6%+methoxy-fenozide 30%+ Mantis	Spinetoram 6%+ methoxyfenozide 30%+ Tricyclazole	-	0.75+0.6	11.3a	4.3a	20.7b	33.3c	55.0a	13.3a	23.0a
7	DPX-RAB 55+Contaf	Triflumezopyrim +Hexaconazole	-	0.48+2.0	10.7a	4.7a	7.3a	12.7a	53.3a	16.7a	17.6a
8	DPX-RAB 55+ Mantis	Triflumezopyrim + Tricyclazole	-	0.48+0.6	11.3a	3.7a	7.3a	27.7b	45.0a	13.3a	18.1a
9	Untreated control	Water		Water spray	15.0a	17.0c	17.7b	24.7b	45.0a	66.7b	31.0b

Means in columns followed by different letters are significantly different at P=0.05

Table:2.71 (Contd...) Grain Yield in different treatments, PCT, *Rabi* 2017-18

Sl. No.	Trade Name	Common Name	%a.i. formulation	g or ml per litre of spray fluid	Yield(Kg/ha)											Mean	% IOC
					ADT	CBT	CHN	CHP	KBP	KJT	MTU	PTB	RNR	RPR	WGL		
1	Spinetoram 6%+methoxyfenozide 30%	Spinetoram 6%+methoxyfenozide 30%	36	0.75	8433b	6166a	4356a	5072a	7156a	3617a	3259d	2398a	4574b	5858a	4714a	4247c	16.3
2	DPX-RAB 55	Triflumezopyrim	106	0.48	9033a	5558ab	3578bc	4681b	6911a	3741a	4270b	1515a	4793a	5667ab	4157b	4617b	26.5
3	Contaf Plus	Hexaconazole	5	2.0	6417d	4635c	3111c	4367c	7467a	2877d	4449b	1898a	4678ab	5517b	4476ab	4497b	23.2
4	Mantis 75 WP	Tricyclazole	75	0.6	6432d	4612c	3156c	4465c	6800a	2321e	3604c	2015a	4858a	5533b	4286b	4026c	10.3
5	Spinetoram 6%+methoxyfenozide 30%+Contaf	Spinetoram 6%+methoxyfenozide 30%+Hexaconazole	-	0.75+2.0	7425c	5231b	3778b	5170a	7244a	3198c	3779c	2564a	4810a	6050a	4464ab	4386b	20.1
6	Spinetoram 6%+methoxyfenozide 30%+Mantis	Spinetoram 6%+methoxyfenozide 30%+Tricyclazole	-	0.75+0.6	8083b	5457ab	3800b	5210a	7156a	3444b	3770c	2264a	4794a	5692ab	4549ab	4407b	20.7
7	DPX-RAB 55+Contaf	Triflumezopyrim+Hexaconazole	-	0.48+2.0	7241c	4757c	3889ab	4544b	7378a	2951d	5380a	2198a	4637b	5805a	3990c	5060a	38.6
8	DPX-RAB 55+Mantis	Triflumezopyrim+Tricyclazole	-	0.48+0.6	7812bc	4684c	3311c	4465c	6444a	2519e	5624a	1848a	4768a	5975a	4173bc	5112a	40.0
9	Untreated control	Water	Water spray		6200d	4400c	3200c	3604d	7311a	2025f	3123d	1965a	4167b	5067b	3845c	3651d	

Means in columns followed by different letters are significantly different at P=0.05

ii) Botanical Insecticide Evaluation Trial (BIET)

Efficacy of commercially available essential oils were tested against major pests of rice in order to identify the effective oil with an aim to integrate in rice IPM. So, the trial with commercially available essential oils initiated last year was continued during Rabi, 2018 to evaluate their relative efficacy against major insect pests at 28 locations.

Treatments:

Four essential oils procured from local market *viz.*, Camphor oil, Cedar wood oil, Eucalyptus oil and Lemon grass oil @ 1000 ml/ha were compared with effective neem formulation, Neemazal and commonly recommended insecticides – Dinotefuran 20 SG @ 40 g a.i./ha and Rynaxypyr 20 SC @ 30 g a.i./ha along with untreated control (only water spray). Standard procedures were followed as incase during Kharif for spraying botanicals, laying out trial and to record observations of insect pest incidence at regular intervals throughout the crop growth period.

Sl. No.	Location	Date of sowing	Date of planting	Date of harvesting	No of applications	Times of application (DAT)
1	Aduthurai	03-10-2017	03-11-2017	07-02-2018	7	35,45,55,65,75,85 & 95
2	Chinsurah	14-12-2017	05-02-2018	01-06-2018	3	15,30 & 50
3	Chiplima	05-01-2018	16-02-2018	08-06-2018	3	20,45, & 60
4	Karjat	04-01-2018	28-01-2018	26-04-2018	1	75
5	Pattambi	10-11-2017	30-11-2017	10-03-2018	3	15,30,60
6	Puducherry(KBP)	08-02-2018	15-03-2018	25-05-2018		
7	Raipur	20-01-2018	14-02-2018	11-06-2018	4	20,40,50 & 70

Results**Pest Infestation (Table 2.72)**

Stem borer incidence was recorded in seven locations, of which Raipur reported high dead hearts damage (14.5-20.7%) followed by Kurumbapet (5.4-19.1%). There was significant difference in damage among the treatments at five centres. Mean dead heart damage in essential oils ranged between 8.1 and 9.0% as compared to 11.8% in control. Rynaxypyr was the most effective treatment against stem borer with 7.2% dead heart damage.

Highest white ear damage was reported from Pattambhi (27.2%) followed by Chinsura with 19.1% in untreated control. All botanicals significantly reduced white ear damage (10.6-12.6%) when compared to 16.0% in control. Rynaxypyr was the most effective treatment against stem borer with 7.4% mean white ear damage. Among botanicals, Eucalyptus and Lemon grass oils were found effective.

Brown planthopper occurrence was recorded in moderate levels at only 2 centres. There was significant difference in the efficacy against BPH among treatments at Aduthurai. Dinotefuran and Rynaxypyr were the most effective treatments showing 2.7-3.0 hoppers /10 hills as compared to 12.4 in control. All essential oils showed similar efficacy against the BPH with mean numbers ranging from 4.4 to 5.9 hoppers /10 hills.

Gall midge damage was recorded at Aduthurai and Kurumbapet. Lowest mean damage of 6.3% SS was noticed in Neemazal treatment followed by Dinotefuran (6.9%) compared to control (10.3%). Among the botanicals, Cedar wood and Lemon grass oils were found effective.

Leaf folder damage was reported from 2 locations and highest leaf damage was recorded at Chinsura (8-9.6%) in untreated plots during 30-50 days after planting. There were significant differences in leaf damage among the treatments at both locations. Rynaxypyr was the most effective treatment showing mean leaf damage of 2.1%. Among the botanicals, Eucalyptus oil recorded lowest infestation (4.9% damage) in comparison to 8.1% in control.

Whorl maggot damage was recorded in Aduthurai, Chinsura and Pattambhi. Lowest mean damage of 2.8% was noticed in dinotefuran treatment followed by Rynaxypyr (2.9) compared to control (7.2%). Among the botanicals, Eucalyptus oil was the most effective treatment with 7.2% damage.

Highest Blue beetle damage was reported from Raipur centre (16.7% leaf damage). Cedar wood oil was the most effective treatment against the beetle with 6.9% damage as compared to 11.3% in control.

Natural enemies like spiders and coccinellids were recorded at Aduthurai, Chiplima and Raipur. There was no significant difference in spider populations in all treatments (10.0-11.7 spiders/10 hills) at Aduthurai centre. Essential oils were found relatively safe to spiders while Dinotefuran was unsafe. At Aduthurai, coccinellids, were recorded in more numbers (6.0-13.0 beetles/10 hills) than at Raipur. Insecticides were not safe to coccinellids compared to botanicals.

Grain Yield (Table 2.73)

There were significant differences in grain yield among the treatments at 5 locations. Based on mean yield of these locations, Rynaxypyr recorded the highest grain yield of 5793.1kg/ha with 53.5% increase over control (IOC) followed by Dinotefuran with 5233.2kg/ha (38.7%IOC). Among the essential oils, Eucalyptus oil treatment recorded highest yield of 4826.2

kg/ha (27.8% IOC). All the treatments gave significantly higher yield than control (3773.7 kg/ha).

Summary

Botanical insecticides trial was carried out at 7 locations to evaluate the efficacy of four essential oils and neemazal along with recommended insecticides, Dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield during Rabi, 2017-18. Based on the performance of the treatments in reducing the pest incidence at various locations, the insecticide-Rynaxypyr and eucalyptus oil were found effective against stem borer damage. Eucalyptus oil was found effective against planthoppers. Regarding the efficacy of treatments against leaf folder and whorl maggot all oils were found effective and their efficacy was superior to control while they were not so effective against gall midge and blue beetle. Highest grain yield of 5793.1kg/ha was recorded in Rynaxypyr and among botanicals, Eucalyptus oil gave highest yield (4826.2kg/ha).

Table 2.72 Insect pest incidence in different treatments, BIET, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Stem Borer Damage (%Dead Hearts)							
			ADT		CHN		PTB		KBP	
			30DAT	50DAT	30DAT	50DAT	30DAT	50DAT	30DAT	50DAT
1	Camphor oil	1000	4.7bc	3.0bc	14.6bc	13.0b	6.5b	14.0a	14.0a	8.6abc
2	Cedar wood oil	1000	5.7ab	3.3b	12.3cd	10.3c	8.3ab	12.9a	12.7a	9.4ab
3	Eucalyptus oil	1000	4.3bcd	3.0bc	7.5e	6.7d	6.6b	14.5a	19.3a	7.2abc
4	Lemon grass oil	1000	4.0cde	2.7bcd	15.8b	13.6b	7.5b	11.3a	13.4a	7.6abc
5	Neem azal	1000	3.7cde	2.7bcd	10.1d	7.6d	10.7ab	11.0a	14.8a	7.0bc
6	Dinotefuran	200	3.0de	2.0cd	6.2ef	4.6e	8.6ab	15.1a	14.1a	10.5ab
7	Rynaxypyr	150	2.7e	1.7d	4.4f	2.6f	11.2ab	12.6a	13.6a	11.0a
8	Untreated Control	Water	7.0a	6.7a	18.6a	18.2a	13.2a	14.0a	19.7a	5.4c

Means in columns followed by different letters are significantly different at P=0.05

Table 2.72 (Contd..) Insect pest incidence in different treatments, BIET, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Stem Borer Damage (%Dead Hearts)						Mean
			CHP		KJT		RPR		
			56DAT	70DAT	30DAT	50DAT	30DAT	50DAT	
1	Camphor oil	1000	3.5b	3.2b	4.8b	3.0bc	15.7abc	17.3ab	9.0
2	Cedar wood oil	1000	2.9bc	2.9bc	3.9b	2.7bcd	14.5c	17.5ab	8.5
3	Eucalyptus oil	1000	2.4bc	2.1dc	4.1b	3.2b	15.1bc	17.4ab	8.1
4	Lemon grass oil	1000	2.7bc	3.2b	4.6b	2.8bcd	17.5abc	16.8b	8.8
5	Neem azal	1000	2.1bc	2.7bcd	4.1b	2.4cd	16.1abc	16.6b	8.0
6	Dinotefuran	200	1.9dc	1.8d	3.9b	2.2d	18.0ab	16.0b	7.7
7	Rynaxypyr	150	0.7d	0.7e	4.3b	0.9e	16.9abc	17.4ab	7.2
8	Untreated Control	Water	5.3a	6.4a	7.0a	4.6a	18.7a	20.7a	11.8

Means in columns followed by different letters are significantly different at P=0.05

Table 2.72 (Contd..) Insect pest incidence in different treatments, BIET, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Stem Borer Damage (% White ears)					Mean
			ADT	CHN	CHP	RPR	PTB	
1	Camphor oil	1000	6.7c	10.3B	3.8b	10.6ab	31.4ab	12.6
2	Cedar wood oil	1000	8.3b	8.8bc	3.9b	10.9ab	45.3a	15.4
3	Eucalyptus oil	1000	6.7c	7.0de	3.1bc	10.3ab	25.7b	10.6
4	Lemon grass oil	1000	8.3b	10.2b	4.4b	10.0b	28.7b	12.3
5	Neem azal	1000	7.3b	8.0cd	4.1b	11.2ab	24.6b	11.0
6	Dinotefuran	200	6.0cd	5.7e	2.4c	10.6ab	29.2b	10.8
7	Rynaxypyr	150	4.7d	2.4f	0.9d	12.0ab	16.8b	7.4
8	Untreated Control	Water	14.3a	19.1a	6.6a	12.9a	27.2b	16.0

Means in columns followed by different letters are significantly different at P=0.05

Table 2.72 (Contd..) Insect pest incidence in different treatments, BIET, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Brown Planthopper/10hills				Mean
			ADT		RPR		
			30DAT	60DAT	BPH75	BPH90	
1	Camphor oil	1000	3.3b	10.3bc	4.7a	4.0ab	5.6
2	Cedar wood oil	1000	3.0bc	13.7bc	2.3a	3.3b	5.6
3	Eucalyptus oil	1000	2.3bc	8.7bcd	4.3a	4.7ab	5.0
4	Lemon grass oil	1000	2.7bc	12.3bc	4.7a	4.0ab	5.9
5	Neem azal	1000	2.3bc	6.7bc	4.3a	4.3ab	4.4
6	Dinotefuran	200	1.7bc	4.3de	2.0a	4.0ab	3.0
7	Rynaxypyr	150	1.0c	2.0e	3.0a	4.7ab	2.7
8	Untreated Control	Water	12.0a	27.0a	3.3a	7.3a	12.4

Means in columns followed by different letters are significantly different at P=0.05

Table 2.72 (Contd..) Insect pest incidence in different treatments, BIET, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Gall midge Damage (%Silver Shoots)				Mean
			ADT		KBP		
			30DAT	50DAT	30DAT	50DAT	
1	Camphor oil	1000	4.0b	2.7b	23.4a	7.2a	9.3
2	Cedar wood oil	1000	3.0bc	2.7b	18.9ab	8.1a	8.2
3	Eucalyptus oil	1000	2.6c	2.3bc	21.8ab	8.0a	8.7
4	Lemon grass oil	1000	2.6c	2.3bc	20.6ab	7.7a	8.3
5	Neem azal	1000	3.0bc	2.0bc	12.7b	7.4a	6.3
6	Dinotefuran	200	2.3c	1.7bc	13.6ab	10.1a	6.9
7	Rynaxypyr	150	2.0c	1.3c	21.3ab	9.4a	8.5
8	Untreated Control	Water	6.0a	5.7a	22.2ab	7.2a	10.3

Means in columns followed by different letters are significantly different at P=0.05

Table 2.72 (Contd..) Insect pest incidence in different treatments, BIET, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Leaf folder damage(% Damaged leaves)			Mean
			ADT		CHN	
			60DAT	50DAT	30DAT	
1	Camphor oil	1000	5.0bc	4.9b	7.7b	5.9
2	Cedar wood oil	1000	4.7bc	4.5bc	6.8b	5.3
3	Eucalyptus oil	1000	5.3b	3.9cd	5.4c	4.9
4	Lemon grass oil	1000	5.7ab	5.0b	7.3b	6.0
5	Neem azal	1000	4.0cd	3.5d	4.8c	4.1
6	Dinotefuran	200	3.0de	1.9e	2.3c	2.4
7	Rynaxypyr	150	2.7e	1.9e	1.7d	2.1
8	Untreated Control	Water	6.7a	8.0a	9.6a	8.1

Means in columns followed by different letters are significantly different at P=0.05

Table 2.72 (Contd..) Insect pest incidence in different treatments, BIET, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Whorl Maggot Damage (% Damaged Leaves)					Mean
			ADT		CHN		PTB	
			30DAT	50DAT	30DAT	50DAT	25DAT	
1	Camphor oil	1000	3.3b	3.3b	6.5b	3.7c	4.7	4.3
2	Cedar wood oil	1000	3.0b	3.0bc	6.7b	3.8c	8.3	4.9
3	Eucalyptus oil	1000	2.7b	3.3b	5.0c	3.1c	5.1	3.8
4	Lemon grass oil	1000	3.3b	3.3b	6.7b	4.7d	7.5	5.1
5	Neem azal	1000	3.0b	2.3bc	5.0c	3.4c	6.8	4.1
6	Dinotefuran	200	2.3b	2.7bc	3.2d	1.9d	3.9	2.8
7	Rynaxypyr	150	2.3b	2.0c	3.1d	1.2d	5.7	2.9
8	Untreated Control	Water	7.0a	6.7a	8.9a	7.4a	6.1	7.2

Means in columns followed by different letters are significantly different at P=0.05

Table 2.72 (Contd..) Insect pest incidence in different treatments, BIET, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Blue Beetle (% Damaged Leaves)		Mean
			PTB	RPR	
			45DAT	DAT	
1	Camphor oil	1000	7.71ab	16.7a	12.2
2	Cedar wood oil	1000	3.1b	10.7b	6.9
3	Eucalyptus oil	1000	10.7a	14.7ab	12.7
4	Lemon grass oil	1000	6.5ab	11.0b	8.8
5	Neem azal	1000	7.7ab	14.0ab	10.8
6	Dinotefuran	200	5.0b	12.3ab	8.7
7	Rynaxypyr	150	6.4ab	14.0ab	10.2
8	Untreated Control	Water	7.9ab	14.7ab	11.3

Means in columns followed by different letters are significantly different at P=0.05

Table 2.72 (Contd..) Incidence of natural enemies in different treatments, BIET, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Spiders(no./10 h)			Mean
			ADT	CHP		
			DAT	56DAT	76DAT	
1	Camphor oil	1000	10.3a	4.6b	6.0b	6.9
2	Cedar wood oil	1000	11.3a	5.0b	6.3b	7.6
3	Eucalyptus oil	1000	11.0a	5.3b	5.7b	7.3
4	Lemon grass oil	1000	11.7a	4.7b	6.0b	7.4
5	Neem azal	1000	11.0a	4.7b	5.7b	7.1
6	Dinotefuran	200	10.3a	2.3c	1.3c	4.7
7	Rynaxypyr	150	10.0a	5.3b	5.3b	6.9
8	Untreated Control	Water	11.0a	7.3a	9.7a	9.3

Means in columns followed by different letters are significantly different at P=0.05

Table 2.72 (Contd...) Incidence of natural enemies in different treatments, BIET, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Coccinellids(No./10h)		Mean
			ADT	RPR	
			DAT	75DAT	
1	Camphor oil	1000	10.7ab	2.7ab	6.67
2	Cedar wood oil	1000	10.0b	3.5a	6.75
3	Eucalyptus oil	1000	8.7bc	1.7b	5.17
4	Lemon grass oil	1000	10.3ab	1.3b	5.83
5	Neem azal	1000	13.0a	3ab	8.00
6	Dinotefuran	200	6.0c	1.7b	3.83
7	Rynaxypyr	150	6.3c	2.7ab	4.50
8	Untreated Control	Water	10.7ab	2.3ab	6.50

Means in columns followed by different letters are significantly different at P=0.05

Table 2.73 Grain Yield in different treatments, Rabi 2017-18

S. No.	Common Name	Rate g or ml of form/ha	Yield (Kg/Ha)								IOC(%)
			ADT	KBP	PTB	CHN	CHP	RPR	KJT	Mean	
1	Camphor oil	1000	7050.0cd	5216.7a	1611.8b	4916.7d	4328.2d	6025.0a	2833.3e	4564.4	20.95
2	Cedar wood oil	1000	7166.7cd	5300.0a	1526.1b	4833.3d	4445.8bcd	6116.7a	3250.0d	4662.6	19.06
3	Eucalyptus oil	1000	7116.7cd	5716.7a	1423.2b	6433.3b	4484.9bc	5983.3a	2625.0f	4826.2	27.8
4	Lemon grass oil	1000	6933.3d	5400.0a	1491.8b	4700.0d	4347.8bc	6233.3a	3194.5d	4614.4	22.27
5	Neem azal	1000	7483.3bc	5266.7a	1457.5b	5750.0c	4387bc	6041.7a	3694.5c	4868.7	29.01
6	Dinotefuran	200	7683.3b	5416.7a	1680.4b	6933.3b	4543.7b	6250a	4125.0b	5233.2	38.67
7	Rynaxypyr	150	8233.3a	5783.3a	3086.4a	7733.3a	4994.1a	6283.3a	4437.5a	5793.1	53.51
8	Untreated Control	Water	6100.0e	4450.0b	1526.1b	4083.3e	3231.5e	5108.3b	1916.7g	3773.7	

Means in columns followed by different letters are significantly different at P=0.05

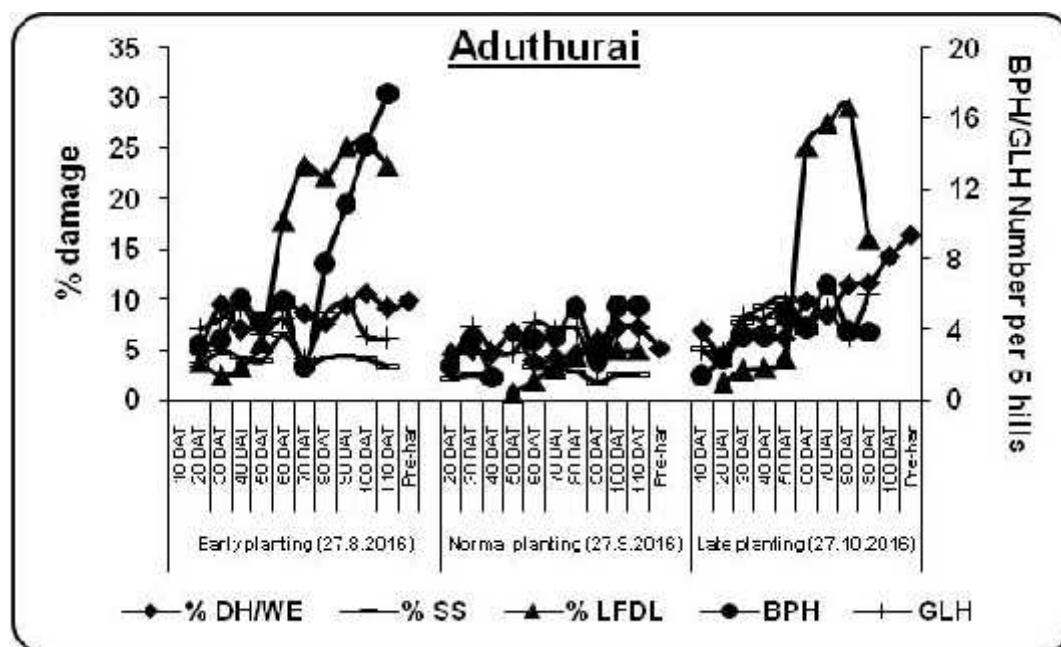
ECOLOGICAL STUDIES

Under ecological studies, one trial, i.e., Effect of planting dates on insect pest incidence was carried out during *Rabi* 2017-18, results of which are presented below:

Effect of Planting Dates on Insect Pest Incidence (EPDP)

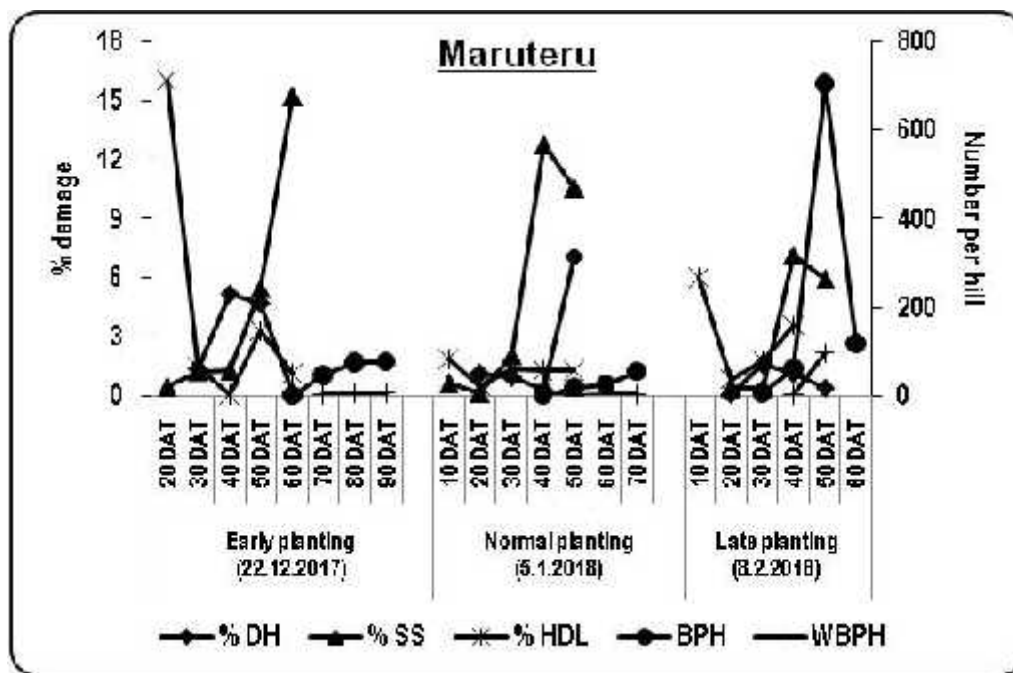
During *Rabi* 2017-18, EPDP trial was conducted at two locations, i.e., Aduthurai during samba season and Maruteru during *Rabi* season.

At **Aduthurai**, CR1009 was grown in this trial in all the three plantings during samba season. Incidence of stem borer, gall midge, leaf folder, whorl maggot, hispa, BPH and GLH was observed in all the three plantings. Stem borer incidence was low to moderate and crossed ETL at 60 DAT (10.91% DH) and 80 DAT (11.24%) in early planting and 80 DAT (11.61%) in late planting. Low incidence of gall midge was observed in all the three plantings (1.51 – 7.64% SS). High leaf folder damage was observed in late planting at 90 DAT (25.8%) and crossed ETL in early planting from 60 to 90 DAT with damage ranging from 15.37 – 20.58%. Whorl maggot incidence was high in early planting at 10 DAT (18.4%) followed by late planting at 30 DAT (14.8%). Hispa incidence was found high in early planting at 10 DAT (19.0%), while there was no incidence in late planting. BPH and GLH incidence was low in all the three plantings. Grain yield of 69.0, 97.5 and 62.5 q/ ha was recorded from early, normal and late plantings, respectively.



At **Maruteru**, IR 64 was grown in this trial in all the three plantings. High incidence of BPH was observed in all the three plantings with maximum incidence in late planting from 40 to 60 DAT (62.3 – 704.0/ hill)

followed by early planting from 70 to 90 DAT (45.6 – 76.3/ hill). WBPH incidence was high only in late planting at 50 DAT (97.0/ hill). Low incidence of stem borer (0.1-7.1% DH) and leaf folder (0.3 – 2.7%) was recorded in three plantings. Gall midge damage crossed ETL in early planting at 60 DAT (15.2% SS) followed by normal planting at 40 to 50 DAT (10.6 – 12.8% SS). Hispa damage was found low in all the three plantings except at 20 DAT in early planting (16.0%). Grain yield ranged between 44.4 and 65.6 q/ ha in all the three plantings.



Effect of planting dates on insect pest incidence (EPDP) trial was conducted at two locations, i.e., at Aduthurai during samba season and at Maruteru during Rabi season of 2017-18. At Aduthurai, incidence of white ears caused by stem borer was high in late planting (16.3%) whereas incidence of leaf folder was high in early planting from 60 DAT to harvest (17.8 – 25.6%) and in late planting from 60 to 90 DAT (16.1 – 29.1%). At Maruteru, very high incidence of BPH was noticed in late planting from 40 DAT to 60 DAT (62.3 – 704/ hill) and high in early planting from 70 DAT to 90 DAT (45.6 – 76.3/ hill).

2.3 BIOCONTROL AND BIODIVERSITY STUDIES

i) Ecological Engineering for Planthopper Management (EPPM)

This trial was carried out at Aduthurai, Maruteru and Moncompu during Rabi 2017-2018.

At Aduthurai, seven border crops were evaluated for their impact on pests and natural enemies of rice. Observations were taken at tillering, active tillering, panicle initiation and Harvest stage on pests and natural enemies occurring on the main and bund crop. Low levels of gall midge damage were observed at tillering stage ranging from 1.13% Silver shoots (SS) on rice crop grown with brinjal as border to 3.07% SS in crops without border (**Table 2.74**). Similar trends were observed at active tillering and panicle initiation stage with crop grown near brinjal recording the lowest silver shoot infestation. Hispa damage of 3.03 % DL in crop with cowpea to a maximum of 5 % DL in crop without border. Similarly, dead hearts caused by stem borer was lowest in crop grown with cowpea as border at active tillering (4.17%) and panicle initiation (2.43%) stages as compared to 5.77 and 7 % in crops without border.

Table 2.74 Effect of ecological engineering on hoppers and its natural enemies at **Aduthurai, EPPM, rabi 2018**

A. Tillering stage

Treatment (Border crop)	Damage caused by		Population of	
	Gall midge (%)	Hispa (%)	Spiders (No./hill)	Coccinellid (No./hill)
T1- Sunflower	1.53 (7.03)	3.97 (11.21)	0.97	0.97
T2- Tomato	1.33 (6.58)	4.70 (12.37)	1.17	0.90
T3 – Cowpea	2.07 (8.24)	3.03 (9.92)	1.13	1.17
T4 – Gingelly	1.50 (7.00)	3.70 (11.00)	1.03	1.13
T5 – Bhendi	2.50 (9.09)	3.30 (10.34)	1.17	1.00
T6 – Brinjal	1.13 (6.11)	4.83 (12.69)	1.17	0.70
T7 – Marigold	1.73 (7.49)	3.50 (10.59)	1.13	0.87
T8- Untreated	3.07 (10.08)	4.93 (12.70)	0.97	0.97
CD(0.05)=	1.62	1.58	NS	NS
CD(0.01)=	2.26	2.20		

Damage by leaffolder was also lowest in plots with cowpea as border crop (3.87%) as compared to 12.60% in plots without border (**Table 2.74B**). White ears caused by stem borer ranged from 3.4% in plots with Gingelly,

B. Active Tillering stage

Treatment (Border crop)	Per cent damage caused by			Population (No. 10 hills)			
	Gall Midge	Stem borer	Leaffolder	GLH	BPH	Spider	Coccinellid
T1- Sunflower	3.13 (10.10)	5.03 (12.85)	8.90 (17.26)	08.30	09.30	12.00	09.70
T2- Tomato	3.10 (9.79)	5.07 (12.92)	8.47 (16.68)	11.00	07.30	11.00	11.00
T3 – Cowpea	2.27 (8.66)	4.17 (11.73)	3.87 (10.91)	09.30	07.00	15.30	17.30
T4 – Gingelly	2.93 (9.82)	4.53 (12.25)	6.50 (14.63)	09.70	09.70	06.00	09.30
T5 – Bhendi	3.27 (10.40)	4.80 (12.63)	8.47 (16.78)	11.00	08.30	17.30	22.70
T6 – Brinjal	2.77 (9.54)	4.73 (12.53)	6.90 (15.12)	09.70	07.30	11.00	10.00
T7 – Marigold	2.90 (9.77)	4.67 (12.45)	9.87 (18.17)	11.30	08.70	11.30	10.30
T8- Untreated	5.57 (13.63)	7.07 (15.40)	12.60 (20.73)	11.70	10.00	11.00	06.70
CD(0.05)=	(2.53)	NS	3.81	NS	NS	NS	03.00
CD(0.01)=			5.28				04.10

C. Panicle initiation to harvest stage

Treatment (Border crop)	Per cent damage caused by		Population (No. 10 hills)				Per cent damage caused by stem borer	Yield* (kg/ha)
	Gall Midge	Stem borer (DH)	GLH	BPH	Spider	Cocci- nellid	(WE)	
T1- Sunflower	2.80 (9.33)	3.77 (11.06)	12.00	8.70	14.0	10.0	3.60 (10.80)	5483.3
T2- Tomato	3.30 (10.44)	5.23 (13.18)	13.00	14.70	5.70	05.0	7.80 (16.17)	5083.3
T3 – Cowpea	1.47 (6.89)	2.43 (8.90)	5.30	5.00	5.70	16.3	3.47 (10.66)	6333.3
T4 – Gingelly	2.20 (8.47)	4.53 (12.26)	11.70	6.70	6.00	08.3	3.47 (10.69)	5766.7
T5 – Bhendi	1.97	3.17	5.70	5.70	15.30	18.7	3.37	5650.0

	(8.06)	(10.24)					(10.41)	
T6 – Brinjal	2.77	4.73	12.00	10.30	4.70	05.0	7.97	
	(9.54)	(12.53)					16.38	4816.7
T7 – Marigold	2.10	4.37	08.00	6.70	14.30	07.0	3.80	
	(8.24)	(12.03)					11.17	5800.0
T8 - Untreated	4.43	7.00	16.00	22.70	16.70	05.3	9.80	
	(12.13)	(15.34)					18.21	4366.7
CD(0.05)=	NS	2.34	NS	4.60	4.50	02.9	3.08	716.4
CD(0.01)=		3.24		6.40	-	04.0	4.27	994.4

Table 2.74C Natural enemies observed on bund crops at **Aduthurai, EEPM, rabi 2018**

Border crop	Population @			
	Spider (No. plant)		Coccinellid (No. plant)	
	Tillering stage	Active Tillering stage	Panicle initiation	Panicle initiation
T1- Sunflower	3.67	2.33	1.67	1.00
T2- Tomato	2.67	2.00	1.33	1.33
T3 – Cowpea	4.00	4.33	4.00	5.00
T4 – Gingelly	2.67	2.00	2.67	1.33
T5 – Bhendi	4.33	4.33	4.67	5.33
T6 – Brinjal	3.33	2.00	1.67	1.00
T7 – Marigold	5.00	3.00	2.33	2.00
T8- Untreated	1.67	1.33	2.67	1.33
CD(0.05)=	NS	1.83	1.58	0.89
CD(0.01)=			2.19	1.23

bhendi and cowpea as borders compared to 7.9% in plots without border and with a border of tomato (**Table 2.74C**). The hopper population was low throughout the crop growth. Abundance of spiders was on par in all treatments during the vegetative phase. Coccinellids on the other hand was significantly higher in plots with bhendi (18.7/ 10hills) and cowpea (16.3/ 10 hills) border (**Table 2.74C**). The yields ranged from 4366.7 to 4816.7 kg/ha among various treatments. Plots with ecological engineering showed significantly higher yields in comparison to the plots without border crop (**Table 2.74C**).

The abundance of natural enemies on border crops was also observed. The number of spiders (4.00 and 5.00 per plant respectively) and coccinellids (15.30 and 18.7 respectively) were higher on cowpea and bhendi (**Table 2.74C**).

The EE interventions tested at Maruteru were alleyways, organic manuring and planting of bund flora. The observations on hoppers and their natural enemies were recorded four times starting from 40 DAT. BPH population was significantly higher in EE treatment (220.20/hill) compared to farmers practices (98.40 hoppers/hill) (**Table 2.75**). However, the population of green mirids was significantly higher in EE plots (13.47/ hill) while spiders and coccinellid numbers were on par. The EE plots yielded (6105 kg/ha) more than that of FP plots (5748 kg/ha), however differences were not significant.

Table 2.75 Effect of ecological engineering on hoppers and its natural enemies at **Maruteru, EEPM, rabi 2018**

Parameters	BPH (No./ hill)		Green mirids (No./ hill)		Spiders (No./ hill)		Coccinellids (No./hill)		Yield (Kg/ha)	
	EE	FP	EE	FP	EE	FP	EE	FP	EE	FP
Mean	220.20	98.40	13.47	9.69	1.52	1.41	1.12	1.05	6105	5748
t value	7.75**		2.72*		0.72 ^{NS}		0.52			
df	398		198		198		198			
P - value	0.01		0.02		0.66		0.60			

**projected yield*

Table 2.76 Effect of ecological engineering on hoppers and its natural enemies at **Moncompu, EEPM, rabi 2018**

Parameters	BPH (No./10 hills)		Green mirids (No./ 10 hills)		Spiders (No./ 10 hills)	
	EE	FP	EE	FP	EE	FP
Mean	29.00	19.58	8.00	5.07	10.25	6.92
t value	2.32 ^{NS}		2.93**		2.70NS	
df	398		398		398	
P - value	0.06		0.01		0.07	

At Moncompu, Marigold was tested as bund flora. Four observations on hoppers and their natural enemies were recorded starting from 15 DAT. BPH population was on par in EE treatment and farmers practices (**Table 2.76**). The populations of predators and parasitoids though higher in EE plots were also on par with FP plots.

Ecological engineering for planthopper management was taken up in Maruteru and Moncompu with a combination of interventions such as organic manuring, and growing of flowering plants on bunds. Such interventions increased the natural enemy populations like mirids, coccinellids and spiders. The BPH population was on par in both treatments indicating the potential of ecological engineering for pest suppression.

ii) Bio-intensive pest management trial (BIPM)

The trial was taken up at Chinsurah during the Boro season.

Chinsurah

Observations were recorded on the damage by whorl maggot, stem borer and natural enemies like spiders, coccinellids and staphylinids. The

per cent leaves damaged by whorl maggot were on par in BIPM and FP plots (**Table 2.77**). The dead heart damage by stem borer was significantly higher in FP plots (13.06%) compared to that of BIPM plots (9.09%). A similar trend was observed with white ear damage in the reproductive phase with 6.47 % damage recorded in BIPM plots as compared to 10.86% in FP plots.

Table 2.77 Pest and natural enemy incidence under Bio-intensive pest management trial at **Chinsurah, rabi 2018**

A. Pest incidence

Parameters	WM		DH		WE		Yield**	
	(% damage)		(% damage)		(% damage)			
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	3.29	3.58	6.70	15.48	5.57	20.57	5195	4430
t value	0.45NS		4.75**		6.06*		3.46*	
df	118		238		118		38	
P - value	0.66		<0.01		<0.01		0.05	

*WM- whorl maggot; DH – Dead heart; WE- white ears

B. Predators

Parameters	Spiders		Coccinellid		Staphylinid	
	(No./ 10 hills)		(No./ 10 hills)		(No./ 10 hills)	
	BIPM	FP	BIPM	FP	BIPM	FP
Mean	3.00	1.67	2.67	0.33	1.50	0.50
t value	1.38NS		2.85*		1.81*	
df	118		118		118	
P - value	0.67		0.03		0.05	

The natural enemy population *viz.*, number of spiders (2.67/ 10 hills) and staphylinids (1.50/10 hills) was significantly higher in BIPM plots than that of Farmers' practice plots. The yield was also significantly higher in BIPM plots (5550 kg/ha) when compared to FP plots (4485 kg/ha).

Bio intensive pest management trial was taken up at Chinsurah during Rabi 2018. The pest incidence was reduced and natural enemy population was higher in BIPM plots. Subsequently the lower pest incidence also reflected in higher yields in BIPM plots.

iii) Monitoring of Pests and Natural Enemies (MPNE)

Monitoring of pest species and natural enemies (MPNE) trial was carried out at one location, Coimbatore during *Rabi 2018*.

1. Stem borer

Three species of stem borer were observed over four observations from January to March 2018. The average composition of the three species was

YSB (48.59%), PSB (20.64%) and DHB (30.77%). The egg mass parasitisation ranged from 42.86-50.00% while the egg parasitisation varied from 32.95 to 47.50 % with a mean egg mass parasitisation of 48.21% and egg parasitisation of 40.46 %. Three egg parasitoids were observed with an average composition of *Tetrastichus schoenobii* (43.33%), *Trichogramma japonicum* (6.15%) and *Telenomus* spp (50.52 %).

2. Hoppers

Information on the hoppers species composition was received from Coimbatore. Low population of GLH was recorded at 12.9/10 hills. The predators observed were green mirids (3.25/10hills) spiders (6.15/10hills) and coccinellids (9.70/10hills).

Monitoring of pest species and natural enemies (MPNE) trial was carried out at only one location, Coimbatore. The stem borer species observed were YSB, PSB and DHB. Three egg parasitoids of stem borer were observed with Telenomus spp being dominant.

INTEGRATED PEST MANAGEMENT

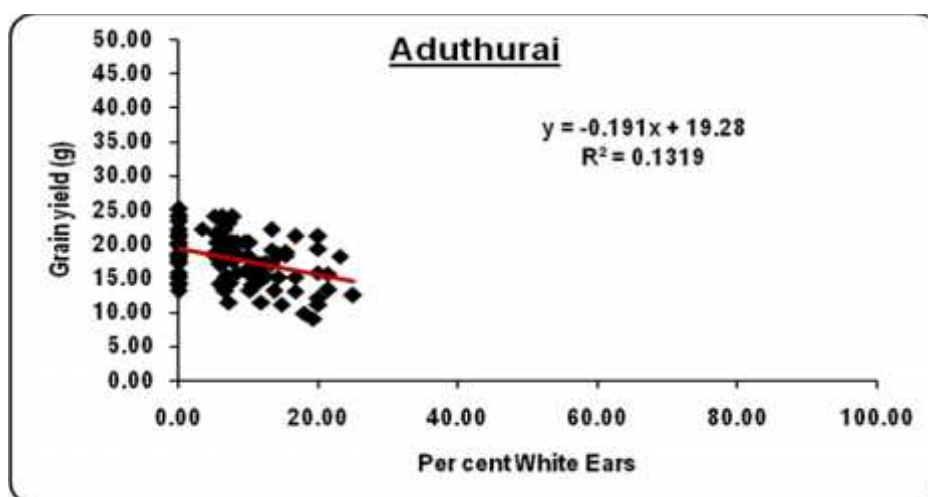
This section consists of two trials *viz.*, i) Yield Loss Estimation Trial (YLET) and ii) Integrated Pest Management special trial (IPMs). Details of these trials are given below:

i) Yield Loss Estimation Trial (YLET)

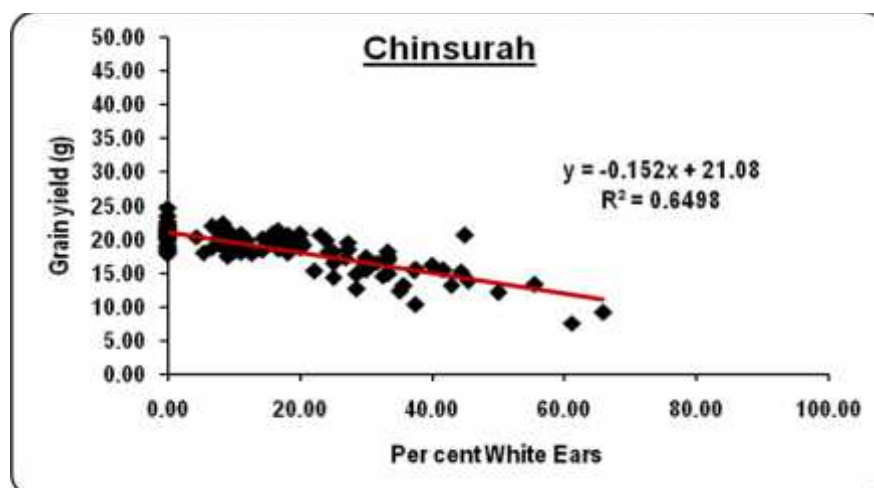
Yield loss estimation trial was conducted at three locations during Rabi 2017-18, i.e., Aduthurai, Chinsurah and Pattambi for stem borer and at one location, Aduthurai for leaf folder.

Target pest: Stem borer

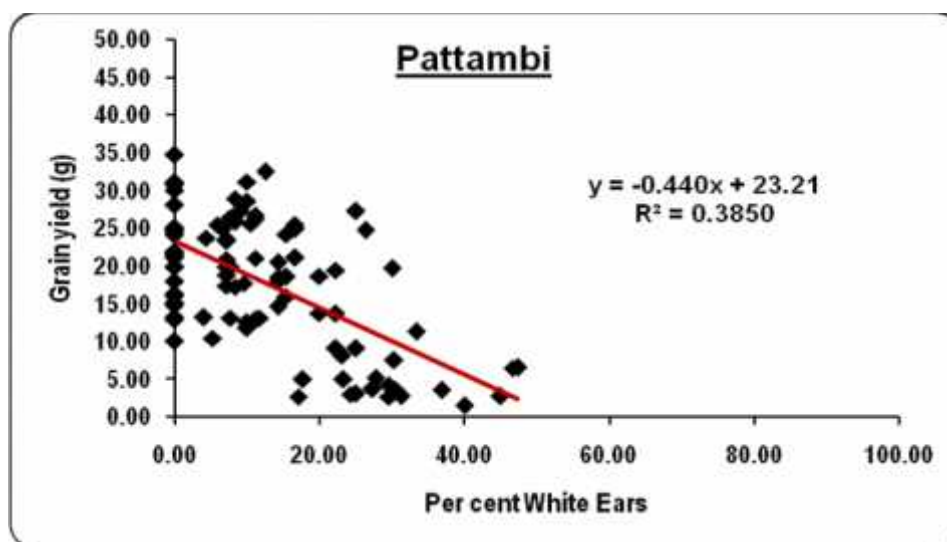
At **Aduthurai**, white ear damage varied from 0 to 25.00% with a grain yield of 9.00 to 25.17 g per hill in ADT 46(R) variety. Linear regression analysis revealed a negative relationship between per cent white ears and grain yield per hill ($R^2 = 0.1319$) but it was not significant.



At **Chinsurah**, Khitish (IET 4094) variety grown in this trial showed white ear damage ranging from 0.00 to 65.85% and grain yield of 7.53 to 24.65 g per hill. Linear regression analysis revealed a significant negative relationship between white ears and grain yield ($R^2 = 0.6498$). The projected decrease in yield is 2.1 g per hill for every 10% increase in white ears.

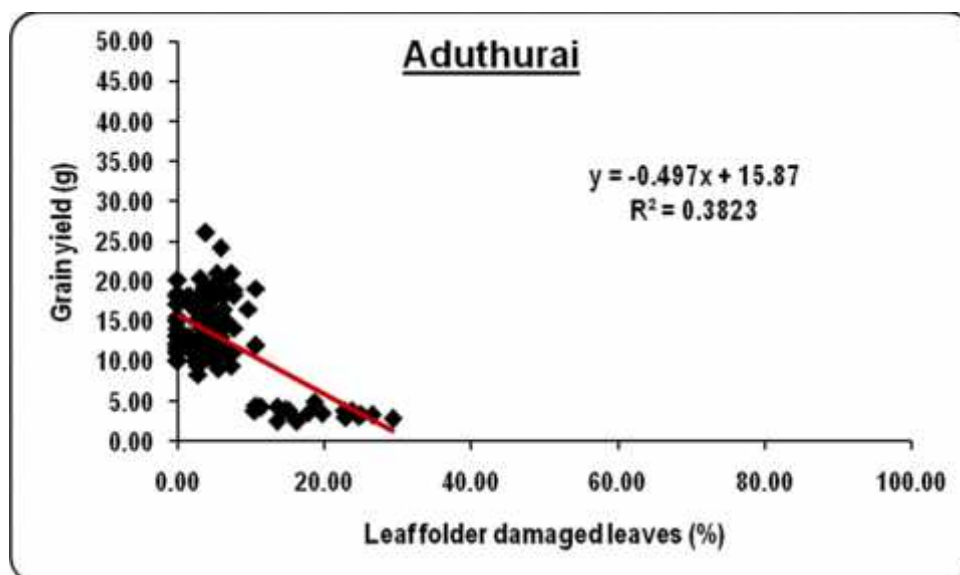


At **Pattambi**, white ear damage ranged from 0.00 to 47.37% resulting in 1.48 to 34.70 g grain yield per hill. The relationship between white ears and grain yield was negative but not significant.



Target pest: Leaf folder

At **Aduthurai**, leaf folder damage ranged between 0.00 and 29.33% resulting in grain yield of 2.53 to 26.10 g per hill. Linear regression analysis revealed a negative relationship between damaged leaves and grain yield ($R^2 = 0.3823$).



Yield loss estimation trial was conducted at three locations viz, Aduthurai, Chinsurah and Pattambi during Rabi 2017-18. Regression analysis revealed a significant negative relationship between white ears and grain yield at Chinsurah ($R^2 = 0.6498$) resulting in 2.1 g reduction in grain yield for every 10% increase in white ear damage. At Aduthurai and Pattambi, relationship between white ears and grain yield was negative but not significant. Similarly, a negative relationship was observed between leaf folder damaged leaves and grain yield at Aduthurai.

ii) Integrated Pest Management special Trial (IPMs)

IPM special trial was carried out at two locations *viz.*, Aduthurai and Pattambi during *Rabi* 2017-18. Location wise details are discussed below:

Aduthurai: IPMs trial was conducted in six farmer's fields, *viz.*, i) Sri Renganathan's field in Tholuvur village; ii) Sri Nandha Kumar's field in Aalangudi village; iii) Sri Ramalingam's field in Naarthang Gudi village; iv) Sri Jayapal's field in Valaigaiman village and v) Sri Sundar's field in Paadagachery village of Thiruvuru district in Tamilnadu State. ADT 51 (AD09367) variety was grown in all the farmers' fields in both IPM and FP plots. Incidence of stem borer, gall midge, leaf folder, whorl maggot, BPH and GLH was observed in all the villages in both IPM and FP plots. Stem borer damage crossed ETL in FP plot (10.48%) at Naarthaangudi village at 22 DAT while it was low in all other villages in both IPM and FP plots (**Table 2.78**). At 50 DAT, dead heart damage was very high in FP plot (32.47%) compared to IPM plot (2.33%) in Tholuvur village and in FP plot (15.17%) in Valaigaiman village. At 71 DAT, stem borer damage was high in FP plots of three farmers fields in 3 villages, Tholuvur village (12.24%), Aalangudi village (13.60%) and Paadagachery village (12.43%) compared to IPM plots (1.18 – 5.63%) in same villages. Gall midge incidence was low in all the fields in five villages except at FP plot in Paadagachery village which showed 17.75% damage.

Table 2.78 Pest incidence in IPMs trial at Aduthurai, *Rabi* 2017-18

Villages	Treatments	%DH			%SS	%LFDL	%WMDL
		22 DAT	50 DAT	71 DAT	29 DAT	57 DAT	29 DAT
V1 -Tholuvur	IPM	6.50 ± 4.15	2.33 ± 1.45	3.51 ± 1.46	3.21 ± 1.97	9.21 ± 2.38	8.05 ± 2.82
	FP	8.48 ± 4.12	32.47 ± 6.76	12.24 ± 4.70	8.94 ± 4.18	28.06 ± 3.63	11.68 ± 3.87
V2 - Aalangudi	IPM	5.83 ± 3.63	2.29 ± 1.40	2.67 ± 1.63	4.50 ± 2.78	7.16 ± 2.00	5.89 ± 2.44
	FP	6.19 ± 3.81	9.56 ± 3.24	13.60 ± 3.09	10.33 ± 6.11	12.90 ± 5.27	8.62 ± 1.04
V3 - Naarthaangudi	IPM	8.22 ± 3.78	2.00 ± 2.00	4.55 ± 2.03	2.76 ± 1.69	3.39 ± 1.09	3.85 ± 1.58
	FP	10.48 ± 6.10	6.56 ± 1.89	5.63 ± 1.42	4.22 ± 2.59	12.10 ± 2.09	3.51 ± 1.71
V4 - Valaigaiman	IPM	4.00 ± 4.00	5.37 ± 2.64	5.63 ± 2.54	4.17 ± 2.64	1.28 ± 0.40	3.94 ± 1.88
	FP	6.50 ± 4.15	15.17 ± 4.24	5.29 ± 2.39	8.61 ± 4.18	5.21 ± 1.65	5.52 ± 1.81
V5 - Paadagachery	IPM	7.86 ± 5.10	4.33 ± 2.07	1.18 ± 0.18	6.33 ± 2.71	2.33 ± 0.99	3.70 ± 0.58
	FP	9.00 ± 5.57	4.98 ± 2.18	12.43 ± 4.49	17.75 ± 4.27	4.43 ± 1.35	9.79 ± 3.35

Leaf folder incidence was low in all the treatments except at Tholuvur village in FP plot which recorded high damage of 28.06% at 57 DAT. Whorl maggot damage was also high (11.68%) in FP plot as compared to other plots (3.51 – 8.62%). Grain yield was relatively higher in IPM plots than FP plots in all the five villages resulting in higher returns (**Table 2.79**). BC ratio was also higher in IPM plots (2.02 – 2.51) than that of FP plots (1.52 – 2.07) mainly due to high cost of cultivation in farmers' practices and low returns.

Table 2.79 Returns and BC ratio in IPMs trial at Aduthurai, Rabi 2017-18

Villages	Treatments	Yield q/ ha	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	BC ratio
V1 -Tholuvur	IPM	44.36	57668	25473	32195	2.26
	FP	38.40	49920	26010	23910	1.92
V2 - Aalangudi	IPM	38.00	49400	24443	24957	2.02
	FP	34.00	44200	25105	19095	1.76
V3 - Naarthaangudi	IPM	48.00	62400	24870	37530	2.51
	FP	38.00	49400	25453	23947	1.94
V4 - Valaigaiman	IPM	44.00	57200	25368	31832	2.25
	FP	40.00	52000	25165	26835	2.07
V5 - Paadagachery	IPM	47.60	61880	24935	36945	2.48
	FP	37.60	48880	32163	16717	1.52

Price of paddy = Rs. 1300/ q

Pattambi: At Pattambi, Jyothi variety was grown in both IPM and Farmer practice fields during Rabi 2017-18. The trial was carried out at Sri Ummer's field in Parambil house, Kondurkara village, Palakkad district, Kerala State. Incidence of stem borer, gall midge, leaf folder, whorl maggot, case worm and blue beetle was observed in both IPM and FP plots. Stem borer damage was high in FP plots at 45 DAT and 70 DAT (20.28 – 27.34% DH) as compared to IPM plots (5.72 – 8.48% DH). White ear damage, leaf folder and gall midge incidence was low (**Table 2.80**). Whorl maggot, caseworm and blue beetle damage was very high in both the treatments. However, at 25 DAT, damage by whorl maggot (37.13%) and caseworm (75.83%) was high in IPM plots compared to FP plots (26.15% & 52.29%) indicating that the spray of econeem alone was not effective in managing these pests. Blue beetle damage was high in FP plot (53.80%) as against IPM plot (21.25%). Grain yield was high in IPM plot (47.04 q/ ha) resulting in higher returns and high BC ratio (1.95) compared to FP plot (1.11) (**Table 2.81**)

LOCATION: PATTAMBI		
	IPM PRACTICES	FARMERS PRACTICES
Farmer 1 – Sri Ummer Haji, Konukara village, Palakkad district, Kerala		
Area	4000 sq.m	4000 sq m
Variety	Jyothi	Jyothi
Fertilizers	Application of NPK @ 70:35:35	Application of 100 kg Factomphos, 70 kg urea and 40 kg Potash
Nursery	- Seed treatment with Pseudomonas @ 10g/kg seed - Seedling dip with Pseudomonas @ 20 g / litre of water - Application of cartaphydrochloride @ 1000 g ai/ ha	
Main field	- Application of weedicide, pretilachlor + Sathi @ 400ml + 40 g /acre - Five sprays with Eco neem 1% at 15, 25, 45, 65 and 80 DAT	Spraying of lambdacyhalothrin at 30, 60 and 75 DAT

Table 2.80 Pest incidence in IPMs trial at Pattambi, Rabi 2017-18

Treatments	%DH		%WE	%SS	%LFDL	%WMDL	%CWDL		%BBDL
	45 DAT	70 DAT	Pre har	25 DAT	55 DAT	25 DAT	25 DAT	45 DAT	25 DAT
IPM	8.48 ± 1.67	5.72 ± 1.91	4.25 ± 0.84	2.22 ± 0.01	1.04 ± 0.34	37.13 ± 9.31	75.83 ± 10.49	54.61 ± 9.38	21.25 ± 8.06
FP	27.34 ± 9.26	20.28 ± 3.46	13.05 ± 1.47	9.22 ± 4.60	14.86 ± 2.50	26.15 ± 4.01	52.29 ± 11.20	57.15 ± 7.06	53.80 ± 8.71

Table 2.81 Returns and BC ratio in IPMs trial at Pattambi, Rabi 2017-18

Treatments	Grain Yield (Q/ ha)	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	BC ratio
IPM	47.04	108192	55350	52842	1.95
FP	38.36	88228	79200	9028	1.11

Price of Paddy = Rs. 2300/Q

Integrated Pest Management special (IPMs) trial was conducted at two locations, Aduthurai and Pattambi during Rabi 2017-18. Incidence of stem borer (2.00 – 5.37%), gall midge (2.76 – 6.33%) and leaf folder (1.28 – 9.21%) was low in IPM plots as compared to FP plots (4.98 – 32.47% DH; 4.22 – 17.75% SS & 4.43 – 28.06% LFDL) in five villages at Aduthurai. Similarly, incidence of dead hearts (5.72 – 8.48%) and leaf folder (1.04%) was low in IPM plots compared to FP plots (20.28 – 27.34% DH & 14.86% LFDL) at Pattambi. However, incidence of whorl maggot and case worm was high in IPM plots (37.13% WMDL & 75.83% CWDL) as compared to FP plots (26.15% WMDL & 52.29% CWDL) indicating that the spray of econeem alone was not effective in managing these pests. Net returns were high in IPM plots at both the locations due to high grain yield and low cost of cultivation resulting in higher BC ratio in IPM plots (1.95 – 2.51) than farmer practice plots (1.11-2.07).

Scientists involved in coordinated programme

IIRR headquarters, Hyderabad: Drs. G. Katti, B. Jhansi Rani, V. Jhansi Lakshmi,
A. P. Padmakumari, Chitra Shanker, Ch.Padmavathi & Y. Sridhar

Cooperating centres

Sl. No.	State	Location	Code	Name of the cooperator, Designation
1	Andhra Pradesh	Bapatla*	BPT	Dr. C. V. Rama Rao, Pr.Scientist(Ento.)& Head
2		Maruteru	MTU	Dr. M. Nandkishore, Scientist (Ento.)
3		Nellore*	NLR	Dr. I. Parmasiva, Scientist (Entomology)
4		Ragolu*	RGL	-
5	Assam	Titabar	TTB	Dr. Mayuri Baruah, Junior Scientist
6	Bihar	Pusa	PSA	Dr. A. K. Misra, Professor (Entomology)
7	Chattisgarh	Jagdalpur	JDP	Dr. N. C. Mandawi, Scientist
8		Raipur	RPR	Dr. Sanjay Sharma, Pr. Scientist (Entomology)
9	New Delhi	New Delhi*	NDL	Dr. Subhash Chander, Prof. & P.S(Ento), IARI
10	Jharkhand	Ranchi	RCI	Dr. Rabindra Prasad, Rice Entomologist
11	Gujarat	Nawagam	NWG	Dr. Sanju Thorat, Asst. Res. Scientist
12		Navsari	NVS	Dr. P. D. Ghoghari, Assoc. Res. Scientist (Ento.)
13	Haryana	Kaul	KUL	-
14	H.P	Malan	MLN	Dr. Ajai Srivastava, Principal Scientist
15	J & K	Chatha	CHT	Dr. Rajan Salalia, Jr. Scientist(Entomology)
16		Khudwani	KHD	Dr. Md. Ayub Mantoo, Scientist, (Entomology)
17	Karnataka	Mandya	MND	Dr. Kitturmath, Entomologist
18		Gangavathi	GNV	Dr. Sujay Hurali, Scientist (Entomology)
19		Brahmavar	BRM	-
20	Kerala	Moncompu	MNC	Dr. Shanas Sudheer, Asst. Prof. (Entomology)
21		Pattambi	PTB	Dr. K. Karthikeyan, Assoc. Prof. of Entomology
22	M.P	Rewa	REW	Dr. M. R. Dhingra, Sr. Scientist
23	Maharashtra	Karjat	KJT	Dr. Vinayak Jalgaonkar, Entomologist
24		Sakoli	SKL	Dr. B. N. Chaudhari, Jr. Entomologist
25	Manipur	Iroisemba*	IRS	Dr. K.I. Singh, Assoc. Professor (Entomology)
26		Wangbal	WBL	Dr. Kuber Singh, Jr. Entomologist.
27	Odisha	Cuttack*	CTC	Dr. P. C. Rath, Principal Scientist(Entomology)
28		Chiplima\$	CHP	Dr. Atanu Seni, Jr Entomologist
29	Punjab	Ludhiana	LDN	Dr. P. S. Sarao, Principal Scientist
30	Tamil Nadu	Aduthurai	ADT	Dr. P. Anandhi, Asst. Professor
31		Coimbatore	CBT	Dr. P. Soundararajan, Asst. Professor,
32	Tripura	Arundhutinagar*	AND	Dr. Dhrubajyoti Pal, Entomologist.
33	Telangana State	Jagtial*	JGT	Dr. S. Omprakash, Scientist (Entomology)
34		Rajendranagar	RNR	Dr. N. Ramagopala Verma, Pr. Scientist (Ento.)
35		Warangal	WGL	Dr. S. Malathi, Sr. Scientist (Entomology)
36	U. Territory	Karaikal*	KRK	Dr. K. Kumar, Prof. & Head, (Agril. Entomology)
37		Kurumbapet@	KBP	-
38	Uttaranchal	Pantnagar	PNT	Dr. S. N. Tiwari, Prof. of Entomology
39	Uttar Pradesh	Masodha#	MSD	-
40		Ghaghrahat	GGT	Dr. Sanjay Rajput,
41	West Bengal	Chinsurah	CHN	Dr. Bijoy Choudhary, Entomologist

* - Voluntary Centre. @ - Kurumbapet (rep. for Puducherry), \$ - Chiplima (rep. for Sambalpur), # - Masodha (rep. for Faizabad).

Appendix-II

State	Location	Rabi 2017-18		Kharif 2018	
Funded co-operating centres		Sent	Recd.	Sent	Recd.
Andhra Pradesh	Maruteru	4	4	13	13
Assam	Titabar	2	0	9	8
Bihar	Pusa			9	8
Chattisgarh	Jagdalpur			13	13
	Raipur	1	1	12	12
Gujarat	Navsari			8	8
	Nawagam			8	8
Haryana	Kaul			0	0
Himachal Pradesh	Malan			11	11
Jammu & Kashmir	Chatha			8	6
	Khudwani			6	6
Jharkhand	Ranchi			8	8
Karnataka	Brahmavar			-	-
	Gangavathi	2	0	12	12
	Mandya			9	9
Kerala	Moncompu	3	3	11	8
	Pattambi	3	3	12	12
Madhya Pradesh	Rewa			7	6
Maharashtra	Karjat	1	1	8	7
	Sakoli			11	11
Manipur	Wangbal			0	0
Odisha	Chiplima	2	2	11	11
Puducherry	Kurumbapet	2	2	7	2
Punjab	Ludhiana			15	15
Tamil Nadu	Aduthurai	6	6	8	8
	Coimbatore	3	3	14	14
Telangana State	Rajendranagar	3	3	11	10
	Warangal	1	1	11	11
Uttar Pradesh	Ghaghraghat			4	4
	Masodha			9	7
Uttaranchal	Pantnagar			12	12
West Bengal	Chinsurah	7	6	12	12
Total trials in funded centres		40	35	289	265
Voluntary centres					
Andhra Pradesh	Bapatla			6	6
	Ragolu	1	1	9	8
	Nellore			7	5
Manipur	Iroisemba			-	-
New Delhi	New Delhi			4	4
Odisha	Cuttack	2	0	10	3
Puducherry	Karaikal			6	4
Telangana State	Jagtial			6	5
Tripura	Arundhutinagar			6	5
Total trials in Voluntary centres		3	1	54	40
Grand totals for <i>kharij</i> & <i>rabi</i>		43	36	350	312
% Receipt of data		83.7		91.0	
% Receipt of data (overall)		87.3			

List of Abbreviations					
a.i.	:	Active ingredient	LF	:	Leaf folder
ADL	:	Average damaged leaves	MB	:	Mirid bug
AT		After treatment	MLB	:	Mealy bug
Av.No./AN	:	Average number	N.n	:	<i>Nephotettix nigropictus</i>
AW	:	Army worm	N.v	:	<i>Nephotettix virescens</i>
BB	:	Blue beetle	N.ve	:	<i>Nezara viridula</i>
BCR	:	Benefit cost ratio	No./10h	:	Number per 10 hills
BPH	:	Brown planthopper	NP	:	Net profit
BT		Before treatment	NPT	:	Number of promising tests
Cocc.	:	Coccinellids	NT	:	Not tested
CPP	:	Cost of plant protection	PH	:	Planthoppers
CW	:	Case worm	PLD	:	Promising level of damage
DAT/DT	:	Days after transplanting	PSB	:	Pink stem borer
DG	:	Damaged grain	RF	:	Rainfall
DH	:	Dead hearts	RH	:	Relative humidity
DHB	:	Dark Headed borer	RT	:	Rice thrips
DL	:	Damaged leaves	SBDH	:	Stem borer dead heart
DP	:	Damaged plants	SBWE	:	Stem borer white ear
DS	:	Damage score	SDW		Standard week
FR	:	Field reaction	SS	:	Silver shoots
RGB	:	Rice Gundhi bug	SSB	:	Striped Stem borer
GH	:	Greenhouse reaction	SSH	:	Sunshine hours
GHC	:	Green horned caterpillar	WB	:	Water bug
GLH	:	Green leafhopper	WBPH	:	Whitebacked planthopper
GMB	:	Gall midge biotype	WE	:	White ears
Gr. H	:	Grass hopper	WLH	:	White leafhopper
GSB	:	Green stink bug	WM	:	Whorl maggot
HB	:	Hopper burn	WSB	:	White Stem borer
HBP	:	Hopper burned plants	YSB	:	Yellow stem borer
IOC	:	Increase over control	ZZLH	:	Zigzag leafhopper
IPD	:	Infested Plants Dead			

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PLANT PATHOLOGY

AICRIP Progress Report- Plant Pathology 2018

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3. PATHOLOGY

SUMMARY

The All India Coordinated Rice Pathology Program of the ICAR-Indian Rice Research Institute (formerly as Directorate of Rice Research) is an example of effective linkage and testing mechanism to assess the advanced breeding lines over a wide range of climatic and disease epidemic conditions and to identify broad spectrum of resistance to major rice diseases. This also helps in developing need based management options for controlling major diseases of rice. During 2018, a total of 14 trials were conducted at 49 locations on host plant resistance, field monitoring of virulence of major pathogens and disease management methods. The details on screening nurseries and disease management trials proposed and conducted at various test locations are given in Table 1. The summary of observations is given below. Detailed data on extensive screening of diverse genotypes are furnished in a separate report entitled 'National Screening Nurseries, 2018'.

I. HOST PLANT RESISTANCE (NSN-1, NSN-2, NSN-H, NHSN and DSN)

❖ LEAF BLAST

The entries for leaf blast resistance were evaluated under NSN-1, NSN-2, NSN-Hills, NHSN and DSN at 28, 16, 14, 22 and 25 centres respectively. In majority of the centres the disease pressure was moderate to high; at few centres it was very high with LSI >7. The entries that exhibited low over all disease score and high promising index were IET# 25640, 26464, 25618, 26866, 26910, 27093, 25745, 24914, 26816, and 25713 under NSN-1; IET #27668, 27607 and 27747 under NSN-2. None of the entries recorded resistant reaction across the locations under NSN-H and NHSN; however a few showed moderate resistance that included IET # 27487, 27472, 27466, 27463, 25826 and 27467 under NSN-H; IET #27364, 27361, 27363, 27346, 27335, 27328, 27353, 27377, 27336, 27379 under NHSN. The promising entries under DSN included RP-Patho-7-59, Phougak-D82, CB 12 132, RP-Patho-12-1-16, RNR 23605, RNR 17941 and RP-Patho-11-18-1.

❖ NECK BLAST

The entries were evaluated under NSN-1, NSN-2, NSN-Hills, NHSN and DSN at 8, 5, 8, 9 and 9 centers respectively. In majority of the locations the disease pressure was moderate to high, which was good enough for selection of the best entries. The entries that exhibited low over all disease score and high promising index were IET# 26750, 28014, 28015, 25804, 25219, 24950, 27286, 28015 and 28020 under NSN-1; IET# 27642, 27635 and 27410, 27746, 26834, 27781, 27668, 27814 and 27754 under NSN-2. The entries with IET No. 27496, 25826, 26576, 26564, 27461, 27483, 27480, 26594, 26588 and 27498 under NSN-H; IET # 27400, 27371, 27389, 27334, 27357, 27403, 27329, 27346, 27363, 27370, 27378, 27388, 27397 and 27352 under NHSN were found to be promising against neck blast disease with low diseases score across the locations. Under DSN, entries RDN-RIL-1, RDN-RIL-31, RDN-RIL-146, RDN-RIL-

161, RDN-RIL-164, RDN-RIL-189 and RDN-RIL-193 were found to be highly promising for neck blast disease.

❖ **SHEATH BLIGHT**

The entries were evaluated under NSN-1, NSN-2, NSN-Hills, NHSN, and DSN at 19, 14, 4, 18 and 18 locations, respectively. In majority of the locations, the disease pressure was moderate to very high. None of the entries were found resistant ($SI \leq 3$) against sheath blight in all the nurseries during *Kharif*-2018. However a few promising entries scored less than five were IET # 27040, 26178, 25618, 27193, 27059, 28029, 25804, 26751 and 26956 in NSN-1; 27926, 27570, 27606, 27571, 27579, 27572, 27610, 27776, 27668, 27858, 27851, 27910 and 28079 in NSN-2; 26591, 27487, 26461, 27473, 27481, 27482 and 26578 in NSN-H; IET Nos. 27376, 27383, 27358, 27391, 27357, 27349, 27378, 27388, 27375, 27350, 27356, 27393 and 27371 in NHSN and entries viz., RDN-RIL-114, RDN-RIL-77, RDN-RIL-146, RDN-RIL-1, RDN 98-2-3-5-14, RDN-RIL-152, RDN-RIL-179 and RDN-RIL-188 in DSN.

❖ **BROWN SPOT**

A total number of 1418 entries were evaluated under NSN-1, NSN-2, NSN-Hills, NHSN and DSN at 18, 11, 6, 14 and 14 centres respectively across the country. In majority of the centres the brown spot pressure was moderate to high; and at few centres it was very high with $LSI > 7$. None of entries found resistant in all the screening nurseries. However, the promising entries scored less than ≤ 5 were IET # 27289, 27291, 25901, 27094, 26716 and 26790 under NSN-1; IET # 28060, 27421, 27760, 27747, 27579, 27806 and 26639 under NSN-2. The entries with IET No. 27498, 25841, 27471, 26576, 27488, 27500, 27470, 27465, 27467, 27466 and 27468 under NSN-H; IET#27384, 27333, 27376, 27393, 27341, 27392, 27397, 27377, 27378 and 27389 under NHSN and RP-Bio-Patho-1-8-6, MIL-SI-1 and RNR 11450 under DSN.

❖ **SHEATH ROT**

The entries under NSN-1, NSN-2, NSN-H, NHSN and DSN were screened against sheath rot at 11, 3, 2, 11 and 10 locations, respectively. Some of the highly promising entries scored less than 3 were IET # 25618 in NSN-1; 27915 in NSN-2; 27461 in NSN-H and none found in NHSN and DSN.

❖ **GLUME DISCOLOURATION**

Glume discolouration (GD) was observed under natural conditions at four centers viz., Chatha, Lonavala, Navasari and Nawagam during *Kharif*, 2018. Some of the promising entries found from NHSN were: IET nos 27350, 27352, 27353, 27360, 27361 and 27393. None of the entries found promising in NSN1, NSN-2, NSNH, and DSN nurseries.

❖ **BACTERIAL LEAF BLIGHT**

The test entries and various checks in different bacterial blight screening nurseries viz., NSN-1, NSN-2, NSN-Hills, NHSN and DSN were evaluated at 23, 14, 4, 20 and 20 locations. The number of entries including checks in different nurseries was 398 in NSN1, 682 in NSN-2, 101 in NSN-Hills, 108 in NHSN and 129 in DSN. None of the entries were found resistant and

some of the promising entries against bacterial blight in different nurseries were IET # 26746, 27275, 28035, 28015, 27293, 28014, 28015, 28014, 27280, 26126, 27295, 27296, 27275, 28035, 26549, 27294, 26745 and 27280 in NSN-1; IET # 27729, 27832, 27721, 27620, 28061, 28073, 27579, 27768, 27650, 27669, 27615, 27764, 27781, 27460, 27739, 28077, 27806, 27837 and 27416 in NSN-2; IET # 27461, 27466, 27487 and 26594 in NSN-Hills; IET # 27384, 27395, 27388, 27350, 27389, 27387 and 27378 in NHSN and RP-Bio-Patho-4-1-2, MSM-TH-151, RDN-RIL-201, IBT-R8, MIL-S7-8, GSY-4-6, GSY-4-1, MIL-S3-1, IL-5 and IL-1 in DSN.

❖ RICE TUNGRO DISEASE

The entries in NSN-1, NSN-2, NHSN and DSN were evaluated at 2 locations for rice tungro virus disease. The promising entries identified in different nurseries were: IET # 25909, 26487, 28030, 28020 and JKRH 3333 in NSN-1; 27566, 27871, 27900, 27668, 27715, 27937, 27957, 27968, 27974, 27823 and 28063 in NSN-2; 26573, 26579, 27467, 27472, 26598 in NSN-H; 27377, 27376, 27400, 27330, 27345 in NHSN and CB 14161, TPL-58-1, NWGR-11048, Tetep and CB 15 144 in DSN.

❖ MULTIPLE DISEASE RESISTANT LINES

In NSN-1, IET # 28014 and 28015 recorded resistant reaction against NB and moderate resistance to BLB. Similarly IET # 26027 and 27077 had shown moderate resistance to BLB and ShR. In addition, IET # 27094 (BS, ShR), 27280 (BLB, ShR), 28020 (NB, RTD), 25618 (LB, ShR) also expressed moderate resistance against two different diseases. In NSN-2, IET # 27579 had shown moderate resistance to three diseases viz., sheath rot, bacterial leaf blight and brown spot. In addition, IET # 27668 (LB, NB), 27781 (NB, BLB), 27747 (LB, BS) and 27806 (BLB, BS) expressed moderate resistance against two diseases. Under NSN-H, some lines expressed resistant reaction to more than two diseases viz., IET # 25826 (moderately resistant to LB, NB and ShR), 26576 (moderately resistant to NB, ShR and BS), IET # 26594 (moderately resistant to NB, ShR and BLB), IET # 27461 (moderately resistant to NB, BLB and resistant to sheath ShR), IET # 27466 (moderately resistant to LB, BLB and BS), IET # 27467 (moderately resistant to LB, BS and RTD). In NHSN, IET # 27378 showed resistant reactions to four diseases (resistant to NB and moderately resistant to ShR, BLB and BS). Entries recorded resistant / moderate resistant reactions against three diseases were IET # 27333 (moderately resistant to ShR, BLB and BS), 27377 (moderately resistant to LB and BS and resistant to RTD) and 27389 (resistant to NB and moderately resistant to BLB and BS). In DSN, CB14161 and NWGR-11048 (moderate resistant to NB, ShR and resistance to RTD) and RNR-11450 (moderate resistant to NB, ShR and BS) showed resistant reaction to three diseases.

II. FIELD MONITORING OF VIRULENCE

1. *Pyricularia oryzae*

The nursery included twenty five cultures consisting of international differentials, donors and commercial cultivars. It was evaluated at twenty four locations with different dates of sowing during the crop season to monitor the blast reaction on different host genotypes.

Tetep, Raminad str-3 and Tadukan were resistant across the locations. Tetep and Raminad str-3 were highly resistant at most of the locations (17) that showed its potentiality as the best donors for resistance against blast disease. Tetep was susceptible at Ghaghraghat and moderately susceptible at Almora, Impal and Karjat. Raminad str-3 was susceptible at Ghaghraghat and Impal and also moderately susceptible at NRRI. Tadukan was showing resistance at all the locations except at Imphal, Almora, Ghaghraghat, Mandya NRRI and Nellore. NP-125 was highly susceptible at Coimbatore, Ghaghraghat and New Delhi. The susceptible checks like HR-12 and CO-39 are showing susceptible reaction at most of the locations but HR-12 resistant reaction were recorded at Khudwani, Pattambi and Karjat and Co-39 also recorded low disease reactions at Karjat, Khudwani and Nawagam. The resistant check Rasi was highly susceptible at Imphal, Upper Shillong and Rajendranagar. IR-64 was susceptible at Almora, Impal and Lonavala. The reaction pattern of genotypes at all the locations was grouped into eight major groups at 60 per cent similarity coefficient. The reaction pattern at Almora, NRRI, Ghaghraghat, Imphal, Coimbatore, Upper Shillong, Mandya, Lonavala, Jagdalpur, New Delhi, Ponnampet, Gudalur, Nellore and Malan were in group one; Gangavati, Karjat, Hazaribagh and Jagdalpur were in group two, three, four and five respectively; IIRR and Navasari are in group six; Nawagam and Pattambi are in group seven and Khudwani in group eight.

2. *Xanthomonas oryzae* pv. *oryzae*

The trial consisted of twenty eight near isogenic lines (IRBB lines) possessing different bacterial blight resistant genes (singly) or various combination 5 BB resistance genes viz., *Xa4*, *xa5*, *Xa7*, *xa13* and *Xa21* in the background of rice cultivar IR 24 and different checks like Improved Samba Mahsuri, TN1 and DV85. The trial was conducted at 25 locations across India. Most of the differentials possessing single bacterial blight resistance genes like *Xa1*, *Xa3*, *Xa4*, *xa5*, *Xa7*, *xa8*, *Xa10*, *Xa11* and *Xa14* were susceptible at most of the locations. BB resistance gene *xa13* was susceptible in 11 locations while *Xa21* was susceptible in 19 locations. The differential, IRBB 55 possessing two BB resistance genes *xa13* and *Xa21* showed susceptibility at 11 hot spot locations. Based on their virulence, the isolates were grouped into high, moderate and low virulence groups. The isolate from Maruteru showed exceptional virulence and all the differentials showed susceptible reaction to this isolate.

III. DISEASE OBSERVATION NURSERY

The trial was conducted at 7 locations viz., Chinsurah, Mandya, Maruteru, Moncompu, Nawagam, Pusa and Malan. It was observed in general that the disease incidence varied according to the sowing dates. Across the locations, delayed sowing/planting increased the disease development of leaf blast, brown spot and sheath rot. Normal sown crop recorded high disease severity of bacterial leaf blight compared to early and late sown crop. With respect to sheath blight, disease progress was high both in the early and normal sown crop. Neck blast was severe in the normal sown crop at Maruteru and Moncompu. Analysis of weather factors inferred that the amount of rainfall directly influenced the disease incidence of neck blast and sheath blight.

IV. DISEASE MANAGEMENT TRIALS

1. EVALUATION OF COMBINATION FUNGICIDES AGAINST LOCATION SPECIFIC DISEASES

The trial was conducted with test products such as flusilazole 12.5% + carbendazim 25% SC (1.0 ml/l), azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l), azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 ml/l), tricyclazole 18 % + mancozeb 62 % WP (2.5 g/l), zineb 68% + hexaconazole 4% WP (2.5g/l), trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l), mancozeb 50% + carbendazim 25% WS (2.5g/l) and fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC (1.5ml/l). The fungicides were evaluated against leaf blast (10 locations), neck blast (eight locations), node blast (one location), sheath blight (15 locations), sheath rot (seven locations), brown spot (six locations) and false smut (one location).

The combination product is trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l) found effective in minimizing the leaf blast, neck blast and sheath rot severity and incidence. Regarding grain yield, both these combination products were performed better than other fungicides in improving the yield. The combination fungicide azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) found effective in minimizing the disease severity and incidence of sheath blight and sheath rot. Two other fungicides viz., mancozeb 50% + carbendazim 25% WS (30.5%) and Flusilazole 12.5% + carbendazim 25% SC found effective in managing brown spot of rice.

2. INTEGRATED DISEASE MANAGEMENT

The treatment (T4-N1+N2+N3+M5+M6+M8+M9+M10) which involves the incorporation of FYM @ 1 kg/m², seed treatment with carbendazim (2 g/kg) alone or along with one application of carbendazim (@1 g/m²) 7 days before uprooting the seedlings and application of DAP @ 108 g/10 m², application of muriate of potash (MOP) @ 85 g/10 m² in the nursery area followed by the application of FYM (@ 1 kg/m² + *Trichoderma* formulation @ 2 g /kg of FYM during land preparation, cultural practices, application of 75% RDF + micronutrient solution @ 0.5 litre /10 m² area, one blanket application of cartap hydrochloride @ 10 kg/acre at 15 DAT, blanket spraying of propiconazole at booting stage @ 1ml/lt followed by application of suitable fungicide in main field found to be most effective and consistent in reducing the incidence of leaf blast, neck blast, sheath blight, brown spot and sheath rot and also increasing the grain yield at all the centers.

3. INTEGRATED PEST MANAGEMENT (SPECIAL - IPM TRIAL)

During Kharif 2018, the trial was conducted at 6 different locations viz., Coimbatore, Mandya, Ludhiana, Jagdalpur, Titabar and Sakoli. Disease severity of various diseases, recorded at weekly intervals was converted in to AUDPC values and compared. The leaf blast and neck blast disease progress was significantly lower in the experimental plots where IPM practices were followed when compared to the farmer practices. At Ludhiana and Titabar sheath blight disease progression was slow when IPM practices were followed compared to non-IPM fields. The sheath rot disease progression was slow in IPM practices as compared to farmer practices at

Sakoli. At Ludhiana false smut disease progression was more rapid under farmers practices compared to IPM practices. In general, the trial results indicated that the IPM practices which integrates all the necessary components for the reduction of pathogen inoculum, providing of necessary nutrients for a host, creating an atmosphere that is not favourable for the pathogen to survive which leads to low disease development.

4. SPECIAL TRIAL ON ESSENTIAL OILS

In *Kharif* 2018, eight essential oils were tested for their performance against leaf blast, neck blast, sheath blight, bacterial blight, false smut, brown spot at 14 locations. Two sprays of Clove oil @ 2 ml/l (T6) is performing better in reducing the leaf blast severity, whereas Neem oil @ 2 ml/l (T7) and Cedar wood oil @ 2 ml/l (T3) effective in reducing both leaf and neck blast disease severity. In case of sheath blight disease, spraying of Neem oil @ 2 ml/l (T7), Citronella oil @ 2 ml/l (T1), Cedar wood oil @ 2.0ml/l, Nirgundi oil @ 2.0 ml/l (T4) and Eucalyptus oil @ 2 ml/l (T2) reported as effective. With respect to bacterial blight, application of Eucalyptus oil @ 2 ml/l (T2), Neem oil @ 2.0 ml/l (T7), Nirgundi oil @ 2.0 ml/l (T4) and Cedar wood oil @ 2.0ml/l reduced the disease development to some extent. Citronella @ 2.0 ml/l (T1) and Neem oil @ 2.0 ml/l are effective against brown spot and false smut respectively.

INTRODUCTION

The All India Co-ordinated Rice Pathology Programme of Indian Institute of Rice Research (ICAR-IIRR) provides an effective linkage for collaboration among state agricultural universities, national institutes and Department of Agriculture, Agrochemical Industry and others. The objectives of the Programme are:

- To accelerate genetic improvement of rice for resistance against major diseases occurring in different ecosystems of the country.
- To provide a testing mechanism to assess the advanced breeding lines over a wide range of climatic, cultural, soil and disease epidemic conditions.
- To identify broad spectrum of resistance to major rice diseases.
- To monitor and evaluate the genetic variation of rice pathogens.
- To monitor the prevalence of diseases in the country.
- To develop need based disease management practice.
- To identify production constraints in different ecosystems through production oriented survey.

To achieve these objectives during 2018, a total of 14 trials were conducted at 49 locations on host plant resistance, field monitoring of virulence in major pathogens and disease management. Five national screening nurseries comprising of 1418 entries of advanced breeding lines and new rice hybrids were evaluated for their reactions to major rice diseases at 49 locations.

The composition of the nurseries is as follows:

- ❖ National Screening Nursery 1 (NSN-1) - 398 entries drawn from Advanced Variety Trials.
- ❖ National Screening Nursery 2 (NSN-2) - 682 entries from Initial Variety Trials.
- ❖ National Screening Nursery-Hills (NSN-H) - 101 entries from Advanced and Initial Varietal Trials.
- ❖ National Hybrid Screening Nursery (NHSN) - 108 entries from Initial National Hybrid Rice Trials (HRT'S).
- ❖ Donor Screening Nursery (DSN) - 129 entries from different centres.

The virulence patterns of blast and bacterial leaf blight pathogens in the field were monitored, using differentials for respective diseases at disease endemic areas. The prevalence of the diseases was monitored in three sequentially sown disease observation nurseries laid-out in the endemic locations.

The disease management trials were conducted at hot-spot locations to evaluate the efficacy of new fungicides and commercially available combination fungicide formulations against major rice diseases. Production Oriented Survey (POS) was undertaken in 17 centres (15 states) to identify the production constraints in different rice growing ecosystems.

The weather conditions and location details are given in Annexure I to Annexure III. Out of 580 experiments proposed, data were received from 541 experiments of 14 trials indicating the good response with 93.2 % data receipt from the centres.

Table 1: Scientists involved in Pathology Coordinated Programme, Kharif 2018. ICAR-IIRR, Headquarters, Hyderabad - Dr. M. Srinivas Prasad, PI; Associates: Drs. G.S. Laha, D. Krishnaveni, C. Kannan, D. Ladhakshmi, V. Prakasam, K. Basavaraj and G. S. Jasudasu

S.No	Location	Co-operators	Funded/ Voluntary	Experiments	
				Proposed	Conducted
1	Aduthurai	Dr. K. Rajappan	Funded	14	11
2	Almora	Dr. H. Rajashekara	Voluntary	12	9
3	Arundhatinagar	Dr. Abhijit Saha	Funded	9	2
4	Bankura	Dr. Partha Pratim Ghosh	Funded	9	13
5	Chakdha	Mr. Raghunath Mandal	Voluntary	5	0
6	Chatha	Dr. Anil Gupta	Funded	13	17
7	Chinsurah	Drs. Dr.C.K.Bhunia, Dilip Kumar Patra & P.Bandyopadhyay	Funded	13	12
8	Chiplima	Dr. Rini Pal	Funded	7	6
9	Coimbatore	Dr. A. Ramanathan	Funded	15	18
10	Cuttack	Drs.Arup K Mukherjee, Sri Kanta Lenka & Manas Kumar Bag	Voluntary	21	24
11	Gangavati	Dr. Pramesh Devanna	Funded	19	18
12	Gerua	Dr. Rupankar Bhagawati	Voluntary	11	11
13	Ghaghraghat	Dr. Amritlal Upadhayay	Funded	10	7
14	Gudalur	Dr. A. Ramanathan	Voluntary	5	6
15	Hazaribagh	Drs. Someshwar Bhagat, Amrita Banerjee & Dipankar Maiti	Voluntary	8	10
16	ICAR-IIRR	Drs. M. S. Prasad, G. S. Laha, D. Krishnaveni, C. Kannan, D. Ladhakshmi, V. Prakasam, K.Basavaraj and G.S. Jasudasu	Voluntary	25	17
17	Imphal	Dr. Susheel Kumar Sharma	Voluntary	8	7
18	Jagdarpur	Dr. R. S. Netam	Funded	16	19
19	Jagtial	Dr. N. Balram	Voluntary	8	15
20	Karjat	Drs. J. J. Kadam, P.G. Borkar & V. N. Jalgaonkar	Funded	16	15
21	Kaul	Dr. Ram Singh	Funded	5	2
22	Khudwani	Dr. Nazir Ahmad Bhat	Funded	8	10
23	Lonavala	Dr. Chandrashekhar Kshirsagar	Voluntary	19	21
24	Ludhiana	Drs. Jagjeet Singh Lore & Jyothi Jain	Funded	15	16
25	Malan	Dr. Sachin Upmanyu	Funded	16	13
26	Mandya	Dr. B. S. Chethana	Funded	18	15
27	Maruteru	Dr. V. Bhuvaneswari	Funded	23	10
28	Isodha (Faizabad)	Dr. Vindeshwari Prasad	Funded	12	9
29	Moncompu	Dr. M. Surendran	Funded	12	9
30	Mugad	Dr. B. C. Kamanna	Voluntary	18	32
31	Navsari	Dr. V. A. Patil	Funded	10	13
32	Nawagam	Dr. Rakeshkumar Gangwar	Funded	10	15
33	Nellore	Dr. P.Madhusudhan	Voluntary	11	8
34	New Delhi	Drs. K.K. Mondal & G. Prakash	Voluntary	8	4
35	Pantnagar	Drs. Vishwanath & Dr. Bijendra kumar	Funded	14	10
36	Patna	Dr. Arvind Kumar	Funded	9	6
37	Pattambi	Dr. Puzhakkal Raji	Funded	17	14
38	Ponnampet	Dr. G. N. Hosagoudar & Dr. Sheshaiah	Funded	14	15
39	Portblair	Mr. K. Sakthivel	Voluntary	3	2
40	Pusa	Dr. Bimla Rai	Funded	11	13
41	Raipur	Dr. Pradeep Kumar Tiwari	Funded	15	12
42	Rajendranagar	Dr. Talluri Kiran Babu	Funded	11	9
43	Rewa	Dr. S.K. Tripathi	Funded	10	14
44	Sabour	Dr. Amarendra Kumar	Voluntary	2	2
45	Titabar	Dr. Bubul Chandra Das	Funded	11	10
46	Umiyam Barapani)	Dr. Akoijam Ratankumar Singh, Dr. Pankaj Baiswar	Voluntary	9	6
47	Upper Shillong	Smt. Lakyntiew Warjri	Funded	10	8
48	Varanasi	Dr. R. K. Singh.	Funded	9	5
49	Wangbal	Dr. Sanaton Sharma	Funded	6	1
Total Experiments (%) 93.2 %				580	541

I. HOST PLANT RESISTANCE

Screening Nursery (NSN-1, NSN-2, NSN-H, NHSN and DSN)

❖ LEAF BLAST

➤ National Screening Nursery-1 (NSN-1)

The National Screening Nursery (NSN-1) comprised of 398 entries that included national regional and pathology checks. The nursery was evaluated at 28 locations across India under different-agro ecological Zones. The frequency distribution of disease scores and the representative location severity index (LSI) are presented in the Table 2. The highest disease pressures (LSI 8.2) was recorded at Umiam and lowest (LSI-1.2) at Nawagam. The disease pressure was high (LSI-6-7) at three centres viz., Coimbatore (6.4), Gangavathi (6.3) and Mandya (6.1). It was moderate (LSI 4-6) at Gudulur (5.8), Malan (5.8), Karjat (5.5), Almora (5.3), Lonavala (5.1), Ghagraghat (5.0), Nellore (5.0), IIRR (4.9), Jagdalpur (4.8), New Delhi (4.7), Navasari (4.4), Ponnampet (4.1), Rajendranagar (4.1) and Hazaribagh (4.0). Accordingly the data from locations viz., Bankura, Jagtial, Gerua, Khudwani, Mugad, Pattambi, Rewa and Upper Shillong where disease pressure was low (<4) was not considered for the selection of promising entries.

None of the entries scored SI<3, therefore the entries that scored SI<4 were considered as promising. The entries included IET Nos. 25640, 26464, 25618, 26866, 26910, 27093, 25745, 24914, 26816, and 25713 (Table 3).

➤ National Screening Nursery-2 (NSN-2)

The nursery consists of 682 lines drawn from initial variety trials (IVTs). These were evaluated at 16 centres under various ecological zones. A very high disease pressure was recorded at Umiam (LSI 7.7) and the lowest at Mugad (LSI 1.2). The disease pressure was very high (>7) at Cuttack (7.4) and Malan (7.1) while it was high (LSI 6-7) at Mandya (6.7) Gangavathi (6.5) and Coimbatore (6.4). It was moderate (LSI 4-6) at Almora (5.2), IIRR (5.1), Nellore (5.1), Jagdalpur (4.8), Titabar (4.4) and Ponnampet (4.3) (Table 4). The Performance of entries at locations viz., Hazaribagh, Mugad, Pattambi and Rewa was not considered where disease pressure was low (<4).

None of the entries were recorded SI less than 3, but a few promising entries whose disease scores were less than 4 were presented in Table 5. The entries that exhibited moderate disease reaction included IET # 27668, 27607 and 27747.

Table 2: Location severity index (LSI) and frequency distribution of Leaf blast scores for NSN-1, Kharif' 2018

Location/Frequency of score(0-9)																												
Score	ALM	BAN	CBT	GDL	GER	GGT	GNV	HZB	IIRR	JDP	JGT	KHD	KJT	LNV	MND	MGD	MLN	NDL	NLR	NRRI	NVS	NWG	PNP	PTB	REW	RNR	UMM	USH
0	0	0	0	0	1	0	0	37	0	0	0	0	0	0	0	261	0	0	0	0	0	21	0	0	0	0	0	1
1	0	0	0	0	71	0	2	48	4	10	0	160	0	0	0	28	70	9	0	0	1	287	1	2	53	44	0	32
2	0	0	0	0	108	0	10	25	14	33	64	0	0	5	3	0	11	0	4	0	17	56	16	54	128	0	0	84
3	23	356	84	152	22	3	23	73	39	30	150	165	6	28	14	46	9	117	27	9	89	3	100	100	65	190	0	115
4	0	0	0	5	28	5	49	41	95	90	107	0	4	156	65	1	31	0	120	0	83	7	137	148	76	0	0	64
5	304	39	92	56	20	309	53	49	145	108	10	41	199	88	49	49	33	198	115	140	143	3	118	60	53	84	1	31
6	0	0	0	0	4	8	64	51	22	68	41	0	152	36	54	0	44	0	88	0	34	0	24	22	23	0	6	24
7	58	3	78	49	2	9	64	36	72	46	1	21	21	31	162	11	42	62	25	124	31	0	0	5	0	43	3	16
8	0	0	0	0	4	0	68	20	2	10	24	0	5	26	21	0	42	0	13	0	0	0	0	1	0	0	271	13
9	10	0	135	128	6	0	64	16	4	2	0	8	0	23	29	2	102	11	3	124	0	0	1	2	0	31	114	16
Total	395	398	389	390	266	334	397	396	397	397	397	395	387	393	397	398	384	397	395	397	398	377	397	394	398	392	395	396
LSI	5.3	3.2	6.4	5.8	2.6	5.0	6.3	4.0	4.9	4.8	3.8	2.7	5.5	5.1	6.1	1.3	5.8	4.7	5.0	6.8	4.4	1.2	4.1	3.8	3.0	4.1	8.2	3.7
SM	N	A	A	N	A	-	A	N	A	N	A	A	A	N	A	N	A	A	N	A	A	N	N	N	-	A	N	N

(N-Natural; A-Artificial) (SM-Screening Method)

Table 3: Promising entries with low susceptibility index (≤ 4.1) and high PI in NSN-1 to Leaf blast disease, *Kharif-2018*

Ent. No.	IET No.	Location/ Score (0-9)																			SI	Total	<=3*	PI (<3)**	<=5*	PI (<5)**
		ALM	CBT	GDL	GGT	GNV	HZB	IIRR	JDP	KJT	LNV	MND	MLN	NDL	NLR	NRRI	NVS	PNP	RNR	UMM						
Tetep	Tetep	3	3	3	5	2	1	1	1	7	2	4	1	3	3	5	1	1	3	8	3.0	19	14	73.7	17	89.5
3506	25640 (R)	5	5	3	5	1	1	4	4	5	3	2	1	5	5	5	3	5	1	5	3.6	19	8	42.1	19	100.0
813	26464	5	3	3	5	3	0	4	2	5	4	4	1	5	4	5	4	3	3	8	3.7	19	8	42.1	18	94.7
3503	25618 (R)	5	7	3	5	4	1	3	3	5	2	4	1	3	5	5	4	3	3	6	3.8	19	9	47.4	17	89.5
1108	26866	5	5	3	5	2	0	4	4	5	4	3	1	5	5	5	3	4	1	8	3.8	19	7	36.8	18	94.7
1109	26910	3	3	3	5	3	1	5	4	5	4	4	1	3	3	7	5	5	3	8	3.9	19	9	47.4	17	89.5
2021	27093	3	9	3	5	5	0	4	2	4	4	5	1	3	4	5	4	3	3	8	3.9	19	8	42.1	17	89.5
1007	25745	5	5	3	5	4	0	4	2	6	4	5	1	3	4	5	6	4	1	8	3.9	19	6	31.6	16	84.2
808	24914	3	3	3	5	5	3	4	2	6	4	5	1	3	3	7	3	3	5	8	4.0	19	10	52.6	16	84.2
1401	26816	5	3	3	6	4	1	5	2	6	4	5	4	5	4	5	3	2	1	8	4.0	19	7	36.8	16	84.2
809	25713	5	3	3	-	4	0	4	2	5	4	5	1	5	5	3	5	5	5	8	4.0	18	6	33.3	17	94.4
HR-12 (SC)		5	-	9	5	9	9	9	8	8	9	9	9	9	9	7	7	9	7	9	8.1	18	0	0.0	2	11.1
LSI		5.3	6.4	5.8	5.0	6.3	4.0	4.9	4.8	5.5	5.1	6.2	5.8	4.7	5.0	6.8	4.5	4.1	4.1	8.2						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 4: Location severity index(LSI) and frequency distribution of leaf blast scores of NSN-2, Kharif 2018

Location/Frequency of score (0-9)																
Score	ALM	CBT	GNV	HZB	IIRR	JDP	MND	MGD	MLN	NLR	NRRI	PNP	PTB	REW	TTB	UMM
0	0	0	0	44	0	4	0	357	0	0	0	0	0	0	0	0
1	8	0	3	64	1	78	0	155	64	0	0	5	0	1	0	0
2	0	0	25	110	0	37	1	1	11	1	0	12	115	76	0	0
3	39	83	19	93	7	16	26	111	9	49	10	140	149	178	202	0
4	0	0	59	74	220	187	44	1	25	182	0	233	288	264	0	0
5	523	264	65	97	272	94	103	51	38	206	131	205	91	147	349	69
6	0	0	177	80	44	79	73	0	41	146	1	55	25	3	0	6
7	81	67	80	87	131	121	237	3	65	46	252	13	4	1	34	155
8	0	0	115	22	0	41	69	1	42	22	0	4	4	0	0	164
9	20	224	130	7	7	17	120	2	331	15	288	9	0	0	1	201
Total	671	638	673	678	682	674	673	682	626	667	682	676	676	670	586	595
LSI	5.2	6.4	6.5	3.9	5.1	4.8	6.7	1.2	7.1	5.1	7.4	4.3	3.7	3.7	4.4	7.7
Screening Method	N	A	A	N	A	N	N/A	N	N/A	N	A	N	N	-	A	N

(N-Natural; A-Artificial)

Table 5: Promising entries with low susceptibility index (≤ 4) and high PI in NSN-2 to leaf blast, Kharif 2018

Ent. No.	IET No.	Designation	Location/ Score (0-9)												SI	Total	<=3*	PI (<3)**	<=5*	PI (<5)**
			ALM	CBT	GNV	IIRR	JDP	MND	MLN	NLR	NRRI	PNP	TTB	UMM						
Tetep			1	5	2	1	0	3	1	3	5	1	5	9	3.0	12	8	67	11	92
1511	27668	TRC 2018-17	5	3	1	4	1	3	1	4	7	4	5	8	3.8	12	5	42	10	83
1709	27607	RP 6112-MS 62-8-6-4-1-5-3-1	5	3	2	6	3	2	-	5	7	3	3	5	4.0	11	6	55	9	82
1212	27747	TRC 2018-2	3	3	5	5	2	4	1	4	5	3	5	8	4.0	12	5	42	11	92
HR-12	HR-12	HR-12	7	9	9	9	9	9	9	7	7	9	5	9	8.2	12	0	0	1	8
LSI			5.2	6.4	6.5	5.1	4.8	6.7	7.1	5.1	7.4	4.3	4.4	7.7						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ **National Screening Nursery-Hills (NSN-Hills)**

The NSN-H included a total of 101 entries screened at 14 locations under hill ecological zones of India. The highest disease pressure was recorded at Cuttack (7.1); while it was lowest at Mugad (2.1) (Table 6). The disease pressure was high (LSI 6-7) at Gudalur (6.6), Imphal (6.2) and Karjat (6.2). Moderate disease pressure (LSI 4-6) was observed at IIRR (4.9), Lonavala (4.6), Ponnampet (4.4), Umiam (4.3) and Upper Shillong (4.3). The data from centres viz., Kudhwani (3.4), Mugad (2.1), Malan (2.7) and Wangbal (2.8); where disease pressure was low (<4) and hence those centres were not considered for the selection of resistance entries.

None of the entries recorded resistant reaction across the locations. However a few showed moderate resistance that included IET # 27487, 27472, 27466, 27463, 25826 and 27467 (Table 7).

➤ **National Hybrid Screening Nursery (NHSN)**

One hundred and eight hybrids that included checks were evaluated at 22 centres against leaf blast disease under NHSN. The highest and lowest disease pressure was recorded at Cuttack (7.0) and Mugad (1.5) respectively. The disease pressure was high (LSI 6-7) at Coimbatore (6.5). Most of the centres exhibited moderate disease pressure viz., Gangavathi (5.8), Mandya (5.5), Jagdalpur (5.4), Nellore (5.1), Imphal (4.9), Umiam (4.6), Lonavala (4.7), Almora (4.6), IIRR (4.4), Ponnampet (4.2), Upper Shillong (4.2) and Karjat (4.0) (Table 8). The Performance of entries at Bankura, Jagtial, Khudwani, Mugad, Malan, Nawagam, Pattambi and Rewa was not considered for identifying promising entries.

None of the entries recorded resistance reaction consistently across the locations however a few promising entries that included IET# 27364, 27361, 27363, 27346, 27335, 27328, 27353, 27377, 27336 and 27379 (Table 9).

➤ **Donor Screening Nursery (DSN)**

The donor screening nursery comprised of 129 entries including checks were evaluated at 25 locations. The highest disease pressure was observed at Coimbatore (7.4), while lowest at Nawgam (1.2) and Mugad (1.3). The disease pressure was high (LSI 6-7) at Cuttack (7.0), Gangavathi (6.4), Jagdalpur (6.0), and Mandya (6.0). It was moderate (LSI 4-6) at centres Almora (5.6), Lonavala (5.5), IIRR (5.2), Imphal (5.0), Nellore (5.1), Gagarghat (5.0), Upper Shillong (4.9), Rajendranagar (4.8), Karjat (4.5), Malan (4.4), Ponnampet (4.2), and Hazaribhag (4.0) (Table 10). The locations viz., Gerua, Jagtial, Mugad, Moncompu, Nawagam, Pattambi and Rewa where disease pressure was low (<4) were not considered for the selection of promising entries.

None of the entries were found superior over resistant check (3.0); however some of the promising donors were listed in the Table 11 that included RP-Patho-7-59, Phougak-D82, CB 12 132, RP-Patho-12-1-16, RNR 23605, RNR 17941 and RP-Patho-11-18-1.

Table 6: Location severity index (LSI) and frequency distribution of leaf blast scores of NSN-H, Kharif 2018

Location/Frequency of score(0-9)														
Score	ALM	GDL	IIRR	IMP	KHD	KJT	LNV	MGD	MLN	NRRI	PNP	UMM	USH	WGL
0	0	0	0	0	0	0	0	27	0	0	0	0	0	0
1	0	0	1	0	40	0	0	29	53	0	2	5	0	5
2	0	0	0	0	0	0	0	0	5	0	2	15	2	32
3	0	27	3	4	16	1	34	26	4	0	24	16	22	23
4	2	0	47	6	0	3	31	0	17	0	26	17	39	18
5	36	16	31	23	27	26	10	13	7	25	29	20	21	4
6	33	0	2	22	0	23	11	0	7	0	9	4	9	1
7	30	9	14	27	16	39	1	6	5	48	5	8	2	0
8	0	0	0	14	0	8	8	0	0	0	0	6	3	0
9	0	48	3	5	1	0	5	0	1	28	3	2	0	0
Total	101	100	101	101	100	100	100	101	99	101	100	93	98	83
LSI	5.9	6.6	4.9	6.2	3.4	6.2	4.6	2.1	2.7	7.1	4.4	4.3	4.3	2.8
Screening Method	N	N	A	N/A	N/A	A	N	N	N/A	A	N	N	N	-

(N-Natural; A-Artificial)

Table 7: Promising entries with low susceptibility index and high PI in NSN-H to leaf blast, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)										SI	Total	<=3*	PI (<-3)**	<=5*	PI (<-5)**
		ALM	GDL	IIRR	IMP	KJT	LVN	NRRI	PNP	UMM	USH						
Tetep	Tetep	5	3	1	3	7	3	5	1	-	4	3.6	9	5	56	8	89
2912	27487	5	5	4	5	5	3	7	3	2	3	4.2	10	4	40	9	90
2714	27472	5	3	4	5	6	3	5	3	-	5	4.3	9	3	33	8	89
2910	VL Dhan 65	5	3	4	7	5	3	7	5	2	3	4.4	10	4	40	8	80
2707	27466	5	3	5	8	7	3	5	4	1	3	4.4	10	4	40	8	80
2906	Vivekdhan 62 (NC)	7	3	4	5	5	4	7	4	3	2	4.4	10	3	30	8	80
2703	27463	6	3	4	7	6	4	7	3	3	3	4.6	10	4	40	6	60
2602	25826	4	7	4	5	7	3	7	3	2	4	4.6	10	3	30	7	70
2708	27467	5	3	4	5	4	3	7	5	5	5	4.6	10	2	20	9	90
2716	27474	5	3	4	5	7	3	7	4	-	4	4.7	9	2	22	7	78
2905	27482	7	3	4	7	6	4	7	5	2	2	4.7	10	3	30	6	60
2913	27488	6	3	5	7	7	3	7	4	1	4	4.7	10	3	30	6	60
HR-12	HR-12 (S)	7	9	9	8	8	8	7	9	6	6	7.7	10	0	0	0	0
LSI		5.9	6.6	4.9	6.2	6.2	4.6	7.1	4.4	4.3	4.3						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 8: Location severity index (LSI) and frequency distribution of leaf blast scores of NHSN, Kharif 2018

Location/Frequency of score (0-9)																						
Score	ALM	BAN	CBT	GNV	IIRR	IMP	JDP	JGT	KHD	KJT	LNV	MGD	MLN	MND	NLR	NRRI	NWG	PNP	PTB	REW	UMM	USH
0	0	0	0	0	0	0	0	0	0	0	0	41	0	0	0	0	7	0	0	0	1	0
1	1	1	0	0	1	0	1	1	67	0	0	34	50	11	0	0	40	1	0	6	15	0
2	0	0	0	11	4	0	0	12	0	0	0	0	9	0	0	0	45	3	27	30	11	2
3	22	75	25	11	17	20	1	40	21	53	17	22	5	12	7	0	10	20	40	31	17	20
4	0	0	0	19	51	8	27	30	0	17	53	0	7	14	25	0	1	38	33	21	4	28
5	82	26	17	10	18	52	37	8	11	28	15	8	15	18	47	26	2	38	5	17	3	9
6	0	0	0	10	1	19	17	11	0	2	7	0	12	9	18	0	0	2	0	2	3	6
7	2	6	8	11	12	8	14	5	9	7	3	1	4	23	4	56	0	2	0	1	8	2
8	0	0	0	13	0	1	9	1	0	1	6	0	2	1	4	0	0	0	0	0	15	2
9	0	0	44	21	4	0	1	0	0	0	5	2	0	18	2	26	0	1	0	0	9	0
Total	107	108	94	106	108	108	107	108	108	108	106	108	104	106	107	108	105	105	105	108	86	69
LSI	4.6	3.7	6.5	5.8	4.4	4.9	5.4	3.8	2.3	4.0	4.7	1.5	2.9	5.5	5.1	7.0	1.7	4.2	3.2	3.2	4.6	4.2
Screening method	N	N	A	A	A	A	N	A	A	A	N	A	A	A	N	A	N	N	N	-	N	N

(N-Natural; A-Artificial)

Table 9: Promising entries with low susceptibility index (≤ 4) and high PI in NHSN to leaf blast, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)														SI	Total	<=3*	PI(<-3)**	<=5*	PI (<-5)**
		ALM	CBT	GNV	IIRR	IMP	JDP	KJT	LVN	MND	NLR	NRRI	PNP	UMM	USH						
Tetep		3	3	2	1	3	1	7	3	3	3	5	1	3	-	2.9	13	11	85	12	92
3222	27364	5	3	2	2	3	5	3	4	3	4	5	4	0	4	3.4	14	7	50	14	100
3219	27361	5	3	3	3	5	5	3	4	1	4	7	3	1	-	3.6	13	7	54	12	92
3221	27363	5	5	3	2	5	4	3	4	1	5	5	5	1	-	3.7	13	5	38	13	100
3201	27346	3	5	2	3	5	4	4	4	1	5	7	4	3	2	3.7	14	6	43	13	93
3110	27335	5	3	3	5	5	5	3	4	3	3	5	4	1	-	3.8	13	6	46	13	100
3203	US-312	3	3	3	3	5	5	4	4	1	4	5	4	8	2	3.9	14	6	43	13	93
3101	27328	5	5	2	4	5	5	5	3	3	4	5	3	1	4	3.9	14	5	36	14	100
3210	27353	5	3	3	5	5	4	3	4	1	4	7	4	2	4	3.9	14	5	36	13	93
3233	Gontra Bidhan-3	3	5	2	3	5	4	3	4	1	5	7	4	4	4	3.9	14	5	36	13	93
3302	27377	5	-	4	5	3	4	3	3	5	4	7	-	1	3	3.9	12	5	42	11	92
3111	27336	1	3	3	5	6	4	4	4	4	3	7	5	2	-	3.9	13	5	38	11	85
3304	27379	3	-	4	4	3	5	3	3	3	4	9	3	-	4	4.0	12	6	50	11	92
HR-12	HR-12 (S)	5	-	9	9	7	8	7	9	9	8	7	9	7	-	7.8	12	0	0	1	8
	LSI	4.6	6.5	5.8	4.4	4.9	5.4	4.0	4.7	5.5	5.1	7.0	4.2	4.6	4.2						

(SI-Susceptibility Index; *No. of locations where the entry has scored ≤ 5 and ≤ 3 ; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 10: Location severity index (LSI) and frequency distribution of leaf blast scores of DSN, Kharif 2018

Location/Frequency of score (0-9)																									
Score	ALM	CBT	GER	GGT	GNV	HZB	IIRR	IMP	JDP	JGT	KJT	LVN	MGD	MLN	MNC	MND	NLR	NRRI	NWG	PNP	PTB	REW	RNR	UMM	USH
0	0	0	0	0	0	11	0	0	0	0	0	0	57	0	28	0	0	0	18	0	0	0	0	1	0
1	0	0	17	0	0	7	1	0	1	0	0	0	41	25	32	6	0	0	59	1	0	0	11	11	0
2	0	0	15	0	4	16	4	0	2	24	0	2	0	6	0	0	0	0	13	1	18	36	0	26	6
3	4	7	4	2	7	18	20	27	3	23	24	8	17	1	34	9	12	0	4	31	42	41	35	13	25
4	0	0	5	0	7	18	22	1	31	34	30	36	0	11	0	14	31	0	1	32	40	28	0	23	27
5	83	26	3	11 8	19	19	21	68	11	17	50	19	10	15	19	16	33	34	3	35	5	22	26	1	18
6	0	0	2	0	17	12	11	16	4	3	5	9	0	18	0	15	32	0	0	2	1	1	0	6	7
7	24	2	0	0	13	12	26	11	31	3	6	8	2	14	3	19	4	63	0	3	0	1	19	5	8
8	0	0	0	0	18	6	2	5	8	5	1	10	0	3	0	5	7	0	0	0	0	0	0	25	10
9	7	58	0	0	22	2	7	1	16	0	0	15	2	4	0	23	0	31	0	1	0	0	15	0	9
Total	118	93	46	120	107	121	114	129	107	109	116	107	129	97	116	107	119	128	98	106	106	129	106	111	110
LSI	5.6	7.4	2.3	5.0	6.4	4.0	5.2	5.0	6.0	3.8	4.5	5.5	1.3	4.4	2.2	6.0	5.1	7.0	1.2	4.2	3.3	3.3	4.8	4.2	4.9
Screening Method	N	A	A	-	A	N	A	A	N	A	A	N	N	A	A	A	N	A	N	N	N	-	A	N	N

(N-Natural; A-Artificial)

Table 11: Promising entries with low susceptibility index (≤ 4.3) and high PI in DSN to leaf blast, Kharif 2018

S.No.	Designations	Location/ Score (0-9)																		SI	Total	<=3*	PI (<3)**	<=5*	PI (<5)**
		ALM	CBT	GGT	GNV	HZB	IIRR	IMP	JDP	KJT	LVN	MLN	MND	NLR	NRRI	PNP	RNR	UMM	USH						
118	Tetep	3	5	5	3	0	1	3	2	7	2	1	3	3	5	1	3	4	4	3.1	18	12	67	17	94
79	RP-Patho-7-5-9	5	-	5	3	0	2	5	4	4	4	1	1	5	7	3	3	4	4	3.5	17	7	41	16	94
119	Phougak-D82	5	5	5	2	1	4	3	4	5	4	1	3	5	9	3	1	3	4	3.7	18	8	44	17	94
23	CB 12 132	7	3	3	5	4	6	5	4	4	4	1	6	3	-	3	1	2	3	3.8	17	8	47	14	82
84	RP-Patho-12-1-16	5	5	5	2	1	3	5	4	3	5	1	1	5	5	4	7	4	3	3.8	18	7	39	17	94
101	RNR 23605	3	-	5	6	2	5	6	4	5	3	1	7	4	5	3	-	1	2	3.9	16	7	44	13	81
100	RNR 17941	5	-	5	6	3	5	5	4	3	5	1	5	3	5	5	1	2	3	3.9	17	7	41	16	94
83	RP-Patho-11-18-1	5	9	5	2	2	3	3	4	5	4	1	1	6	5	4	5	4	4	4.0	18	6	33	16	89
86	RP-Bio-Patho-2-9-2	5	9	5	5	0	3	3	4	5	4	3	4	6	5	4	1	4	3	4.1	18	6	33	16	89
81	RP-Patho-9-1-9	5	9	5	4	0	3	5	4	3	5	1	3	7	5	4	3	5	3	4.1	18	7	39	16	89
78	RP-Patho-6-1-13	5	9	5	5	0	3	5	4	4	4	1	4	5	7	4	3	4	4	4.2	18	4	22	16	89
126	MSM-ISM-3-3	5	5	5	4	2	5	5	5	4	6	6	3	3	7	4	3	2	3	4.3	18	6	33	15	83
85	RP-Bio-Patho-1-8-6	5	9	5	5	1	3	5	4	3	4	1	3	6	5	5	5	4	4	4.3	18	5	28	16	89
102	RNR- 25993	5	3	5	5	0	4	5	7	5	5	2	4	4	7	4	5	2	5	4.3	18	4	22	16	89
74	RP-Patho-2-1-28	5	9	5	5	0	3	5	4	4	4	1	4	6	7	3	7	3	3	4.3	18	6	33	14	78
6	RDN-RIL-77	3	-	5	-	-	-	3	-	-	-	-	-	4	9	-	-	2	-	4.3	6	3	50	5	83
105	HR-12 (S)	7	5	5	9	8	9	9	9	7	9	7	-	8	7	7	7	8	6	7.5	17	0	0	2	12
	LSI	5.6	7.4	5.0	6.4	4.0	5.2	5.0	6.0	4.5	5.5	4.4	6.0	5.1	7.0	4.2	4.8	4.2	4.9						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

❖ NECK BLAST

➤ NSN-1

The National Screening Nursery-1 (NSN-1) for neck blast disease was evaluated at 8 locations across India with 398 entries during *Kharif* 2018. The entries were screened under natural conditions in all the centres except at Mandya and Rajendranagar, where artificial method of screening was followed with spray of spore suspension. The frequency distribution of disease scores and location severity indices are presented in Table 12. The disease pressure was high (LSI 6-7) at Mandya (6.9) and Ponnampet (6.7); while it was moderate (LSI 4-6) at Rajendranagar (5.2) and Jagtial (4.2). The centres viz., Bankura (2.0), Mugad (2.4), Jagdalpur (2.7) and Nellore (3.1) recorded a low disease pressure (0-4) and hence these centers were not considered for selection of best entries.

The data presented in the Table 12 depicts the frequency distribution of disease scores along with location severity indices. The selection of promising entries was done based on the data of those locations where LSI was more than 4; accordingly, Jagtial, Mandya, Ponnampet and Rajendranagar were considered for selection of best entries. Some of the highly promising entries which performed better across all locations include IET # 26750, 28014, 28015, 25804, 25219, 24950, 27286, 28015 and 28020 (Table 13).

➤ NSN-2

A total of 682 entries were evaluated under NSN-2 at five different locations during *kharif* 2018. The screening was done under natural infection condition at Jagdalpur, Mugad and Ponnampet; while at Mandya and Titabar artificial method of screening was followed. The location severity index and frequency distribution of scores presented in the Table 14 indicated that, the disease pressure was high (LSI 6-7) at Mandya (7.0) and Ponnampet (6.5); while it was moderate at Titabar (4.6). The centres viz., Jagdalpur (2.7) and Mugad (2.3) showed lower disease pressure (LSI <4); and hence these centres were not considered for selection of best entries. The entries that had shown low disease scores across the locations were listed in Table 15. The entries such as IET# 27642, 27635 and 27410 performed better (SI=3.0) across locations. Other promising entries include IET# 27746, 26834, 27781, 27668, 27814 and 27754.

➤ NSN-H

A total of 101 entries were evaluated under NSN-hills nursery at eight different locations across India under hill ecosystem. The entries were screened under natural infection condition in most of the locations except at Imphal, Khudwani and Malan. The location severity index and frequency distribution of scores were presented in the Table 16. The disease pressure was high at Ponnampet (LSI 6.7); while it was moderate (LSI 4-6) at Lonavala (5.8), Umiam (4.8), Imphal (4.5) and Almora (4.0). The disease pressure was low at Malan (3.1), Mugad (1.9) and Khudwani (0.8) and hence these centres were not considered for selection of promising entries.

Table 12: Location severity index (LSI) and frequency distribution of Neck blast scores of NSN-1, Kharif 2018

Score	Location/Frequency of score (0-9)							
	BAN	JDP	JGT	MND	MGD	NLR	PNP	RNR
0	39	92	0	0	102	1	0	40
1	192	90	0	0	100	106	0	5
2	0	1	31	0	0	0	0	0
3	123	88	84	36	101	172	11	14
4	1	1	186	0	0	0	0	0
5	41	88	15	69	56	109	91	166
6	0	0	66	0	0	0	0	0
7	2	34	0	162	30	7	224	163
8	0	0	15	0	0	0	0	0
9	0	3	0	130	9	1	63	2
Total	398	397	397	397	398	396	389	390
LSI	2.0	2.7	4.2	6.9	2.4	3.1	6.7	5.2
Screening Method	N	N	N	N/A	N	N	N	N/A

(N-Natural; A-Artificial)

Table 13: Promising entries with low susceptibility index and high PI in NSN 1 to Neck blast, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)				SI	Total	<=3*	PI(<=3)**	<=5*	PI (<=5)**
		JGT	MND	PNP	RNR						
4464	26750(R)	3	5	-	0	2.7	3	2	67	3	100
4423	28014	3	3	5	0	2.8	4	3	75	4	100
4424	28015	3	3	5	0	2.8	4	3	75	4	100
4004	25804	3	3	5	1	3.0	4	3	75	4	100
301	25219	4	3	5	0	3.0	4	2	50	4	100
4462	Gayatri (RP)	4	7	3	0	3.5	4	2	50	3	75
1012	24950	4	5	5	0	3.5	4	1	25	4	100
5010	27286	4	5	5	0	3.5	4	1	25	4	100
5021	28015	4	5	5	0	3.5	4	1	25	4	100
4446	28020	4	5	5	0	3.5	4	1	25	4	100
IR-50	IR-50	2	-	-	5	3.5	2	1	50	2	100
Tetep	Tetep (R)	4	3	3	5	3.8	4	2	50	4	100
HR-12	HR-12 (S)	2	9	9	7	6.8	4	1	25	1	25
	LSI	4.2	6.9	6.7	5.2						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 14: Location severity index (LSI) and frequency distribution of Neck blast scores of NSN-2, Kharif 2018

Score	Location/Frequency of score (0-9)				
	JDP	MND	MGD	PNP	TTB
0	144	0	168	0	0
1	115	0	178	3	0
2	0	0	0	0	0
3	227	28	193	9	232
4	0	0	0	0	0
5	133	143	95	222	244
6	1	0	0	0	0
7	52	290	36	344	97
8	0	0	0	0	0
9	1	209	12	90	13
Total	673	670	682	668	586
LSI	2.7	7.0	2.3	6.5	4.6
Screening Method	N	N/A	N	N	A

(N-Natural; A-Artificial)

Table 15: Promising entries with low susceptibility index and high PI in NSN-2 to Neck blast, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)			SI	Total	<=3*	PI (<=3)**	<=5*	PI (<=5)**
		MND	PNP	TTB						
Tetep	Tetep	3	3	3	3.0	3	3	100	3	100
1747	27642	5	1	3	3.0	3	2	67	3	100
1739	27635	5	1	-	3.0	2	1	50	2	100
4205	27410	-	-	3	3.0	1	1	100	1	100
1211	27746	3	5	3	3.7	3	2	67	3	100
1243	26834	3	5	3	3.7	3	2	67	3	100
1254	27781	3	5	3	3.7	3	2	67	3	100
1511	27668	3	5	3	3.7	3	2	67	3	100
2112	27814	3	5	3	3.7	3	2	67	3	100
1219	27754	3	5	-	4.0	2	1	50	2	100
HR-12	HR-12 (S)	9	9	3	7.0	3	1	33	1	33
	LSI	7.0	6.5	4.6						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 16: Location severity index (LSI) and frequency distribution of Neck blast scores of NSN-H, Kharif 2018

Score	Location/Frequency of score(0-9)							
	ALM	IMP	KHD	LNV	MGD	MLN	PNP	UMM
0	0	0	57	1	15	0	0	0
1	17	3	0	4	46	34	0	0
2	0	0	0	0	0	0	0	0
3	37	36	6	4	31	10	6	21
4	0	0	0	0	0	0	0	0
5	26	48	7	49	7	12	25	60
6	0	0	0	0	0	0	0	0
7	21	13	0	30	2	6	52	12
8	0	0	0	0	0	0	0	0
9	0	1	0	11	0	4	16	0
Total	101	101	70	99	101	66	99	93
LSI	4.0	4.5	0.8	5.8	1.9	3.1	6.6	4.8
Screening Method	N	N/A	N/A	N	N	N/A	N	N

(N-Natural; A-Artificial)

The entries with IET No. 27496, 25826, 26576, 26564, 27461, 27483, 27480, 26594, 26588 and 27498 were found to be promising against neck blast disease with low diseases score across the locations (Table 17).

Table 17: Promising entries with low susceptibility index and high PI in NSN-H to Neck blast, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)						Total	<=3*	PI(<=3)**	<=5*	PI(<=5)**
		ALM	IMP	LNV	PNP	UMM	SI					
Tetep	Tetep	3	3	1	3	-	2.5	4	4	100	4	100
2921	27496	1	3	3	5	3	3.0	5	4	80	5	100
2602	25826	3	1	5	3	5	3.4	5	3	60	5	100
2612	26576	1	3	5	3	5	3.4	5	3	60	5	100
2613	26564	1	5	1	5	5	3.4	5	2	40	5	100
2701	27461	1	5	0	7	5	3.6	5	2	40	4	80
2907	27483	3	3	7	3	3	3.8	5	4	80	4	80
2903	27480	3	3	5	3	5	3.8	5	3	60	5	100
2813	26594	3	3	5	5	3	3.8	5	3	60	5	100
2814	26588	3	3	3	5	5	3.8	5	3	60	5	100
3008	27498	1	3	5	5	5	3.8	5	2	40	5	100
HR-12 (S)		7	7	9	9	5	7.4	5	0	0	1	20
LSI		4.0	4.5	5.8	6.6	4.8						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no.of locations where the entry had scored ≤ 3 and ≤ 5)

➤ **NHSN**

National Hybrid Screening Nursery (NHSN) was screened for neck blast reaction at nine locations with 108 entries. The entries were screened under natural infection conditions in all the locations except at Imphal, Mandya and Malan; where artificial method of screening was followed. The disease pressure was high at Mandya (LSI 6.0); it was moderate (LSI 4-6) Almora (4.8) and Lonavala (4.6). The centres (Bankura, Imphal, Jagdalpur, Jagtial, Mugad and Malan) where the disease pressure was low (LSI<4) were not considered for selection of best entries (Table 18).

Table 18: Location severity index (LSI) and frequency distribution of Neck blast scores of NHSN, Kharif 2018

Score	Location/Frequency of score(0-9)								
	ALM	BAN	IMP	JDP	JGT	LNV	MND	MGD	MLN
0	0	10	0	0	0	8	0	15	0
1	1	69	36	14	0	13	0	48	10
2	0	0	0	0	19	0	0	0	0
3	4	22	54	52	35	14	19	32	7
4	0	0	0	0	31	0	0	0	0
5	8	6	18	30	5	41	30	9	4
6	0	0	0	0	14	0	0	0	0
7	4	1	0	11	1	20	40	3	4
8	0	0	0	0	3	0	0	0	0
9	0	0	0	0	0	10	17	1	1
Total	17	108	108	107	108	106	106	108	26
LSI	4.8	1.6	2.7	3.7	3.8	4.6	6.0	2.0	3.4
Screening Method	N	N	N/A	N	N	N	N/A	N	N/A

(N-Natural; A-Artificial)

The entries which showed low disease score were considered as highly promising against neck blast and were listed in Table 19. The entries viz., IET# 27400, 27371, 27389, 27334, 27357, 27403, 27329, 27346, 27363, 27370, 27378, 27388, 27397 and 27352 were found to be promising against neck blast disease with low diseases score across the locations.

Table 19: Promising entries with low susceptibility index and high PI in NHSN to Neck blast, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)			SI	Total	<=3*	PI (<=3)**	<=5*	PI (<=5)**
		ALM	LNV	MND						
3410	27400	-	0	3	1.5	2	2	100	2	100
3229	27371	-	1	3	2.0	2	2	100	2	100
3317	27389	-	1	3	2.0	2	2	100	2	100

Ent. No.	IET No.	Location/ Score (0-9)			SI	Total	<=3*	PI (<=3)**	<=5*	PI (<=5)**
		ALM	LNV	MND						
3109	27334	-	1	3	2.0	2	2	100	2	100
Tetep	Tetep	3	1	3	2.3	3	3	100	3	100
3214	27357	-	0	5	2.5	2	1	50	2	100
3414	27403	-	0	5	2.5	2	1	50	2	100
3103	27329	-	0	5	2.5	2	1	50	2	100
3201	27346	1	5	3	3.0	3	2	67	3	100
3221	27363	-	3	3	3.0	2	2	100	2	100
3228	27370	-	1	5	3.0	2	1	50	2	100
3303	27378	-	1	5	3.0	2	1	50	2	100
3315	27388	-	1	5	3.0	2	1	50	2	100
3405	27397	-	0	7	3.5	2	1	50	1	50
Swarnadhan	Swarnadhan	3	1	7	3.7	3	2	67	2	67
3208	27352	5	1	5	3.7	3	1	33	3	100
HR-12 (S)		-	9	9	9.0	2	0	0	0	0
LSI		4.8	4.6	6.0						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ DSN

A total of 129 entries were evaluated under Donor screening nursery at nine locations during *Kharif*, 2018. The location severity index and frequency distribution of scores were presented in the Table 20. The disease pressure was very high at Rajendranagar (LSI 7.0); while it was high at Mandya (6.3). The moderate disease pressure (LSI 4-6) was observed at Jagtial (4.1) and Imphal (4.1) while it was low at (<4) Jagdalpur (3.6) and Lonavala (3.4) and hence data from these centres were not considered for selection of best entries under DSN. The number of entries was very low at Malan (4) and Umiam (1); hence these location data was also not considered for selection of best entries.

The promising entries with low disease pressure across the locations were presented in Table 21. The highly promising entries which scored <3.3 (R Check Tetep-3.3) included RDN-RIL-1, RDN-RIL-31, RDN-RIL-146, RDN-RIL-161, RDN-RIL-164, RDN-RIL-189 and RDN-RIL-193. Other promising entries included RNR 11450, MTU1010, NWGR-14035, IBT-R5, NWGR-11048, NWGR-12016, CB 14161, TPL-60-3, RP-Patho-2-1-28, RP-Patho-3-73-8, RP-Patho-6-1-13, RP-Patho-10-6-1 and RP-Bio-Patho-2-9-2.

Table 20: Location severity index (LSI) and frequency distribution of Neck blast scores of DSN, Kharif 2018

Score	Location/Frequency of score(0-9)								
	IMP	JDP	JGT	LNV	MND	MGD	MLN	RNR	UMM
0	0	10	0	30	0	33	0	0	1
1	2	14	0	5	2	56	2	3	0
2	0	1	7	0	0	0	0	0	0
3	61	34	25	15	2	25	0	1	0
4	0	0	38	1	0	0	0	0	0
5	61	32	29	12	4	13	2	14	0
6	0	0	10	0	0	0	0	0	0
7	5	16	0	11	11	2	0	60	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	11	5	0	0	26	0
Total	129	107	109	85	24	129	4	104	1
LSI	4.1	3.6	4.1	3.4	6.3	1.6	3.0	7.0	0.0
Screening Method	N/A	N	N	N	N/A	N	N/A	N/A	N

(N-Natural; A-Artificial)

Table 21: Promising entries with low susceptibility index and high PI in DSN to Neck blast, Kharif 2018

S.No.	Designations	Location/Score (0-9)					Total	<=3*	PI (<=3)**	<=5*	PI(<=5)**
		IMP	JGT	MND	RNR	SI					
1	RDN-RIL-1	3	-	-	-	3.0	1	1	100	1	100
3	RDN-RIL-31	3	-	-	-	3.0	1	1	100	1	100
9	RDN-RIL-146	3	-	-	-	3.0	1	1	100	1	100
12	RDN-RIL-161	3	-	-	-	3.0	1	1	100	1	100
13	RDN-RIL-164	3	-	-	-	3.0	1	1	100	1	100
17	RDN-RIL-189	3	-	-	-	3.0	1	1	100	1	100
19	RDN-RIL-193	3	-	-	-	3.0	1	1	100	1	100
118	Tetep	1	2	3	7	3.3	4	3	75	3	75
99	RNR 11450	5	4	-	1	3.3	3	1	33	3	100
63	MTU1010	3	3	-	5	3.7	3	2	67	3	100
71	NWGR-14035	3	3	-	5	3.7	3	2	67	3	100
60	IBT-R5	3	2	-	7	4.0	3	2	67	2	67
68	NWGR-11048	3	2	-	7	4.0	3	2	67	2	67
70	NWGR-12016	3	2	-	7	4.0	3	2	67	2	67
26	CB 14 161	3	4	-	5	4.0	3	1	33	3	100
46	TPL-60-3	3	4	-	5	4.0	3	1	33	3	100
74	RP-Patho-2-1-28	3	4	-	5	4.0	3	1	33	3	100

S.No.	Designations	Location/Score (0-9)					Total	<=3*	PI (<=3)**	<=5*	PI(<=5)**
		IMP	JGT	MND	RNR	SI					
75	RP-Patho-3-73-8	5	4	-	3	4.0	3	1	33	3	100
78	RP-Patho-6-1-13	3	4	-	5	4.0	3	1	33	3	100
82	RP-Patho-10-6-1	3	4	-	5	4.0	3	1	33	3	100
86	RP-Bio-Patho-2-9-2	3	4	-	5	4.0	3	1	33	3	100
105	HR-12 (S)	7	6	-	9	7.3	3	0	-	0	0
	LSI	4.1	4.1	6.3	7.0						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

❖ SHEATH BLIGHT

➤ NSN-1

The National Screening Nursery-1 (NSN-1) was evaluated for resistance to sheath blight at 19 locations across India. The entries were screened by artificial inoculation at most of the centres except Patna where the entries were evaluated under natural condition and disease pressure was 4.1. The highest disease pressure was recorded at Gangavati (8.8) and lowest at Moncompu (3.7) through artificial inoculation. The frequency distribution of disease scores and location severity indices (LSI) were presented in Table 22. The disease pressure was very high ($LSI > 7$) at Gangavathi (8.8), Aduthurai (8.1), Cuttack (7.7), Maruteru (7.4), Mandya (7.1) and Ludhiana (7.1) high ($LSI 6 - 7$) at Raipur (6.9), Kaul (6.7), Pattambi (6.7), IIRR (6.3), Varanasi (6.2) and Faizabad (6.1); moderate ($LSI 3-6$) at Chiplima (5.4), Pant Nagar (5.3), Chinsurah (4.8), Titabar (4.7), Bankura (4.6), Patna (4.1) and Moncompu (3.7). The selection of best entries in NSN-1 was done based on the reaction at those locations where LSI was ≥ 4 . Some of the promising entries with $SI \leq 5.3$ are presented in the Table 23. None of the entries were found resistant ($SI \leq 3.0$) against sheath blight. Promising entry was IET No. 27040 identified better than tolerant check (Tetep). Some of the other promising entries were selected based on low susceptibility index are IET Nos. 26178, 25618, 27193, 27059, 28029, 25804, 26751 and 26956.

Table 22: Location severity index and frequency distribution of sheath blight disease score for NSN-1 entries, Kharif-2018

Score	Location/Frequency of score (0-9)																		
	ADT	BAN	CHN	CHP	NRRI	FZB	GNV	IIRR	KUL	LUD	MND	MNC	MTU	PNT	PTB	PTN	RPR	TTB	VRN
0	14	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0	2	2	0
1	3	47	13	5	0	0	0	0	1	0	0	58	0	1	0	0	1	1	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
3	19	110	117	61	15	4	0	0	19	0	0	99	0	31	17	42	1	105	19
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	28	141	176	192	22	156	2	143	71	0	84	138	20	273	120	55	86	238	170
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	8	83	78	112	160	208	12	212	245	385	211	53	276	76	153	0	228	45	157
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	321	17	11	21	191	30	138	42	53	12	102	0	91	12	98	0	78	2	50
Total	393	398	395	391	388	398	152	397	389	397	397	386	387	393	388	97	397	393	396
LSI	8.0	4.6	4.8	5.4	7.7	6.3	8.8	6.5	6.7	7.1	7.1	3.7	7.4	5.3	6.7	4.1	6.9	4.7	6.2
Screening Method	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	N	A	A	-

(N- Natural; A- Artificial)

Table 23: Promising entries with low susceptibility index (SI≤5.3) and high promising index in NSN1 to sheath blight, Kharif-2018

E.No.	IET No.	Location/ Score (0-9)																		SI	Total	≤3	PI (≤3)*	≤5	PI(≤5)**
		ADT	BAN	CHN	CHP	NRRI	FZB	GNV	IIRR	KUL	LUD	MND	MTU	PNT	PTB	PTN	RPR	TTB	VRN						
262	Tetep	0	3	3	7	5	5	-	5	5	7	5	7	5	3	-	5	3	7	4.7	16	5	31	12	75
239	27040	7	1	3	1	7	5	-	5	7	7	7	5	7	3	-	5	3	5	4.9	16	5	31	10	63
323	26752(R)	3	1	3	5	9	5	-	5	5	7	7	5	7	3	5	5	3	7	5.0	17	5	29	12	71
2	26178	9	5	3	1	7	5	9	5	5	7	7	7	3	5	-	1	5	3	5.1	17	5	29	11	65
3	25618 (R)	5	3	7	1	5	5	9	5	7	7	7	7	3	5	-	3	5	3	5.1	17	5	29	11	65
47	27193	5	1	3	3	7	5	9	5	7	7	5	7	1	3	-	5	5	9	5.1	17	5	29	11	65
324	Varshadhan (RP)	3	1	3	5	7	7	-	5	7	7	7	7	7	3	5	5	3	5	5.1	17	5	29	10	59
356	Tetep	0	3	3	5	9	5	-	5	5	7	7	7	5	5	5	5	3	9	5.2	17	4	24	12	71
240	27059	0	5	3	3	9	7	-	5	7	7	7	7	5	5	-	5	5	3	5.2	16	4	25	10	63
381	28029	9	5	5	5	NG	5	-	5	1	7	7	7	3	5	5	5	5	5	5.3	16	2	13	12	75
71	25804	9	3	3	3	9	5	9	5	5	7	5	7	5	5	-	5	0	5	5.3	17	4	24	12	71
322	26751(R)	0	3	3	7	7	5	-	5	7	7	7	7	9	3	5	5	5	5	5.3	17	4	24	10	59
207	26956	0	3	3	5	9	5	-	7	7	7	7	7	5	5	-	5	5	5	5.3	16	3	19	10	63
261	Swarnadhan	3	7	3	5	7	5	-	5	7	7	9	5	5	5	-	7	5	5	5.6	16	2	13	10	63
251	TN1 (S)	9	1	3	5	7	7	-	9	7	9	7	7	5	9	-	9	7	7	6.8	16	2	13	4	25
LSI		8.0	4.6	4.8	5.4	7.7	6.3	8.8	6.5	6.7	7.1	7.1	7.4	5.3	6.7	4.1	6.9	4.7	6.2						

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3* and ≤5**)

➤ NSN-2

The National Screening Nursery-2 (NSN-2) was evaluated for their resistance to sheath blight at 14 locations. The entries were screened by artificial inoculation at most of the centres except Patna where the entries were evaluated under natural condition and observed moderate level of (LSI <2.0) disease severity. The frequency distribution of disease scores and location severity index (LSI) are presented in Table 24. The disease pressure was very high (LSI >7) at Gangavati (8.6), Mandya (8.4), Cuttack (7.8), Aduthurai (7.7), Ludhiana (7.1), and Maruteru (7.1); high (LSI 6 - 7) at IIRR (6.7), Raipur (6.6), Faizabad (6.6) Pantnagar (6.0) and Pattambi (6.2); moderate (LSI 3-6) at Varanasi (5.3), Patna (3.1) and Moncompu (5.2). The selection of promising entries was done based on the reaction at those locations where LSI was ≥ 4.0 . Some of the entries with SI ≤ 5.5 are presented in the Table 25. None of the entries were resistant (SI ≤ 3.0) against sheath blight based on susceptibility index. Two promising entries (IET Nos. 27926, and 27570) were found on par with tolerant check (Tetep). Besides, some of the other promising entries were IET Nos. 27606, 27571, 27579, 27572, 27610, 27776, 27668, 27858, 27851, 27910 and 28079.

➤ NSN-H

The National Screening Nursery - Hills (NSN-H) was evaluated for their resistance to sheath blight at Chakdaha, Cuttack, IIRR and Pantnagar. These entries were screened under artificial inoculation in all the locations except Chakdaha. The frequency distribution of disease scores and location severity indices are presented in Table 26. The disease pressure was high (LSI 6-7) at Cuttack (7.7), Chakdaha (7.5), IIRR (7.3) and moderate at (LSI 3-6) Pantnagar (5.4). The selection of best entries was done based on the reaction at these four locations. None of the entries were resistant (SI ≤ 3.0) against sheath blight. Some of the promising entries were found better than tolerant check (Tetep) viz., IET Nos. 26591, 27487, 26461, 27473, 27481, 27482 and 26578 from NSN-H, 2018 screening (Table 27).

➤ NHSN

The National Hybrid Screening Nursery (NHSN) was evaluated for their resistance to sheath blight at 18 varied hot spot locations. The entries were screened by artificial inoculation at most of the centres except Patna where the entries were evaluated under natural incidence with high disease pressure (LSI 5.2). The frequency distribution of disease score and location severity index (LSI) are presented in the Table 28. The disease pressure was very high (LSI >7) at Gangavathi (8.9), Kaul (8.8), Aduthurai (8.6), Mandya (8.2), Ludhiana (7.9), Maruteru (7.7), Chakdaha (7.1) and IIRR (7.0); high (LSI 6-7) at Raipur (6.6), and moderate (LSI 3-6) at Faizabad (5.8), Pattambi (5.7), Chinsurah (5.4), Pantnagar (5.3), Varanasi (5.2), Bankura (4.6), Titabar (4.4), and and low (LSI <3) at Moncompu (2.7) and Patna (2.6). Therefore, the data from those centers having LSI ≤ 4.0 was not considered for selecting the promising entries. None of the entries were showed resistant against sheath blight based on the 0-9 disease screening scale (Table 29). Some of the selected promising entries (IET 27376, 27383, 27358, 27391, 27357, 27349, 27378, 27388, 27375, 27350, 27356, 27393 and 27371) showed less disease severity index when compare to tolerant check (Swarnathan).

Table 24: Location severity index and frequency distribution of sheath blight disease score for NSN-2 entries, Kharif-2018

Score	Location/Frequency of score (0-9)													
	ADT	NRRI	FZB	GNV	IIRR	LUD	MND	MNC	MTU	PNT	PTB	PTN	RPR	VRN
0	41	0	0	0	0	0	0	164	0	0	0	0	0	0
1	2	0	0	0	0	0	0	79	0	4	0	42	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	26	20	7	1	0	1	1	161	4	16	29	294	19	112
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	58	32	284	8	176	8	4	154	58	300	306	274	219	375
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	33	267	323	114	384	629	196	108	501	227	224	70	330	150
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	507	350	67	549	120	35	472	1	97	124	98	0	111	33
Total	667	669	681	672	680	673	673	667	660	671	657	680	679	670
LSI	7.7	7.8	6.3	8.6	6.8	7.1	8.4	3.1	7.1	6.3	6.2	4.1	6.6	5.3
Screening Method	A	A	A	A	A	A	A	A	A	A	A	N	A	A

(N- Natural; A- Artificial)

Table 25: Promising entries with low susceptibility index (SI≤5.5) and high promising index in NSN-2 to sheath blight, Kharif-2018

E.No.	IET No.	Location/ Score (0-9)													SI	Total	√3	PI (≤3)*	√5	PI(≤5)**
		ADT	NRRI	FZB	GNV	IIRR	LUD	MND	MTU	PNT	PTB	PTN	RPR	VRN						
514	Tetep	5	5	5	9	5	7	3	7	5	3	3	5	5	5.2	13	3	23.1	10	76.9
550	27926	3	7	5	9	7	-	9	3	5	5	3	3	3	5.2	12	5	41.7	8	66.7
1	27570	5	5	5	9	5	7	7	5	3	3	3	-	5	5.2	12	3	25.0	9	75.0
117	27606	3	9	5	9	5	7	9	5	5	3	1	5	3	5.3	13	4	30.8	9	69.2
2	27571	5	7	5	9	5	7	7	5	3	3	3	5	-	5.3	12	3	25.0	8	66.7
10	27579	0	3	5	7	7	7	9	5	7	5	3	5	7	5.4	13	3	23.1	7	53.8
3	27572	1	9	5	9	5	7	7	5	5	5	3	5	5	5.5	13	2	15.4	9	69.2
122	27610	0	3	5	9	7	7	9	5	5	7	5	3	7	5.5	13	3	23.1	7	53.8
281	27776	0	3	7	9	7	7	9	7	5	7	1	5	5	5.5	13	3	23.1	6	46.2
449	27668	0	3	7	9	5	7	7	7	7	5	5	7	3	5.5	13	3	23.1	6	46.2
369	27858	0	9	5	9	5	7	7	7	5	5	5	5	3	5.5	13	2	15.4	8	61.5
361	27851	0	7	5	9	5	7	7	7	7	5	5	5	3	5.5	13	2	15.4	7	53.8
425	27910	0	7	5	7	5	7	7	7	7	5	3	5	7	5.5	13	2	15.4	6	46.2
669	28079	-	7	5	9	5	7	7	-	7	3	3	3	5	5.5	11	3	27.3	6	54.5
513	Swarnadhan	9	7	5	9	5	7	9	7	5	5	3	5	5	6.2	13	1	7.7	7	53.8
503	T(N1) (S)	9	5	5	9	9	7	9	7	5	9	5	7	7	7.2	13	0	0	4	30.8
LSI		7.7	7.8	6.3	8.6	6.8	7.1	8.4	7.1	6.3	6.2	4.1	6.6	5.3						

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3* and ≤5**)

Table 26: Location severity index and frequency distribution of sheath blight disease score for NSN-H entries, Kharif-2018

Score	Location/Frequency of score (0-9)			
	CKD	NRRI	IIRR	PNT
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	5	0	9
4	0	0	0	0
5	11	9	19	74
6	0	0	0	0
7	55	31	48	14
8	0	0	0	0
9	35	54	34	3
Total	101	99	101	100
LSI	7.5	7.7	7.3	5.2
Screening Method	N	A	A	A

(N- Natural; A- Artificial)

Table 27: Promising entries with low susceptibility index (SI≤6.0) and high promising index in NSN-H to sheath blight, Kharif-2018

Ent. No.	IET No.	Location/ Score (0-9)				SI	Total	≤3	PI (≤3)*	≤5	PI (≤5)**
		CKD	NRRI	IIRR	PNT						
42	26591	7	3	7	3	5.0	4	2	50.0	2	50.0
10	VL Dhan 65	7	3	7	5	5.5	4	1	25.0	2	50.0
12	27487	7	7	5	3	5.5	4	1	25.0	2	50.0
53	27461	7	7	5	3	5.5	4	1	25.0	2	50.0
41	Vivekdhan 62 (NC)	5	7	5	5	5.5	4	0	0.0	3	75.0
65	27473	7	3	9	5	6.0	4	1	25.0	2	50.0
76	Sukaradhan 1 (NC)	7	9	5	3	6.0	4	1	25.0	2	50.0
97	RP-Bio-226	9	3	7	5	6.0	4	1	25.0	2	50.0
4	27481	7	7	7	3	6.0	4	1	25.0	1	25.0
5	27482	7	7	7	3	6.0	4	1	25.0	1	25.0
89	IR-64	7	3	7	7	6.0	4	1	25.0	1	25.0
49	26578	5	5	9	5	6.0	4	0	0.0	3	75.0
101	Tetep (T)	9	5	5	5	6.0	4	0	0.0	3	75.0
100	Swarnadhan T)	9	7	5	5	6.5	4	0	0.0	2	50.0
90	T(N1)(S)	9	7	9	5	7.5	4	0	0.0	1	25.0
LSI		7.5	7.7	7.3	5.2						

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3* and ≤5**)

Table 28: Location severity index and frequency distribution of sheath blight disease score for NHSN entries, Kharif-2018

Score	Location/Frequency of score (0-9)																	
	ADT	BAN	CKD	CHN	FZB	GNV	IIRR	KUL	LUD	MND	MNC	MTU	PNT	PTB	PTN	RPR	TTB	VRN
0	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0	0	1	0
1	0	14	0	0	0	0	0	0	0	0	6	0	0	0	24	0	0	5
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3	29	0	12	5	0	0	0	1	1	27	0	3	4	79	1	32	23
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	2	33	33	65	59	0	22	0	0	1	25	1	89	54	5	28	38	42
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	7	30	38	31	39	6	65	8	55	40	11	62	14	34	0	70	10	30
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	92	2	37	0	5	100	20	95	50	64	0	39	2	2	0	9	0	7
Total	104	108	108	108	108	106	107	103	106	106	107	102	108	94	108	108	81	107
LSI	8.6	4.6	7.1	5.4	5.8	8.9	7.0	8.8	7.9	8.2	2.7	7.7	5.3	5.7	2.6	6.6	4.4	5.2
Screening Method	A	N	N	N	N	N	A	A	A	A	A	A	A	A	N	A	A	A

(N- Natural; A- Artificial)

Table 29: Promising entries with low susceptibility index ($SI \leq 6.1$) and high promising index in NHSN to sheath blight, Kharif- 18

Ent. No.	IET No.	Location/ Score (0-9)																SI	Total	≤3	PI (≤3)*	≤5	PI (≤5)**
		ADT	BAN	CKD	CHN	FZB	GNV	IIRR	KUL	LUD	MND	MTU	PNT	PTB	RPR	TTB	VRN						
108	Tetep	5	3	9	3	5	9	5	9	7	3	7	5	-	5	-	5	5.7	14	3	21.4	9	64.3
35	27376	9	1	5	5	5	9	7	-	9	7	-	5	5	7	3	5	5.9	14	2	14.3	8	57.1
43	27383	7	3	5	5	7	9	5	9	7	7	7	5	5	7	3	3	5.9	16	3	18.8	8	50.0
16	27358	7	7	9	3	5	9	5	-	9	9	-	5	5	7	3	1	6.0	14	3	21.4	7	50.0
53	27391	9	3	5	5	5	9	5	9	3	7	7	5	5	7	5	7	6.0	16	2	12.5	9	56.3
14	27357	9	1	5	5	7	9	7	9	7	9	7	5	5	5	5	1	6.0	16	2	12.5	8	50.0
5	27349	9	3	5	3	5	9	7	9	9	9	7	7	5	5	3	3	6.1	16	4	25.0	8	50.0
37	27378	9	3	5	5	5	9	7	9	9	9	7	5	5	5	3	3	6.1	16	3	18.8	9	56.3
49	27388	9	1	7	5	5	9	7	9	7	9	7	5	5	7	3	3	6.1	16	3	18.8	7	43.8
34	27375	9	1	9	3	7	7	7	7	9	7	7	5	5	7	3	5	6.1	16	3	18.8	6	37.5
6	27350	9	5	5	5	5	9	5	9	9	7	7	5	5	7	3	3	6.1	16	2	12.5	9	56.3
13	27356	9	5	5	5	5	9	7	9	7	7	7	5	5	7	3	3	6.1	16	2	12.5	8	50.0
56	27393	9	3	5	3	7	9	7	9	7	7	7	5	5	5	5	5	6.1	16	2	12.5	8	50.0
63	NCH-2	9	3	7	5	5	9	5	7	7	7	9	5	5	7	3	5	6.1	16	2	12.5	8	50.0
29	27371	9	5	5	5	5	9	5	9	7	7	7	5	7	5	3	5	6.1	16	1	6.3	9	56.3
107	Swarnadhan	9	7	9	5	5	9	5	7	7	7	7	5	5	5	-	5	6.5	15	0	0.0	7	46.7
97	TN1(S)	9	1	9	7	7	9	9	9	9	9	9	5	7	9	-	7	7.7	15	1	6.7	2	13.3
LSI		8.6	4.6	7.1	5.4	5.8	8.9	7.0	8.8	7.9	8.2	7.7	5.3	5.7	6.6	4.4	5.2						

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤ 3 * and ≤ 5 **)

➤ **DSN**

The Donor Screening Nursery (DSN) was evaluated for resistance to sheath blight at 18 disease hot spot locations in India. The entries were screened by artificial inoculation at all the centres except Patna where the entries were evaluated under natural conditions and it was showed moderate disease pressure (4.5). The frequency distribution of disease scores and location severity index (LSI) were presented in Table 30. The disease pressure was very high (LSI >7) at Gangavati (8.8), Mandya (8.5), Aduthurai (8.3), Maruteru (8.1), Cuttack (8.0) and Chakdha (7.6); high (LSI 6-7) at Kaul (7.0), Pattambi (6.6), IIRR (6.5), Raipur (6.5); moderate (LSI 3-6) at Chiplima (5.9), Faizabad (5.8), Pant Nagar (5.3), Varanasi (4.7), Patna (4.5) and Titabar (4.1); and less (LSI <3) at and Moncompu (1.8) and Mugad (0.5). The selection of promising entries in DSN was done based on the reaction at those locations where LSI was ≥ 4.0 . None of the entries were showed resistant (≤ 3) against sheath blight. However, some of the promising entries were presented in the Table 31. Few promising entries viz., RDN-RIL-114, RDN-RIL-77, RDN-RIL-146, RDN-RIL-1, RDN 98-2-3-5-14, RDN-RIL-152, RDN-RIL-179 and RDN-RIL-188 performed better than tolerant check Tetep. Besides these, few entries namely RDN-RIL-31, MIL-S8-3, MIL-S3-1, S15-Wazuhophek, KMP-280, RDN-RIL147, RDN-RIL-189 and RDN-RIL-201 were showed lower susceptibility index than field tolerant check Swarnadhan. In this trial, RDN-RIL entries were reported that seed germination problem from most of the test locations.

❖ **BROWN SPOT**

➤ **NSN-1**

The National Screening Nursery (NSN-1) comprised of 398 entries evaluated at 18 locations across India under different-agro ecological Zones. The entries were screened under natural infection conditions at most of the centres except at Coimbatore, Chinsurah, Gerua, Gangavathi, Ludhiana, Cuttack and Pusa; where screening was conducted under artificial inoculation with spore suspension. The frequency distribution of disease scores and the representative location severity index (LSI) are presented in the Table 32. The disease pressure was highest at Gangavathi (8.1), while it was lowest at Mugad (2.6). It was very high (LSI >7) at Gudalur (7.5), Pusa (7.4), Coimbatore (7.2) and Cuttack (7.1). Moderate disease pressure (LSI 4-6) was observed at Chatha (5.7), Hazaribagh (5.3), Gagarghat (5.2), Gerua (4.8), Rewa (4.7), Jagdalpur (4.6) and Jagtihi (4.5). The selection of promising entries was done based on the data of those locations where LSI was more than 4. Accordingly data of Chinsurah, Mugad and Upper Shillong were not considered for selection of promising entries. None of the entry was shown resistance reaction; however; a few promising entries with low disease score across the centres included IET# 27289, 27291, 25901, 27094, 26716, 26790, 27288, 26816, 26721, 25055, 26804, 25903 and 27230 (Table 33).

Table 30: Location severity index and frequency distribution of sheath blight disease score for DSN entries, Kharif-2018

Score	Location/Frequency of score (0-9)																	
	ADT	CKD	CHP	NRRI	FZB	GNV	IIRR	KUL	MND	MNC	MGD	MTU	PNT	PTB	PTN	RPR	TTB	VRN
0	0	0	0	0	0	0	0	0	0	55	115	0	0	0	0	0	2	0
1	0	0	4	0	0	0	0	0	0	14	1	0	0	0	1	0	3	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	18	5	4	0	0	2	0	13	5	0	5	3	23	7	41	33
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	2	37	8	72	0	37	21	3	16	4	0	89	22	27	23	53	40
6	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
7	5	85	26	33	31	9	71	57	20	9	3	46	13	71	9	86	5	16
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	9	42	23	83	9	97	10	25	84	0	1	57	4	6	0	8	0	1
Total	14	129	108	129	116	106	119	105	107	107	129	103	111	102	60	124	104	90
LSI	8.3	7.6	5.9	8.0	5.8	8.8	6.5	7.0	8.5	1.8	0.5	8.1	5.3	6.6	4.5	6.5	4.1	4.7
Screening Method	A	N	A	A	A	A	A	A	A	A	N	A	A	A	N	A	A	A

(N- Natural; A- Artificial)

Table 31: Promising entries with low susceptibility index (SI≤6.0) and high promising index in DSN to sheath blight, Kharif-2018

S.No.	Designations	Location/ Score (0-9)															SI	Total	Σ	PI (≤3)*	Σ	PI (≤5)**
		CKD	CHP	NRRI	FZB (MSD)	GNV	IIRR	KUL	MND	MTU	PNT	PTB	PTN	RPR	TTB	VRN						
8	RDN-RIL-114	7	-	3	-	-	-	-	-	-	-	-	3	7	-	-	5.0	4	2	50	2	50
6	RDN-RIL-77	7	-	9	-	-	5	-	-	-	-	-	3	3	-	-	5.4	5	2	40	3	60
9	RDN-RIL-146	7	-	9	-	-	5	-	-	-	-	-	3	3	-	-	5.4	5	2	40	3	60
1	RDN-RIL-1	7	-	9	-	-	-	-	-	-	-	-	3	3	-	-	5.5	4	2	50	2	50
22	RDN 98-2-3-5-14	7	5	9	5	-	-	-	-	-	5	-	3	-	-	5	5.6	7	1	14	5	71
11	RDN-RIL-152	9	-	7	5	-	5	-	-	-	-	-	5	3	-	-	5.7	6	1	17	4	67
15	RDN-RIL-179	5	-	9	5	-	5	-	-	-	-	-	3	7	-	-	5.7	6	1	17	4	67
16	RDN-RIL-188	7	-	9	-	-	5	-	-	-	5	-	5	3	-	-	5.7	6	1	17	4	67
14	RDN-RIL-178	5	-	7	5	-	5	-	-	-	-	-	7	5	-	-	5.7	6	0	0	4	67
118	Tetep	9	5	7	5	9	5	7	5	7	5	7	-	5	0	5	5.8	14	1	7	8	57
3	RDN-RIL-31	7	-	9	-	-	5	-	-	-	-	-	3	5	-	-	5.8	5	1	20	3	60
56	MIL-S8-3	7	5	9	5	9	5	5	7	7	5	5	3	7	3	-	5.9	14	2	14	8	57
53	MIL-S3-1	7	5	9	5	9	7	7	7	7	5	5	3	7	3	3	5.9	15	3	20	7	47
121	S15-Wazuhophek	7	5	5	5	9	5	7	9	9	5	7	-	5	3	3	6.0	14	2	14	8	57
104	KMP-280	7	5	9	5	7	7	5	7	7	5	7	-	7	3	3	6.0	14	2	14	6	43
10	RDN-RIL147	9	-	9	-	-	5	-	-	-	5	-	5	3	-	-	6.0	6	1	17	4	67
17	RDN-RIL-189	7	-	9	-	-	5	-	-	-	-	-	3	-	-	-	6.0	4	1	25	2	50
20	RDN-RIL-201	7	-	9	5	-	-	-	-	-	-	-	3	-	-	-	6.0	4	1	25	2	50
117	Swarnadhan (T)	9	5	7	5	7	5	7	7	9	5	7	-	7	3	5	6.3	14	1	7	6	43
107	T(N1) (S)	9	7	7	7	9	9	7	9	9	5	7	-	7	7	-	7.6	13	0	0	1	8
	LSI	7.6	5.9	8.0	5.8	8.8	6.5	7.0	8.5	8.1	5.3	6.6	4.5	6.5	4.1	4.7						

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3* and ≤5**)

Table 32: Location severity index (LSI) and frequency distribution of brown spot scores of NSN-1, Kharif 2018

Score	Location/Frequency of score(0-9)																	
	BAN	CBT	CHN	CHT	GDL	GER	GGT	GNV	HZB	JDP	JGT	LUD	MGD	NRRI	PNP	PSA	REW	USH
0	0	0	0	0	0	0	0	0	0	0	0	0	82	0	0	0	0	1
1	11	0	0	9	0	4	0	0	0	0	0	0	84	0	0	0	0	94
2	100	0	120	8	0	30	0	0	22	16	9	0	0	0	2	0	5	147
3	224	29	202	51	23	48	6	0	61	67	72	3	135	3	9	17	73	61
4	3	0	26	0	4	31	0	0	59	84	186	0	0	0	31	5	109	37
5	57	102	46	123	65	54	250	1	67	130	20	9	73	72	69	31	116	19
6	0	0	3	0	0	48	77	13	73	79	88	0	0	0	79	25	63	23
7	3	53	1	149	87	41	1	38	34	21	2	386	17	228	116	91	29	11
8	0	0	0	0	0	10	0	15	13	0	20	0	0	0	26	105	1	2
9	0	205	0	30	210	4	0	84	46	0	0	0	7	94	57	109	2	1
Total	398	389	398	370	389	270	334	151	375	397	397	398	398	397	389	383	398	396
LSI	3.0	7.2	3.0	5.7	7.5	4.8	5.2	8.1	5.3	4.6	4.5	6.9	2.6	7.1	6.4	7.4	4.7	2.7
Screening Method	N	N	A	N	N	N\A	-	A	N	N	N	A	N	A	N	A	-	N

(N-Natural; A-Artificial)

Table 33: Promising entries with low susceptibility index and high PI in NSN-1 to brown spot, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)														SI	Total	<=3*	PI (<=3)**	<=5*	PI (<=5)**
		CBT	CHT	GDL	GER	GGT	GNV	HZB	JDP	JGT	LUD	NRRI	PNP	PSA	REW						
Tetep	Tetep	5	3	9	1	6	-	5	4	2	7	7	3	5	3	4.6	13	5	38	9	69
4420	27289 (R)	9	3	5	3	5	-	3	3	4	5	7	4	8	3	4.8	13	5	38	10	77
4422	27291 (R)	9	2	5	1	-	-	3	5	4	5	7	5	9	3	4.8	12	4	33	9	75
4414	Tella Hamsa (RP)	7	3	5	2	5	-	2	4	4	7	7	6	8	4	4.9	13	3	23	8	62
312	25901	3	5	9	7	5	-	3	5	2	7	7	3	6	3	5.0	13	5	38	8	62
2007	27094	5	5	7	3	5	9	6	2	4	3	7	6	3	5	5.0	14	4	29	9	64
314	PA 6444 (HC)	5	7	9	-	5	-	3	3	3	7	7	4	3	4	5.0	12	4	33	8	67
311	26716	3	3	5	-	5	-	3	5	4	7	5	6	9	5	5.0	12	3	25	9	75
802	26790	5	5	7	-	-	-	2	2	4	7	5	-	7	6	5.0	10	2	20	6	60
4419	27288 (R)	9	1	7	2	6	-	4	4	3	7	7	2	9	5	5.1	13	4	31	7	54
1401	26816	5	2	7	4	5	-	4	3	6	7	5	6	9	4	5.2	13	2	15	8	62
309	26721	7	5	7	-	5	-	2	5	3	7	5	5	7	4	5.2	12	2	17	8	67
2203	25055	3	3	9	-	-	-	3	3	4	7	7	6	8	4	5.2	11	4	36	6	55
803	26804	3	7	7	6	6	7	3	3	4	3	5	7	7	5	5.2	14	4	29	7	50
502	25903	9	3	5	5	5	6	6	3	3	5	5	5	8	5	5.2	14	3	21	10	71
3608	27230	5	3	5	3	5	9	3	4	4	7	5	5	8	7	5.2	14	3	21	10	71
4439	Akshyadhan (RP)	9	3	7	2	6	-	6	5	2	7	7	3	8	3	5.2	13	5	38	6	46
4112	BPT 5204	9	3	9	6	5	7	9	6	6	7	7	5	9	6	6.7	14	1	7	3	21
	LSI	7.2	5.7	7.5	4.8	5.2	8.1	5.3	4.6	4.5	6.9	7.1	6.4	7.4	4.7						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤5 and ≤3;**Promising index (PI) based on no.of locations where the entry had scored ≤3 and ≤5)

➤ **NSN-2**

A total of 682 entries were screened under NSN- 2 at 11 locations across the India for brown spot disease. The entries were screened under artificial inoculation conditions at Coimbatore, Gangavathi, Ludhiana, Cuttack, Pusa and Rewa; while it was under natural infection condition at Chatha, Hazaribagh, Jagdalpur, Mugad and Ponnampet. The disease pressure was highest and lowest at Gangavathi (7.9) and Mugad (1.2) respectively. The disease pressure was very high (LSI >7) at Coimbatore (7.7), Cuttack (7.8) and Pusa (7.0) while it was high (LSI 6-7) at Ludhiana (6.9). It was moderate (4-6) at centres Ponnampet (5.9), Rewa (5.5), Jagdalpur (5.1), Hazaribagh (4.8) and Chatha (4.6). The disease pressure was very low at Chatha (1.6); hence this centre was not considered for selection of best entries Table 34.

The promising entries with low disease pressure across the locations presented in Table 35. Some of the promising entries included IET# 28060, 27421, 27760, 27747, 27579, 27806, 26639, 27856, 27874, 27994, 26898, 27968 and 27925.

➤ **NSN-H**

The NSN-hills nursery was evaluated at six centres viz., Gudulur, Khudwani, Cuttack, Lonavala, Mugad and Ponnampet. The screening for the disease was carried out under natural infection condition in all the centres except at Khudwani and Cuttack; where artificial method of inoculation was followed. The disease pressure was very high (LSI >7) at Gudulur (7.4) and Cuttack (7.4) while it was high (LSI 6-7) at Ponnampet (6.1). The moderate disease pressure (LSI 4-6) was observed at Lonavala (4.3) and Khudwani (4.3). The data from Mugad (1.4) was not considered for selection of best entries as the location severity index was very low Table 36.

The promising entries with low disease pressure across the locations were presented in Table 37 and that included IET # 27498, 25841, 27471, 26576, 27488, 27500, 27470, 27465, 27467, 27466 and 27468.

➤ **NHSN**

The entries under National Hybrid Screening Nursery (NHSN) were screened for brown spot reaction at 14 locations with 108 entries across India. The frequency distribution of disease scores and location severity indices are presented in Table 38. The highest and lowest disease pressure was recorded at Coimbatore (7.8) and Mugad (1.4) centers respectively. The disease pressure was very high (LSI >7) at Cuttack (7.7); while it was high (LSI 6-7) at Gangavathi (6.9) and Pusa (6.7). The moderate disease pressure (4-6) was recorded at Almora (5.0), Lonavala (5.0), Jagdalpur (4.5) and Rewa (4.2). The data of centers (Bankura, Chinsurah, Chatha, Jagtial and Mugad) where the disease pressure was less than 4 were not considered for selection of best entries.

The promising entries with low disease pressure across the locations were presented in Table 39 and that includes IET#27384, 27333, 27376, 27393, 27341, 27392, 27397, 27377, 27378, 27389, 27398 and 27404.

Table 34: Location severity index (LSI) and frequency distribution of brown spot scores of NSN-2, Kharif 2018

Score	Location/Frequency of score(0-9)										
	CBT	CHT	GGV	HZB	JDP	LUD	MGD	NRRI	PNP	PSA	REW
0	0	0	0	0	0	0	290	0	0	0	0
1	0	16	0	0	0	0	126	0	4	1	0
2	0	47	0	74	9	0	0	0	8	2	1
3	6	185	0	174	45	4	188	3	21	47	6
4	0	0	0	47	139	0	0	0	56	9	95
5	109	274	1	136	213	19	61	63	169	86	255
6	0	0	102	62	208	0	0	0	169	70	200
7	170	122	183	118	60	651	16	269	183	157	107
8	0	0	64	4	0	0	1	0	6	140	4
9	353	23	314	46	0	0	0	347	52	159	1
Total	638	667	664	661	674	674	682	682	668	671	669
LSI	7.7	4.6	7.9	4.8	5.1	6.9	1.6	7.8	5.9	7.0	5.5
Screening Method	N	N	A	N	N	A	N	A	N	A	-

(N-Natural; A-Artificial)

Table 35: Promising entries with low susceptibility index and high PI in NSN-2 to brown spot, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)										SI	Total	<=3*	PI (<=3)**	<=5*	PI(<=5)**
		CBT	CHT	GGV	HZB	JDP	LUD	NRRI	PNP	PSA	REW						
4802	28060	-	1	-	2	5	7	7	5	7	4	4.8	8	2	25	5	63
4216	27421	9	2	9	4	3	5	5	3	3	5	4.8	10	4	40	8	80
4261	27421	9	2	9	4	3	5	5	3	3	5	4.8	10	4	40	8	80
1228	27760	5	2	6	6	4	5	5	4	6	5	4.8	10	1	10	7	70
1212	27747	3	3	7	3	3	5	7	5	8	5	4.9	10	4	40	7	70
610	27579	5	3	7	3	3	7	9	6	3	4	5.0	10	4	40	6	60
2104	27806	5	3	7	3	3	5	7	3	8	6	5.0	10	4	40	6	60
918	26639	5	3	6	3	4	7	7	6	3	6	5.0	10	3	30	5	50
2337	27856	5	3	6	3	4	5	9	4	8	4	5.1	10	2	20	7	70
909	27874	-	1	9	3	6	7	7	5	3	5	5.1	9	3	33	5	56
3913	27994	-	5	-	3	5	7	5	5	5	6	5.1	8	1	13	6	75
919	26898	9	3	6	3	3	7	7	7	2	5	5.2	10	4	40	5	50
Tetep	Tetep	7	2	9	3	5	7	7	3	4	5	5.2	10	3	30	6	60
3748	27968	3	5	8	5	5	7	5	3	5	6	5.2	10	2	20	7	70
3702	27925	7	5	9	2	3	-	7	4	5	5	5.2	9	2	22	6	67
4220	BPT 5204	9	3	7	5	5	7	7	5	7	5	6.0	10	1	10	5	50
LSI		7.7	4.6	7.9	4.8	5.1	6.9	7.8	5.9	7.0	5.5						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤5 and ≤3;**Promising index (PI) based on no.of locations where the entry had scored ≤3 and ≤5)

Table 36: Location severity index (LSI) and frequency distribution of brown spot scores of NSN-H, Kharif 2018

Score	Location/Frequency of score(0-9)					
	GDL	KHD	LNv	MGD	NRRI	PNP
0	0	0	25	24	0	0
1	0	1	0	52	0	2
2	0	5	1	0	0	3
3	5	23	1	17	0	5
4	3	21	15	0	0	4
5	14	41	16	7	11	15
6	0	3	16	0	0	20
7	29	1	17	1	57	36
8	0	5	6	0	0	6
9	49	0	2	0	33	8
Total	100	100	99	101	101	99
LSI	7.4	4.3	4.3	1.4	7.4	6.1
Screening Method	N	N/A	N	N	A	N

(N-Natural; A-Artificial)

Table 37: Promising entries with low susceptibility index and high PI in NSN-H to brown spot, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)					SI	Total	≤3*	PI (≤3)**	≤5*	PI (≤5)**
		GDL	KHD	LNv	NRRI	PNP						
Tetep	Tetep	3	3	0	7	1	2.8	5	4	80	4	80
3008	27498	4	2	0	5	7	3.6	5	2	40	4	80
Swarnadhan	Swarnadhan	3	4	3	9	1	4.0	5	3	60	4	80
2802	25841	7	2	0	7	4	4.0	5	2	40	3	60
2713	27471	3	5	0	7	6	4.2	5	2	40	3	60
2612	26576	7	5	0	9	2	4.6	5	2	40	3	60
2913	27488	9	4	0	5	5	4.6	5	1	20	4	80
3010	27500	7	3	2	7	5	4.8	5	2	40	3	60
2712	27470	7	3	0	7	7	4.8	5	2	40	2	40
2706	27465	7	2	4	5	6	4.8	5	1	20	3	60
2708	27467	5	5	0	7	7	4.8	5	1	20	3	60
2707	27466	3	5	5	7	5	5.0	5	1	20	4	80
Vikramarya	Vikramarya	5	3	5	7	5	5.0	5	1	20	4	80
2710	27468	5	2	5	7	6	5.0	5	1	20	3	60
T(N1)		9	3	6	7	7	6.4	5	1	20	1	20
LSI		7.4	4.3	4.3	7.4	6.1						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤5 and ≤3;**Promising index (PI) based on no.of locations where the entry had scored ≤3 and ≤5)

Table 38: Location severity index (LSI) and frequency distribution of brown spot scores of NHSN, Kharif 2018

Location/Frequency of score(0-9)														
Score	ALM	BAN	CBT	CHN	CHT	GNV	JDP	JGT	LNV	LUD	MGD	NRRI	PSA	REW
0	0	0	0	0	0	0	0	0	13	0	26	0	0	0
1	0	3	0	0	19	0	0	2	0	3	53	0	0	0
2	0	0	0	27	21	0	4	12	1	0	0	0	0	6
3	0	89	0	56	35	0	16	32	3	80	21	0	7	17
4	36	0	0	10	0	0	37	39	26	0	0	0	1	43
5	48	16	16	12	26	6	30	2	16	10	6	12	8	36
6	16	0	0	3	0	41	16	18	13	0	0	0	4	5
7	8	0	26	0	4	32	4	1	24	6	1	46	10	1
8	0	0	0	0	0	9	0	2	4	0	0	0	7	0
9	0	0	52	0	3	18	0	0	6	0	0	50	14	0
Total	108	108	94	108	108	106	107	108	106	99	107	108	51	108
LSI	5.0	3.2	7.8	3.1	3.3	6.9	4.5	3.9	5.0	3.4	1.4	7.7	6.7	4.2
Screening Method	N	N	N	A	N	A	N	N	N	A	N	A	A	-

(N-Natural; A-Artificial)

Table 39: Promising entries with low susceptibility index and high PI in NHSN to brown spot Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)								SI	Total	<=3*	PI (<=3)**	<=5*	PI (<=5)**
		ALM	CBT	GNV	JDP	LNV	NRRI	PSA	REW						
3310	27384	5	5	7	4	0	7	-	2	4.3	7	2	29	5	71
3108	27333	5	-	6	3	4	7	-	2	4.5	6	2	33	4	67
3301	27376	4	-	6	5	0	7	-	5	4.5	6	1	17	4	67
3322	27393	4	5	5	4	0	9	-	5	4.6	7	1	14	6	86
Tetep	Tetep	5	5	6	3	3	7	5	3	4.6	8	3	38	6	75
3116	27341	4	7	6	4	0	7	5	5	4.8	8	1	13	5	63

Ent. No.	IET No.	Location/ Score (0-9)								SI	Total	<=3*	PI (<=3)**	<=5*	PI (<=5)**
		ALM	CBT	GNV	JDP	LVN	NRRI	PSA	REW						
3321	27392	4	7	5	5	0	9	-	4	4.9	7	1	14	5	71
3405	27397	5	9	6	5	0	7	-	3	5.0	7	2	29	4	57
3302	27377	4	-	7	3	4	7	-	5	5.0	6	1	17	4	67
3303	27378	4	5	7	6	0	9	-	4	5.0	7	1	14	4	57
3317	27389	5	5	7	6	0	7	-	5	5.0	7	1	14	4	57
3406	27398	5	9	6	6	0	7	-	3	5.1	7	2	29	3	43
3416	27404	5	7	6	4	4	5	-	5	5.1	7	0	0	5	71
T(N1)		6	9	6	3	7	7	8	4	6.3	8	1	13	2	25
	LSI	5.0	7.8	6.9	4.5	5.0	7.7	6.7	4.2						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no.of locations where the entry had scored ≤ 3 and ≤ 5)

➤ DSN

The entry under donor screening nursery (DSN) was evaluated for their resistance to brown spot at 14 locations with 129 entries across the country. The brown spot resistance screening was done under natural infection conditions in most of the centres except at Coimbatore, Gerua, Cuttack, Gangavati, Ludhiana and Pusa; where artificial method of screening was followed. The frequency distribution of disease scores and location severity index (LSI) are presented in Table 40. The highest and lowest disease pressure was recorded at Coimbatore (8.2) and Mugad (1.2) respectively. The disease Pressure was very high (LSI >7) at Gangavathi (8.0) and Cuttack (7.7) while it was high (LSI 6-7) at Ludhiana (6.9) and Pusa (6.7). The moderate disease pressure (LSI 4-6) was observed at Gagarghat (5.1), Lonavala (5.1), Rewa (5.0), Chatha (4.2), Gerua (4.2) and Jagdalpur (4.0). The data from the locations (Hazaribagh, Jagtial and Mugad) where the disease pressure was low (LSI <4) was not considered for selection of promising entries. The promising entries with low disease pressure across the locations were presented in Table 41 and that includes RP-Bio-Patho-1-8-6, MIL-SI-1 and RNR 11450.

Table 40: Location severity index (LSI) and frequency distribution of brown spot scores of DSN Kharif 2018

Score	Location/Frequency of score(0-9)													
	CBT	CHT	GER	GGT	GNV	HZB	JDP	JGT	LVN	LUD	MGD	NRRI	PSA	REW
0	0	0	0	0	0	0	0	0	5	0	64	0	0	0
1	0	1	0	0	0	21	1	1	0	0	25	0	0	0
2	0	7	10	0	0	94	7	18	1	0	0	0	0	0
3	0	40	11	2	0	5	29	39	3	0	35	0	10	9
4	0	0	7	0	0	0	37	28	31	0	0	0	5	39
5	6	45	6	109	0	0	22	11	7	6	5	19	24	42
6	0	0	6	7	21	0	7	10	15	0	0	0	14	24
7	26	9	2	1	18	0	4	1	12	112	0	46	29	13
8	0	0	4	1	6	0	0	1	6	0	0	0	16	2
9	61	2	0	0	62	0	0	0	5	0	0	63	31	0
Total	93	104	46	120	107	120	107	109	85	118	129	128	129	129
LSI	8.2	4.2	4.2	5.1	8.0	1.9	4.0	3.6	5.1	6.9	1.2	7.7	6.7	5.0
Screening Method	N	N	N\A	-	A	N	N	N	N	A	N	A	A	-

(N-Natural; A-Artificial)

Table 41: Promising entries with low susceptibility index and high PI in DSN to brown spot, Kharif 2018

S.No.	Designations	Location/ Score (0-9)											SI	Total	<=3*	PI(<=3)**	<=5*	PI(<=5)**
		CBT	CHT	GER	GGT	GNV	JDP	LVN	LUD	NRRI	PSA	REW						
85	RP-Bio-Patho-1-8-6	9	3	2	5	9	4	0	-	5	7	4	4.8	10	3	30	7	70
52	MIL-SI-1	7	3	-	5	6	5	0	7	9	3	5	5.0	10	3	30	6	60
99	RNR 11450	9	3	-	5	6	3	4	5	5	5	5	5.0	10	2	20	8	80
97	Tetep	5	5	-	5	9	4	3	7	5	5	4	5.2	10	1	10	8	80
64	Tellahamsa	-	2	-	5	7	4	6	7	5	6	5	5.2	9	1	11	5	56
94	IR-64	9	3	3	5	9	4	4	7	5	3	6	5.3	11	3	27	7	64
98	HR-12	9	3	4	5	7	3	5	7	5	5	5	5.3	11	2	18	8	73
47	TPL-62-2	9	3	-	5	6	3	0	7	9	4	7	5.3	10	3	30	5	50
100	RNR 17941	-	3	-	5	6	4	5	7	7	7	4	5.3	9	1	11	5	56
95	C 101 LAC	9	5	2	5	9	3	-	7	5	5	4	5.4	10	2	20	7	70
96	C 101 A 51	7	3	-	5	9	3	5	7	5	5	5	5.4	10	2	20	7	70
91	BPT-5204	-	5	-	5	9	5	-	7	9	3	4	5.9	8	1	13	5	63
	LSI	8.2	4.2	4.2	5.1	8.0	4.0	5.1	6.9	7.7	6.7	5.0						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤5 and ≤3;**Promising index (PI) based on no.of locations where the entry had scored ≤3 and ≤5)

❖ **SHEATH ROT**➤ **NSN -1**

The National Screening Nursery 1 consisting of 398 entries was evaluated at 11 locations across the country. The screening was done under artificial inoculation at Cuttack, Pusa and naturally at the remaining centers. Very high disease pressure ($LSI > 7$) was recorded at Raipur (7.9) and high disease pressure at Pusa (6.8), Karjat (6.8); moderate disease pressure at Cuttack (5.6), Navasari (5.6), Aduthurai (4.9), Chinsurah (4.7), Rajendranagar (3.6) and Bankura (3.4). The disease pressure was very low ($LSI < 3$) at Nawagam (1.0) and Nellore and hence, the data from these centers was not considered for selecting the resistant entries for sheath rot. The frequency distribution of sheath rot scores are presented in the Table 42 along with location severity indices.

Table 42: Location severity index (LSI) and frequency distribution of sheath rot disease scores for NSN-1 entries, Kharif, 2018

Score	Location/Frequency of score(0-9)										
	ADT	BAN	CHN	KJT	NLR	NRRI	NVS	NWG	PSA	RNR	RPR
0	128	4	23	0	34	53	0	176	0	185	2
1	18	42	41	0	30	0	0	132	7	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	36	232	65	11	265	23	29	58	25	2	11
4	0	0	0	0	0	0	0	0	0	0	1
5	13	111	145	98	67	90	212	11	72	61	5
6	0	0	0	0	0	0	0	0	0	0	0
7	18	9	95	186	0	167	150	0	168	89	167
8	0	0	0	0	0	0	0	0	1	0	0
9	180	0	29	78	0	55	3	0	109	54	211
Total	393	398	398	373	396	388	394	377	382	391	397
LSI	4.9	3.4	4.7	6.8	2.9	5.6	5.6	1.0	6.8	3.6	7.9
Screening Method	-	N	A	N	N	A	N/A	N	A	N	A

(N-Natural; A-Artificial)

The selection of promising entries was done based on the disease data of those locations where the disease pressure was moderate to very high. The promising entries with $SI \leq 5$ are presented in the Table 43. Some of the promising entries include IET # 25618(R), 26178, 25903, 26027, 26024, 26538, 27077, 27094, 27279, 25912, 27280 and 26498.

Table 43: Promising entries with low susceptibility index and high PI in NSN-1 to sheath rot, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)							SI	Total	<=3*	PI(<=3)**	<=5*	PI(<=5)**
		ADT	CHN	KJT	NRRI	NVS	PSA	RPR						
3503	25618	0	0	5	0	5	5	3	2.6	7	4	57	7	100
3502	26178	1	3	5	0	3	7	3	3.1	7	5	71	6	86
503	CR Dhan 506 (NC)	0	0	5	0	5	9	3	3.1	7	4	57	6	86
502	25903	1	0	5	0	5	7	5	3.3	7	3	43	6	86
1301	26027	0	0	3	9	5	-	3	3.3	6	4	67	5	83
1305	26024	0	1	5	0	7	-	7	3.3	6	3	50	4	67
1415	26538	0	5	5	5	5	1	3	3.4	7	3	43	7	100
2006	27077	0	1	-	0	7	5	9	3.7	6	3	50	4	67
2007	27094	0	0	5	0	7	5	9	3.7	7	3	43	5	71
5032	27279	0	1	-	5	5	5	7	3.8	6	2	33	5	83
501	25912	0	3	3	0	5	7	9	3.9	7	4	57	5	71
4437	27280	0	0	3	5	3	9	7	3.9	7	4	57	5	71
5033	27280	0	5	5	5	3	3	7	4.0	7	3	43	6	86
1103	26498	3	1	5	0	7	5	7	4.0	7	3	43	5	71
3505	CR Dhan 201 (NC)	5	1	5	0	5	5	7	4.0	7	2	29	6	86
	T(N1)	5	7	9	7	7	5	9	7.0	7	0	0	2	29
	LSI	4.9	4.7	6.8	5.6	5.6	6.8	7.9						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤5 and ≤3;**Promising index (PI) based on no.of locations where the entry had scored ≤3 and ≤5)

➤ **NSN-2**

The entries in NSN-2 consisting of 682 entries were evaluated at 3 locations viz., Aduthurai, Raipur and Pusa. A very high disease pressure was noticed at Raipur (8.2) and high disease pressure was recorded at Pusa (6.5) and moderate at Aduthurai (3.9). At all the centers the entries were screened under artificial infection. The frequency distribution of disease scores along with location severity indices are presented in the Table 44.

The selection of promising entries was done based on the disease data from Raipur and Pusa. Some of the IET Nos. 27915, 27572, 27578, 27579, 26678, 27540 and 27559 were promising against sheath rot (Table 45).

➤ **NSN-H**

The nursery consisting of 101 test entries including checks was evaluated at two centers viz., Lonavala and Karjat. The disease pressure was high at Lonavala (LSI 6.7) and Kajrat (6.2). The disease screening was done under natural conditions at both the centers (Table 46). The selection of promising entries was done based on the disease data from those locations where the disease was moderate to very high. Some of the IET Nos. 27461 and 27500 were found to be promising against sheath rot (Table 47).

Table 44: Location severity index (LSI) and frequency distribution of sheath rot scores for NSN- 2 entries, Kharif, 2018

Location/Frequency of score(0-9)			
Score	ADT	PSA	RPR
0	53	0	0
1	0	6	0
2	0	0	0
3	5	76	5
4	0	0	0
5	4	161	3
6	0	3	0
7	1	253	267
8	0	3	0
9	40	170	404
Total	103	672	679
LSI	3.9	6.5	8.2
Screening Method	-	A	A

(N- Natural; A- Artificial)

Table 45: NSN-2 entries with high promising index to sheath rot, Kharif, 2018

Ent. No.	IET No.	Location/Score (0-9)		SI	Total	<=3*	PI (<=3)**	<=5*	PI(<=5)**
		PSA	RPR						
955	27915	3	-	3.0	1	1	100	1	100
Ajaya	Ajaya	1	7	4.0	2	1	50	1	50
603	27572	7	3	5.0	2	1	50	1	50
609	27578	3	7	5.0	2	1	50	1	50
610	27579	3	7	5.0	2	1	50	1	50
619	26678	3	7	5.0	2	1	50	1	50
404	27540	1	9	5.0	2	1	50	1	50
425	27559	3	7	5.0	2	1	50	1	50
T(N1)		7	7	7.0	2	0	0	0	0
LSI		6.5	8.2						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 46: Location severity index (LSI) and frequency distribution of sheath rot scores for NSN-H entries, Kharif - 2018

Location/Frequency of score (0-9)		
Score	LNV	KJT
0	2	0
1	0	0
3	0	14
4	0	0
5	12	17
6	0	0
7	82	56
8	0	0
9	3	8
Total	99	95
LSI	6.7	6.2
Screening Method	N	N

(N- Natural; A- Artificial)

Table 47: Promising entries with low susceptibility index and high PI in NSN-H to sheath rot, Kharif 2018

Ent. No.	IET No.	Location/ Score (0-9)		SI	Total	<=3*	PI (<=3)**	<=5*	PI(<=5)*
		LNV	KJT						
2701	27461	0	5	2.5	2	1	50	2	100
3010	27500	0	7	3.5	2	1	50	1	50
2910	VL Dhan 65	7	3	5.0	2	1	50	1	50
2918	27493	7	3	5.0	2	1	50	1	50
2920	27495	7	3	5.0	2	1	50	1	50
2921	27496	7	3	5.0	2	1	50	1	50
2602	25826	7	3	5.0	2	1	50	1	50
2606	26565	7	3	5.0	2	1	50	1	50
2609	Shalimar Rice 3	7	3	5.0	2	1	50	1	50
2612	26576	7	3	5.0	2	1	50	1	50
2613	26564	7	3	5.0	2	1	50	1	50
2802	25841	7	3	5.0	2	1	50	1	50
2806	25836	7	3	5.0	2	1	50	1	50
2811	26585	7	3	5.0	2	1	50	1	50
2706	27465	7	3	5.0	2	1	50	1	50
IR-64	IR-64	7	3	5.0	2	1	50	1	50
2813	26594	5	5	5.0	2	0	0	2	100
Vikramarya		5	5	5.0	2	0	0	2	100
Swarnadhan		5	5	5.0	2	0	0	2	100
T(N1)		5	7	6.0	2	0	0	1	50
LSI		6.7	6.2						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ **NHSN**

The NHSN trial consisted of 108 entries including checks was evaluated at 11 locations representing different geographical regions. The frequency distribution of disease scores and the LSI are presented in Table 48. The disease pressure was very high (LSI >7) at Raipur (8.4) and Aduthurai (8.1), and; high disease pressure at Karjat (6.3), Lonavala (6.2) and Navsari (6.0) and Rajendranagar (6.0); Moderate disease pressure was noticed at Pusa (5.4), Chinsurah (5.8) and Bankura (3.6). Very low disease pressure was recorded at Mugad (0.3), Nawagam (0.9) and Cuttack (2.5). The disease screening was done under natural conditions at Bankura, Karjat, Lonaval, Mugad, Navasari and Nawagam and artificial inoculation at Chinsurah, Cuttack and Pusa (Table 48).

Table 48: Location severity index (LSI) and frequency distribution of sheath rot scores for NHSN entries, Kharif - 2018

Location/Frequency of score(0-9)											
Score	ADT	BAN	CHN	KJT	LNV	MGD	NRRI	NVS	NWG	PSA	RPR
0	6	1	2	0	9	96	58	0	54	0	0
1	0	14	0	0	0	5	0	0	33	5	0
2	0	0	0	0	0	0	0	0	0	0	0
3	5	50	12	14	1	4	4	0	15	9	0
4	0	0	0	0	0	0	0	0	0	0	0
5	2	39	45	25	13	3	28	50	3	16	2
6	0	0	0	0	0	0	0	0	0	0	0
7	3	4	38	48	81	0	14	52	0	13	27
8	0	0	0	0	0	0	0	0	0	0	0
9	88	0	11	16	2	0	2	1	0	8	79
Total	104	108	108	103	106	108	106	103	105	51	108
LSI	8.1	3.6	5.8	6.3	6.2	0.3	2.5	6.0	0.9	5.4	8.4
Screening Method	-	N	A	N	N	N	A	N/A	N	A	A

(N- Natural; A- Artificial)

The selection of promising entries was done based on the disease data of those locations where the disease pressure was moderate to very high. The promising entries with SI≤5 are presented in the Table 49. Some of the promising entries include IET # 27350, 27333, 27396 and 27378.

Table 49: Promising entries with low susceptibility index and high PI in NHSN to sheath rot, Kharif 2018

Ent. No.	IET No.	Location/ Score(0-9)							SI	Total	<=3*	PI (<=3)**	<=5*	PI(<=5)**
		ADT	CHN	KJT	LVN	NVS	PSA	RPR						
3206	27350	0	5	3	5	5	1	9	4.0	7	3	43	6	86
3108	27333	0	0	7	7	5	-	7	4.3	6	2	33	3	50
Swarnadhan		0	3	5	7	5	3	9	4.6	7	3	43	5	71
3403	27396	9	3	3	0	5	-	9	4.8	6	3	50	4	67
3303	27378	7	5	5	0	5	-	7	4.8	6	1	17	4	67
Tetep		0	5	7	7	5	3	9	5.1	7	2	29	4	57
3219	27361	9	5	3	0	7	7	7	5.4	7	2	29	3	43
T(N1) (S)		9	7	7	7	7	5	9	7.3	7	0	0	1	14
LSI		8.1	5.8	6.3	6.2	6.0	5.4	8.4						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ DSN

The DSN trial consisted of 129 entries including checks were screened at 10 locations across the country. The frequency distribution of disease scores and the LSI are presented in Table 50. The nursery was screened under natural conditions at all the locations except at Raipur and Pusa. At Raipur (8.4) followed by Lonavala (7.0), a very high disease pressure was recorded. A high disease pressure was recorded at Aduthurai (LSI 6.6). At Pusa (5.8), Navasari (5.3), Karjat (4.9) and Rajendranagar (3.8), moderate disease pressure was recorded where as at Mugad (1.1) and Nawagam (0.8), very low disease pressure was observed during the season. The selection of promising entries were done based on the data of those locations where the disease pressure was moderate to high. The promising entries with $SI \leq 5$ are presented in the Table 51. Some of the promising lines were MSM-T1-6 and MIL-SI-1.

Table 50: Location severity index (LSI) and frequency distribution of sheath rot scores for DSN entries, Kharif - 2018

Location/Frequency of score(0-9)											
Score	ADT	KJT	LVN	MGD	NRRI	NVS	NWG	PSA	RNR	RPR	
0	3	0	3	70	59	0	47	0	26	0	
1	0	0	0	32	0	0	36	1	2	0	
2	0	0	0	0	0	0	0	0	0	0	

Location/Frequency of score(0-9)										
Score	ADT	KJT	LVN	MGD	NRRI	NVS	NWG	PSA	RNR	RPR
3	1	38	4	14	9	7	15	28	23	0
4	0	0	0	0	0	0	0	0	0	1
5	0	40	3	11	29	75	0	43	36	0
6	0	0	0	0	0	0	0	0	0	0
7	0	23	55	2	5	24	0	33	14	32
8	0	0	0	0	0	0	0	0	0	0
9	10	4	20	0	4	0	0	24	6	91
Total	14	105	85	129	106	106	98	129	107	124
LSI	6.6	4.9	7.0	1.1	2.3	5.3	0.8	5.8	3.8	8.4
Screening Method	-	N	N	N	A	N/A	N	A	N	A

(N- Natural; A- Artificial)

Table 51: Promising entries with low susceptibility index and high PI in DSN to sheath rot, Kharif 2018

S.No	Designation	Location/ Score(0-9)						SI	Total	<=3*	PI (<=3)**	<=5*	PI(<=5)**
		ADT	KJT	LVN	NVS	PSA	RPR						
128	MSM-T1-6	3	3	0	3	7	4	3.3	6	4	67	5	83
52	MIL-SI-1	-	3	0	5	3	7	3.6	5	3	60	4	80
117	Swarnadhan	0	5	-	5	3	7	4.0	5	2	40	4	80
53	MIL-S3-1	-	3	0	7	5	7	4.4	5	2	40	3	60
68	NWGR-11048	-	3	3	3	9	-	4.5	4	3	75	3	75
99	RNR 11450	-	3	7	3	3	9	5.0	5	3	60	3	60
26	CB 14 161	-	3	7	5	3	7	5.0	5	2	40	3	60
80	RP-Patho-8-1-33	-	3	-	5	3	9	5.0	4	2	50	3	75
88	RP-Bio-Patho-4-1-2	-	3	3	5	7	7	5.0	5	2	40	3	60
93	Improved Samba Mahsuri	-	3	7	5	3	7	5.0	5	2	40	3	60
94	IR-64	-	3	7	5	1	9	5.0	5	2	40	3	60
104	KMP-280	-	3	5	5	5	7	5.0	5	1	20	4	80
22	RDN 98-2-3-5-14	-	-	-	-	5	-	5.0	1	0	0	1	100
107	T(N1)	-	7	9	7	7	9	7.8	5	0	0	0	0
	LSI	6.6	4.9	7.0	5.3	5.8	8.4						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

❖ **GLUME DISCOLOURATION**➤ **NSN-1**

The National Screening Nursery (NSN-1) for grain discoloration was evaluated at three locations viz., Chatha, Navasari and Nawagam. The frequency distribution of disease scores and the representative location severity index (LSI) are presented in the Table 52. The entries were screened under natural infection. The disease pressure was moderate at Navasari (LSI 5.5); while it was very low at Nawagam (LSI 0.9). The number of entries screened at Chatha was very low (6 entries). Accordingly the data from Nawagam and Chatha were not considered for the selection of resistance entries. At Navasari, 41 entries showed disease score of 3 and were found promising.

Table 52: Location severity index (LSI) and frequency distribution of Grain discoloration scores of NSN-1, Kharif 2018

Score	Location/Frequency of score(0-9)		
	CHT	NVS	NWG
0	0	0	106
1	0	0	246
2	1	0	0
3	2	41	22
4	0	0	0
5	2	217	3
6	0	0	0
7	1	136	0
8	0	0	0
9	0	0	0
Total	6	394	377
LSI	4.2	5.5	0.9
Screening Method	N	N	N

(N- Natural; A- Artificial)

➤ **NSN-2 and NSN-H**

In NSN-2, around 682 entries were screened at Chatha centre under natural conditions. Under NSN-H, 101 entries were screened at Lonavala centre under natural conditions and the disease pressure was 6.0 and most of the entries scored 5 to 7.

➤ **NHSN**

National Hybrid Screening Nursery (NHSN) consisting of 108 entries including checks were screened under natural conditions for glume discoloration at 4 locations (Chatha, Lonavala, Navsari and Nawagam). The frequency distribution of disease scores and location severity indices are presented in Table 53. The disease pressure was moderate at Navasari (LSI 5.9) and Lonavala (LSI 5.5); while it was low (<4) at Chatha (LSI 3.2) and Nawagam (LSI 1.1). Hence the data from Chatha and Nawagam were not considered for selection of promising entries.

Table 53: Location severity index (LSI) and frequency distribution of Grain discoloration scores of NHSN, Kharif 2018

Score	Location/Frequency of score (0-9)			
	CHT	LNV	NVS	NWG
0	0	0	0	26
1	9	0	0	62
2	22	0	0	0
3	41	5	4	17
4	0	0	0	0
5	23	73	50	0
6	0	0	0	0
7	3	25	49	0
8	0	0	0	0
9	0	3	0	0
Total	98	106	103	105
LSI	3.2	5.5	5.9	1.1
Screening Method	N	N	N	N

(N- Natural; A- Artificial)

Some of the promising entries with SI ≤ 4 under NHSN for grain discoloration were IET# 27350, 27352, 27353, 27360, 27361 and 27393 (Table 54).

Table 54: Promising entries with low susceptibility index and high PI in NHSN to grain discoloration, Kharif 2018

IET No.	Name	Location/ Score (0-9)		SI	Total	<=3*	PI (<=3)**	<=5*	PI(<=5)**
		LNV	NVS						
27350	HRI-198	3	5	4.0	2	1	50	2	100
27352	NPH-X2	3	5	4.0	2	1	50	2	100
HR-12	HR-12	5	3	4.0	2	1	50	2	100
27353	US-321	3	5	4.0	2	1	50	2	100
27360	PHI-18106	5	3	4.0	2	1	50	2	100
27361	RH-169001	3	5	4.0	2	1	50	2	100
27393	IIRRH-124	5	3	4.0	2	1	50	2	100
	LSI	5.5	5.9						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5).

➤ **DSN**

Donor screening nursery (DSN) comprising of 129 entries including checks were tested at 4 locations viz., Chatha, Lonavala, Navasari and Nawagam under natural infection. The frequency distribution of disease scores and LSI are presented in Table 55. The disease pressure was very high at Lonavala (LSI 6.3); moderate at Navasari (LSI 5.4); low at Chatha (LSI 3.3). and Nawagam (0.9). The selection of promising entries were based the LSI, where disease pressure was more than 4 and the data from the Chatha, and Nawagam was not considered. The number of entries screened at Lonavala was very less (six) and hence data was not considered for selection of promising entries.

Table 55: Location severity index (LSI) and frequency distribution of Grain discoloration scores of DSN, Kharif 2018

Location/Frequency of score(0-9)				
Score	CHT	LNV	NVS	NWG
0	0	0	0	22
1	1	0	0	69
2	41	0	0	0
3	13	0	14	6
4	0	0	0	0
5	15	2	58	1
6	0	0	0	0
7	9	4	34	0
9	0	0	0	0
Total	79	6	106	98
LSI	3.3	6.3	5.4	0.9
Screening Method	N	N	N	N

(N- Natural; A- Artificial)

❖ **BACTERIAL BLIGHT**➤ **NSN-1**

The National Screening Nursery-1 (NSN-1) consisted of 398 entries including 62 checks. The entries were evaluated at 23 locations across the country. The entries were evaluated through artificial inoculation at all the locations except at Chiplima, Chatha and Nellore. The frequency distribution of the disease scores and location severity indices are presented in Table 56. The disease pressure was exceptionally high at Maruteru (LSI-8.9); high (LSI-6-8) at IIRR (7.8), Chiplima (7.2), Raipur (6.9), Karjat (6.5), Ludhiana (6.5), Gangavathi (6.4), Pant Nagar (6.2) and New Delhi (6.0); moderate (LSI-3-6) at Faizabad (5.8), Patna (5.7), Aduthurai (5.6), Port Blair (5.6), Navsari (4.8), Varanasi (4.6), Jagtiyal (4.4), Nellore (4.4), Chinsurah (4.3), Titabar (4.1), Chatha (3.6), Gerua (3.6) and Moncompu (3.4) and very low (LSI < 3) at Nawagam (1.6).

For selection of best entries, data from Nawagam was not considered as the disease pressure was extremely low (LSI-1.6). Data of Maruteru was also not considered as the data showed unexpected high disease pressure (LSI-8.91) indicating that more than 99% of the entries showed highly susceptible reaction with score of 9 which needs reconfirmation. Out of 398 entries, data of only 97 entries were received from Patna and therefore data of this centre was also not considered for selection of promising entries. Data of Aduthurai was also not considered based on the report of our AICRIP monitoring team. At Aduthurai, checks like WGL-14, BPT 5204, NDR 359, Swarna, Pooja, Swarna Sub-1, Swarnadhan, Pusa 44 and other showed highly resistant reaction with score of 0-3 while resistant check Improved Samba Mahsuri showed highly susceptible reaction with a disease score of 9. The promising entries with SI less than 4.5 and which exhibited a score of 5 at or more than 60% of the locations are presented in Table 57. Some of the promising entries which were on par or better than resistant check Improved Samba Mahsuri were IET # 26746(R), 27275 (R), 28035, 28015, 27293, 28014, 28015, 28014, 27280, 26126, 27295, 27296, 27275, 28035, 26549, 27294, 26745(R) and 27280. Some of the other promising entries with SI less than 4.5 were IET # 24855, 27296 (R), 26027, 24931, 27293 (R), 27077, 25746, 27294 (R), 26858, 27297, 26715 and 26263.

➤ NSN-2

The National Screening Nursery-2 (NSN-2) consisted of 682 entries including checks. The entries were evaluated at 14 locations across the country. The entries were evaluated using artificial inoculation at all the centres except at Chatha where the screening was done under natural condition. The frequency distribution of the disease scores and location severity indices are presented in Table 58. The disease pressure was extremely high at Maruturu (LSI-8.8); high (LSI-6-8) at NRRI (7.6), IIRR (7.3), Pantnagar (7.1), Raipur (6.9), Gangavathi (6.5), Aduthurai (6.4), Ludhiana (6.4), Pattambi (6.3) and Faizabad (6.0) and moderate (LSI-3-6) at Patna (5.4), Varanasi (5.2), Chatha (3) and Moncompu (3).

For selection of best entries, data of Maruteru was not considered as the disease pressure was unusually very high (LSI-8.82) where more than 99% of the entries showed highly susceptible reaction with disease score of 9 which needs reconfirmation. Data of Aduthurai was also not considered based on the report of AICRIP monitoring team. At Aduthurai, usually susceptible checks like Swarna, Swarna Sub-1, BPT 5204, WGL-14, Pusa 44, Swarnadhan, Pusa Basmati 1 and Vardhan showed highly resistant reaction while resistant check Improved Samba Mahsuri showed a score of 7-9 which needs reconfirmation. The promising entries with SI less than 4.5 and which exhibited a score of 5 at or more than 60% of the locations are presented in Table 59. Two entries viz., IET 27729 and IET 27832 performed on par or better than the resistant check Improved Samba Mahsuri. Some of the other promising entries which exhibited an SI of less than 4.5 were IET # 27721, 27620, 28061, 28073, 27579, 27768, 27650, 27669, 27615, 27764, 27781, 27460, 27739, 28077, 27806, 27837 and 27416.

Table 56: Location severity index (LSI) and frequency distribution of bacterial blight scores of NSN-1, *Kharif* 2018

Score	Location/Frequency of scores (0-9)										
	A	A	N	N	A	N/A	A	A	A	A	A
Inoculation	ADT	CHN	CHP	CHT	FZB	GER	GNV	IIRR	JGT	KJT	LUD
0	35	1	0	0	0	0	0	0	0	0	0
1	19	70	0	7	0	24	0	12	6	0	0
2	0	0	0	75	0	0	0	0	45	0	0
3	75	107	2	172	34	157	85	29	81	10	55
4	0	0	0	0	0	0	0	0	73	0	0
5	78	125	51	78	180	79	82	9	92	139	13
6	0	0	0	0	0	0	0	0	67	0	0
7	54	82	244	37	177	10	104	76	15	167	305
8	0	0	0	0	0	0	0	0	11	0	0
9	132	10	94	1	7	0	124	269	7	57	25
Total	393	395	391	370	398	270	395	395	397	373	398
LSI	5.6	4.3	7.2	3.6	5.8	3.6	6.4	7.8	4.4	6.5	6.5

(N- Natural; A- Artificial)

Table contd..

Score	Location/Frequency of scores (0-9)											
	A	A	A	N	A	A	A	A	A	A	A	A
Inoculation	MNC	MTU	NDL	NLR	NVS	NWG	PNT	PTB	PTN	RPR	TTB	VRN
0	55	0	0	0	0	0	0	0	0	0	0	0
1	52	0	7	72	10	284	19	4	0	3	2	12
2	0	0	0	0	0	0	0	0	0	0	0	0
3	110	0	24	98	92	79	66	49	5	14	192	137
4	0	0	0	0	0	0	0	0	0	0	0	0
5	135	1	154	116	211	14	86	167	52	40	173	171
6	0	0	0	0	0	0	0	0	0	0	0	0
7	34	15	190	93	81	0	111	158	40	275	26	63
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	375	23	17	0	0	111	9	0	63	0	13
Total	386	391	398	396	394	377	393	387	97	395	393	396
LSI	3.4	8.9	6.0	4.4	4.8	1.6	6.2	5.6	5.7	6.9	4.1	4.6

Table 57: NSN-1 entries with low susceptibility index (SI <4.5) with score <5 to BB at or more than 60% of the locations

E. No.	IET No.	Locations/Score (0-9)																			SI	PI (≤3)*	PI (≤5)**
		CHN	CHP	CHT	FZB	GER	GNV	IIRR	JGT	KJT	LUD	MNC	NDL	NLR	NVS	PNT	PTB	RPR	TTB	VRN			
4458	26746(R)	1	5	5	5	3	5	1	3	5	3	0	7	1	5	3	5	1	3	3	3.4	57.9	94.7
4402	27275 (R)	1	5	1	5	-	7	1	6	5	7	1	7	1	3	1	5	1	7	1	3.6	50.0	72.2
4483	28035	1	5	3	7	-	3	3	5	7	7	0	3	1	7	1	5	1	3	5	3.7	55.6	77.8
5021	28015	3	7	5	5	3	3	3	3	5	7	0	7	1	3	1	5	5	3	3	3.8	57.9	84.2
5025	27293	1	7	2	5	1	5	1	7	5	3	5	5	7	3	1	7	3	3	3	3.9	52.6	78.9
4423	28014	3	7	3	5	5	7	3	5	5	3	0	7	1	5	1	5	5	3	1	3.9	47.4	84.2
4424	28015	3	7	-	5	3	3	7	5	-	3	5	3	1	3	3	3	3	5	5	3.9	58.8	88.2
5020	28014	3	-	5	5	1	7	3	5	5	7	0	5	1	5	1	5	7	3	3	3.9	44.4	83.3
4437	27280	1	7	-	3	5	7	9	2	5	7	0	7	1	3	5	3	3	3	1	4.0	55.6	72.2
1001	26126	1	7	-	5	3	7	3	2	-	3	1	7	5	5	3	5	3	5	3	4.0	52.9	82.4
5027	27295	1	7	3	5	3	7	1	5	5	3	-	5	3	3	1	9	5	3	3	4.0	55.6	83.3
5028	27296	3	7	2	5	5	3	1	5	5	3	3	1	3	5	3	9	5	5	3	4.0	52.6	89.5
5002	27275	3	7	2	5	5	9	1	3	5	3	1	5	1	3	1	5	7	5	7	4.1	47.4	78.9
5046	28035	3	7	5	5	5	5	3	5	5	3	0	5	1	5	3	5	5	3	5	4.1	36.8	94.7
4115	26549	1	5	3	7	3	7	3	5	7	3	3	3	3	5	5	3	3	5	5	4.2	52.6	84.2
5026	27294	1	7	2	5	-	5	1	5	5	3	3	7	5	5	3	7	5	3	3	4.2	44.4	83.3
4457	26745(R)	3	7	5	5	-	3	3	5	5	3	0	7	3	3	5	5	7	3	3	4.2	50.0	83.3
5033	27280	3	7	2	5	3	5	9	3	5	7	1	5	3	3	1	7	3	5	3	4.2	52.6	78.9
1016	24855	1	7	2	5	-	3	7	2	5	7	-	7	3	5	3	5	7	3	1	4.3	47.1	70.6
4432	27296 (R)	1	7	3	5	3	9	1	6	7	3	5	1	5	5	1	7	3	3	7	4.3	47.4	68.4
1301	26027	1	7	3	5	3	7	5	1	5	3	0	7	3	5	7	5	7	3	5	4.3	42.1	73.7
1008	24931	3	7	5	5	3	7	3	2	5	3	0	7	3	5	5	7	5	3	5	4.4	42.1	78.9
4429	27293 (R)	1	7	-	7	5	3	1	6	7	3	1	7	5	5	1	7	7	5	1	4.4	38.9	61.1
2006	27077	3	7	2	5	3	3	7	1	-	7	3	7	5	5	5	3	5	5	3	4.4	44.4	77.8
1003	25746	1	5	-	5	5	7	3	3	-	7	1	9	3	5	3	5	7	3	3	4.4	47.1	76.5
4430	27294 (R)	1	7	2	5	5	7	1	5	7	3	5	1	5	5	1	7	7	5	5	4.4	31.6	73.7
1417	26858	5	7	3	3	3	5	7	4	5	7	3	7	1	5	3	3	7	3	3	4.4	47.4	73.7
5029	27297	3	9	2	7	5	5	1	9	5	3	5	3	1	3	3	7	5	5	3	4.4	47.4	78.9
313	26715	5	7	3	5	-	5	9	4	3	7	0	3	1	7	3	1	7	5	5	4.4	38.9	72.2
4006	26263	3	7	-	5	3	5	7	3	5	7	1	3	3	5	3	1	7	5	7	4.4	44.4	72.2
RP-Bio-226	RP-Bio-226	5	5	-	3	-	3	3	4	5	9	5	7	5	1	1	7	3	3	3	4.2	47.1	82.4
T(N1)	T(N1)	7	7	2	9	-	9	9	8	9	3	5	7	7	7	9	9	9	5	5	7.0	11.1	27.8
LSI		4.3	7.2	3.6	5.8	3.6	6.4	7.8	4.4	6.5	6.5	3.4	6.0	4.4	4.8	6.2	5.6	6.9	4.1	4.6			

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 58: Location severity index (LSI) and frequency distribution of bacterial blight scores of NSN- 2, Kharif' 2018

Score	Location/Frequency of scores (0-9)													
	A	N	A	A	A	A	A	A	A	A	A	A	A	A
Inoculation	ADT	CHT	FZB	GNV	IIRR	LOUD	MNC	MTU	NRRI	PNT	PTB	PTN	RPR	VRN
0	56	0	0	0	0	0	137	0	0	1	0	0	0	0
1	26	144	0	0	0	0	76	0	0	14	0	0	10	0
2	0	149	0	0	0	0	0	0	0	0	0	0	0	0
3	88	217	48	117	1	112	206	0	15	43	24	94	15	145
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	65	108	278	163	17	49	208	1	31	131	207	370	57	345
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	108	49	332	158	543	447	40	59	132	183	394	216	523	157
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	324	0	23	234	120	62	0	604	154	301	33	0	74	23
Total	667	667	681	672	681	670	667	664	332	673	658	680	679	670
LSI	6.4	3.0	6.0	6.5	7.3	6.4	3.0	8.8	7.6	7.1	6.3	5.4	6.9	5.2

(N- Natural; A- Artificial)

➤ **NSN-Hills**

The National Screening Nursery-Hills (NSN-Hills) consisted of 101 entries including 22 different checks. The entries were evaluated at 4 locations across the country. The entries were evaluated using artificial inoculation at all the four locations. The frequency distribution of the disease scores and location severity indices are presented in Table 60. The disease pressure was high (LSI-6-8) at NRRI (7.8), IIRR (7.6) and Pantnagar (6.2) and moderate at Karjat (LSI-5.9).

Data of all the four locations were considered for selection of promising entries. The promising entries with SI less than 5.5 and which exhibited a score of 5 at or more than 50% of the locations are presented in Table 61. Some of the highly promising entries which were on par or better than the resistant check Improved Samba Mahsuri were IET # 27461, 27466, 27487 and 26594. Some other promising entries were IET # 25818, 26596 and 26576.

Table 59: NSN-2 entries with low susceptibility index ($SI \leq 4.5$) with score ≤ 5 to bacterial blight at or more than 60% of the locations

S No.	E. No.	IET No.	Locations/Score (0-9)												SI	PI (≤ 3)**	PI (≤ 5)**
			CHT	FZB	GNV	IIRR	LUD	MNC	NRRI	PNT	PTB	PTN	RPR	VRN			
539	1816	27729	1	5	7	5	-	0	-	1	5	7	1	5	3.7	40.0	80.0
341	2309	27832	7	3	3	7	3	1	-	1	7	7	1	3	3.9	63.6	63.6
527	1804	27721	2	7	9	5	-	0	-	1	5	3	3	5	4.0	50.0	80.0
132	1723	27620	3	5	7	7	3	0	7	1	3	5	1	7	4.1	50.0	66.7
648	4803	28061	1	9	3	5	3	3	-	1	7	7	1	5	4.1	54.5	72.7
662	4817	28073	1	7	3	7	3	0	-	3	7	7	3	5	4.2	54.5	63.6
10	610	27579	1	5	7	7	3	0	5	5	3	5	7	3	4.3	41.7	75.0
271	1239	27768	1	5	3	7	3	0	7	3	5	7	5	5	4.3	41.7	75.0
163	1755	27650	2	7	9	5	3	1	3	3	5	5	3	5	4.3	50.0	83.3
450	1512	27669	3	5	3	5	7	1	-	1	5	7	3	7	4.3	45.5	72.7
127	1718	27615	2	5	3	7	7	0	7	3	5	3	5	5	4.3	41.7	75.0
267	1235	27764	5	5	3	7	3	3	9	3	5	5	1	3	4.3	50.0	83.3
286	1254	27781	2	3	3	7	7	3	7	3	5	3	7	3	4.4	58.3	66.7
229	4259	27460	1	5	9	7	5	0	3	5	5	3	7	3	4.4	41.7	75.0
237	1204	27739	3	5	3	7	3	0	9	5	5	3	5	5	4.4	41.7	83.3
667	4822	28077	1	7	5	7	5	3	-	3	7	5	1	5	4.5	36.4	72.7
613	2104	27806	1	5	9	7	3	1	-	3	5	5	5	5	4.5	36.4	81.8
346	2314	27837	3	5	3	5	3	5	-	3	7	7	3	5	4.5	45.5	81.8
182	4211	27416	1	7	5	7	3	3	3	3	7	5	5	5	4.5	41.7	75.0
510	RP-Bio-226 (R check)		1	3	3	3	5	3	-	1	7	7	3	7	3.9	63.6	72.7
503	TN1 (S Check)		2	7	9	9	9	-	-	9	7	3	7	5	6.7	20.0	30.0
	LSI		2.96	5.97	6.51	7.3	6.37	3.02	7.56	7.11	6.33	5.36	6.87	5.17			

(SI-Susceptibility Index; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 60: Location severity index (LSI) and frequency distribution of bacterial blight scores of NSN-Hills, Kharif' 2018

Score	Location/Frequency of scores (0-9)			
	IIRR	KJT	NRRI	PNT
Inoculation	A	A	A	A
0	0	0	0	1
1	0	0	0	5
2	0	0	0	0
3	1	16	0	18
4	0	0	0	0
5	4	28	11	21
6	0	0	0	0
7	61	44	39	22
8	0	0	0	0
9	35	7	51	33
Total	101	95	101	100
LSI	7.6	5.9	7.8	6.2

(N- Natural; A- Artificial)

Table 61: NSN-H entries with low susceptibility index (SI ≤ 5.5) with score ≤ 5 to bacterial blight at or more than 50% of the locations

S. No.	Entry No	IET No	Locations/Score (0-9)				SI	PI ($\sqrt[3]{\quad}$)**	PI ($\sqrt[5]{\quad}$)**
			IIRR	KJT	NRRI	PNT			
53	2701	27461	5	5	7	0	4.3	25.0	75.0
58	2707	27466	5	3	9	1	4.5	50.0	75.0
12	2912	27487	7	5	5	3	5.0	25.0	75.0
47	2813	26594	7	5	5	3	5.0	25.0	75.0
22	2601	25818	7	5	7	3	5.5	25.0	50.0
52	2818	26596	7	3	7	5	5.5	25.0	50.0
33	2612	26576	7	3	9	3	5.5	50.0	50.0
90	TN1 (S Check)		9	7	7	9	8.0	0.0	0.0
97	RP-Bio-226 (R Check)		3	7	9	1	5.0	50.0	50.0
LSI			7.6	5.9	7.8	6.2			

(SI-Susceptibility Index; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ **NHSN**

The National Hybrid Screening Nursery (NHSN) consisted of 108 entries including 28 different checks. The entries were evaluated at 20 locations across the country. The entries were evaluated using artificial inoculation at all the centres except at Chatha where the screening was done under natural condition. The frequency distribution of the disease scores and location severity indices are presented in Table 62. The disease pressure was extremely high at Maruteru (LSI-8.9); high (LSI 6-8) at NRRI (7.9), IIRR (7.7), Raipur (7.7), Aduthurai (7.3), Pattambi (6.6), Karjat (6.5), Pantnagar (6.4), Gangavathi (6.1) and Navsari (6.0); moderate (LSI-3-6) at Faizabad (5.7), Ludhiana (5.4), Chinsurah (5.3), Titabar (4.9), Varanasi (4.8), Jagtiyal (4.4), Chatha (4.2) and Patna (3.7) and very low (LSI < 3) at Moncompu (2.8) and Nawagam (2.0).

For selection of promising entries, data of Moncompu and Nawagam were not considered as the disease pressure was very low (LSI <3). Data of Maruteru was also not considered as the disease pressure was exceptionally high (LSI-8.9) where more than 99% of the entries showed highly susceptible reaction with a disease score of 9 which needs reconfirmation. Data of Aduthurai was also not considered based on the report of AICRIP monitoring team. At Aduthurai, BB susceptible checks like BPT 5204, Gontra Bidhan, Benibhog, Swarnadhan, Tetep and other showed a highly resistant reaction with a disease score of 1-3 while resistant check Improved Samba Mahsuri showed highly susceptible reaction with a disease score of 9 which needs reconfirmation. The promising entries with SI less than 5.5 and which exhibited a score of 5 at or more than 60% of the locations are presented in Table 63. None of the entries were on par or better than resistant check Improved Samba Mahsuri. Some of the highly promising entries with an average SI below 5 were IET # 27384, 27395, 27388, 27350, 27389, 27387 and 27378. Some of the other promising entries in NHSN were 27333, 27334, 27336, 27398, 27370, 27374, 27358, 27363, 27381, 27362, 27404 and 27400.

➤ **DSN**

The Donor Screening Nursery (DSN) consisted of 129 entries including 25 different checks. The entries were evaluated at 20 locations across the country. The entries were evaluated using artificial inoculation at all the centres except at Chatha and Chiplima where the screening was done under natural condition. The frequency distribution of the disease scores and location severity indices are presented in Table 64. The disease pressure was extremely high at Maruteru (LSI-8.7); high (LSI-6-8) at NRRI (7.9), Chiplima (7.6), Raipur (7.6), Aduthurai (7.1), IIRR (6.9), Pattambi (6.6), Ludhiana (6.0) and Patna (6.0); moderate (LSI-3-6) at Faizabad (5.8), Pantnagar (5.7), Port Blair (5.7), Gangavathi (5.1), Karjat (5.0), Navsari (5.0), Varanasi (4.8), Titabar (4.2), Gerua (4.0) and Chatha (3.7) and very low (LSI < 3) at Nawagam (1.7).

Table 62: Location severity index (LSI) and frequency distribution of bacterial blight scores of NHSN, Kharif' 2018

Score	Location/Frequency of scores (0-9)									
	ADT	CHN	CHT	FZB	GNV	IIRR	JGT	KJT	LUD	MNC
Inoculation	A	A	N	A	A	A	A	A	A	A
0	0	0	0	0	0	0	0	0	0	15
1	0	3	6	0	2	0	1	0	0	25
2	0	0	8	0	0	0	14	0	0	0
3	6	18	44	12	25	9	23	3	37	32
4	0	0	0	0	0	0	27	0	0	0
5	18	47	30	56	22	9	9	40	19	32
6	0	0	0	0	0	0	15	0	0	0
7	33	40	17	32	28	25	8	41	43	3
8	0	0	0	0	0	0	5	0	0	0
9	47	0	3	8	29	64	3	19	7	0
Total	104	108	108	108	106	107	105	103	106	107
LSI	7.3	5.3	4.2	5.7	6.1	7.7	4.4	6.5	5.4	2.8

(N- Natural; A- Artificial)

Table contd..

Score	Location/Frequency of scores (0-9)									
	MTU	NRRI	NVS	NWG	PNT	PTB	PTN	RPR	TTB	VRN
Inoculation	A	A	N/A	A	A	A	A	A	A	A
0	0	0	0	0	1	0	0	0	0	0
1	0	0	1	60	8	0	2	1	0	2
2	0	0	0	0	0	0	0	0	0	0
3	0	0	5	39	18	0	67	6	11	34
4	0	0	0	0	0	0	0	0	0	0
5	1	9	42	6	18	24	38	1	65	45
6	0	0	0	0	0	0	0	0	0	0
7	4	43	53	0	15	63	1	44	5	23
8	0	0	0	0	0	0	0	0	0	0
9	98	56	2	0	48	5	0	56	0	3
Total	103	108	103	105	108	92	108	108	81	107
LSI	8.9	7.9	6.0	2.0	6.4	6.6	3.7	7.7	4.9	4.8

(N- Natural; A- Artificial)

Table 63: NHSN entries with low susceptibility index (SI ≤ 5) with score ≤ 5 to BB at or more than 65% of the locations

S. No.	Ent. No.	IET No.	Locations/Score (0-9)																SI	PI (≤ 3)**	PI (≤ 5)**
			CHN	CHT	FZB	GNV	IIRR	JGT	KJT	LUD	NRRI	NVS	PNT	PTB	PTN	RPR	TTB	VRN			
44	3310	27384	3	3	3	7	3	4	5	3	9	9	0	5	3	3	5	1	4.1	56.3	81.3
58	3402	27395	3	3	7	3	3	3	5	3	5	7	1	—	3	7	3	7	4.2	60.0	73.3
49	3315	27388	1	3	3	9	3	4	5	3	7	5	1	7	3	7	5	3	4.3	50.0	75.0
6	3206	27350	1	3	7	7	3	6	3	3	5	7	3	7	5	7	5	3	4.7	43.8	62.5
51	3317	27389	5	3	9	7	5	4	5	3	7	5	1	5	3	7	3	3	4.7	37.5	75.0
48	3314	27387	3	2	7	7	5	2	5	3	7	7	5	5	5	7	3	3	4.8	37.5	68.8
37	3303	27378	3	3	3	9	5	6	5	5	7	7	3	7	5	3	5	3	4.9	37.5	68.8
80	3108	27333	5	2	5	5	9	2	7	5	9	5	5	—	3	7	3	3	5.0	33.3	73.3
81	3109	27334	5	5	3	7	7	2	5	7	7	5	3	7	3	7	5	3	5.1	31.3	62.5
83	3111	27336	5	3	7	3	7	4	7	3	7	7	5	5	3	7	5	3	5.1	31.3	62.5
62	3406	27398	3	3	7	9	5	4	5	3	9	5	1	7	5	3	7	5	5.1	31.3	68.8
28	3228	27370	5	3	5	9	3	3	5	9	9	5	1	7	3	7	-	3	5.1	40.0	66.7
32	3232	27374	7	2	5	5	9	3	5	3	7	5	7	7	3	7	5	3	5.2	31.3	62.5
16	3216	27358	5	5	7	7	3	4	5	3	7	-	3	7	5	7	3	7	5.2	26.7	60.0
21	3221	27363	5	5	5	3	5	8	5	3	9	5	5	7	3	7	-	3	5.2	26.7	73.3
41	3307	27381	5	5	3	3	7	3	5	5	9	7	7	7	5	7	5	1	5.3	25.0	62.5
20	3220	27362	5	3	7	3	5	3	5	3	9	7	9	5	5	7	-	3	5.3	33.3	66.7
72	3416	27404	5	1	5	5	9	4	7	5	9	5	1	7	3	7	5	7	5.3	18.8	62.5
66	3410	27400	5	3	5	3	9	-	7	3	9	5	9	—	5	7	3	3	5.4	35.7	64.3
104	RP-Bio-226 (R Check)		3	3	3	3	3	2	7	3	9	1	1	5	3	3	5	3	3.6	75.0	87.5
97	TN1 (S Check)		7	5	7	9	9	8	9	7	7	9	9	7	3	9	-	9	7.6	6.7	13.3
	LSI		5.3	4.2	5.7	6.1	7.7	4.4	6.5	5.4	7.9	6	6.4	6.6	3.7	7.7	4.9	4.8			

(SI-Susceptibility Index; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 64: Location severity index (LSI) and frequency distribution of bacterial blight scores of DSN, Kharif' 2018

Score	Location/Frequency of scores (0-9)									
	ADT	CHP	CHT	FZB	GER	GNV	IIRR	KJT	LUD	MTU
Inoculation	A	N	N	A	N/A	A	A	A	A	A
0	2	0	0	0	0	0	0	0	0	0
1	1	0	15	0	1	0	4	0	0	0
2	0	0	26	0	0	0	0	0	0	0
3	5	2	14	7	27	33	26	33	28	0
4	0	0	0	0	0	0	0	0	0	0
5	22	12	32	61	12	47	1	40	7	5
6	0	0	0	0	0	0	0	0	0	0
7	31	43	17	45	6	16	26	30	76	6
8	0	0	0	0	0	0	0	0	0	0
9	46	51	0	3	0	10	62	2	6	95
Total	107	108	104	116	46	106	119	105	117	106
LSI	7.1	7.6	3.7	5.8	4.0	5.1	6.9	5.0	6.0	8.7

Table contd..

Score	Location/Frequency of scores (0-9)									
	NRRI	NVS	NWG	PNT	POB	PTB	PTN	RPR	TTB	VRN
Inoculation	A	A	N/A	A	A	A	A	A	A	A
0	0	0	0	2	0	0	0	0	0	0
1	0	0	70	16	6	0	0	3	1	0
2	0	0	0	0	0	0	0	0	0	0
3	4	24	23	17	21	3	9	3	45	25
4	0	0	0	0	0	0	0	0	0	0
5	5	58	2	18	34	22	52	1	51	49
6	0	0	0	0	0	0	0	0	0	0
7	36	24	3	24	43	71	55	66	7	16
8	0	0	0	0	0	0	0	0	0	0
9	62	0	0	34	15	6	8	51	0	0
Total	107	106	98	111	119	102	124	124	104	90
LSI	7.9	5.0	1.7	5.7	5.7	6.6	6.0	7.6	4.2	4.8

For selection of promising entries, data of Nawagam was not considered as the disease pressure was extremely low (LSI-1.7). The data of Maruteru was also not considered as the disease pressure was exceptionally high (LSI-8.7) where more than 95% of the entries of DSN showed high level of susceptibility with disease score of 9 which needs further reconfirmation. Data of Aduthurai was also not considered for selection of promising entries based on the report of the AICRIP monitoring team. At Aduthurai, Swarna showed a score of 3 while Improved Samba Mahsuri showed a score of 7 which needs further reconfirmation. The promising entries with SI less than 5.3 and which exhibited a score of 5 at or more than 55% of the locations are presented in Table 65. Some of the entries which performed on par or better than resistant check Improved Samba Mahsuri were RP-Bio-Patho-4-1-2, MSM-TH-151, RDN-RIL-201 and IBT-R8. Some of the other promising entries which showed as SI of less than 5 were MIL-S7-8, GSY-4-6, GSY-4-1, MIL-S3-1, IL-5 and IL-1. Other promising entries were RP-Bio-Patho-5-156-24-216, TPL-68-3, MIL-SI-1, CB 15 144, IL-2, IL-4, RP-Patho-1-12-4, GSY-4-8, TPL-60-3, RP-Patho-12-1-16, UBKVR-15, CB 15 133 and RDN-RIL-152.

Table 65: DSN entries with low susceptibility index (SI < 5.3) with score ≤5 to BB at or more than 55% of the locations

S.No.	Designations	Locations/Score (0-9)																	SI	PI (≤3)**	PI (≤5)**
		CHP	CHT	FZB	GER	GNV	IIRR	KJT	LUD	NRRI	NVS	PNT	POB	PTB	PTN	RPR	TTB	VRN			
88	RP-Bio-Patho-4-1-2	7	2	5	3	5	3	3	-	3	3	3	7	3	3	9	3	5	4.2	62.5	81.3
123	MSM-TH-151	7	5	5	3	3	3	3	3	7	5	1	3	7	5	7	1	5	4.3	47.1	76.5
20	RDN-RIL-201	-	-	3	-	-	-	-	3	-	-	-	-	-	7	-	-	-	4.3	66.7	66.7
62	IBT-R8	9	3	7	-	3	3	3	7	9	3	1	5	5	-	1	3	-	4.4	57.1	71.4
55	MIL-S7-8	9	5	5	3	3	3	5	3	7	5	0	1	7	5	7	5	5	4.6	35.3	76.5
41	GSY-4-6	9	5	5	-	5	1	5	7	9	3	1	1	7	3	7	3	3	4.6	43.8	68.8
38	GSY-4-1	9	1	3	-	3	3	7	5	7	5	1	3	9	5	5	3	5	4.6	43.8	75.0
53	MIL-S3-1	9	2	7	-	5	3	3	3	7	5	1	3	5	7	7	5	3	4.7	43.8	68.8
37	IL-5	9	2	5	3	5	3	7	3	9	5	1	-	7	5	1	5	5	4.7	37.5	75.0
33	IL-1	9	2	5	-	5	1	5	3	7	5	1	3	7	5	7	-	7	4.8	33.3	66.7
89	RP-Bio-Patho-5-156-24-216	7	1	7	5	7	3	-	-	7	5	3	5	5	5	7	3	5	5.0	26.7	66.7
50	TPL-68-3	9	2	5	-	3	3	3	7	9	5	3	1	7	7	7	3	7	5.1	43.8	56.3
52	MIL-SI-1	9	3	5	-	5	3	5	3	9	7	0	3	5	9	7	3	5	5.1	37.5	68.8
24	CB 15 144	7	1	5	-	3	7	5	3	7	5	3	7	7	7	7	3	5	5.1	31.3	56.3
34	IL-2	9	1	7	-	5	1	5	3	9	5	1	5	7	7	7	3	7	5.1	31.3	56.3
36	IL-4	9	2	7	3	5	3	7	3	9	5	1	5	7	5	7	3	7	5.2	35.3	58.8
73	RP-Patho-1-12-4	7	2	5	3	3	9	5	7	7	3	7	7	5	5	7	3	3	5.2	35.3	58.8
42	GSY-4-8	9	7	7	-	5	3	7	7	5	3	3	3	7	7	3	3	5	5.3	37.5	56.3
46	TPL-60-3	7	1	7	-	3	3	3	7	9	5	1	5	7	9	9	3	5	5.3	37.5	56.3
84	RP-Patho-12-1-16	5	3	5	5	3	9	3	-	7	3	5	7	7	7	9	3	3	5.3	37.5	62.5
103	UBKVR-15	9	5	5	-	5	9	3	3	9	3	3	1	7	7	7	3	5	5.3	37.5	62.5
25	CB 15 133	7	5	5	-	5	7	3	7	7	3	5	5	5	5	9	3	3	5.3	25.0	68.8
11	RDN-RIL-152	-	-	7	-	-	9	3	3	-	-	-	5	-	3	7	-	-	5.3	42.9	57.1
114	RP-Bio-226 (R Check)	5	2	3	3	3	3	5	3	9	3	3	9	5	7	3	3	5	4.4	58.8	82.4
107	TN1 (S Check)	9	5	9	3	9	9	7	7	7	7	9	9	7	5	9	5	-	7.3	6.3	25.0
	LSI	7.6	3.7	5.8	4.0	5.1	6.9	5.0	6.0	7.9	5.0	5.7	5.7	6.6	6.0	7.6	4.2	4.8			

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3 and ≤5)

❖ RICE TUNGRO DISEASE (RTD)

➤ NSN-1

The national screening nursery 1 (NSN-1) trial consisting of 398 entries including checks was proposed and conducted at 2 locations viz., Coimbatore and IIRR. At both the locations the nursery was evaluated by artificial inoculations with the aid of leafhopper transmission in the glass house. The frequency distribution of disease scores and location severity indices are presented in Table 66. The disease pressure was high at IIRR (LSI 6.4) and moderate at Coimbatore (LSI 4.0).

Some of the entries performed better than the resistant check Vikramarya and the entries that showed moderate resistance to rice tungro disease are IET 25909, IET 26487, IET 28030, IET 28020, JKRH 3333 and Vikramarya (Table 67).

➤ NSN-2

The national screening nursery 2 (NSN-2) trial consisting of 682 entries including checks was conducted only at IIRR. The disease pressure recorded was high with LSI 6.4. Among the lines, 13 lines showed score 3, 179 lines with score 5 and rest of the entries were susceptible to the disease. Promising lines included IET nos., IET 27566, IET 27871, IET 27900, IET 27668, IET 27715, IET 27937, IET 27957, IET 27968, IET 27974, IET 27823 and 28063 (Table 68).

➤ NSN-H

One hundred and one entries were screened against rice tungro disease at Coimbatore and IIRR under high disease pressure with LSI of 5.9 and 6.1 respectively. The frequency distribution of disease scores and location severity indices are presented in Table 69. Only 16 lines at Coimbatore and 2 at IIRR expressed resistant reaction. The lines with score 3 are: IET 26573(TRC 2017-1), IET 26579 (HPR 2922), IET 27467 (VL 32300), IET 27472(HPR 2865), IET 26598 (VL 20083) (Table 70).

➤ NHSN

The National Hybrid Screening Nursery (NHSN) consisted of 108 entries including checks. The entries were tested at two centers viz., Coimbatore and IIRR. The frequency distribution of disease scores and LSI are presented in Table 71. The disease pressure was high at IIRR (LSI 6.1) and Moderate at Coimbatore (LSI 4.9). For the selection of promising entries both the locations were taken into consideration. The best entries which showed overall SI < 5 are listed in Table 72. The best entries are IET 27377(NRX-02), IET 27376 (IRH-119), IET 27400(MR-8655), IET 27330(SHX-023), IET 27345(JRH-102), IET 27372(LP-18302), IET 27375(JRH-107), IET 27398(PHI-18101), IET 27402(Bio-690) and IET 27328(SHX-015).

Table 66: Location severity index (LSI) and frequency distribution of rice tungro disease scores for NSN-1, Kharif, 2018

Score	Location/Frequency of Score (0-9 scale)	
	CBT	IIRR
1	85	0
3	99	8
5	129	110
7	67	279
9	8	0
Total	388	397
LSI	4.0	6.4
Screening Method	A	A

(N- Natural; A- Artificial)

Table 67: NSN-1 entries with low susceptibility index (SI $\leq$ 5) against rice tungro disease, Kharif, 2018

IET No.	Designation	Location/ Score (0-9)		SI	Total	<=3*	PI (≤ 3)**	<=5*
		CBT	IIRR					
25909	CR 3898-113-4-2-1	1	3	2.0	2	2	100	2
26487	YRH-2052 (Hybrid)	1	3	2.0	2	2	100	2
JKRH 3333 (HC)		3	3	3.0	2	2	100	2
28030	R-RF-139	3	3	3.0	2	2	100	2
28020	RP 6286-Bio Patho 5-156-24-32	3	3	3.0	2	2	100	2
Vikramarya (R)		3	3	3.0	2	2	100	2
T(N1) (S)		3	7	5.0	2	1	50	1
LSI		4.0	6.4					

(SI- Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ; **Promising Index (PI) based on percentage of locations the entry has scored ≤ 3 and ≤ 5)

Table 68: NSN-2 entries with low susceptibility index ($SI \leq 3$) against RTD, Kharif, 2018

Entry No.	IET No.	RTD score (0-9) at IIRR
701	27566	3
906	27871	3
940	27900	3
1511	27668	3
1561	27715	3
3714	27937	3
3736	27957	3
3748	27968	3
3754	27974	3
2124	27823	3
4805	28063	3
Vikramarya (R)		3
T(N1) (S)		7

Table: 69 Location severity index (LSI) and frequency distribution of rice tungro disease scores for NSN-H, Kharif, 2018

Score	Location/Frequency of Score (0-9 scale)	
	CBT	IIRR
1	0	0
3	16	2
5	32	42
7	44	57
9	8	0
Total	100	101
LSI	5.9	6.1
Screening Method	A	A

(N- Natural; A- Artificial)

Table 70: NSN-H entries with low susceptibility index ($SI \leq 5$) against RTD, Kharif 2018

Ent. No.	IET No.	Designation	Location/ Score (0-9)		SI	Total	<=3*	PI (≤ 3)**	<=5*	PI (≤ 5)**
			CBT	IIRR						
2611	26573	TRC 2017-1	3	5	4.0	2	1	50	2	100
2809	26579	HPR 2922	3	5	4.0	2	1	50	2	100
2708	27467	VL 32300	3	5	4.0	2	1	50	2	100
2714	27472	HPR 2865	3	5	4.0	2	1	50	2	100
3004	26598	VL 20083	3	5	4.0	2	1	50	2	100
Vikramarya (R)			7	3	5.0	2	1	50	1	50
T(N1) S)			7	7	7.0	2	0	0	0	0
LSI			5.9	6.1						

(SI- Susceptibility Index; *No. of locations where the entry has scored ≤ 3 and ≤ 5 ; **Promising Index (PI) based on percentage of locations the entry has scored ≤ 3 and ≤ 5)

Table 71: Location severity index (LSI) and frequency distribution of rice tungro disease scores for NHSN, Kharif, 2018

Score	Location/Frequency of score (0-9)	
	CBT	IIRR
1	10	0
3	21	3
5	43	44
7	26	61
9	6	0
Total	106	108
LSI	4.9	6.1
Screening Method	A	A

(N- Natural; A- Artificial)

Table 72: NHSN entries with low susceptibility index (SI ≤5) against rice tungro disease, Kharif, 2018

Ent. No	IET No.	Location/ Score (0-9)		SI	Total	<=3*	PI (≤3)**	<=5*	PI (≤5)**
		CBT	IIRR						
3302	27377	1	3	2.0	2	2	100	2	100
3301	27376	1	5	3.0	2	1	50	2	100
3410	27400	1	5	3.0	2	1	50	2	100
3104	27330	1	5	3.0	2	1	50	2	100
3122	27345	1	5	3.0	2	1	50	2	100
3230	27372	3	5	4.0	2	1	50	2	100
3234	27375	3	5	4.0	2	1	50	2	100
3406	27398	3	5	4.0	2	1	50	2	100
3413	27402	3	5	4.0	2	1	50	2	100
3101	27328	3	5	4.0	2	1	50	2	100
Vikramarya		5	3	4.0	2	1	50	2	100
T(N1) (S)		7	7	7.0	2	0	0	0	0
		LSI	4.9	6.1					

(SI- Susceptibility Index;*No. of locations where the entry has scored ≤3 and ≤5; **Promising Index (PI) based on percentage of locations the entry has scored ≤3 and ≤5)

➤ **DSN**

Donor screening nursery (DSN) comprising of 129 entries including checks were tested at Coimbatore and IIRR. The frequency distribution of disease scores and LSI are presented in Table 73. The disease pressure was high at IIRR (LSI 6.7) and moderate at Coimbatore (LSI 4.4).

Table 73: Location severity index (LSI) and frequency distribution of rice tungro disease scores for DSN Kharif, 2018

Score	Location/Frequency of scores (0-9 scale)	
	CBT	IIRR
1	26	0
3	29	1
5	32	24
7	18	86
9	2	0
Total	107	111
LSI	4.4	6.7
Screening Method	A	A

(N- Natural; A- Artificial)

The DSN entries that showed a moderate level of resistance to rice tungro disease are listed in Table 74. The promising entries included are CB 14 161, TPL-58-1, NWGR-11048, Tetep and CB 15 144.

Table 74: DSN entries with low susceptibility index (SI ≤5) against rice tungro disease, Kharif, 2018

S.No.	Ent. No.	Location/ Score (0-9)		SI	Total	<=3*	PI (≤3)**	<=5*	PI (≤5)**
		CBT	IIRR						
26	CB 14161	1	5	3.0	2	1	50	2	100
44	TPL-58-1	1	5	3.0	2	1	50	2	100
68	NWGR-11048	1	5	3.0	2	1	50	2	100
97	Tetep	1	5	3.0	2	1	50	2	100
24	CB 15 144	3	-	3.0	1	1	100	1	100
108	Vikramarya (R)	3	3	3.0	2	2	100	2	100
107	T(N1) (S)	1	7	4.0	2	1	50	1	50
	LSI	4.4	6.7						

(SI- Susceptibility Index;*No. of locations where the entry has scored ≤3 and ≤5; **Promising Index (PI) based on percentage of locations the entry has scored ≤3 and ≤5).

❖ MULTIPLE DISEASE RESISTANCE

In NSN-1, eight entries had shown resistant/moderately resistant reaction to two diseases. IET # 28014 and 28015 recorded resistant reaction against neck blast and moderate resistance to bacterial leaf blight. Similarly IET # 26027 and 27077 had shown moderate resistance to bacterial leaf blight and sheath rot. In addition, IET # 27094 (BS, ShR), 27280 (BLB, ShR), 28020 (NB, RTD), 25618 (LB, ShR) also expressed moderate resistance against two different diseases (Table 75).

Table 75: Multiple disease resistant lines in NSN-1, Kharif -2018

S.No	IET. No	Disease/Susceptible Index					
		LB	NB	BS	BLB	RTD	ShR
1	28014		2.8		3.9		
2	28015		2.8		3.8		
3	26027				4.3		3.3
4	27077				4.4		3.7
5	27094			5.0			3.7
6	27280				4.2		4.0
7	28020		3.5			3.0	
8	25618	3.8					2.6

(LB-Leaf Blast; NB-Neck blast; BS-Brown spot; BLB-Bacterial leaf blight; RTD-Rice tungro disease; ShR – Sheath rot)

In NSN-2, IET # 27579 had shown moderate resistance to three diseases viz., sheath rot, bacterial leaf blight and brown spot. In addition, IET # 27668 (LB, NB), 27781 (NB, BLB), 27747 (LB, BS) and 27806 (BLB, BS) expressed moderate resistance against two diseases (Table 76).

Table 76: Multiple disease resistance in NSN-2, Kharif – 2018

S.No	IET. No	Disease/Susceptible Index				
		LB	NB	ShR	BLB	BS
1	27579			3.3	4.3	5.0
2	27668	3.8	3.7			
3	27781		3.7		4.4	
4	27747	4.0				4.9
5	27806				4.5	5.0

(LB-Leaf Blast; NB-Neck blast; BS-Brown spot; BLB-Bacterial leaf blight; ShR – Sheath rot)

Under NSN-H, some lines expressed resistant reaction to more than two diseases viz., IET # 25826 (moderately resistant to leaf blast, neck blast and sheath rot), 26576 (moderately resistant to neck blast, sheath rot and brown spot), IET # 26594 (moderately resistant to neck blast, sheath rot and bacterial leaf blight), IET # 27461 (moderately resistant to neck blast, bacterial leaf blight and resistant to sheath rot), IET # 27466 (moderately resistant to leaf blast, bacterial leaf blight and brown spot), IET # 27467 (moderately resistant to leaf blast, brown spot and RTD). Nine entires viz., IET # 27472 (LB, RTD), 25841 (ShR, BS), 26564 (NB, ShR), 27465 (ShR, BS), 27487(LB, BLB), 27488(LB, BS), 27496 (NB, ShR), 27498 (NB, BS) and 27500 (ShR, BS) recorded moderate resistant reaction against two diseases (Table 77).

Table 77: Multiple disease resistance in NSN-H, Kharif- 2018

S.No	IET. No	Disease/Susceptible Index					
		LB	NB	ShR	BLB	BS	RTD
1	25826	4.6	3.4	5.0			
2	26576		3.4	5.0		4.6	
3	26594		3.8	5.0	5.0		
4	27461		3.6	2.5	4.3		
5	27466	4.4			4.5	5.0	
6	27467	4.6				4.8	4.0
7	27472	4.3					4.0
8	25841			5.0		4.0	
9	26564		3.4	5.0			
10	27465			5.0		4.8	
11	27487	4.2			5.0		
12	27488	4.7				4.6	
13	27496		3.0	5.0			
14	27498		3.8			3.6	
15	27500			3.5		4.8	

(LB-Leaf blast; NB-Neck blast; BS-Brown spot; BS-Brown spot; BLB-Bacterial leaf blight; ShR – Sheath rot; RTD-Rice tungro disease)

In NHSN, IET # 27378 showed resistant reactions to four diseases (resistant to neck blast and moderately resistant to sheath rot, bacterial leaf blight and brown spot). Entries recorded resistant/ moderate resistant reaction against three diseases were IET # 27333 (moderately resistant to sheath rot, bacterial leaf blight and brown spot), 27377 (moderately resistant to leaf blast and brown spot and resistant to Rice tungro disease) and 27389 (resistant to neck blast and moderately resistant to bacterial leaf blight and brown spot).

The entries which shown resistance to two diseases included IET Nos. 27328 (moderately resistant to leaf blast and rice tungro disease), 27346 and 27363 (moderately resistant to leaf blast and resistant to neck blast), 27376 (moderately resistant to brown spot and resistant to RTD), 27384 (moderately resistant to bacterial leaf blight and brown spot), 27388 (resistant to neck blast and moderately resistant to bacterial leaf blight) and 27397 (moderately resistant to neck blast and brown spot) (Table 78).

Table 78: Multiple disease resistance in NHSN, Kharif – 2018

S.No	IET. No	Disease/Susceptible Index					
		LB	NB	ShR	BLB	BS	RTD
1	27378		3.0	4.8	4.9	5.0	
2	27333			4.3	5.0	4.5	
3	27377	3.9				5.0	2.0
4	27389		2.0		4.7	5.0	
5	27328	3.9					4.0

S.No	IET. No	Disease/Susceptible Index					
		LB	NB	ShR	BLB	BS	RTD
1	27378		3.0	4.8	4.9	5.0	
2	27333			4.3	5.0	4.5	
3	27377	3.9				5.0	2.0
4	27389		2.0		4.7	5.0	
6	27346	3.7	3.0				
7	27363	3.7	3.0				
8	27350			4.0	4.7		
9	27376					4.5	3.0
10	27384				4.1	4.3	
11	27388		3.0		4.3		
12	27397		3.5			5.0	

(LB-Leaf blast; NB-Neck blast; BS-Brown spot; BS-Brown spot; BLB-Bacterial leaf blight; ShR – Sheath rot; RTD- Rice tungro disease)

In DSN, CB14161 and NWGR-11048 (moderate resistant to neck blast, sheath rot and resistance to rice tungro disease) and RNR-11450 (moderate resistant to neck blast, sheath rot and brown spot) showed resistant reaction to three diseases. IET numbers showed moderate resistant reaction to two diseases were MIL-S3-1(sheath rot and bacterial leaf blight), MIL-SI-1(sheath rot and brown spot), RP-Bio-Patho-1-8-6 (leaf blast and brown spot) , RP-Bio-Patho-2-9-2 (leaf blast and neck blast) , RP-Bio-Patho-4-1-2 (sheath rot and bacterial leaf blight), RP-Patho-2-1-28 and RP-Patho-6-1-13 (leaf blast and neck blast) (Table 79).

Table 79: Multiple disease resistance in DSN Kharif – 2018

IET. No	Disease/Susceptible Index					
	LB	NB	ShR	BLB	BS	RTD
CB 14161		4.0	5.0			3.0
NWGR-11048		4.0	4.5			3.0
RNR 11450		3.3	5.0		5.0	
MIL-S3-1			4.4	4.7		
MIL-SI-1			3.6		5.0	
RP-Bio-Patho-1-8-6	4.3				4.8	
RP-Bio-Patho-2-9-2	4.1	4.0				
RP-Bio-Patho-4-1-2			5.0	4.2		
RP-Patho-2-1-28	4.3	4.0				
RP-Patho-6-1-13	4.2	4.0				

(LB-Leaf blast; NB-Neck blast; ShR – Sheath rot; BS-Brown spot; BLB-Bacterial leaf blight; RTD- Rice tungro disease)

II. FIELD MONITORING OF VIRULENCE

1. *Pyricularia oryzae*

The experiment was conducted at 24 locations across the India against *Pyricularia oryzae* during *Kharif* 2018. The aim of this experiment was to monitor virulence pattern in the population of rice blast pathogen. The nursery included twenty five cultivars consisting of international differentials, donors and commercial cultivars. The experiment was conducted at twenty four locations with different dates of sowing during the crop season to monitor the blast reaction on different host genotypes and is presented in Figure 1. The disease pressure was high (LSI 6.4, 6.3 and 6.2) at Ghaghraghat, Imphal and Coimbatore. It was moderate (LSI 4.3 to 5.7) at Mandya, Almora, Gudalur, New Delhi, Lonavala, NRRI, Upper Shillong, Gangavati, Nellore, Ponnampet, Jagdalpur and Malan. It was low (LSI 3.7 to 2.2) at Karjat, Rajendranagar, Jagdalpur, Navsari, Hazaribagh, IIRR, Pattambi, Nawagam and Khudwani. The data from these locations are presented in Table 80.

Tetep, Raminad str-3 and Tadukan were resistant across the locations with SI 2.8, 2.9 and 3.1 respectively. Tetep and Raminad str-3 was highly resistant at most of the locations about 17 locations that showed its potentiality as the best donors for resistance against blast disease. Tetep was susceptible at Ghaghraghat and moderately susceptible at Almora, Imphal and Karjat. Raminad str-3 was susceptible at Ghaghraghat and Imphal and also moderately susceptible at NRRI. Tadukan was showing resistant all the locations except Imphal, Almora, Ghaghraghat, Mandya NRRI and Nellore. NP-125 was highly susceptible at Coimbatore, Ghaghraghat and New Delhi. The susceptible checks like HR-12 and CO-39 are showing susceptible reaction at most of the locations but HR-12 recorded resistant reaction at Khudhwani, Pattambi and Karjat and Co-39 also recorded low disease score at Karjat, Khudhwani and Nawagam. The resistant check Rasi was highly susceptible at Imphal, Upper Shillong and Rajendranagar. IR-64 was showing susceptible reaction at Almora, Imphal and Lonavala.

The difference in disease reaction score of susceptible and resistant checks reveals that a shift in the pathogen population. Cluster analysis of *Pyricularia oryzae* reaction on 25 different genotypes at 24 locations was done and is presented in Figure 2. The reaction pattern of genotypes at all the locations was grouped into eight major groups at 60 percent similarity coefficient. The reaction pattern at Almora, NRRI, Ghaghraghat, Imphal, Coimbatore, Upper Shillong, Mandya, Lonavala, Jagdalpur, New Delhi, Ponnampet, Gudalur, Nellore and Malan were in group one; Gangavati, Karjat, Hazaribagh and Jagtial were in group two, three, four and five respectively; IIRR and Navasari are in group six; Nawagam and Pattambi are in group seven and Khudhwani in group Eight.

Table 80: Reaction of rice differentials to *Pyricularia oryzae* at across the locations in India during Kharif -2018

Ent. No	Differentials	GGT	IMP	CBT	MDY	ALM	GDL	NDL	LVN	NRRI	USH	GGV	NLR	PNP	JDP	MLN	KJT	RNR	JGT	NVS	HZB	IIRR	PTB	NWG	KHU	SI	<=3*	<=5*	Total
	LSI	6.4	6.3	6.2	5.7	5.3	5.2	5.2	5.1	5.1	4.6	4.6	4.4	4.4	4.3	4.3	3.7	3.4	3.4	3.4	3.3	3.1	3.0	3.0	2.2				
	Screening Method	-	N	-	N/A	N	N	A	N	A	N	A	N	N	N	N/A	A	N/A	-	N/A	N	A	N	N	N/A				
22	Tetep	7.0	4.8	3.0	3.0	5.0	3.0	3.0	1.8	4.0	3.3	2.8	3.0	2.5	2.3	1.0	4.8	2.5	1.3	1.0	0.5	1.0	3.5	1.0	1.5	2.8	17	23	24
12	Raminad -STR -3	7.0	6.8	-	3.0	2.5	3.0	0.0	2.8	6.0	3.3	2.3	3.0	4.5	2.3	1.3	-	2.5	2.0	2.5	2.5	2.0	2.5	1.8	1.0	2.9	17	19	22
20	Tadukan	5.0	5.5	3.0	4.5	5.5	3.0	3.0	3.0	4.0	3.3	3.3	4.0	2.5	3.5	1.3	-	3.0	1.3	3.0	0.5	3.0	3.0	1.8	2.0	3.1	14	21	23
14	NP - 125	7.0	5.3	9.0	4.5	4.0	3.0	7.0	3.8	4.0	4.0	2.8	3.0	5.5	4.5	0.5	3.3	2.8	2.0	2.5	0.5	2.0	1.8	2.3	3.0	3.7	12	19	24
16	Dular	5.0	5.8	-	1.0	7.0	3.0	6.0	3.8	4.0	4.0	2.5	2.5	5.0	4.8	6.5	3.5	2.5	5.0	2.8	2.0	2.0	3.3	-	1.0	3.8	9	18	22
5	RIL - 10	6.0	6.3	-	5.0	4.0	-	5.0	3.5	4.0	-	2.8	3.5	-	4.8	4.8	-	3.0	4.0	2.5	-	3.0	2.5	3.3	1.5	3.8	6	16	18
7	<i>O. minuta</i>	7.0	6.0	5.0	4.5	4.5	6.0	2.0	6.8	4.0	4.3	3.0	5.5	4.3	2.5	4.3	4.0	2.3	3.5	3.0	2.0	2.0	2.0	2.5	2.0	3.9	10	19	24
6	RIL - 29	7.0	5.8	5.0	5.0	5.0	4.0	4.0	4.5	6.0	3.8	3.8	3.5	4.3	3.8	3.8	3.5	2.8	3.5	3.5	2.0	3.0	1.8	3.0	1.5	3.9	6	21	24
21	IR - 64	5.5	6.8	5.0	4.5	7.0	3.0	5.0	6.8	6.0	4.3	3.5	5.0	3.8	2.3	5.0	3.3	2.0	2.3	3.0	0.5	3.0	2.0	1.3	3.0	3.9	10	19	24
1	C101 LAC	7.0	7.0	5.0	4.0	5.0	6.0	6.0	5.0	4.0	4.0	2.8	4.5	3.5	4.3	3.5	3.5	1.8	2.3	3.0	2.0	3.0	2.3	2.8	2.5	3.9	9	20	24
13	Zenith	7.0	6.0	5.0	6.5	5.0	4.0	3.0	5.8	4.0	3.8	5.8	2.5	4.5	3.0	1.8	4.0	3.3	3.0	2.8	5.5	2.0	3.5	2.5	1.0	4.0	9	18	24
2	C101 A51	7.0	6.8	7.0	6.5	5.0	4.0	5.0	5.0	4.0	4.3	3.0	5.0	3.5	4.3	3.3	4.0	2.3	2.3	2.5	2.0	3.0	2.5	3.3	2.5	4.1	8	20	24
11	C101 PKT	6.0	6.5	7.0	7.0	3.5	3.0	4.0	5.5	4.0	4.0	7.3	5.0	4.8	5.5	1.5	3.5	2.8	2.3	3.0	2.5	3.0	2.5	3.5	1.0	4.1	9	17	24
4	C101 TTP	6.0	6.0	5.0	5.5	5.0	6.0	6.5	5.3	4.0	4.3	7.8	4.5	2.8	4.5	4.8	3.8	3.0	3.8	3.0	0.5	2.0	2.8	3.0	2.0	4.2	8	17	24
17	Kanto - 51	7.0	5.3	5.0	5.5	5.5	3.0	8.0	3.8	6.0	4.0	3.0	3.0	3.3	5.3	4.3	3.3	3.3	4.3	4.5	2.0	4.0	3.5	-	3.0	4.3	5	16	23
10	A 57	7.0	7.0	9.0	7.0	5.0	6.0	5.0	4.0	6.0	4.8	9.0	5.5	5.0	5.0	1.0	3.3	2.8	1.3	3.0	3.0	3.0	3.3	3.0	2.0	4.6	8	16	24
19	Calaro	7.0	5.5	-	6.5	6.5	-	6.0	8.0	4.0	-	3.0	3.0	-	2.8	6.8	-	3.0	4.3	3.0	4.0	2.0	-	-	3.5	4.6	6	10	17
9	BL-245	7.0	6.8	7.0	7.5	5.5	5.0	6.0	4.3	6.0	4.0	6.0	5.5	4.5	4.5	4.3	2.8	2.8	2.8	3.8	6.0	3.0	2.8	3.3	1.0	4.7	6	14	24
8	BL-122	7.0	6.3	9.0	8.0	4.5	6.0	4.0	7.5	6.0	3.8	7.3	5.0	3.8	4.5	5.5	3.8	3.0	3.0	3.0	3.0	3.0	2.8	3.5	1.0	4.8	7	15	24
3	C104 PKT	7.0	7.0	-	7.0	5.0	9.0	6.0	3.0	4.0	6.5	4.3	5.5	5.0	4.8	5.5	3.5	2.0	3.8	2.5	7.0	2.0	3.5	3.0	3.0	4.8	6	14	23
24	Rasi	5.0	7.8	7.0	5.5	7.0	4.0	4.0	3.5	6.0	7.8	2.8	4.5	5.0	4.3	7.5	4.5	7.8	4.5	3.0	3.5	3.0	3.8	4.5	4.5	5.0	3	16	24
15	USEN	7.0	5.5	7.0	7.0	6.0	9.0	7.0	7.3	6.0	6.0	3.3	5.5	5.8	5.3	6.8	3.0	3.3	5.3	3.0	5.5	3.0	4.0	-	2.0	5.4	4	7	23
18	Shi-tia-tao	7.0	7.0	5.0	8.0	6.5	9.0	6.5	6.5	6.0	6.3	4.3	6.0	4.5	4.5	7.8	4.5	5.5	3.5	5.5	7.0	5.0	4.0	-	3.5	5.8	0	9	23
25	Co - 39	5.0	7.3	9.0	7.5	7.0	9.0	8.0	8.3	8.0	6.3	9.0	5.5	5.8	8.5	8.0	3.8	8.0	6.8	7.0	7.0	7.0	5.0	4.3	4.0	6.9	0	5	24
23	HR - 12	5.0	6.5	-	9.0	7.0	9.0	9.0	9.0	8.0	6.8	9.0	7.5	8.0	7.3	8.0	4.0	8.5	6.8	7.5	9.0	9.0	3.8	6.5	3.0	7.3	1	4	23

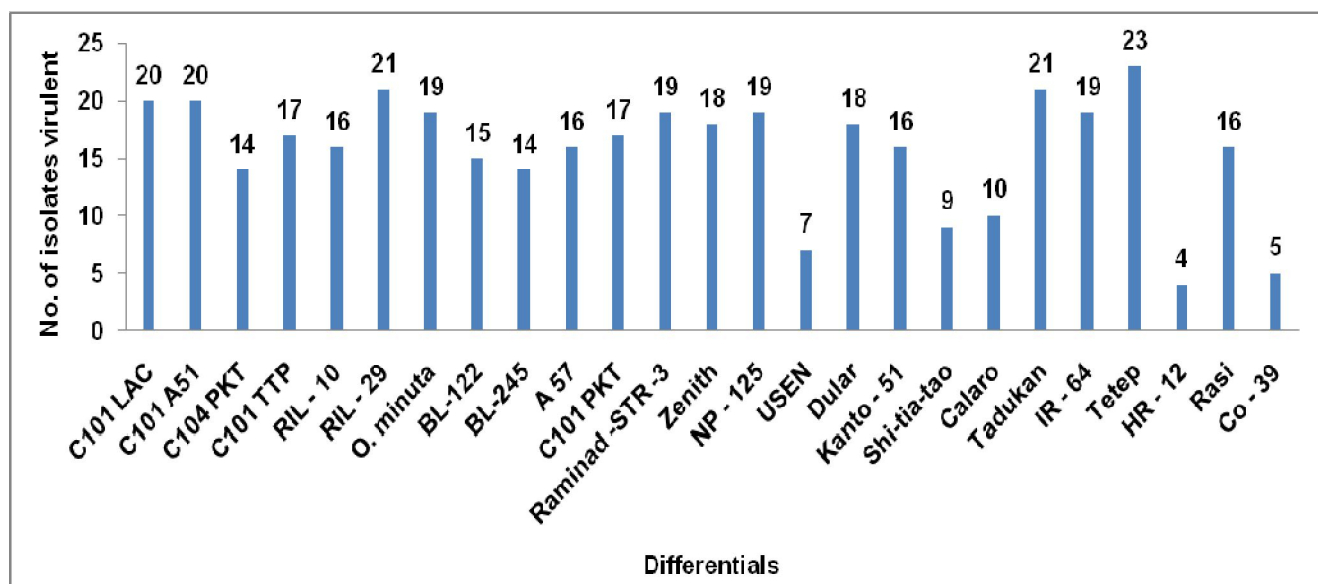


Figure 1: Differential reaction of hosts to rice blast pathogen (*Pyricularia oryzae*) at different locations - Kharif 2018

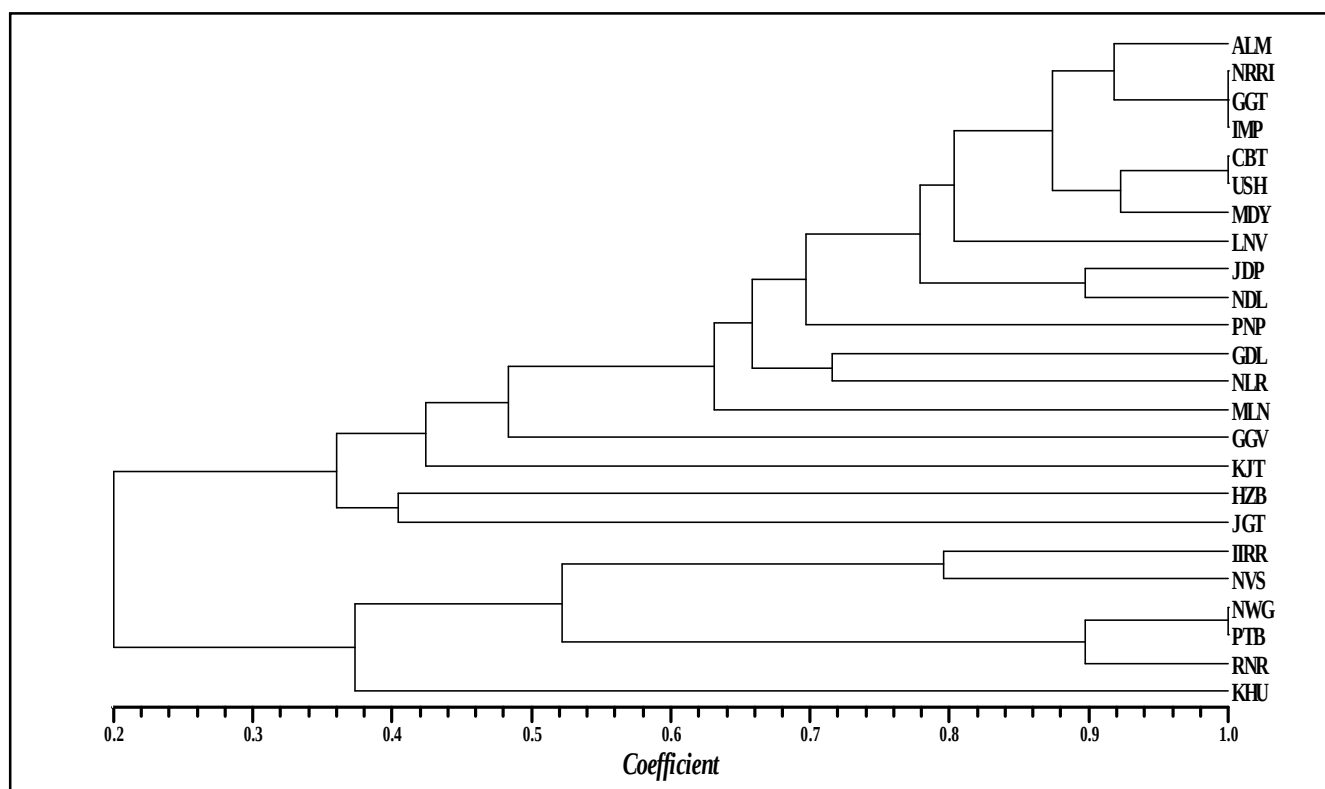


Figure 2: Dendrogram showing relatedness of different reactions of *P. oryzae* at different locations during Kharif -2018

2. *Xanthomonas oryzae* pv. *oryzae*

Xanthomonas oryzae pv. *oryzae* virulence monitoring trial was proposed at 26 hot spot locations across India for *Kharif* season of 2018. However, the data were received from 25 locations. At Ludhiana, the trial was conducted with 10 different strains of *Xanthomonas oryzae* pv. *oryzae*. The rice differentials used in this trial consisted of twenty eight near isogenic lines (IRBB lines) possessing different bacterial blight resistant genes (singly) or various combination 5 BB resistance genes viz., *Xa4*, *xa5*, *Xa7*, *xa13* and *Xa21* in the background of rice cultivar IR 24. The differentials like DV 85, TN1 (susceptible check) and Improved Samba Mahsuri (RP Bio 226) (resistant check) were also included in the trial. The isolates from Maruteru, Sabour and New Delhi were highly virulent with LSI (location Severity Index) more than 6. The isolate from Maruteru produced susceptible reaction on all the 31 differentials. The isolates from Sabour and New Delhi produced susceptible reaction on 19 differentials. All these three isolates produced susceptible reaction on *Xa21*. However, the isolate from Sabour showed moderate reaction on *xa13*. Though combinations like *xa13*+*Xa21* and *xa5*+*xa13*+*Xa21* showed resistant reaction to Sabour and New Delhi isolates, they were susceptible to isolate from Maruteru. The isolates from Jagtiyal, Gerua, Titabar, NRRI, Moncompu, Nawagam and some isolates from Ludhiana like Lud-2, Lud-3 and Lud-4 were less virulent with LSI ranging from 2.1-3.9. These isolates produced susceptible reaction on 1-5 differentials. These isolates produced resistant reaction on most of the major genes and on different gene combinations. The isolates from Faizabad, Gangavathi, Rajendranagar, Chiplima, Aduthurai, Pattambi, Patna, Chinsurah, Port Blair, Pantnagar, Karjat, Raipur, Navsari and many isolates from Ludhiana (Lud-1, Lud-5, Lud-6, Lud-7, Lud-8, Lud-9 and Lud-10) showed moderate reaction with LSI ranging from 4.1-5.9. These isolates produced susceptible reaction on 1-17 differentials. If we see the overall reaction of the differentials, *xa13* was susceptible in 11 locations while *Xa21* was susceptible in 19 locations (Table 81; Figure 3). Among the 2-gene combinations, IRBB 55 (*xa13* + *Xa21*) showed susceptibility at many places. Most of the 3,4 and 5 genes combinations lines also showed susceptibility at some locations indicating minor changes in the *Xoo* pathogen population. Cluster analysis of *Xanthomonas oryzae* pv. *oryzae* reaction on different genotypes at various locations was done and is presented in Figure 4. The isolates belonging to different virulence categories (high virulence, moderate virulence and low virulence) very clearly formed separate groups.

Table 81: Reaction of rice differentials to *Xanthomonas oryzae* pv. *oryzae* at different locations during Kharif 2018

Differen- tials	Gene combinations	Highly virulent			Moderately virulent															
		MTU	SBR	NDL	FZB	GNV	RNR	CHP	CBT	LUD-9	ADT	IIRR	PTB	LUD-5	LUD-7	PTN	CHN	POB	PNT	
IRBB - 1	<i>Xa1</i>	8	9	9	5	9	5	9	7	7	5	9	7	7	7	4	5	-	9	
IRBB - 3	<i>Xa3</i>	8	7	9	5	9	5	8	7	7	1	9	5	7	7	5	7	7	9	
IRBB - 4	<i>Xa4</i>	8	9	9	6	9	6	7	7	7	5	9	5	7	7	4	6	3	9	
IRBB - 5	<i>xa5</i>	8	9	9	5	8	7	8	7	7	7	9	5	7	7	6	6	7	7	
IRBB - 7	<i>Xa7</i>	7	5	5	6	3	6	6	3	7	5	9	5	7	7	5	6	5	5	
IRBB - 8	<i>xa8</i>	8	9	7	5	6	7	6	5	7	7	9	5	7	7	4	5	7	3	
IRBB - 10	<i>Xa10</i>	9	9	9	7	5	9	9	7	7	6	9	6	7	7	6	8	9	9	
IRBB - 11	<i>Xa11</i>	9	9	5	8	5	9	8	5	7	5	7	6	7	7	5	8	9	9	
IRBB - 13	<i>xa13</i>	9	5	7	7	3	8	6	5	-	7	9	7	-	-	6	4	7	3	
IRBB - 14	<i>Xa14</i>	9	9	5	7	6	8	9	5	7	7	6	6	7	7	6	7	7	3	
IRBB - 21	<i>Xa21</i>	8	9	6	5	7	7	6	3	7	8	9	5	7	7	6	4	7	7	
IRBB - 50	<i>Xa4+xa5</i>	8	5	7	7	9	6	7	5	7	6	3	5	7	5	4	5	1	3	
IRBB - 51	<i>Xa4+xa13</i>	8	9	7	4	5	5	6	7	3	5	1	5	3	3	5	3	5	3	
IRBB - 52	<i>Xa4+Xa21</i>	8	7	9	5	3	4	5	7	3	1	5	6	3	3	6	3	3	1	
IRBB - 53	<i>xa5+xa13</i>	8	9	5	6	4	3	5	7	-	1	1	5	-	3	7	4	7	5	
IRBB - 54	<i>xa5+Xa21</i>	8	9	6	7	5	6	4	7	5	3	2	5	3	7	4	3	3	3	
IRBB - 55	<i>xa13+Xa21</i>	8	5	4	7	7	8	4	7	-	7	3	7	-	3	2	6	7	7	
IRBB - 56	<i>Xa4+xa5+xa13</i>	8	3	1	7	4	4	4	5	-	3	3	5	-	-	5	5	3	3	
IRBB - 57	<i>Xa4+xa5+Xa21</i>	8	9	3	7	5	4	3	3	3	6	1	6	3	3	6	3	1	1	
IRBB - 58	<i>Xa4+xa13+Xa21</i>	8	5	7	7	3	3	3	3	3	5	1	4	3	3	6	3	3	3	
IRBB - 59	<i>xa5+xa13+Xa21</i>	7	3	4	5	5	3	4	7	3	5	3	4	3	3	5	4	3	5	
IRBB - 60	<i>Xa4+xa5+xa13+Xa21</i>	7	3	3	5	3	2	4	7	-	5	1	3	-	-	3	6	5	0	
IRBB - 61	<i>Xa4 + xa5 + Xa7</i>	6	3	5	7	3	-	4	3	7	8	5	5	3	7	4	5	1	3	
IRBB - 62	<i>Xa4 + Xa7 + Xa21</i>	8	7	7	4	8	5	3	7	3	5	7	4	3	3	4	3	1	-	
IRBB - 63	<i>xa5 +Xa7 + xa13</i>	6	7	7	5	7	5	3	5	3	5	7	4	3	3	6	3	1	-	
IRBB - 64	<i>Xa4 + xa5 + Xa7 + Xa21</i>	8	9	9	5	8	3	3	5	3	4	6	4	3	3	4	7	5	1	
IRBB - 65	<i>Xa4 + Xa7 + xa13 + Xa21</i>	9	1	4	7	8	9	5	-	-	3	3	5	-	-	6	9	7	9	
IRBB - 66	<i>Xa4 + xa5 + Xa7 + xa13 + Xa21</i>	8	3	6	4	5	3	3	5	3	6	1	4	3	3	6	3	7	5	
DV - 85	-	8	7	5	7	9	9	6	3	7	5	-	5	7	7	5	3	3	1	
ISM	<i>xa5+xa13+Xa21</i>	7	5	9	3	3	1	3	5	3	7	1	5	3	3	8	1	7	1	
TN1	-	9	9	9	9	9	9	9	3	7	9	9	8	7	7	6	9	9	9	
LSI		7.9	6.7	6.4	5.9	5.9	5.6	5.5	5.4	5.3	5.2	5.2	5.2	5.1	5.1	5.1	5	5	4.7	
Min Score		6	1	1	3	3	1	3	3	3	1	1	3	3	3	2	1	1	0	
Max Score		9	9	9	9	9	9	9	7	7	9	9	8	7	7	8	9	9	9	
# entries > 5		31	19	19	17	15	15	15	13	14	13	15	9	13	14	14	12	14	10	

Table 81: Reaction of rice differentials to *Xanthomonas oryzae* pv. *oryzae* at different locations during Kharif 2018 (Contd..)

Differen- tials	Gene combinations	Moderately virulent							Less virulent								
		KJT	RPR	LUD-10	LUD-6	LUD-8	NVS	LUD-1	JGT	LUD-4	GER	LUD-2	TTB	LUD-3	NRRI	MNC	NWG
IRBB - 1	<i>Xa1</i>	5	6	7	7	-	7	7	5	-	3	3	5	3	5	1	3
IRBB - 3	<i>Xa3</i>	5	6	7	7	7	6	5	5	-	3	-	5	-	5	0	2
IRBB - 4	<i>Xa4</i>	5	6	7	-	3	6	3	5	3	4	3	5	3	5	0	2
IRBB - 5	<i>xa5</i>	4	3	7	5	-	5	7	5	7	4	3	5	3	3	2	2
IRBB - 7	<i>Xa7</i>	5	6	7	7	7	5	5	4	3	3	5	4	3	1	1	3
IRBB - 8	<i>xa8</i>	5	7	7	5	7	6	3	4	3	4	3	3	3	3	4	2
IRBB - 10	<i>Xa10</i>	5	5	7	7	7	5	7	6	7	5	7	7	7	1	4	1
IRBB - 11	<i>Xa11</i>	5	5	7	7	7	5	7	6	-	3	-	5	-	1	4	3
IRBB - 13	<i>xa13</i>	5	5	3	3	7	3	3	3	3	5	3	5	3	3	1	3
IRBB - 14	<i>Xa14</i>	5	6	7	7	7	5	7	6	7	3	7	5	7	5	3	1
IRBB - 21	<i>Xa21</i>	4	6	7	7	-	4	7	4	7	4	5	5	5	1	1	2
IRBB - 50	<i>Xa4+xa5</i>	4	4	3	3	3	5	3	4	3	4	3	4	3	1	0	2
IRBB - 51	<i>Xa4+xa13</i>	4	4	3	-	3	1	3	3	3	3	5	3	3	1	2	3
IRBB - 52	<i>Xa4+Xa21</i>	3	5	3	3	3	3	3	3	3	2	3	3	3	3	4	1
IRBB - 53	<i>xa5+xa13</i>	5	4	3	-	3	4	3	2	3	5	3	5	3	1	1	3
IRBB - 54	<i>xa5+Xa21</i>	5	3	3	3	3	4	3	4	3	2	3	3	3	1	2	2
IRBB - 55	<i>xa13+Xa21</i>	4	6	3	3	7	3	3	4	3	3	3	5	3	1	8	1
IRBB - 56	<i>Xa4+xa5+xa13</i>	5	6	3	3	3	-	3	3	3	4	3	2	3	1	3	1
IRBB - 57	<i>Xa4+xa5+Xa21</i>	5	6	5	3	3	3	3	3	3	3	3	2	3	1	0	1
IRBB - 58	<i>Xa4+xa13+Xa21</i>	3	2	3	3	3	1	3	2	3	5	3	1	3	3	1	-
IRBB - 59	<i>xa5+xa13+Xa21</i>	5	2	3	3	3	2	3	2	3	3	3	2	3	3	1	-
IRBB - 60	<i>Xa4+xa5+xa13+Xa21</i>	3	3	3	3	3	3	3	2	3	5	3	1	3	3	1	2
IRBB - 61	<i>Xa4 + xa5 + Xa7</i>	5	3	3	3	3	1	3	5	3	3	3	3	3	3	1	1
IRBB - 62	<i>Xa4 + Xa7 + Xa21</i>	-	3	3	3	3	5	3	4	3	2	3	5	3	1	1	2
IRBB - 63	<i>xa5 +Xa7 + xa13</i>	-	2	3	3	3	6	3	4	3	4	3	1	3	3	3	1
IRBB - 64	<i>Xa4 + xa5 + Xa7 + Xa21</i>	4	4	3	3	3	7	3	3	3	3	3	2	3	3	3	2
IRBB - 65	<i>Xa4 + Xa7 + xa13 + Xa21</i>	-	5	-	-	-	3	-	4	-	4	-	3	-	3	5	-
IRBB - 66	<i>Xa4 + xa5 + Xa7 + xa13 + Xa21</i>	-	5	3	3	3	3	3	2	3	2	3	1	3	3	1	2
DV - 85	-	-	5	3	5	3	7	3	3	3	2	3	3	3	5	2	3
ISM	<i>xa5+xa13+Xa21</i>	-	3	3	3	3	3	3	2	3	5	3	1	3	5	0	1
TN1	-	8	8	7	7	7	8	7	8	7	6	7	7	7	7	8	6
LSI		4.6	4.6	4.5	4.4	4.3	4.3	4.1	3.9	3.7	3.6	3.6	3.6	3.5	2.7	2.2	2.1
Min Score		3	2	3	3	3	1	3	2	3	2	3	1	3	1	0	1
Max Score		8	8	7	7	7	8	7	8	7	6	7	7	7	7	8	6
# entries > 5		1	11	11	8	9	8	7	4	5	1	3	2	3	1	2	1

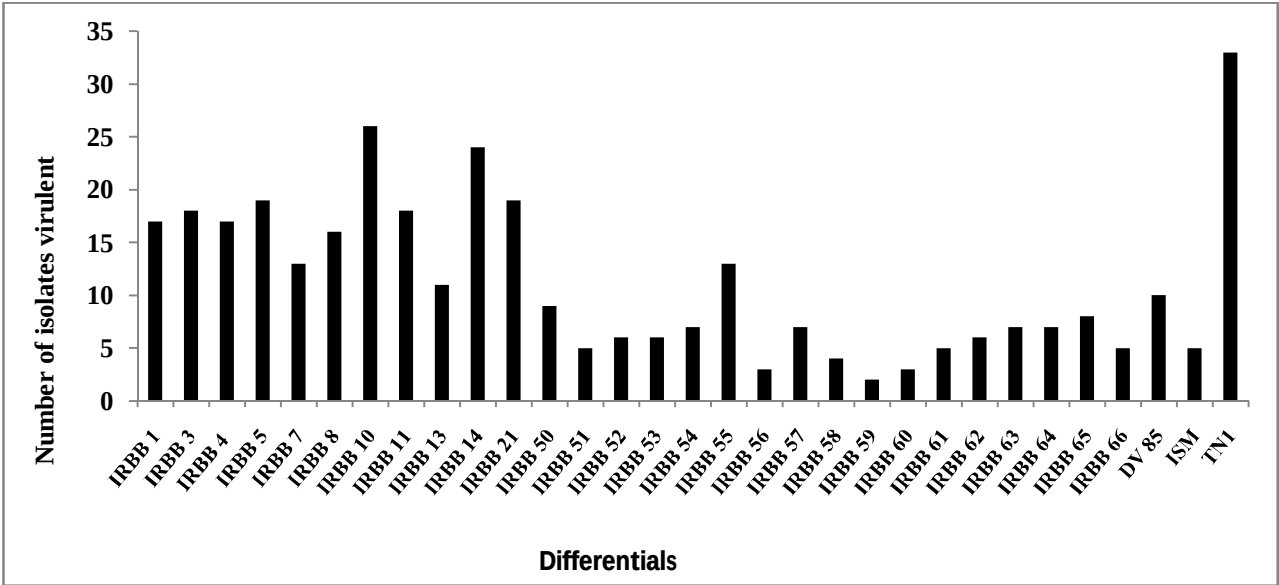


Figure 3: Number of *Xoo* isolates showing moderate to high virulence on different BB resistance genes and their combinations

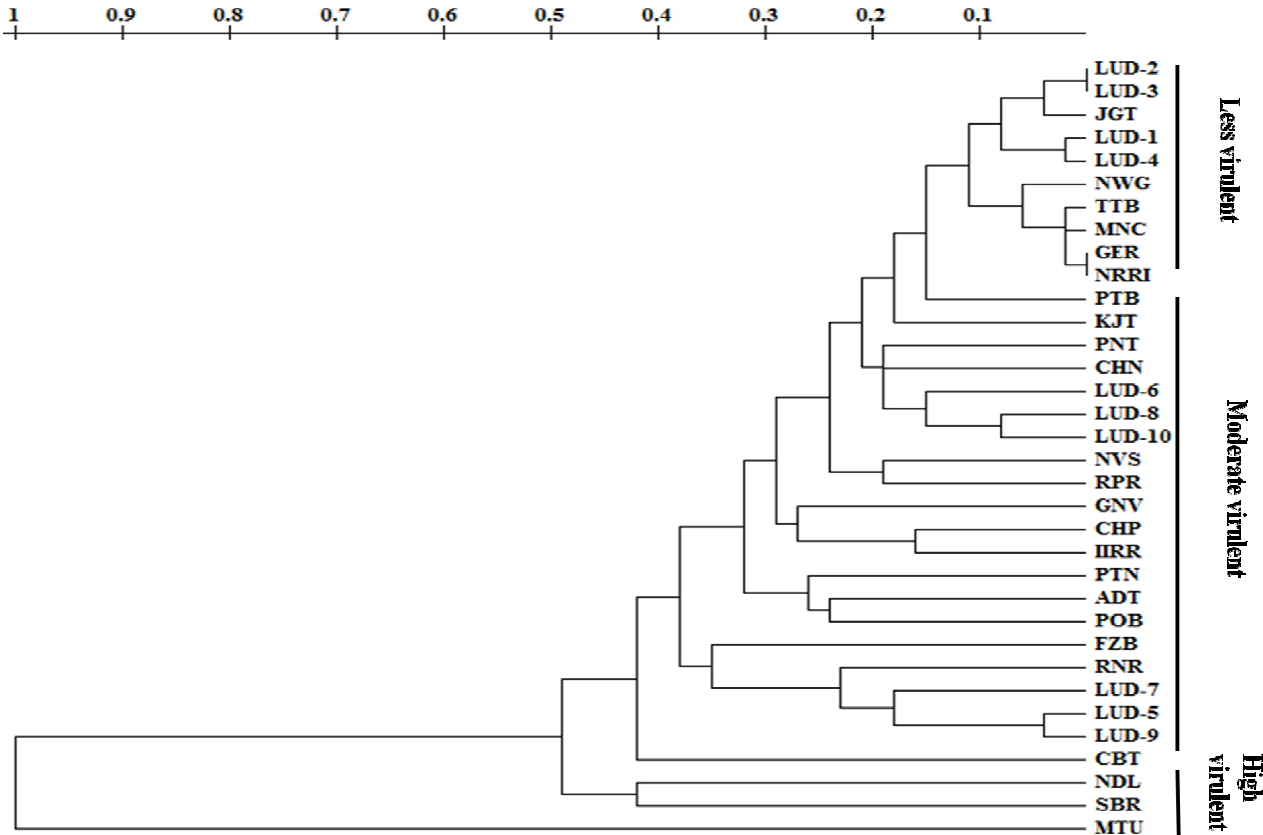


Figure 4: Dendrogram showing the relatedness of different *Xanthomonas oryzae* pv. *oryzae* isolates from various locations during Kharif' 2018

III. DISEASE OBSERVATION NURSERY – *Kharif-2018*

The disease observation trial is conducted to study the effect of different sowing dates viz., early, normal and late in the occurrence and severity of the disease in the respective endemic regions. Availability of susceptible host and prevalence of favorable weather condition play important role in the process of disease development. The trial was formulated to sow a susceptible variety in three different dates of sowing to collect the information on the appearance of disease and data was recorded as percent disease index/disease severity of various rice diseases throughout the cropping period in a particular locality. Knowledge on the occurrence of particular disease on specific location based on susceptible host and time of sowing may help us to formulate the management strategy. The trial was proposed at 10 locations Chinsurah, Cuttack, Kaul, Malan, Mandya, Maruteru, Moncompu, Nawagam, Pusa and Raipur. However data was received from only 7 locations viz., Chinsurah, Mandya, Maruteru, Moncompu, Nawagam, Pusa and Malan (Table 82). Cuttack, Kaul and Raipur had not sent the data. The salient findings of this study are presented on location-wise as below.

Chinsurah: Three different sowing dates viz., 31.05.18, 26.06.18 and 30.07.18 were followed as early, normal and late sowing periods respectively. The variety MTU 7029 was used to study the diseases in that region. The diseases that were incident in this centre were sheath blight, sheath rot, brown spot and bacterial leaf blight (BLB). In general the incidence of disease was less in all stages of the crops in all the sowing dates. Sheath rot was present in the grain filling stage in all the sowing periods. The incidence of sheath rot was maximum (53%) during grain filling stage in the late sown crop. Brown spot was observed in moderate intensity (10, 20 and 23% DS) in the flowering stage in all the sowing periods. The incidence of sheath blight was found in tillering stage in all the sowing periods, however the incidence was maximum (35%) in the normal sown crop.

Mandya: The trial was conducted with the susceptible variety MTU 1001 which was sown on 09.07.18 (early), 28.07.18 (normal) and 30.08.18 (late). Leaf blast, sheath and brown spot was recorded in all the stages of growth of the crop. The incidence of leaf blast was high in the late sown crop (5.50 to 50.38%) during various stages of the crop. The incidence was highest during the maturity stage, which could have been the accumulated disease intensity since the initial disease incidence in the tillering stage. Rice crop sown early date had more of disease incidence of sheath blight i.e., 71% (panicle emergence), 57.22% (flag leaf stage) and 44.44% (booting stage). In case of leaf blast disease the incidence was seen higher towards to maturity stage of the crop (50.38) in the late sown crop. Similarly the brown spot disease was found to be high in the late sown crop, especially toward the flowering stage of the crop (54.11%). Minor incidence of neck blast was observed in the early and normal sown crops (25.08 and 15.21%) in the ripening stage of the crop. The information on rainfall and rainy days were also correlated with the disease severity of neck blast, wherein high amount of rainfall influenced the disease progress of neck blast

Maruteru: Two susceptible varieties BPT 5204 and MTU 7029 were taken for sowing in three dates i.e., early (15.06.18), normal (30.06.18) and late (16.07.18). In case of the variety BPT5204, Sheath blight, false smut and BLB were the major diseases observed on the plants. In general BLB was severe in normal sown crop (56.59 to 97.47%) in various stages of the crop. The disease was also more in early (33.68 to 73.42%) and late sown crop (3.34 to 71.74%) during the different stages of the crop. The disease in general was very severe in the grain hardening stage of the crop, which could be the accumulated score of the disease percentage from the beginning stage of the plants. False smut diseases was seen only in the grain hardening stage in this variety BPT5204, more in the normal sown crop (61.43%) when compared to the late sown crop (25.16%). The incidence of sheath blight disease was less in this variety BPT 5204 when compared with the other variety MTU 7029. The disease was observed to be maximum (22.51%) in the milky stage in the normal sowing crop. The variety MTU 7029 had more and wide spread incidence of sheath blight in all the stages of the crop and in all the sowing dates. The disease was almost similar in all the three sowing dates ranging from 10.77 to 47.59% among the different sowing dates and the stages of the crop. However, the sheath blight incidence was more in case of normal (55.17% maximum) and late sown (38.82%) crops. The incidence of neck blast was observed in the grain hardening stage in both the normal (69.13%) and late sown (40.30%) crops.

Moncompu: Three varieties viz., Uma, Shreyas and Prathyasa were sown on 04.10.18, 29.10.18 and 20.11.18 early, normal and late respectively. Due to the very severe cyclone and heavy rains that accompanied in this region during the cropping period, there was no incidence of diseases other than minor incidence of sheath blight and neck blast in all the three varieties. The incidence of sheath blight and neck blast disease was observed in all the three varieties and in all stages of the crop. Both the diseases were observed to be more in the maturity stages in normal sown crop (25.55% sheath blight and 25% neck blast).

Nawagam: Two susceptible varieties Gujarati and P203 were sown in three different sowing dates viz., 20.06.18, 05.07.18 and 20.07.18 as early, normal and late sowing dates respectively. Leaf blast and sheath rot diseases were observed in all the growth stages of the crop and in all the three different dates sown crops. The incidence of sheath blight disease was moderate, ranging from 12.78% (milky stage in early sown) to 30.56% (maturity stage in late sown). In case of sheath rot disease, the disease ranged from a maximum of 21.67% in late sown maturity stage crop of variety Gujarati to 0.56% in milky stage of variety Gujarati in early sown crop. The disease was almost on par in both the varieties in their respective sowing dates.

Pusa: The susceptible variety Pusa was sown in three different sowing dates viz., 15.06.18, 30.06.18 and 15.07.18 as early, normal and late sowing dates. Only brown spot disease was observed in severe intensity, especially in the late sown conditions. Maximum incidence of 72.5% was observed in both the dough and maturity stages in the late sown conditions when compared with a maximum of 51% in normal and 50.5% in early sow conditions in the same stage.

Malan: Variety HPU-2216 was used as the susceptible variety in the trial where the three sowing dates viz., 21.05.18, 05.06.18 and 20.06.18 were considered as early, normal and late sowing periods. Only leaf blast was observed in moderate intensity in the late sown crops. The disease intensity ranged from a minimum of 3.7% in tillering to 36.75% in flowering stage. There was no disease in the early and normal sown crops.

Influence of weather parameters and date of sowing on sheath blight and neck blast disease intensity at various locations

The data presented in the Table 83 indicates the influence of weather parameters viz., number of rainy days, total rainfall, maximum/minimum temperature and relative humidity in the morning and evening hours, in the percent disease index in the two diseases namely sheath blight and neck blast. The data in general indicates that the relative humidity and temperature is almost on par in all the locations and in all the sowing dates. However there was significant difference with respect to number of rainy days and the total rainfall.

Accordingly in the early sowing conditions the incidence of the sheath blight disease (71.11%) and neck blast (25.08%) was maximum in Mandya which had the lowest number of rainy days (25) and total rainfall (321.4 mm) when compared to Maruteru and Moncompu. It is to be observed that Maruteru, which had the highest number of rainy days (53) and rainfall (1060.8 mm) had moderate sheath blight disease (4.44 %) and no neck blast at all. Similarly in case of the normal sowing conditions, the incidence of sheath blight disease was on par at both Mandya and Maruteru (40.00 and 39.92 %) while the incidence of neck blast was highest in Maruteru (69.13 %) when compared to Moncompu (25 %) and Mandya (15.21%). However the number of rainy days and total rainfall was highest in Maruteru (42, 764 mm) when compared to 21, 213.8mm in Moncompu and 20 and 297.7 mm in Mandya. Results from the late sown conditions indicate that the incidence of sheath blight and neck blast was maximum (32.86 and 40.33 % respectively) in Maruteru where the number of rainy days (28) and total rainfall (513.8) was highest when compared to the other two centres (Table 83; Figure 5 and 6).

To conclude, across the locations, delayed sowing/planting increased the disease development of leaf blast, brown spot and sheath rot. Normal sown crop recorded high disease severity of bacterial leaf blight compared to early and late sown crop. With respect to sheath blight, disease progress was high both in the early and normal sown crop. Neck blast was severe in the normal sown crop at Maruteru and Moncompu.

With respect to weather parameters, it can be seen that in the case of early sown conditions there was no correlation of sheath blight disease incidence or the neck blast disease and the number of rainy days or the total rainfall. Under normal sowing conditions the incidence of neck blast seems to have direct positive correlation with number of rainy days and the total rainfall. Similarly in the late sown conditions, incidence of both the diseases had direct positive correlation with the weather parameters viz., number of rainy days and the total rainfall. More such studies are required with various other factors to arrive at a conclusion about the correlation of incidence of sheath blight and neck blast disease and the weather parameters at various sowing dates.

Table 82: Occurrence of different rice diseases in disease observation nursery at different locations, Kharif - 2018

Location/ Date of sowing	Stage of the crop	Percentage of Disease Severity																	
		Leaf blast			Sheath blight			Sheath rot			Brown spot			False smut			Bacterial leaf blight		
		(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)
Chinsurah																			
V- MTU 7029	Tillering	-	-	-	21	35	7	-	-	-	-	-	-	-	-	-	5	6	0
E: 31-05-18	Flowering	-	-	-	-	-	-	-	-	-	10	20	23	-	-	-	-	-	-
N: 26-06-18	Grain filling	-	-	-	-	-	-	23	30	53	-	-	-	-	-	-	-	-	-
L: 30-07-18	Maturing	-	-	-	-	-	-							0	0	1			
Location/ Date of sowing	Stage of the crop	Leaf blast			Sheath blight			Sheath rot			Brown spot			Neck blast			Bacterial leaf blight		
		(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)
Mandya																			
V: MTU 1001																			
E: 09-07-18	Tillering	0.00	0.00	5.50	22.22	7.77	0.00	-	-	-	1.65	3.30	3.85	-	-	-	-	-	-
N: 28-07-18	Booting	0.00	2.75	17.75	44.44	17.78	0.00	-	-	-	5.5	9.96	16.11	-	-	-	-	-	-
L: 30-08-18	Flag leaf	0.00	3.65	25.28	57.22	22.22	0.00	-	-	-	5.5	9.97	30.00	-	-	-	-	-	-
	Panicle emergence	0.00	5.15	33.05	71.11	31.11	10.00	-	-	-	5.5	14.44	44.44	-	-	-	-	-	-
	Flowering	-	-	-	-	40.00	23.33	-	-	-	-	16.66	54.11	-	-	-	-	-	-
	Dough	0.00	6.05	40.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Maturity	-	-	50.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ripening	-	-	-	-	-	-	-	-	-	-	-	-	25.08	15.21	0.0	-	-	-
Maruteru	Maximum Tillering	-	-	-	-	-	5.36	-	-	-	-	-	-	-	-	-	-	-	3.34
V: BPT 5204	Panicle initiation stage	-	-	-	1.06	4.1	0.84	-	-	-	-	-	-	-	-	-	-	56.59	58.24
E: 15-06-18	Panicle emergence stage	-	-	-	0.0	14.67	13.81	-	-	-	-	-	-	-	-	-	33.68	76.19	33.93
N: 30-06-18	Milky stage	-	-	-	5.92	22.51	NR	-	-	-	-	-	-	-	-	-	74.77	69.48	NR
L: 16-07-18	Grain Hardening	-	-	-	3.52	2.33	1.09	-	-	-	-	-	-	0.00	61.43	25.16	73.42	97.47	71.74

Location/ Date of sowing	Stage of the crop	Percentage of Disease Severity														
		Leaf blast			Sheath blight			Sheath rot			Neck blast			Bacterial leaf blight		
		(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)
V:MTU-7029	Max. Tillering	-	-	-	-	-	10.77	-	-	-	-	-	-	-	-	0.00
E: 15-06-18	Panicle initiation	-	-	-	0.0	42.52	24.72	-	-	-	-	-	-	-	1.11	0.00
N: 30-06-18	Panicle emergence	-	-	-	45.40	47.59	24.61	-	-	-	-	-	-	6.89	0.00	38.82
L: 16-07-18	Milky stage	-	-	-	37.31	41.00	NR	-	-	-	-	-	-	0.00	55.17	NR
	Grain Hardening	-	-	-	40.44	39.92	32.86	-	-	-	0.00	69.13	40.3	8.66	2.72	12.36
Moncompu		-	-	-				-	-	-	-	-	-	-	-	-
V-Uma	Active tillering	-	-	-	6.67	0.00	0.00	-	-	-	0.00	0.00	0.00	-	-	-
E: 04-10-18	Panicle Initiation	-	-	-	11.67	0.00	0.00	-	-	-	0.00	0.00	0.00	-	-	-
N: 29-10-18	Booting	-	-	-	1.67	0.05	0.25	-	-	-	0.00	0.00	0.00	-	-	-
L: 20-11-18	Flowering stage	-	-	-	3.85	1.61	1.94	-	-	-	0.37	1.10	0.28	-	-	-
	Dough stage	-	-	-	1.86	5.00	13.33	-	-	-	1.11	14.44	1.67	-	-	-
	Maturity stage	-	-	-	6.67	10.55	13.89	-	-	-	6.44	21.11	2.22	-	-	-
V: Shreyas	Active tillering	-	-	-	5.55	0.00	0.00	-	-	-	0.00	0.00	0.00	-	-	-
E: 04-10-18	Panicle Initiation	-	-	-	7.15	0.00	0.00	-	-	-	0.00	0.00	0.00	-	-	-
N: 29-10-18	Booting	-	-	-	1.11	0.45	1.00	-	-	-	0.00	0.00	0.00	-	-	-
L: 20-11-18	Flowering stage	-	-	-	7.75	3.59	4.17	-	-	-	0.93	1.60	0.00	-	-	-
	Dough stage	-	-	-	1.11	6.94	13.33	-	-	-	1.11	12.22	2.22	-	-	-
	Maturity stage	-	-	-	10.22	14.44	13.89	-	-	-	9.11	20.00	3.89	-	-	-
V: Prathysa	Active tillering	-	-	-	7.22	0.00	0.00	-	-	-	0.00	0.00	0.00	-	-	-
E: 04-10-18	Panicle Initiation	-	-	-	8.89	0.00	0.00	-	-	-	0.00	0.00	0.00	-	-	-
N: 29-10-18	Booting	-	-	-	0.56	0.55	1.85	-	-	-	0.00	0.00	0.00	-	-	-
L: 20-11-18	Flowering stage	-	-	-	6.60	7.08	5.55	-	-	-	2.22	0.55	0.00	-	-	-
	Dough stage	-	-	-	1.85	22.56	8.33	-	-	-	1.11	12.22	0.00	-	-	-
	Maturity stage	-	-	-	11.56	25.55	10.00	-	-	-	21.33	25.00	0.56	-	-	-
Nawagam		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
V: Gurjari	Milky stage	12.78	16.11	17.78	-	-	-	0.56	3.89	8.34	-	-	-	-	-	-
E: 20-06-18	Dough stage	16.11	20.56	21.67	-	-	-	5.56	10.56	11.67	-	-	-	-	-	-
N: 05-07-18	Grain hardening	21.67	23.89	27.22	-	-	-	10.00	15.00	17.23	-	-	-	-	-	-
L: 20-07-18	Maturity stage	23.89	26.11	28.34	-	-	-	11.67	18.34	21.67	-	-	-	-	-	-
V: P 203	Milky stage	17.22	13.33	20.00	-	-	-	0.00	1.67	6.11	-	-	-	-	-	-
E: 20-06-18	Dough stage	20.00	19.45	25.56	-	-	-	4.44	7.23	9.45	-	-	-	-	-	-
N: 05-07-18	Grain hardening	23.89	26.11	30.00	-	-	-	9.45	12.78	13.33	-	-	-	-	-	-
L: 20-07-18	Maturity stage	24.44	28.34	30.56	-	-	-	10.00	16.67	17.78	-	-	-	-	-	-

Location/ Date of sowing	Stage of the crop	Percentage of Disease Severity					
		Leaf blast			Brown spot		
		(E)	(N)	(L)	(E)	(N)	(L)
Pusa		-	-	-	-	-	-
V- Pankaj	Tillering	-	-	-	20.0	22.5	27.5
E: 15-06-18	Panicle initiation	-	-	-	41.25	37.5	47.5
N: 30-06-18	Dough	-	-	-	50.5	51.0	72.5
L: 15-07-18	Maturity	-	-	-	50.5	51.0	72.5
Malan		-	-	-	-	-	-
V-HPU-2216	Tillering	0	0	3.7	-	-	-
E:21.05.18	Maximum Tillering	0	0	10.85	-	-	-
N:05.06.18	Booting	0	0	22.3	-	-	-
L:20.06.18	Flowering	0	0	36.75	-	-	-

(E- Early sowing; N- Normal Sowing; L- Late sowing)

Table 83: Influence of weather parameters on sheath blight intensity (PDI) in different date of sowing at different locations

Locati- ons	Under Early sown conditions							
	Sheath blight Maximum PDI (%)	Neck blast Maximum PDI (%)	Rainy days	Total rainfall	Temperature		RH	
					Max.	Min.	Morning	Evening
MND	71.11	25.08	25	321.4	30.03	19.17	89.67	75.17
MTU	40.44	0.0	53	1060.8	31.18	25.69	83.97	74.42
MNC	11.56	21.33	38	487.7	34.01	24.50	88.67	88.50
Locati- ons	Under Normal sown conditions							
	Sheath blight Maximum PDI (%)	Neck blast Maximum PDI (%)	Rainy days	Total rainfall	Temperature		RH	
					Max.	Min.	Morning	Evening
MND	40.00	15.21	20	297.7	29.8	18.98	89.4	75
MTU	39.92	69.13	42	764	30.60	25.34	83.80	75.45
MNC	25.55	25.00	21	213.8	33.92	24.56	88.11	88.20
Locati- ons	Under Late sown conditions							
	Sheath blight Maximum PDI (%)	Neck blast Maximum PDI (%)	Rainy days	Total rainfall	Temperature		RH	
					Max.	Min.	Morning	Evening
MND	23.33	0.0	17	281.7	29.43	18.90	88.25	74.25
MTU	32.86	40.33	28	513.8	30.84	25.16	83.62	75.22
MNC	10.00	0.56	21	213.8	33.92	24.56	88.11	88.20

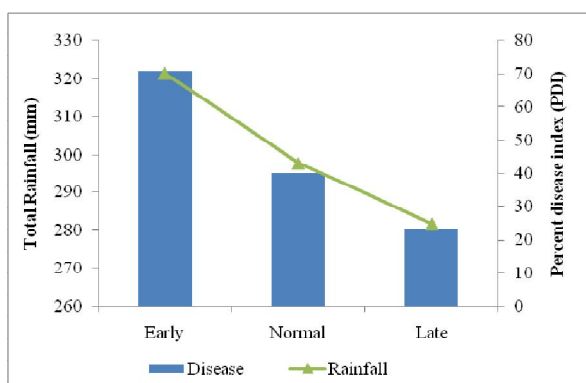


Figure 5: Progress of sheath blight in MTU 1001 variety, sown in the three different sowing dates (Early, Normal and Late) at Mandya

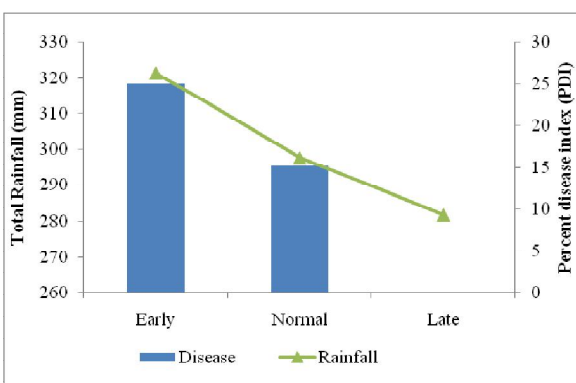


Figure 6: Progress of neck blast in MTU 1001 variety, sown in the three different sowing dates (Early, Normal and Late) at Mandya

Conclusion: The disease observation trial was conducted with a view to study the influence of the local weather factors and the different sowing dates on the endemic diseases of the region. Accordingly three sowing dates i.e., early, normal and late were followed for sowing of the rice crop. The weather factors including total rain fall, rainy days, RH and temperature were recorded and correlated with the disease incidence. The results obtained from the different locations were analyzed and tabulated for discussion. It was observed in general that the disease incidence varied according to the sowing dates, however there was no constant pattern to infer regarding the correlation between sowing dates and incidence of the diseases. To conclude, it can be seen that in the case of early sown conditions there was no correlation of sheath blight disease incidence or the neck blast disease and the number of rainy days or the total rainfall. Under normal sowing conditions the incidence of neck blast seems to have direct positive correlation with number of rainy days and the total rainfall. Similarly in the late sown conditions, incidence of both the diseases had direct positive correlation with the weather parameters viz., number of rainy days and the total rainfall. More such studies are required with various other factors to arrive at a conclusion about the correlation of incidence of sheath blight and neck blast disease and the weather parameters at various sowing dates.

IV. DISEASE MANAGEMENT TRIALS

1. EVALUATION OF COMBINATION FUNGICIDES AGAINST LOCATION SPECIFIC DISEASES

The trial was conducted with an objective to evaluate commercially available combination fungicides those are registered under Central Insecticides Board (CIB), Government of India (GOI) against various paddy diseases caused by fungi. This is a second year trial during *Kharif*-2018 to reconfirm the results of last year trial *Kharif*-2017. Test products names are viz., flusilazole 12.5% + carbendazim 25% SC (1.0 ml/l), azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l), azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 ml/l), tricyclazole 18 % + mancozeb 62 % WP (2.5 g/l), zineb 68% + hexaconazole 4% WP (2.5g/l), trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l), mancozeb 50% + carbendazim 25% WS (2.5g/l) and fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC (1.5ml/l). These products bio-efficacy were reconfirmed against fungal diseases of rice which are popular in a particular rice growing region. The recommended dose of each product was applied to the diseased plants at the rate of two to four sprays with an interval of 10 to 15 days. These molecules comprises of different formulations such as suspension concentrates (SC), wettable powder (WP), wettable granules (WG), water soluble and emulsifiable concentrates (EC). The trial was conducted during *Kharif*-2018 by using Randomised Block Design (RBD) as a statistical method with four or three replications in each centre.

The trial was proposed at 33 centres and conducted the experiment at 34 centres viz., Aduthurai, Arundhatinagar, Bankura, Chatha, Chinsurah, Chiplima, Coimbatore, Cuttack, IIRR, Faizabad, Gangavati, Ghaghraghat, Jagdalpur, Kaul, Khudwani, Lonavala, Ludhiana, Malan, Mandya, Maruteru, Moncompu, Mugad, Navsari, Nawagam, Pantnagar, Pattambi, Ponnampet, Pusa, Raipur, Rajendranagar, Rewa, Sabour, Titabar and Varanasi across the rice growing regions in India. The experiment was conducted with locally popular disease susceptible rice varieties among the farmers at each testing location. In general, sowings were taken up during June and July across the locations except in Aduthurai where sowing was done in the month of September. At Moncompu sowing was done late in the month of October and at Jagdalpur and Khudwani where sowing was done at early in the month of April and mid of May. The details related to diseases against these chemicals were tested, test variety used, date of sowing, date of transplanting, method of screening, date of initial symptoms observed, number of spray, spraying dates, disease observation and date of harvesting are mentioned in the Table 84. In general fungicides were sprayed after noticing the initial symptoms at all the locations. Each combination fungicide was applied at the rate of two sprays with an interval of 15 days in all the test centres except Chiplima, Ghaghraghat, Jagdalpur, Khudwani and Titabar where three or four sprays were given. The fungicides were evaluated against leaf blast (10 locations), neck blast (eight locations), node blast (one location), sheath blight (15 locations), sheath rot (seven locations), brown spot (six locations) and false smut (one location).

Table 84: Experimental details of fungicidal evaluation against location specific diseases of rice during *Kharif*, 2018

S. No	Location	Disease Recorded	Test Variety	Screening	Date of activities						
					Sowing/ Transplanting	Inoculation	Initial symptom	No of Spray	Spraying	Observation	Harvesting
1	Aduthurai	Brown spot, Sheath rot	ADT(R) -46	Natural	07.09.18/12.10.18	-	-	1	24.12.18	07.01.2019	21.01.2019
2	Arundhutanagar	Sheath blight	-	-	-	-	-	-	-	-	-
3	Bankura	Sheath blight,	Swarna (MTU7029)	Artificial	11.07.18/09.08.18	20.09.18	25.09.18	2	12.10.18 29.10.18	12.10.18 26.10.18 14.11.18	12.12.18
4	Chatha	Brown spot	Basmati-370	Natural	06.07.18/ 18.07.18	-	15.09.18	2	18.09.18 03.10.18	-	20.11.18
5	Coimbatore	Leaf blast	CO39	Artificial	10.12.18/ 31.10.18	27.11.18	11.12.18	2	18.12.18 26.12.18	7.01.2019	25.01.2019
6	Chinsurah	Sheath blight	Swarna (MTU 7029)	Artificial	26.06.18/ 26.07.18	17.09.18	28.09.18	2	01.10.18 10.10.18	-	26.11.18
		Sheath rot	Swarna (MTU 7029)	Artificial	30.07.18/ 28.08.18	26.10.18	14.11.18	2	15.11.18 26.11.18	-	07.12.18
7	Chiplima	Sheath blight	Swarna	Artificial	09.07.18/ 09.08.18	18.09.18	27.09.18	2	06.10.18 23.10.18	05/22.10.18 06.11.18	27.11.18
8	Cuttack	False smut	Moudamani	Natural	26.07.18/ 20.08.18	-	-	2	06.11.18; 16.11.18	-	-
		Sheath blight	Tapaswini	Artificial	24.07.18/ 25.08.18	27.09.18	08.10.18	2	18.10.18; 27.10.18	30.10.18 10.11.18	08.12.18
9	ICAR-IIRR	Leaf blast	HR-12	Artificial	15.06.18/12.07.18	25-08-18	04.09.18	2	05.09.18 15.09.18	20.09.18 30.09.18	18-10-18
		Sheath blight	BPT 5204	Artificial	13.06.18/12.07.18	22-09-18	24.09.18	2	25.09.18 05.10.18	09.10.18 / 21-10-18	17.11.18
10	Faizabad (Masodha)	Sheath blight	Pusa Basmati-1	Artificial	23.06.18/25.07.18	3.10.18	14.10.18	2	12.10.18 1.11.18	18/29.10.18 16.11.18	16.11.18
11	Gangavati	Sheath blight	BPT 5204	Artificial	07.07.18/09.08.18	04-10-18	10.10.18	2	10.10.18 25.10.18	24.10.18 20.11.18	
12	Ghagaraghat	Leaf blast and Neck blast	Jalprika	Natural	26.6.18/31.6.18			3	26.09.18 10.10.18 26.10.18	10/12/18	16.12.18
13	Jagdarpur	Leaf blast and Neck blast	Swarna	Natural	04.06.18/08.07.18		28.08.18	4	05.09.18 20.09.18 04.10.18 17.10.18	18.09.18 28.09.18 15.10.18 Nb 5.12.18	15.12.18
14	Kaul	Neck blast	Basmati CSR 30	Natural	22.06.18/23.07.18		18.10.18	2	30.08.18 05.10.18	02.11.18	10.11.18
15	Khudwani	Rice blast	Mushka Budji	Natural	15.05.18/11.06.18		15.07.18	3	16/07/18 08-01-18 16/08/18	15.07.18 31.07.18 29.08.18	01.10.18
16	Lonavala	Leaf and Neck blast	EK-70	Natural	07.06.18/04.07.18	-	27.08.18/10.0 9.18	2	27.08.18 12.09.18	27.8.18 11/12.09.18	29.9.18
		Node blast	EK-70	Natural	21.06.18; 21.07.18	-	10.09.18	2	27.08.18 12.09.18	12.09.18	29.9.18

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S. No	Location	Disease Recorded	Test Variety	Screening	Date of activities						
					Sowing/ Transplanting	Inoculation	Initial symptom	No of Spray	Spraying	Observation	Harvesting
		Sheath rot	EK-70	Natural	21.06.18; 21.07.18	-	-	2	27.08.18 12.09.18	10.09.18	29.9.18
17	Ludhiana	Sheath blight	PR114	Artificial	01.06.18/29.06.18	17.09.18	20.09.18	2	19.09.18 29.09.18	10.10.18	20.10.18
		Brown spot	PR114	Natural	01.06.18/29.06.18	-	18.09.18	2	19.09.18 29.09.18	12.10.18	20.10.18
18	Malan	Neck blast	HPU 2216	Natural	14.06.18/ 16.07.18	-	20.08.18	2	31.08.18 15.09.18	-	03.11.18
19	Mandya	Sheath blight	MTU 1001	Artificial	07.08.18/31.08.18	12.10.18	5.10.18	2	20.10.18 05.11.18	19.10.18 4.11.18	-
20	Maruteru	Neck blast and Sheath blight	Swarna (MTU 7029)	Nb: Natural/ Sbl: Artificial	27.6.18/28.7.18	21.8.18	29.8.18	2	31.8.18 15.9.18	11/28.09.18 04.10.18 13.11.18	20.11.18
21	Moncompu	Sheath blight	Uma	Natural	10.09.18/30.10.18	-	01.02.2019	2	01.04.2019 19.01.2019	01-03-2019 18/01/2019	21.02.2019
22	Mugad	Leaf blast	Intan	Natural	21.06.18	-	25.08.18	2	03.10.18 20.10.18	10.10.18 20.10.18 27.10.18	07.12.18
23	Navsari	Sheath rot	Jaya	Natural	03.07.18/31.07.18	-	14.09.18	2	03.10.18 14.10.18	09.10.18 21.10.18	26.11.18
24	Nawagam	Leaf blast	Gurjari	Artificial	10.07.18/14.08.18	17.09.18 27.09.18	01.10.18	2	03.10.18 18.10.18	03.10.18 17.10.18 02.11.18	30.11.18
		Sheath rot	Gurjari	Natural	10.07.18/14.08.18	-	08.10.18	2	03.10.18 18.10.18	17.10.18 02.11.18	30.11.18
25	Pantnagar	Sheath blight	Pant Dhan-4	Artificial	01.06.18/25.06.18	17.08.18	24.08.18	2	27.08.18 14.09.18	26.09.18	05.11.18
26	Pattambi	Brown spot	Uma	Natural	13.7.18/09.08.18	-	8.10.18	2	11.10.18 22.10.18	8.10.18 1.11.18	27.11.18
27	Ponnampet	Leaf blast and Neck blast	Intan	Natural	16.07.18/19.08.18	-	LB:15.08.18 NB:25.11.18	2	24.09.18 26.11.18	Lb:23-10-18 Nb:28-12-18	08.01.2019
28	Pusa	Brown spot	Pankaj	Artificial	10.06.18/08.07.18	-	25.08.18	2	01.09.18 21.09.18	30.09.18 15.10.18 10.11.18	15.11.18
29	Raipur	Sheath blight	Swarna	Artificial	20.07.18/23.08.18	13.10.18	06.09.18	2	17.10.18 25.10.18	24.10.18 03.11.18	05.12.18
30	Rajendra nagar	Neck blast and Sheath rot	Tellahamsa	Natural	17.07.18/17.08.18	-	NB:25.09.18 Srt: 27.10.18	2	06.10.18 24.10.18	22.10.18 16.11.18	20.12.18
31	Rewa	Leaf blast	PS4	Natural	5.07.18/25.07.18	10.09.18	18.09.18	2	22-09-18 05-10-18	24.09.18 05.10.18	23.11.18
32	Sabour	Brown spot	Rajendra Mahsuri-1	Natural	20.06.18/17.07.18	-	25.09.18	2	28.09.18; 14.10.18	01.10.18; 18.10.18	26.11.18
33	Titabar	Sheath rot	Gitesh	Artificial	21.07.18/21.08.18	10.10.18	20.10.18	3	20.10.18; 30.10.18 10.11.18	20.10.18 30.10.18 10.11.18	10.12.18
34	Varanasi	Sheath blight	HUR-917	Artificial	09.07.18/07.08.18	28.09.18	02.10.18	2	11.10.18 26.10.18	04.11.18	20.11.18

Leaf blast: The fungicides were evaluated against leaf blast disease at ten locations across the rice growing region of the country. In all the centres uniformly two sprays of fungicides were applied except Ghagrahat, Jagdalpur and Khudwani where three or four sprays were given. Disease severity was recorded at all the test locations. Besides, disease incidence was also observed at five locations viz., Khudwani, Lonavala, Mugad, Nawagam and Rewa. The test fungicidal products were evaluated against the disease under natural incidence at six location except Coimbatore, IIRR, Nawagam and Rewa where through artificial inoculation. Disease severity at test locations in check plots varied from 23.1% (Rewa) to 100% (IIRR). Severity on check plot was very high (>50%) at IIRR (100%), Mugad (64.0), Jagdalpur (63.3%), Ponnampet (60.9%), Lonavala (56.6) and Ghagrahat (54.5); high (>30-50%) at Coimbatore (44.3%) and Nawagam (33.1) and moderate (20-29%) at Khudwani (28.0) and Rewa (23.1%). Disease incidence at test locations in check plots varied from 28.5% (Rewa) to 87.9% (Nawagam).

All eight fungicidal treatments significantly reduced the disease severity and incidence at all test locations when compared to control. The combination product viz., trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l) was significantly reduced the severity at seven locations viz., Ghagrahat, Jagdalpur, Lonavala, Mugad, Ponnampet, Coimbatore and Nawagam; incidence at three locations (Lonavala, Mugad and Nawagam).

However, the same treatment (T6) showed low mean disease severity (18.9%) and disease incidence (31.9%) compared to other treatments from ten and five test centres, respectively. The other combi-product azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) was found significantly reducing the disease severity at three locations viz., Coimbatore, Khudwani and Nawagam and disease incidence at two locations (Khudwani and Nawagam). This treatment (T2) showed mean disease severity and incidence of 21.0% and 38.6% from all the test centres. It also reduced the disease severity on par with other best treatment at both ICAR-IIRR and Ponnampet (Figure 7 and Table 85a, 85b).

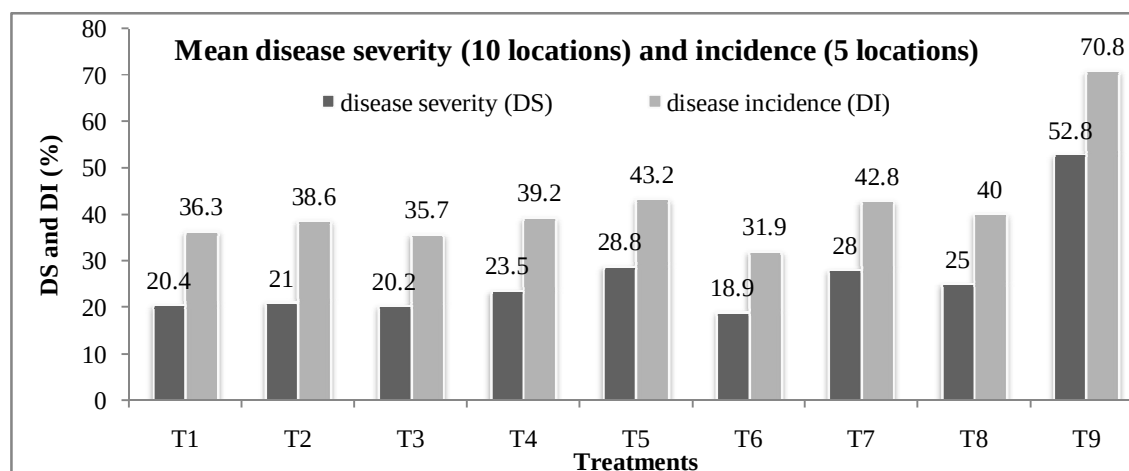


Figure 7: Effect of fungicides against leaf blast of rice, Kharif-2018

Table 85a: Evaluation of fungicides against leaf blast disease severity of rice, *Kharif*, 2018

Treatments	Dose/L	Leaf blast disease severity (%)										
		CBT	GGT	IIRR	JDP	KHD	LNV	MGD	NWG	PNP	REW	Mean
T1 - Flusilazole 12.5% + carbendazim 25% SC	1.0 ml/l	20.7 (27.0)	13.7 (21.7)	17.4 (24.6)	45.0 (45.0)	8.7 (3.1)	23.7 (29.1)	12.6 (20.7)	23.2 (28.7)	25.7 (30.4)	13.8 (3.8)	20.4
T2-Azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC	1.0 ml/l	12.7 (20.8)	16.4 (23.8)	13.0 (21.1)	47.2 (47.2)	3.5 (2.1)	39.9 (39.1)	23.4 (28.9)	22.7 (28.4)	19.5 (26.1)	11.5 (3.5)	21.0
T3 - Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5ml/l	19.7 (26.2)	12.4 (20.6)	11.9 (20.1)	48.1 (48.1)	3.7 (2.2)	21.3 (27.5)	18.5 (25.4)	27.2 (31.4)	23.8 (29.2)	15.7 (4.1)	20.2
T4 - Tricyclazole 18 % + mancozeb 62 % WP	2.5 g/l	21.3 (27.4)	15.4 (23.1)	25.2 (30.1)	44.4 (44.4)	4.9 (2.4)	36.2 (36.9)	20.3 (26.7)	28.5 (32.2)	29.7 (32.9)	8.7 (3.1)	23.5
T5 - Zineb 68% + hexaconazole 4% WP	2.5g/l	14.3 (21.9)	21.4 (27.6)	54.4 (47.5)	47.8 (47.8)	6.8 (2.8)	45.7 (42.5)	20.5 (26.9)	26.9 (31.2)	32.3 (34.5)	17.6 (4.3)	28.8
T6 - Trifloxystrobin 25% + tebuconazole 50% WG	0.4g/l	16.3 (23.7)	10.4 (18.8)	35.6 (36.6)	38.3 (38.3)	4.7 (2.4)	17.4 (24.6)	8.1 (16.5)	24.3 (29.5)	19.2 (25.8)	15.3 (4.1)	18.9
T7 - Mancozeb 50% + carbendazim 25% WS	2.5g/l	24.7 (29.7)	18.4 (25.4)	47.4 (43.3)	50.0 (50.0)	10.8 (3.4)	33.7 (35.5)	17.5 (24.7)	27.2 (31.4)	31.8 (34.2)	18.9 (4.5)	28.0
T8 - Fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC	1.5ml/l	21.3 (27.5)	19.2 (26.0)	35.9 (36.6)	52.2 (52.2)	8.9 (3.1)	29.0 (32.5)	21.5 (27.6)	27.6 (31.7)	27.2 (31.3)	7.7 (2.9)	25.0
T9 - Control	-	44.3 (41.7)	54.5 (47.6)	100.0 (90.0)	63.6 (63.6)	28.0 (5.4)	56.6 (48.8)	64.0 (53.5)	33.1 (35.1)	60.9 (51.3)	23.1 (4.9)	52.8
General Mean		21.7	20.2	37.9	48.5	8.9	33.7	22.9	26.7	30.0	14.7	-
LSD @ 5% ($P= 0.05$)		4.7	0.3	7.2	1.9	0.1	3.7	6.2	1.9	3.0	0.2	-
CV (%)		9.9	0.7	10.5	2.7	3.3	7.2	12.7	4.2	6.2	3.1	-
SE(m)		1.6	0.1	2.4	0.7	0.0	1.3	2.0	0.7	1.0	0.1	-
SE(d)		2.2	0.1	3.3	0.9	0.1	1.8	2.9	0.9	1.4	0.1	-
Transformation		AT	AT	AT	AT	ST	AT	AT	AT	AT	ST	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

In addition to these two products, other combi-products such as azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5ml/l) and Flusilazole 12.5% + carbendazim 25% SC (1.0 ml/l) also reduced the disease severity (20.2% and 20.4) and incidence (35.7% and 36.3%) on with the better product in different test locations. The grain yield data was recorded at all five test locations and observed that all treated plots yielded superior to check plot (2940 Kg/ha). Treatment (T6) trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l) was superior in increasing the mean yield (4576 Kg/ha) from all ten locations. This is followed by azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5ml/l) compared to the other treatments (Table 86).

Table 85b: Evaluation of fungicides against leaf blast disease incidence of rice, Kharif, 2018

Treatments	Dose/ L	Leaf blast disease incidence (%)					
		KHD	LNV	MGD	NWG	REW	Mean
T1 - Flusilazole 12.5% + carbendazim 25% SC	1.0 ml/l	22.7 (28.4)	47.9 (43.8)	20.1 (26.6)	74.7 (59.9)	16.0 (4.1)	36.3
T2-Azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC	1.0 ml/l	9.2 (17.7)	64.6 (53.7)	32.0 (34.4)	74.1 (59.6)	13.2 (3.8)	38.6
T3 - Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5ml/l	10.3 (18.7)	44.9 (42.1)	27.2 (31.4)	80.3 (63.7)	15.8 (4.1)	35.7
T4 - Tricyclazole 18 % + mancozeb 62 % WP	2.5 g/l	12.5 (20.7)	59.5 (50.5)	31.0 (33.8)	80.2 (63.6)	12.6 (3.7)	39.2
T5 - Zineb 68% + hexaconazole 4% WP	2.5g/l	18.5 (25.5)	66.6 (54.7)	31.4 (34.1)	77.9 (62.0)	21.7 (4.8)	43.2
T6 - Trifloxystrobin 25% + tebuconazole 50% WG	0.4g/l	12.4 (20.6)	41.2 (39.9)	12.0 (20.3)	76.8 (61.3)	17.2 (4.3)	31.9
T7 - Mancozeb 50% + carbendazim 25% WS	2.5g/l	27.5 (31.6)	60.0 (50.7)	22.3 (28.1)	81.1 (64.2)	23.3 (4.9)	42.8
T8 - Fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC	1.5ml/l	23.3 (28.8)	51.5 (45.8)	34.9 (36.2)	78.9 (62.7)	11.2 (3.5)	40.0
T9 - Control	-	66.8 (54.8)	85.5 (67.7)	85.2 (67.8)	87.9 (69.8)	28.5 (5.4)	70.8
General Mean		22.6	58.0	32.9	79.1	17.7	-
LSD @ 5% ($P=0.05$)		1.9	4.8	4.5	4.9	0.2	-
CV (%)		4.6	6.5	7.3	5.2	2.9	-
SE(m)		0.6	1.6	1.5	1.7	0.1	-
SE(d)		0.9	2.3	2.1	2.3	0.1	-
Transformation		AT	AT	AT	AT	ST	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Neck blast: The trial was conducted at eight locations to know the efficacy of the test product against neck blast disease. Disease incidence was recorded at six centres and disease severity was noted at Ghagaraghat and Rajendranagar. Two sprays of fungicidal treatments were given at all the centres. The test fungicidal products were evaluated against the disease under natural condition at all the centres. Disease incidence in control plot was very high

(>50%) at Lonavala (90%), Jagdalpur (55.7%) and Ponnampet (54.1%); high (30-50%) at Malan (48.8%) and Marateru (45%); and low (>20%) at Kaul (18.9%). The severity on check plots was about 49.3% and 46.3% at Rajendranagar and Ghagaraghat, respectively.

The performance of all the six fungicidal treatments was superior in reducing the neck blast incidence and severity at all the test locations except Maruteru when compare to control (DI: 52.1% and DS: 47.8%). This trial showed statistically non significant difference between the treatments including control at Mareteru. The formulations viz., trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l) was significantly reduced the incidence of the neck blast at three locations (Jagdalpur, Lonavala, Ponnampet and) and severity at Ghagaraghat. Besides, the same combination fungicide was statistically on par with the best treatments at Kaul and Rajendranagar for minimising the neck blast incidence and severity, respectively. In addition to this, low mean disease incidence (25.9%) and severity (33.4%) was observed from the plots where trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l) applied in the test locations. This was followed by azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 g/l) in respect to disease severity (Figure 8 and Table 87). The mean yield across the locations in check plot was 3246 kg/ha. Among the eight fungicidal treatments, trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l) sprayed plots produced highest mean yield (4488 Kg/ha) followed by azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 g/l) (4373 Kg/ha) compared to other treatments. The treatment T6 and T3 significantly increased the yield at five and two locations, respectively. These two treatments (T6 and T3) showed correlation between disease reduction and yield increase (Table 88).

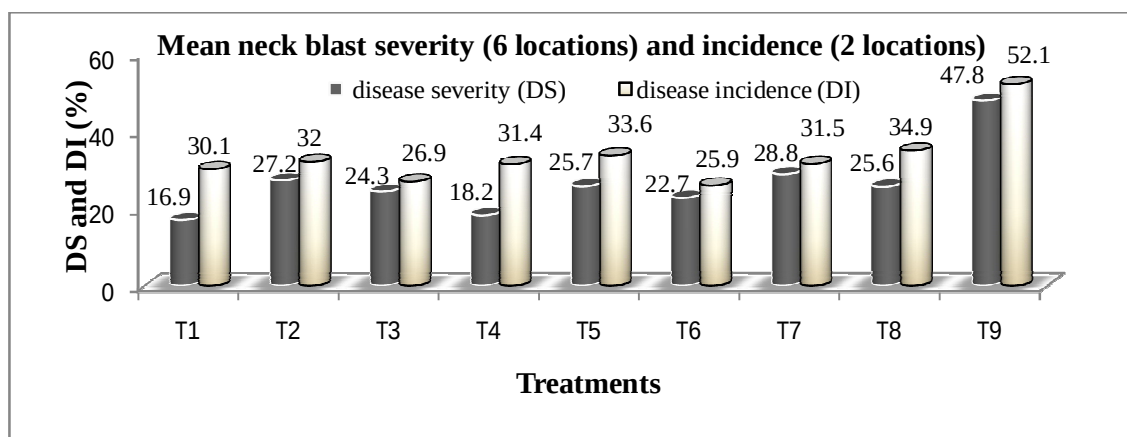


Figure 8: Effect of fungicides against neck blast of rice, Kharif-2018

Node Blast: Fungicidal efficacy on Node blast incidence was observed only at Lonavala centre. Disease incidence of 69.5% was recorded in control plot. Among all the treatments significantly less disease incidence (33.4%) was observed from trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l) treated plot followed by azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5ml/l) treatment (Table 87). Grain yield was also recorded and it was about 1532 kg/ha in the control plots. Trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l) treatment applied was showed highest yield (2851 Kg/ha) (Table 88).

Table 86: Effect of fungicides on grain yield with respect to rice leaf blast, Kharif, 2018

Treatments	Dose/L	Leaf blast yield (Kg/ha)										
		CBT	GGT	IIRR	JDP	KHD	LNV	MGD	NWG	PNP	REW	Mean
T1 - Flusilazole 12.5% + carbendazim 25% SC	1.0 ml/l	4288	5788	4343	3980	3238	2686	3417	6810	3844	3695	4209
T2-Azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC	1.0 ml/l	4910	4913	4273	3818	3760	2287	3187	6750	4373	3761	4203
T3 - Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5ml/l	4514	6313	4547	3698	3744	2731	3438	5720	4117	3445	4227
T4 - Tricyclazole 18 % + mancozeb 62 % WP	2.5 g/l	4391	5213	4257	4045	3671	2404	3546	6035	3833	3927	4132
T5 - Zineb 68% + hexaconazole 4% WP	2.5g/l	4714	4325	3680	3323	2981	2065	2925	5826	3533	3015	3639
T6 - Trifloxystrobin 25% + tebuconazole 50% WG	0.4g/l	4605	6863	4297	4620	3591	2851	4534	6665	4479	3262	4576
T7 - Mancozeb 50% + carbendazim 25% WS	2.5g/l	4100	4775	4273	3133	2633	2482	3017	5885	3681	3188	3717
T8 - Fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC	1.5ml/l	4246	4563	3973	3095	3202	2601	2827	6085	3978	4207	3878
T9 - Control	-	3266	3863	3540	2895	1375	1532	1771	5542	2745	2872	2940
General Mean		4337	5179	4131	3623	3133	2404	3184	6147	3843	3486	3947
LSD @ 5% ($P=0.05$)		309.4	213.8	N/A	236.5	177.8	387.3	863.0	805.7	489.1	289.4	-
CV (%)		4.1	2.8	10.8	4.4	3.9	11.0	15.5	8.9	8.7	4.8	-
SE(m)		102.3	72.8	258.3	80.6	60.5	131.9	285.4	274.4	166.6	95.7	-
SE(d)		144.7	103.0	365.3	113.9	85.6	186.5	403.6	388.1	235.6	135.4	-

Table 87: Evaluation of fungicides against neck blast and node blast disease of rice, Kharif, 2018

Treatments	Dose/L	Neck blast-disease incidence (%)							Neck blast-DS (%)			Node blast-DI
		JDP	KUL	LNV	MLN	MTU	PNP	Mean	GGT	RNR	Mean	LNV
T1 - Flusilazole 12.5% + carbendazim 25% SC	1.0 ml/l	22.4 (28.2)	8.1 (3.0)	57.0 (49.1)	30.0 (33.2)	43.8 (43.8)	19.3 (26.0)	30.1	16.4 (23.9)	17.4 (24.7)	16.9	44.0 (41.5)
T2-Azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC	1.0 ml/l	25.8 (30.5)	4.2 (2.3)	74.0 (59.5)	30.5 (33.5)	41.4 (41.4)	16.2 (23.5)	32.0	17.7 (24.9)	36.7 (37.2)	27.2	54.2 (47.4)
T3 - Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5ml/l	27.6 (31.6)	5.8 (2.6)	51.0 (45.6)	23.7 (29.1)	35.7 (35.7)	17.8 (25.0)	26.9	16.0 (23.5)	32.6 (34.8)	24.3	38.6 (38.3)
T4 - Tricyclazole 18 % + mancozeb 62 % WP	2.5 g/l	20.0 (26.6)	8.0 (3.0)	68.0 (55.9)	22.9 (28.6)	44.4 (44.4)	25.1 (30.1)	31.4	16.9 (24.2)	19.6 (26.2)	18.2	54.2 (47.5)
T5 - Zineb 68% + hexaconazole 4% WP	2.5g/l	28.3 (32.1)	10.1 (3.3)	75.0 (60.4)	22.7 (28.4)	42.2 (42.2)	23.0 (28.6)	33.6	19.3 (26.0)	32.2 (34.6)	25.7	58.0 (49.6)
T6 - Trifloxystrobin 25% + tebuconazole 50% WG	0.4g/l	17.9 (25.0)	4.6 (2.4)	45.0 (42.1)	23.1 (28.7)	49.9 (49.9)	14.9 (22.6)	25.9	14.7 (22.5)	30.7 (33.4)	22.7	33.4 (35.2)
T7 - Mancozeb 50% + carbendazim 25% WS	2.5g/l	32.1 (34.5)	8.6 (3.1)	61.0 (51.4)	18.0 (25.1)	47.0 (47.0)	22.3 (28.1)	31.5	18.0 (25.1)	39.6 (38.9)	28.8	50.2 (45.1)
T8 - Fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC	1.5ml/l	45.5 (42.4)	8.1 (3.0)	55.0 (47.9)	- (-)	43.6 (43.6)	22.3 (28.1)	34.9	18.6 (25.5)	32.6 (34.7)	25.6	47.6 (43.6)
T9 - Control	-	55.7 (48.2)	18.9 (4.5)	90.0 (72.0)	48.8 (44.3)	45.0 (45.0)	54.1(47.3)	52.1	46.3 (42.9)	49.3 (44.6)	47.8	69.5 (56.5)
General Mean		30.6	8.5	64.0	27.5	43.7	23.9	-	20.4	32.3	-	50.0
LSD @ 5% ($P= 0.05$)		1.9	0.4	8.0	3.8	N/A	3.5	-	0.3	6.4	-	9.9
CV (%)		4.0	7.0	10.1	6.8	16.1	8.2	-	0.6	10.6	-	15.0
SE(m)		0.7	0.1	2.7	1.2	3.5	1.2	-	0.1	2.1	-	3.4
SE(d)		0.9	0.2	3.8	1.7	5.0	1.7	-	0.1	3.0	-	4.8
Transformation		AT	ST	AT	AT	NT	AT		AT	AT		AT

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation; NT- No transformation)

Table 88: Effect of fungicides on grain yield with respect to rice neck and node blast, Kharif, 2018

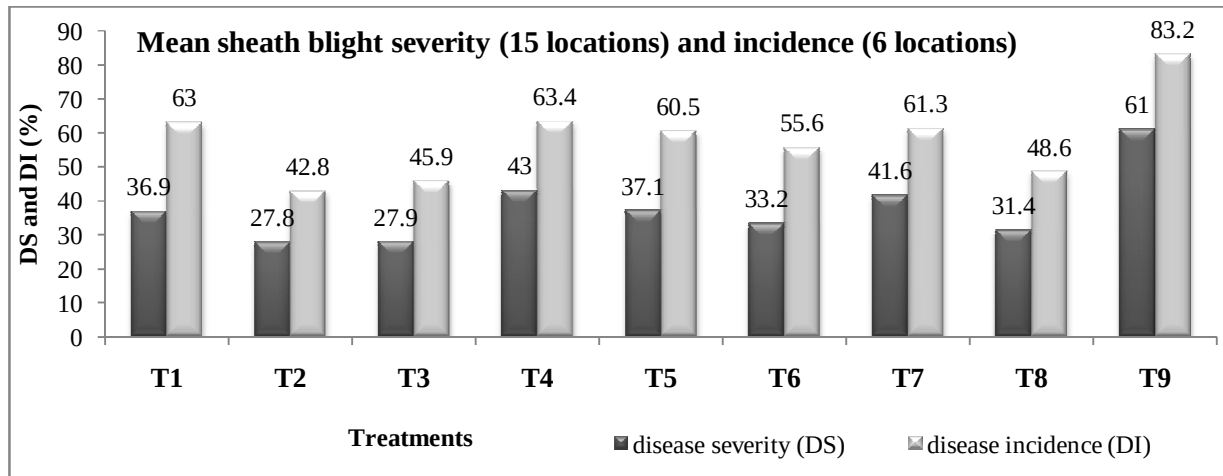
Treatments	Dose/L	Neck blast yield (Kg/ha)									Nd. Bl.	
		GGT	JGL	KUL	LNV	MLN	MTU	PNP	RNR	Mean	LNV	
T1 - Flusilazole 12.5% + carbendazim 25% SC	1.0 ml/l	5788	3980	4267	2686	3661	4856	3844	4861	4243	2686	
T2-Azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC	1.0 ml/l	4913	3818	4333	2287	3606	5348	4373	4152	4104	2287	
T3 - Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5ml/l	6313	3698	4233	2731	3466	5999	4117	4423	4373	2731	
T4 - Tricyclazole 18 % + mancozeb 62 % WP	2.5 g/l	5213	4045	4433	2404	3599	4982	3833	4435	4118	2404	
T5 - Zineb 68% + hexaconazole 4% WP	2.5g/l	4325	3323	4367	2065	3165	5295	3533	4288	3795	2065	
T6 - Trifloxystrobin 25% + tebuconazole 50% WG	0.4g/l	6863	4620	4500	2851	3126	5343	4479	4124	4488	2851	
T7 - Mancozeb 50% + carbendazim 25% WS	2.5g/l	4775	3133	4300	2482	3258	5487	3681	4328	3930	2482	
T8 - Fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC	1.5ml/l	4563	3095	4267	2601	3079	4626	3978	4405	3827	2601	
T9 - Control	-	3863	2895	3833	1532	-	4262	2745	3590	3246	1532	
General Mean		5179	3623	4281	2404	3370	5133	3843	4290	-	2404	
LSD @ 5% ($P= 0.05$)		213.8	236.5	251.5	387.3	422.4	N/A	489.1	N/A	-	387.3	
CV (%)		2.8	4.4	3.4	11.0	7.1	13.6	8.7	16.1	-	11.0	
SE(m)		72.8	80.6	83.2	131.9	137.9	347.9	166.6	398.6	-	131.9	
SE(d)		103.0	113.9	117.6	186.5	195.0	492.0	235.6	563.7	-	186.5	

Sheath blight: Commercially available fungicide combinations were evaluated against sheath blight disease at 15 locations. The experiment was conducted under artificial inoculation at all the test locations except Moncompu. Both disease severity and incidence was observed at five locations viz., Bankura, Cuttack, Faizabad (Masodha), Ludhiana, Maruteru, and Pantnagar. All other nine locations only disease severity was observed during the trial. Two sprays were given at all the centres. Disease severity in check plots was varied between 32.8% (Raipur) and 92.6% (IIRR). Disease severity on untreated plot was very high (>50%) at IIRR (92.6%), Varanasi (79.3%), Bankura (75.3%), Cuttack (74.4%), Chinsurah (72.3%), Arundhutinagar (69.6%), Faizabad (68.7%), Mandya (58.5%), Maruteru (57.5%), Chiplima (51.9%) and Pantnagar (50.3%); high (30-50%) at Moncompu (47.9%), Gangavathi (45.2%) Ludhiana (39.2%) and Raipur (32.8%). Disease incidence was varied between 46.0% (Faizabad) and 100% (Bankura). It was very high at Bankura (100%), Ludhiana (98.7%), Pantnagar (89.1%), Maruteru (87%), Cuttack (78.3%) and Faizabad (46%).

All fungicidal applications significantly reduced the disease compared to control across the test locations. The combination fungicide azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) maximum reduced the severity at six locations (Arundhutinagar, Chiplima, Maruteru, Moncompu, Pantnagar and Raipur) and showed on par with best treatment at another six locations (Cuttack, Faizabad, IIRR, Ludhiana, Mandya and Varanasi). Besides, treatments viz., azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 ml/l) and trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l) significantly reduced the disease severity at each three locations and on par with the better treatment at seven and two locations, respectively. The mean disease severity was low at azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (27.8%) treatment followed by azoxystrobin 11% + tebuconazole 18.3% w/w SC (27.9).

Combination fungicide azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0ml/l) significantly reduced the intensity at two locations (Maruteru and Pantnagar) and on par with better one at other two locations (Cuttack and Faizabad). This was followed by azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 ml/l) minimised incidence at three locations. The average disease incidence was very low (42.8%) at azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0ml/l) treatment compared to other commercial products followed by azoxystrobin 11% + tebuconazole 18.3% w/w SC treatment (Figure 9 and Table 89a, 89b).

It was observed that grain yield was more in fungicide treated plots compared to check plot (3907 Kg/ha). Highest yield was recorded in the plots where azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0ml/l) sprayed (5584 Kg/ha) followed by azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5ml/l) and trifloxystrobin 25% + tebuconazole 50% WG (0.4g/l) sprayed plots (Table 90).

Figure 9: Effect of fungicides against sheath blight of rice, *Kharif*-2018Table 89a: Evaluation of fungicides against sheath blight incidence of rice, *Kharif*, 2018

Treatments	Dose/ L	Sheath blight disease incidence (%)						
		BAN	NRRI	FZB	LDN	MTU	PNT	Mean
T1 - Flusilazole 12.5% + carbendazim 25% SC	1.0 ml/l	100 (10.1)	26.2 (30.7)	33.9 (35.6)	87.3 (69.2)	64.1 (53.5)	66.3 (54.5)	63.0
T2-Azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC	1.0 ml/l	100 (10.1)	23.4 (28.8)	20.9 (27.2)	40.7 (39.5)	11.0 (13.6)	60.8 (51.2)	42.8
T3 - Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5ml/l	100 (10.1)	20.6 (26.9)	32.3 (34.6)	46.0 (42.7)	14.0 (20.3)	62.3 (52.1)	45.9
T4 - Tricyclazole 18 % + mancozeb 62 % WP	2.5 g/l	100 (10.1)	46.6 (43.0)	38.1 (38.1)	38.7 (38.4)	85.7 (69.2)	71.6 (57.8)	63.4
T5 - Zineb 68% + hexaconazole 4% WP	2.5g/l	100 (10.1)	48.5 (44.1)	36.8 (37.3)	54.7 (47.7)	58.9 (50.2)	63.9 (53.0)	60.5
T6 - Trifloxystrobin 25% + tebuconazole 50% WG	0.4g/l	100 (10.1)	39.3 (38.8)	28.2 (32.0)	27.3 (31.4)	73.1 (60.1)	65.9 (54.3)	55.6
T7 - Mancozeb 50% + carbendazim 25% WS	2.5g/l	100 (10.1)	44.0 (41.5)	38.8 (38.5)	45.3 (42.3)	69.6 (57.4)	69.8 (56.6)	61.3
T8 - Fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC	1.5ml/l	100 (10.1)	33.8 (35.4)	20.6 (27.0)	61.3 (51.6)	14.1 (21.8)	61.8 (51.8)	48.6
T9 - Control	-	100 (10.1)	78.3 (62.6)	46.0 (42.7)	98.7 (86.10)	87.0 (72.8)	89.1 (70.8)	83.2
General Mean		100.0	40.1	32.8	55.6	53.1	67.9	-
LSD @ 5% ($P= 0.05$)		0.0	6.8	3.0	7.3	16.1	1.9	-
CV (%)		0.0	11.9	5.9	8.4	23.5	2.0	-
SE(m)		0.0	2.3	1.0	2.4	5.5	0.6	-
SE(d)		0.0	3.3	1.4	3.4	7.7	0.9	-
Transformation		ST	AT	AT	AT	AT	AT	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Table 89b: Evaluation of fungicides against sheath blight disease severity of rice, Kharif, 2018

Treatments	Dose/L	Sheath blight disease severity (%)															
		ARD	BAN	CHN	CHP	NRRI	FZB	GNV	IIRR	LDN	MND	MTU	MNC	PNT	RPR	VRN	Mean
T1	1.0 ml/l	50.1 (45.1)	71.4 (57.7)	46.1 (42.7)	21.9 (27.8)	19.7 (19.7)	33.3 (35.2)	24.5 (29.6)	35.3 (36.4)	23.5 (29.0)	25.9 (30.6)	47.5 (43.5)	23.2 (28.6)	36.4 (37.1)	25.9 (30.6)	68.6 (55.9)	36.9
T2	1.0 ml/l	35.7 (36.6)	48.9 (44.3)	51.6 (45.9)	9.6 (17.9)	16.4 (16.4)	21.9 (27.9)	33.4 (35.2)	30.2 (33.3)	5.5 (13.5)	26.3 (30.8)	12.5 (14.8)	6.3 (14.2)	29.6 (33.0)	25.6 (30.4)	64.1 (53.2)	27.8
T3	1.5ml/l	42.4 (40.6)	22.8 (28.4)	50.7 (45.4)	13.7 (21.7)	15.8 (15.8)	31.3 (34.0)	28.7 (32.3)	27.5 (31.5)	7.2 (15.5)	28.9 (32.5)	15.6 (22.2)	10.8 (17.7)	33.1 (35.1)	25.7 (30.5)	63.8 (53.0)	27.9
T4	2.5 g/l	60.0 (50.8)	60.6 (51.2)	60.6 (51.1)	28.5 (32.2)	42.7 (42.7)	39.3 (38.8)	42.4 (40.6)	43.5 (41.2)	7.1 (15.4)	33.3 (35.2)	53.9 (47.2)	23.6 (28.3)	45.9 (42.6)	26.0 (30.6)	78.1 (62.1)	43.0
T5	2.5g/l	56.3 (48.6)	49.4 (44.7)	29.9 (33.1)	23.0 (28.5)	38.0 (38.0)	36.8 (37.3)	34.4 (35.9)	38.2 (38.1)	11.6 (19.9)	27.4 (31.4)	49.4 (44.6)	24.0 (29.0)	35.1 (36.3)	26.4 (30.9)	76.2 (60.8)	37.1
T6	0.4g/l	38.9 (38.5)	54.2 (47.4)	55.4 (48.1)	14.4 (22.3)	36.2 (36.2)	26.8 (31.1)	30.3 (33.4)	32.9 (35.0)	5.0 (12.8)	24.4 (29.6)	49.0 (44.4)	8.0 (16.3)	36.3 (37.0)	26.4 (30.9)	60.0 (50.8)	33.2
T7	2.5g/l	53.5 (47.0)	57.2 (49.2)	44.8 (42.0)	27.8 (31.8)	49.3 (49.3)	42.8 (40.8)	38.1 (38.1)	41.2 (39.9)	9.5 (18.0)	40.7 (39.6)	49.6 (44.7)	26.1 (30.5)	39.0 (38.6)	26.3 (30.9)	78.1 (62.1)	41.6
T8	1.5ml/l	43.1 (41.0)	75.0 (60.0)	21.3 (27.4)	15.2 (22.9)	30.6 (30.6)	21.8 (27.8)	25.0 (30.0)	31.1 (33.8)	12.2 (20.4)	34.8 (36.0)	17.1 (23.8)	23.1 (27.4)	29.9 (33.1)	25.8 (30.5)	64.4 (53.4)	31.4
T9	-	69.6 (56.6)	75.3 (60.3)	72.3 (58.2)	51.9 (46.0)	74.4 (74.4)	68.7 (56.0)	45.2 (42.2)	92.6 (74.2)	39.2 (38.7)	58.5 (49.9)	57.5 (49.3)	47.9 (43.6)	50.3 (45.1)	32.8 (34.9)	79.3 (63.0)	61.0
General Mean		50.0	57.2	48.1	22.9	35.9	35.8	33.6	41.4	13.4	33.4	39.1	21.4	37.3	26.8	70.3	
LSD @ 5% ($P=0.05$)		3.6	7.2	2.0	4.5	7.5	3.2	5.1	4.9	2.9	5.9	11.2	9.9	2.1	1.2	4.1	
CV (%)		5.4	10.0	3.1	9.2	14.2	6.0	8.3	7.0	8.2	9.6	20.4	25.7	3.2	2.2	4.1	
SE(m)		1.2	2.5	0.7	1.5	2.5	1.1	1.7	1.6	1.0	2.0	3.8	3.4	0.7	0.4	1.3	
SE(d)		1.7	3.5	1.0	2.1	3.6	1.6	2.4	2.3	1.4	2.8	5.4	4.7	1.0	0.6	1.9	
Transformation		AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Table 90: Effect of fungicides on grain yield with respect to sheath blight, Kharif, 2018

Treatments	Sheath blight yield (Kg/ha)															
	ARD	BNK	CHN	CHP	NRRI	FZB	GNV	IIRR	LDN	MND	MTU	MNC	PNT	RPR	VRN	Mean
T1	3873	3818	5656	4084	5164	3200	6310	4657	5550	5513	4856	7787	5639	6733	4695	5169
T2	4307	5430	5250	4729	5328	3700	6160	5121	6343	5338	5348	9143	6072	6617	4881	5584
T3	4083	6002	5450	4318	5670	3313	5843	5500	6201	5018	5999	8325	5934	6117	5351	5542
T4	3715	4582	4750	3782	3982	3025	5810	5329	5953	4698	4982	7166	5506	5483	4582	4890
T5	3586	4396	6000	4024	4060	3150	6117	5097	5758	5263	5295	7619	5820	5983	4373	5103
T6	4249	4974	5000	4594	4182	3425	6623	5133	6379	5538	5343	8522	5645	4750	5438	5320
T7	3624	3485	5800	4018	4026	2963	5960	4618	5417	4348	5487	7764	5559	5767	4306	4876
T8	3861	2880	6800	4513	4490	3750	6340	5280	5195	4577	4626	7200	5999	5333	5126	5065
T9	3358	2741	3925	3220	3374	2363	4872	3642	4317	3917	4262	4339	5459	4690	4131	3907
Mean	3851	4256	5403	4142	4475	3210	6004	4931	5679	4912	5133	7540	5737	5719	4765	-
LSD @ 5% ($P= 0.05$)	155.6	999.7	788.2	346.4	1383.3	358.0	357.8	892.8	275.7	586.6	N/A	N/A	203.1	1179.8	730.1	-
CV (%)	2.8	16.0	9.9	4.8	21.1	7.6	3.4	10.4	2.8	6.8	13.6	25.9	2.0	11.8	8.8	-
SE(m)	53.0	340.5	268.5	114.6	471.1	121.9	118.3	295.3	91.2	194.0	347.9	976.9	67.2	390.2	241.4	-
SE(d)	75.0	481.5	379.6	162.0	666.2	172.4	167.3	417.6	128.9	274.4	492.0	1381.6	95.0	551.8	341.4	-

Sheath rot: The fungicidal molecules were tested against sheath rot disease at seven locations viz., Aduthurai, Chinsurah, Lonavala, Navasari, Nawagam, Rajendranagar and Titabar. Both disease severity and incidence was recorded at Lonavala, Navasari, Nawagam and Titabar. Only disease severity was observed at Aduthurai and Chinsurah and disease incidence was observed at Rajendranagar. These were evaluated against the disease under natural infestation at most of the locations except Chinsurah and Titabar. Disease severity in check plots was very high (>50%) at Chinsurah (75.3%) and Lonavala (60.6%); high (30-50%) at Aduthurai (47.8), Navasari (39.6%) and Titabar (32.7%); moderate at Nawagam (24.1%). Disease incidence in check plots was varied from 93% to 36.4%. Incidence was very high at Lonavala (93%) and Nawagam (88.0%); high at and Navasari (48.4%) and moderate at Rajendranagar (39.3%) and Titabar (36.4%). Uniformly two sprays of fungicides were applied in all the centres except Titabar where three sprays were given. All the combination fungicides were significantly reduced the disease incidence and severity when compared to check and also increased the yield.

The combination fungicide *ie.*, azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 ml/l) significantly reduced the sheath rot severity at two locations (Chinchura and Navsari) and incidence at one location (Navsari). It also reduced the disease severity and incidence on par with the better treatment at Lonavala and Nawagam, respectively. The same treatment showed minimum average disease severity (DS: 20.3%) from six test locations. On the other side, treatment (T1) flusilazole 12.5% + carbendazim 25% SC showed minimum average disease incidence from five test locations. Besides, other two treatments viz., azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1 ml/l) and trifloxystrobin 25% + tebuconazole 50% WG reduced the severity on par with the better one at various test locations. However, these three products viz., azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 ml/l), trifloxystrobin 25% + tebuconazole 50% WG and azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1 ml/l) were found better in reducing the disease severity as well as incidence on par with each other (Figure 10 and Table 91).

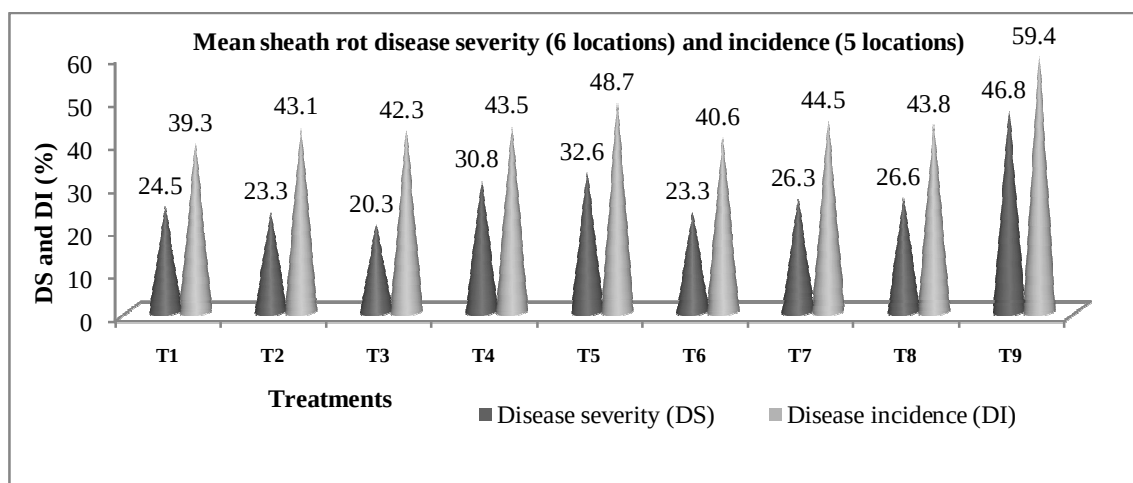


Figure 10: Effect of fungicides against sheath rot of rice, Kharif-2018

The mean yield across the experimental locations in check plot was 3925 Kg/ha. Among the treatments, azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1 ml/l) yielded more (5089 Kg/ha) followed by azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 ml/l) when compare to other treatments (Table 93).

Brown spot: Test fungicidal products were evaluated against brown spot at six different locations. Disease severity was recorded from five locations namely Chatha, Ludhiana, Pattambi, Pusa and Sabour. Disease incidence only was recorded at Aduthurai. Disease severity in control plot was very high (>50%) at Pattambi (78.8%) and Pusa (64.5%); and high at Aduthurai (45.6%), Chatha (45.1%), Sabour (42.6%) and Ludhiana (40.6%). The high disease incidence (45.6%) was noticed at Aduthurai. Bio-efficacy of the fungicides were tested under natural infection at all the centres except Pusa where disease pressure was augmented with artificial inoculation.

All eight combi-products were performed better in reducing the brown spot at all six centres compared to untreated control. Among all the treatment, combination fungicide mancozeb 50% + carbendazim 25% WS (2.5g/l) was significantly reduced the disease severity at two locations (Chata (7.3%) and Pusa (16.9%)) and incidence at Aduthurai (10.4%) compared to other treatments. In other side, treatment (T1) flusilazole 12.5% + carbendazim 25% SC (1ml/l) significantly suppressed the severity (15.8) at Sabour and on par with better treatments at Ludhiana (15.5%). Treatment (T1) showed low mean disease severity (27.4%) from all five locations compared to other treatments followed by mancozeb 50% + carbendazim 25% WS (30.5%) (Figure 11; Table 92). Regarding yield data, fungicide sprayed plots showed significantly higher yield compared to control plot (3882 Kg/ha). Highest mean yield (5031 Kg/ha) was obtained from the plots where azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) sprayed followed by flusilazole 12.5% + carbendazim 25% SC (5009 Kg/ha) sprayed (Table 93).

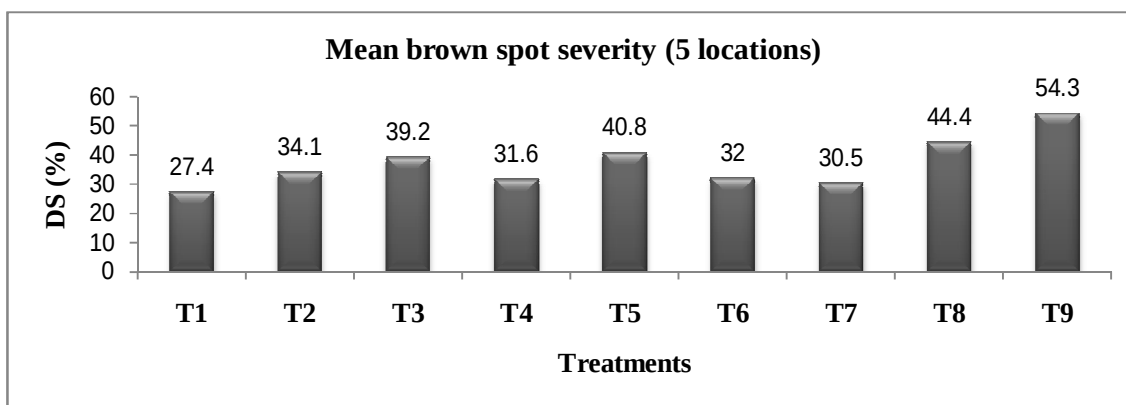


Figure 11: Effect of fungicides against brown spot of rice, Kharif-2018

False smut: Trial was conducted at Cuttack and observed that moderate (21.67%) level of panicle infection in control plot. Fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC showed minimum panicle infection (10.27%) and maximum grain yield (1.5 ml/l) followed by Azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 ml/l) compare to other fungicides (Table 92).

Table 91: Evaluation of fungicides on sheath rot disease of rice, Kharif, 2018

Treatments	Dose/L	Sheath rot disease severity (%)							Sheath rot disease incidence (%)					
		ADT	CHN	LNV	NWG	NVS	TTB	Mean	LNV	NWG	NVS	RNR	TTB	Mean
T1 - Flusilazole 12.5% + carbendazim 25% SC	1.0 ml/l	21.7 (27.5)	50.8 (45.4)	30.8 (33.6)	13.5 (3.8)	24.1 (29.4)	6.4 (14.6)	24.5	77.0 (8.8)	59.7 (50.6)	36.6 (37.2)	16.6 (23.9)	6.8 (15.1)	39.3
T2-Azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC	1.0 ml/l	22.2 (27.7)	32.0 (34.3)	41.0 (39.8)	14.5 (3.9)	17.9 (24.9)	12.5 (20.7)	23.3	81.0 (9.0)	62.8 (52.4)	26.6 (31.0)	30.4 (33.3)	14.5 (22.4)	43.1
T3 - Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5ml/l	17.8 (24.0)	30.3 (33.3)	22.9 (28.6)	17.8 (4.3)	16.2 (23.6)	17.2 (24.5)	20.3	74.0 (8.7)	61.6 (51.7)	23.5 (28.9)	32.6 (34.8)	19.6 (26.3)	42.3
T4 - Tricyclazole 18 % + mancozeb 62 % WP	2.5 g/l	38.9 (41.6)	55.0 (47.9)	35.7 (36.6)	18.1 (4.4)	22.7 (28.4)	14.6 (22.4)	30.8	79.0 (8.9)	67.0 (55.0)	32.6 (34.8)	22.3 (28.1)	16.5 (23.9)	43.5
T5 - Zineb 68% + hexaconazole 4% WP	2.5g/l	37.2 (37.1)	52.8 (46.6)	49.8 (44.9)	16.1 (4.1)	24.5 (29.6)	15.5 (23.2)	32.6	88.0 (9.4)	67.5 (55.3)	37.0 (37.4)	32.2 (34.3)	18.8 (25.7)	48.7
T6 - Trifloxystrobin 25% + tebuconazole 50% WG	0.4g/l	27.2 (30.7)	47.5 (43.5)	21.1 (27.2)	15.3 (4.0)	19.0 (25.8)	10.0 (18.3)	23.3	70.0 (8.4)	63.6 (52.9)	27.3 (31.5)	31.1 (33.7)	10.8 (19.4)	40.6
T7 - Mancozeb 50% + carbendazim 25% WS	2.5g/l	20.6 (26.0)	55.0 (47.9)	35.0 (36.2)	16.2 (4.1)	23.1 (28.6)	8.3 (16.7)	26.3	81.0 (9.1)	66.7 (54.8)	34.0 (35.6)	32.2 (34.6)	8.4 (16.8)	44.5
T8 - Fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC	1.5ml/l	28.9 (32.1)	49.5 (44.7)	29.8 (33.0)	15.9 (4.1)	20.3 (26.8)	15.1 (22.8)	26.6	78.0 (8.9)	64.6 (53.5)	29.9 (33.1)	31.1 (33.8)	15.6 (23.2)	43.8
T9 - Control		47.8 (43.7)	75.3 (60.2)	60.6 (51.1)	24.1 (5.0)	40.2 (39.3)	32.7 (34.9)	46.8	93.0 (9.7)	80.0 (63.5)	48.4 (44.1)	39.3 (38.8)	36.4 (37.1)	59.4
General Mean		29.1	49.8	36.3	16.8	23.1	14.7	-	80.1	65.9	32.9	29.8	16.4	-
LSD @ 5% ($P=0.05$)		N/A	5.2	3.6	0.2	3.1	1.6	-	0.4	3.7	3.7	7.3	1.7	-
CV (%)		42.0	7.9	6.7	3.9	7.5	4.9	-	3.1	4.6	7.2	12.7	4.9	-
SE(m)		6.8	1.8	1.2	0.1	1.1	0.5	-	0.1	1.3	1.3	2.4	0.6	-
SE(d)		9.6	2.5	1.8	0.1	1.5	0.8	-	0.2	1.8	1.8	3.4	0.8	-
Transformation		AT	AT	AT	ST	AT	AT	-	AT	AT	AT	AT	AT	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Table 92: Evaluation of fungicides on brown spot disease of rice, Kharif, 2018

Treatments	Dose/L	BS-DI (%)	Brown spot- disease severity (%)						FS-NRRI	
		ADT	CHT	LDN	PTB	PSA	SBR	Mean	Panicle infection	Spikelet infection
T1 - Flusilazole 12.5% + carbendazim 25% SC	1.0 ml/l	19.4 (25.1)	12.8 (20.9)	15.5 (23.2)	71.9 (58.0)	21.1 (27.3)	15.8 (23.4)	27.4	12.60 (3.7)	1.2 (1.2)
T2-Azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC	1.0 ml/l	14.4 (22.3)	32.7 (34.8)	12.7 (20.8)	55.0 (47.8)	39.2 (38.7)	31.0 (33.8)	34.1	13.60 (3.8)	3.0 (3.0)
T3 - Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5ml/l	17.2 (24.3)	34.6 (36.0)	23.7 (29.1)	59.1 (50.2)	49.3 (44.6)	29.3 (32.8)	39.2	10.60 (3.7)	1.0 (1.0)
T4 - Tricyclazole 18 % + mancozeb 62 % WP	2.5 g/l	30.6 (33.1)	15.1 (22.9)	25.5 (30.3)	71.4 (57.7)	15.6 (23.1)	30.4 (33.4)	31.6	13.77 (3.8)	1.9 (1.9)
T5 - Zineb 68% + hexaconazole 4% WP	2.5g/l	21.7 (27.7)	40.2 (39.3)	26.4 (30.9)	61.6 (51.8)	42.6 (40.7)	33.3 (35.2)	40.8	12.93 (3.7)	1.4 (1.7)
T6 - Trifloxystrobin 25% + tebuconazole 50% WG	0.4g/l	23.9 (29.2)	19.1 (25.8)	14.7 (22.5)	71.1 (57.5)	38.0 (38.0)	17.2 (24.5)	32.0	12.97 (3.7)	1.2 (1.2)
T7 - Mancozeb 50% + carbendazim 25% WS	2.5g/l	10.4 (16.1)	7.3 (15.5)	32.5 (34.7)	70.3 (57.0)	16.9 (24.3)	25.6 (30.4)	30.5	13.07 (3.7)	1.2 (1.2)
T8 - Fluxapyroxad 62.5g/l + epoxiconazole 62.5g/l EC	1.5ml/l	19.4 (26.1)	41.3 (39.9)	33.1 (35.1)	74.1 (59.4)	53.2 (46.8)	20.4 (26.9)	44.4	10.27 (3.3)	0.7 (0.7)
T9 - Control	-	45.6 (42.4)	45.1 (42.1)	40.6 (39.6)	78.8 (62.7)	64.5 (53.5)	42.6 (40.7)	54.3	21.67 (4.7)	1.5 (1.5)
General Mean		22.5	27.5	25.0	68.1	37.8	27.3	-	13.5	1.5
LSD @ 5% ($P= 0.05$)		6.9	3.5	2.9	4.1	5.0	1.6	-	0.6	N/A
CV (%)		17.2	7.7	5.6	5.0	9.1	3.0	-	9.0	88.2
SE(m)		2.3	1.2	1.0	1.4	1.7	0.5	-	0.2	0.1
SE(d)		3.3	1.7	1.4	2.0	2.4	0.8	-	0.3	1.0
Transformation		AT	AT	AT	AT	AT	AT	-	ST	ST

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Table 93: Effect of fungicides on grain yield with respect to sheath rot, brown spot and false smut, Kharif, 2018

Treatments	Sheath rot yield (Kg/ha)								Brown spot yield (Kg/ha)							FS
	ADT	CHN	LNV	NVS	NAW	RNR	TTB	Mean	ADT	CHT	LDN	PTB	PSA	SBR	Mean	NRRI
T1	6210	4431	2686	5362	6810	4861	4575	4991	6210	2685	5550	4500	3716	7394	5009	663
T2	6550	5139	2287	6441	6750	4152	4300	5089	6550	2128	6343	5063	3564	6537	5031	688
T3	6385	5222	2731	6602	5720	4423	4250	5048	6385	2358	6201	4750	2966	6574	4872	887
T4	6285	4500	2404	5767	6035	4435	4355	4826	6285	2403	5953	4313	4019	6534	4918	663
T5	5848	4486	2065	5162	5826	4288	4380	4579	5848	2053	5758	4875	3401	6427	4727	691
T6	5935	4653	2851	6434	6665	4124	4480	5020	5935	2565	6379	4375	3700	7160	5019	673
T7	5820	4417	2482	5553	5885	4328	4525	4716	5820	2788	5417	4625	3794	6607	4842	730
T8	5823	4917	2601	5898	6085	4405	4260	4855	5823	2078	5195	4375	3025	7084	4597	968
T9	5420	3125	1532	4504	5542	3590	3760	3925	5420	1935	4317	4038	2223	5357	3882	520
General Mean	6031	4543	2404	5747	6147	4290	4321	-	6031	2332	5679	4546	3379	6630	4766	720
LSD @ 5% ($P=0.05$)	276.6	785.7	387.3	698.5	805.7	N/A	214.7	-	276.6	204.1	275.7	594.4	388.9	546.6	-	N/A
CV (%)	3.1	11.8	11.0	8.3	8.9	16.1	3.4	-	3.1	6.0	2.8	8.9	7.8	4.7	-	22.8
SE(m)	94.2	267.6	131.9	237.9	274.4	398.6	73.1	-	94.2	69.5	91.2	202.4	132.4	180.8	-	94.7
SE(d)	133.2	378.4	186.5	336.5	388.1	563.7	103.4	-	133.2	98.3	128.9	286.3	187.3	255.7	-	133.9

2. INTEGRATED DISEASE MANAGEMENT, *Kharif* -2018

To study the effect of Integrated Disease Management practices on the incidence of different diseases in rice, the trials were proposed at about twelve locations i.e., Cuttack, Faizabad, Gerua, Kaul, Lonavala, Malan, Mandya, Maruteru, Moncompu, Pantnagar, Rajendranagar, Rewa, Gudalur, Ponnampet and Titabar and trial was conducted at ten locations. The layout suggested was RBD with 3 replications adopting a net plot size of 5 x 2 m and a spacing of 15 x 15 cm. Locally popular variety was suggested for the trial. The fertilizers recommended were (N:P: K: Zn-120:60:40:25)-Apply fertilizer @ 120 kg N/ha, 60kg P₂O₅/ha and 40 K₂O/ha. Apply entire P and K and ½ N as basal dose and the remaining ½N at maximum tillering stage. Apply additional 25% N at booting to make the plants more prone to the disease. Apply ZnSO₄ @ 25 kg/ha as basal dose. Location wise adopted practices were given in Table 94.

The different components for integrated Disease Management trial are given below

N-1 (Nursery)	Incorporation of FYM @ 1 kg/m ² in the nursery
N-2 (Nursery)	Seed treatment with carbendazim (2 g/kg) alone or along with one application of carbendazim (@1 g/m ²) 7 days before uprooting the seedlings. (Procedure for seed treatment: Soak the required quantity of seeds in a bucket of water overnight, decant the water and mix the soaked seeds thoroughly with the required quantity of fungicides and then put the treated warm and humid place for 1-2 days for initiation of germination; use these seeds for raising the seedlings)
N-3 (Nursery)	Apply DAP @ 108 g/10 m ² nursery area (to supply 20 and 50 kg /ha of nitrogen and phosphorus) before sowing the seeds. Apply muriate of potash(MOP) @ 85 g/10 m ² nursery area (to supply 50 kg/ha potassium)
M-4 (Main field)	Application of FYM during land preparation before transplanting (@ 1 kg/m ²)
M-5 (Main field)	Application of FYM during land preparation before transplanting (@ 1 kg/m ²) + <i>Trichoderma</i> formulation (2 g /kg of FYM)
M-6 (Main field)	Cultural practices (cleaning of bunds i.e no weeds/infected straw on bunds and main field)
M-7 (Main field)	Apply 100% RDF(Recommended dose of fertilizers). Apply fertilizers @ 120 kg N/ha, 60 kg P ₂ O ₅ /ha, 40 K ₂ O/ha and ZnSO ₄ @ 25 kg/ha (N:P:K: Zn-120:60:40:25). Apply entire P and K and ½ N as basal dose and the remaining ½ N at maximum tillering stage. Apply additional 25% N at booting to make the plants more prone to the disease. Apply ZnSO ₄ as basal dose.
M-8 (Main field)	75% RDF (i.e. 90 kg N/ha; 45 kg P ₂ O ₅ /ha, 30 K ₂ O/ha and ZnSO ₄ @ 18 kg/ha (N:P:K:Zn-90:45:30:18) + micronutrient solution @ 0.5 litre /10 m ² area[micronutrient solution should be made by mixing 2 g or 2 ml micronutrient product/litre of water]] Micronutrient should be sprayed 15-20 days after transplanting. Micronutrient application should be repeated after 15 after the first application

M-9 (Main field)	One blanket application of granular insecticide (cartap hydrochloride or fipronil) at 15 DAT
M-10 (Main field)	Need based application of following fungicides based on the disease In areas which are endemic for neck blast, give one spray of tricyclazole 75 WP (Beam or Sivic) @ 0.6 g/l or iprobenphos 48 EC (Kitazin) @ 2g/l or isoprothiolane 40 EC (Fiji-One) @ 1.5 ml/l during panicle emergence In case of brown spot/sheath rot/grain discoloration: Give one spray of carbendazim 50 WP (Bavistin) @ 1g/l or combination of carbendazim (12%) and mancozeb (63%) (Saaf) @ 1.5-2 g/l In case of bacterial blight: Spray twice with 250 ppm of Agrimycin-100 or any other suitable antibiotic at 10 days interval Apply propiconazole @1ml/lit at booting stage for the false smut
M-11	Two times spray of neem based product @ 3 ml/lt at the time of tillering and booting stage

Treatment details

- T1** - N3 + M4 + M7
- T2** - N1 + N2 + N3 + M4 + M7 + M10
- T3** - N1 + N2 + N3 + M5 + M7 + M9 + M10
- T4** - N1 + N2 + N3 + M5 + M6 + M8 + M9 + M10
- T5** - N3 + M7(control)
- T6** - Control

Table 94: Integrated Disease Management - Details of the practices adopted at Chiplima, Kharif 2018

IDM Practices	CHP	CHP
Ecosystem	Irrigated	Irrigated
Test Variety(s):	Swarna	Swarna
Date of sowing/planting	09.07.2018 / 31.07.2018	09.07.2018/ 31.07.2018
Name of the Disease:	BLB	Sheath blight
Dose of the FYM applied in the Nursery (N-1)	1 kg per sqm	1 kg per sqm
Name and Dose of the Chemical used for seed treatment (N-2)	Carbendazim @ 2g/kg seed	Carbendazim @ 2g/kg seed
Dose of DAP and MOP applied in the nursery (N-3)	DAP 10.8g /sqm and MOP 8.5 g/sqm	DAP 10.8g /sqm and MOP 8.5 g/sqm
Dose of the FYM applied during land preparation (M-4)	1 kg per sqm	1 kg per sqm
Dose of FYM applied during land preparation and dose of <i>Trichoderma</i> applied (M-5)	FYM @ 1 kg/sqm and T viride @ 2g/kg of FYM	FYM @ 1 kg/sqm and T viride @ 2g/kg of FYM
Cultural Practices Followed (M-6)	Manual weeding	Manual weeding
Dose of 100% RDF Application (M-7) (Basal and Top)	80: 40: 40 Kg NPK/ha, Basal-40:40:20 Kg NPK/ha, Top-20:0:20(25 DAP), 20:0:0 (45 DAP).	80: 40: 40 Kg NPK/ha, Basal-40:40:20 Kg NPK/ha, Top-20:0:20(25 DAP), 20:0:0 (45 DAP).
(Basal and Top) on 75% RDF + Name and dose of micronutrient Application (M-8)	60: 30: 30 Kg NPK/ha, Basal-30:30:15 Kg NPK/ha, Top-15:0:15(25 DAP), 15:0:0 (45 DAP).	60: 30: 30 Kg NPK/ha, Basal-30:30:15 Kg NPK/ha, Top-15:0:15(25 DAP), 15:0:0 (45 DAP).
Name and Dose of Granular insecticide Applied (M-9)	Cartap hydrochloride (Cartap 4G) @ 10 kg/acre	Cartap hydrochloride (Cartap 4G) @ 10 kg/acre
Disease and name, dose of fungicide Applied (M-10)		
a) Name of the disease and fungicide	BLB, Streptocycline	Sheath blight, Propiconazole and (Trifloxystrobin + Tebuconazole)
(b) Date of Spray and dose of the fungicide/observation date		
1st Spray:	Streptocycline @ 1g/10 l on 29.09.2018	Blanket application of Propiconazole @ 1ml/l on 05.09.2018
2 nd Spray:	Streptocycline @ 1g/10 l on 10.10.2018	Spraying of (Trifloxystrobin + Tebuconazole) @ 0.4g/l on 25.10.2018
Details about the stage of the crop and name, dose of the neem product (M-11)	M-11 is not mentioned in Technical programme	M-11 is not mentioned in Technical programme
(a) Name of the neem product		
(b) Date of Spray and dose of the product:		
1st Spray and stage of the crop: / observation date	15.56 /28.09.2018	22.10.2018
2 nd Spray and stage of the crop: / observation date	24.44 /09.10.2018	09.11.2018
Date of Harvest	26.11.2018	26.11.2018

(Contd.) Table 94: Integrated Disease Management - Details of the practices adopted at Faizabad and Gerua, Kharif 2018

IDM Practices	MSD (FZB)	GER
Ecosystem	Irrigated	Rainfed lowland
Test Variety(s):	Pusa Basmati-1	Tapaswini
Date of sowing/planting	23.06.18/ 25.07.18	02.07.2018 / 15.08.2018
Name of the Disease:	Sheath Blight	Bacterial Leaf Blight, Brown spot
Dose of the FYM applied in the Nursery (N-1)	1 kg/m ²	1 kg/sqm
Dose of the Chemical used for seed treatment (N-2)	Bavistin @ 2.0 g/kg seed	Carbendazim @ 2 g/kg seed
Dose of DAP and MOP applied in the nursery (N-3)	DAP @ 108 g/10m ² and MOP @ 85 g/10m ²	DAP @108 g/10 sqm, MOP @ 85 g/10 sqm
Dose of the FYM applied - land preparation (M-4)	1 kg/m ²	1 kg/sqm
Dose of FYM applied during land preparation and dose of Trichoderma Applied (M-5)	FYM @ 1 kg/m ² + Trichoderma @ 2g/kg FYM	FYM- 1 kg/sqm, Trichoderma- 2 g/kg FYM
Cultural Practices Followed (M-6)	Cleaning of bund and plots	Cleaning of bunds and main field
Dose of 100% RDF Application (M-7) (Basal and Top)	120:60:60:25 Kg NPK ZnSO ₄ /ha	N: P:K:Zn @ 120:60:40:25 kg/ha, Basal- Entire P, K, Zn and half of N, Top dress- Remaining half of N, Additional 25% N at booting stage
Dose (Basal and Top) on 75% RDF + Name and dose of micro nutrient Application (M-8)	90:45:45:18 Kg NPK ZnSO ₄ /ha	: P:K:Zn @ 90:45:30:18 kg/ha, UPAJ (Micronutrient) @ 2 g/l water
Dose of Granular insectide Applied (M-9)	Cartap Hydrochloride at 20 DAT (17.08.18)	Cartap hydrachloride @ 25 g/ha
Disease and name, dose of fungicide Applied (M-10)		Propiconazole 25 EC @ 1ml/l water
a) Name of the disease and fungicide	Sheath Blight, Bavistin	Brown spot, Carbendazim 50 WP
(b) Date of Spray and dose of the fungicide	1 g/l	
1st Spray:	16.10.18 (One Spray)	08.12.2018
2 nd Spray:		
Details about the stage of the crop and name, dose of the neem product (M-11)		
a) Name of the neem product		
(b) Date of Spray and dose of the product:		
1st Spray and stage of the crop / observation date	6.11.18	
2 nd Spray and stage of the crop / observation date		
Date of harvest :	18.11.18	10.12.2018

(Contd.,) Table 94: Integrated Disease Management - Details of the practices adopted at Jagdalpur and Malan, Kharif 2018

IDM Practices	JDL	MLN
Ecosystem	Upland / Rainfed	Irrigated
Test Variety(s):	Swarna	HPU 2216
Date of sowing/planting	06-04-2018 / 07-08-2018	30.06.2018 / 26.07.2018
Name of the Disease:	Leaf blast and Neck blast	Leaf blast, Neck blast
Dose of the FYM applied in the Nursery (N-1)	1 kg/m ²	1 kg / sq m
Dose of the Chemical used for seed treatment (N-2)	carbendazim @ 2g/kg	Carbendazim 50 WP @ 2 g/ kg seed
Dose of DAP and MOP applied in the nursery (N-3)	108 g/10m ² & 85g/10m ²	As per technical programme
Dose of the FYM applied - land preparation (M-4)	1 kg/m ²	As per technical programme
Dose of FYM applied during land preparation and dose of Trichoderma Applied (M-5)	1kg/m ² +2g/kg	As per technical programme i.e. 2 g Trichoderma formulation/ kg of FYM/ sq m
Cultural Practices Followed (M-6)	Cleaning of bunds i.e no weeds/infected straw on bunds and main field)	cleaning of bunds
Dose of 100% RDF Application (M-7) (Basal and Top)	Applied @ 120 kg N/ha, 60 kg P ₂ O ₅ /ha, 40 K ₂ O/ha and ZnSO ₄ @ 25 kg/ha (N:P:K: Zn-120:60:40:25).	Urea = 70 g basal & 70 g as top dressing per plot (5.04 sq. m); SSP = 210 g/ plot basal; MOP = 37 g/ plot as basal + Zn sulphate @ 14 g/ plot as basal
Dose (Basal and Top) on 75% RDF + Name and dose of micro nutrient Application (M-8)	75% RDF (i.e. 90 kg N/ha; 45 kg P ₂ O ₅ /ha, 30 K ₂ O/ha and ZnSO ₄ @ 18 kg/ha(N:P:K: Zn-90:45:30:18) + micronutrient solution @ 0.5 litre /10 m ² area	Urea = 55 g basal & 55 g as top dressing per plot (5.04 sq. m); SSP = 155 g/ plot basal; MOP = 28 g/ plot as basal + Zn sulphate @ 10 g/ plot as basal + Micronutrient (Ferrous sulphate) @ 2g/ L as per technical programme
Dose of Granular insectide Applied (M-9)	Cartap hydrochloride @2ml/lit	Not used instead, Chlorpyrifos was sprayed @ 2.5 ml/ L
Disease and name, dose of fungicide Applied (M-10)	Tricyclazole 75 WP (Beam or Sivic) @ 0.6 g/l and carbendazim 50 WP (Bavistin) @ 1g/l	
a) Name of the disease and fungicide	Leaf blast & Neck blast and brown spot and Tricyclazole 75 WP (Beam or Sivic) @ 0.6 g/l and carbendazim 50 WP (Bavistin) @ 1g/l	Disease: Leaf blast, Neck blast; Fungicide: Tricyclazole @ 0.6 g/ L
(b) Date of Spray and dose of the fungicide	20/08/18 and 05/09/18	
1st Spray:		Single spray (as per tech. program) of Tricyclazole at panicle emergence stage on 18.09.2018
Details about the stage of the crop and name, dose of the neem product (M-11)		
a) Name of the neem product		
(b) Date of Spray and dose of the product:		
1st Spray and stage of the crop / observation date		
2 nd Spray and stage of the crop / observation date		
Date of harvest :	12-10-2018	28.10.2018

(Contd.,) Table 94: Integrated Disease Management - Details of the practices adopted at Maruteru, Kharif 2018

IDM Practices	MTU	MTU
Ecosystem:	Irrigated <i>kharif</i> 2018	Irrigated <i>kharif</i> 2018
Test Variety(s):	Swarna (MTU 7029)	Krishnaveni (MTU-2077)
Date of sowing/planting	27.6.2018 / 28.7.2018	27.6.2018 / 30.7.2018
Name of the Disease:	Sheath blight	Bacterial leaf blight
Dose of the FYM applied in the Nursery (N-1)	1 kg/m ²	1 kg/m ²
Name and Dose of the Chemical - for seed treatment (N-2)	Carbendazim 2g/kg seed/litre water	carbendazim 2g/kg seed/litre water
Dose of DAP and MOP applied in the nursery (N-3)	DAP @ 108 g/10 m ² nursery area and MOP @ 85 g/10 m ² nursery	DAP @ 108 g/10 m ² nursery area and MOP @ 85 g/10 m ² nursery
Dose of the FYM applied during land preparation (M-4)	1 kg/m ²	1 kg/m ²
Dose of FYM applied during land preparation and dose of <i>Trichoderma</i> Applied (M-5)	1 kg/m ² and 2 g of <i>Trichoderma</i> formulation/kg of FYM	1 kg/m ² and 2 g of <i>Trichoderma</i> formulation/kg of FYM
Cultural Practices Followed (M-6)	Bunds cleaning i.e., no weeds/infected straw on bunds and main field, thorough land preparation	Bunds cleaning i.e. no weeds/infected straw on bunds and main field, thorough land preparation
Dose of 100% RDF Application (M-7) (Basal and Top)	120:60:40: 25 NPK & Zinc sulphate @ 25 kg/ha	120:60:40: 25 NPK & Zinc sulphate @ 25 kg/ha
Dose (Basal and Top) on 75% RDF + Name and dose of micro-nutrient Application (M-8)	90:45:30 kg NPK and Zinc 18 kg/ha ; micronutrient solution (Gromor Formula 4) @ 2 ml/litre water	90:45:30 kg NPK and Zinc 18 kg/ha ; micronutrient solution (Gromor Formula 4) @ 2 ml/litre water
Name and Dose of Granular insecticide Applied (M-9)	20 g/10 m ² area	20 g/10 m ² area
Disease and name, dose of fungicide Applied (M-10)	Sheath blight, Propiconazole 25 EC @ 1.0 ml/litre	bacterial leaf blight, propiconazole 25 EC @ 1.0 ml/litre
a) Name of the disease and fungicide	Sheath blight, hexaconazole 5 EC @ 2.0 ml/litre	bacterial leaf blight, plantomycin @ 1.0 g/litre
(b) Date of Spray and dose of the fungicide	9.10.2018	
1st Spray:	9.10.2018	5.10.2018
2 nd Spray:	24.10.2018	20.10.2018
Details about the stage of the crop and name, dose of the neem product (M-11)		
a) Name of the neem product		
(b) Date of Spray and dose of the product:		
1st Spray and stage of the crop:	06.9.2018 at tillering stage	6.9.2018 at tillering stage
2 nd Spray and stage of the crop:	22.9.2018 at booting stage	22.9.2018 at booting stage
Date of Harvest:	20.11.2018	04.12.2018

(Contd.,) Table 94: Integrated Disease Management - Details of the practices adopted at Mandya and Pantnagar, Kharif 2018

IDM Practices	MND	PNT
Ecosystem:	Irrigated	Irrigated
Test Variety(s):	Jyothi	Pant Dhan-4
Date of sowing/planting	7.08.2018/ 31.08.2018	01.06.2018 / 26.06.2018
Name of the Disease:	Sheath blight , Brown spot	Sheath Blight
Dose of the FYM applied in the Nursery (N-1)	FYM @ 1Kg/Sq.m	Applied FYM @ 1 kg/m ² in nursery
Name and Dose of the Chemical - for seed treatment (N-2)	Carbendazim 50WP @4g/kg PDI of brown spot on 28.08.2018 is 8.88	Seed Treatment with Carbendazim 2gm/kg seed alone for nursery raising
Dose of DAP and MOP applied in the nursery (N-3)	DAP 11g/sq.m and MOP 8g/Sq.m PDI of brown spot on 28.08.2018 4.44	Applied DAP @ 108 g and MOP @ 85 g/10 m ² nursery area
Dose of the FYM applied during land preparation (M-4)	10kg per plot 1 kg/ sq.m	Applied FYM just before transplanting (@ 1 kg/m ²) in plots.
Dose of FYM applied during land preparation and dose of <i>Trichoderma</i> Applied (M-5)	10kg <i>Trichoderma</i> enriched manure per plot 1 kg/ sq.m (<i>Trichoderma</i> formulation@2g/kg)	Applied FYM (@ 1 kg/m ²) + <i>Trichoderma harzianum</i> formulation (2 g /kg of FYM) just before transplanting in the plots
Cultural Practices Followed (M-6)	Deep ploughing and bund cleaning in the main field	Plots and their bunds were kept clean i.e no weeds/infected straw
Dose of 100% RDF Application (M-7) (Basal and Top)	120:50:50 per Ha Zn so ₄ @20 kg/ha (Basal 60:50:50 ; Top dress 30:0:0 ; 30:0:0)	Applied 100% RDF (N:P:K: Zn-120:60:40:25). Entire P, K, ZnSO ₄
Dose (Basal and Top) on 75% RDF + Name and dose of micro-nutrient Application (M-8)	90:37.5:37.5 per ha and Znso ₄ @15 Kg/ha (Basal 45:37.5:37.5 ; Top dress 45:0:0)	Applied 75% RDF (N:P:K: Zn-90:45:30:18).
Name and Dose of Granular insecticide Applied (M-9)	Fipronil @ 10kg/acre 13/10/2018	Applied cartap hydrochloride 4% granules @ 18.75kg/ha at 15 DAT
Disease and name, dose of fungicide Applied (M-10)		Sprayed propiconazole @ 0.1% twice at booting and after booting stage to manage sheath blight
a) Name of the disease and fungicide	Brown spot	sheath blight propiconazole
(b) Date of Spray and dose of the fungicide		0.1% (1g/lit of water)
1st Spray:	27.10.2018; carbendazim (12%) and mancozeb (63%) (Saaf) @ 1.5-2 g/l	
2 nd Spray:	Neck blast: Tricyclazole 0.6 gm/l 7.11.2018	
Details about the stage of the crop and name, dose of the neem product (M-11)		
a) Name of the neem product	Neem Baan1500 PPM from PCI @ 2ml/l	
(b) Date of Spray and dose of the product:		
1st Spray and stage of the crop:		22.09.2018
2 nd Spray and stage of the crop:		04.10.2018
Date of Harvest:	10.1.2019	06.11.2018

(Contd.,) Table 94: Integrated Disease Management - Details of the practices adopted at Pattambi and Rewa, Kharif 2018

IDM Practices	PTB	REW
Ecosystem	Rainfed lowland	Upland irrigated
Test Variety(s):	Jyothi	PS-4
Date of sowing/planting	13.7.2018 / 9.8.2018	5.7.18 / 25.7.18
Name of the Disease:	Sheath blight	Leaf Blast
Dose of the FYM applied in the Nursery (N-1)	FYM @1 kg per sqm	1kg/m ²
Name and Dose of the Chemical used for seed treatment (N-2)	Carbendazim 2 g per kg seed	Carbendazim@2g/kg
Dose of DAP and MOP applied in the nursery (N-3)	DAP -108 g/ 10 m ² MOP 85 g/m ²	DAP@110g/10m ² and MOP@85g/10m ²
Dose of the FYM applied during land preparation (M-4)	1 kg /m ²	1kg/m ²
Dose of FYM applied during land preparation and dose of Trichoderma Applied (M-5)	1 kg /m ² + trichoderma 2 g / kg FYM	FYM@1kg/m ² +Trichoderma@2gm/kg of FYM
Cultural Practices Followed (M-6)	Manual weeding in field and on bunds	cleaning of bunds weed free
Dose of 100% RDF Application (M-7) (Basal and Top)	NPK 120:60:40 kg per ha 60:60:40 kg NPK /ha + Zn So ₄ 25 kg /ha as basal ,60 kg N at Maximum tillering stage 30 kg N/ha at booting	120:60:40 NPK kg/ha+ 20 kg/ha ZnSO ₄ (Entire PK and half N as basal dose and remaing half N at Tillering stage)
Dose (Basal and Top) on 75% RDF + Name and dose of micro-nutrient Application (M-8)	NPK 90:45:30 kg per ha 45:45:30 kg NPK /ha as basal , 45 kg N at maximum tillering stage. Micronutrient mixture for rice developed at RARS,Pattambi @ 10 g per litre at 30DAT and 50DAT	75%RDF(N:P:K:Zn 90:45:30:18) + Pentagon@0.5kg/10m ² . Humic gold spray@2g/l applied after transplanting
Dose of Granular insecticide Applied (M-9)	Cartap hydrochloride 4 G @ 12.5 kg / ha	Carbofuron@10kg/ha at 15DAT
Disease and name, dose of fungicide Applied (M-10)		
a) Name of the disease and fungicide	Sheath blight. Propionazole	Leaf Blast : Tricyclazole75WP(Beam)@0.6gm/l
(b) Date of Spray and dose of the fungicide/observation date		
1st Spray:	Propionazole @ 1 ml/ l 19.9.2018	20-09-2018 Beam @0.6gm/l
2 nd Spray:		02-10-2018
Details about the stage of the crop and name, dose of the neem product (M-11)		Neemex@3ml/l at the time of tillering and booting stage
a) Name of the neem product		
(b) Date of Spray and dose of the product:		
1st Spray and stage of the crop:		24-09-2018
2 nd Spray and stage of the crop:		05-10-2018
Date of Harvest:	22.11.2018	24-11-2018

Effect of IDM practices against leaf blast disease at different locations

The effect of IDM practices on the management of leaf blast disease of rice was studied at three centres viz., Jagdalpur, Malan and Rewa. Accordingly the disease severity and grain yield data were recorded from the treatments and analyzed. Among the three centres the disease severity was high in Jagdalpur (77.78%) followed by Malan (51%) and least in Rewa (26.20%) in control. Among the different treatments in Rewa, the application of *T. viride* during field preparation (M5) and neem based product at the time of tillering and booting stage (T4) has helped in achieving the least severity of disease (9%) followed by the treatment (T3-11%) in the Rewa centre, with the complete package of IDM practices. Both these treatments have significantly improved the yield (4735 and 4571 Kg/ha respectively) when compared with the control (3473 Kg/ha). However the highest percentage decrease in disease severity over the control was found in the treatment with *T. viride* (T4) in Malan centre (62.74%) when compared with the least in Jagdalpur (37.14%) for the same treatment. The treatments T3 and T4 in case of Malan (25.40% and 19.00% respectively) and Rewa (9% and 11% respectively), were on par with each other in the reducing the disease severity in treated plants when compared to control (51% and 23.16%) was found to be more effective followed by T5 (22.65% and 23.16% respectively). However the treatment T4 was able to significantly improve the yields in both Malan (2333 Kg/ha) and Rewa (4735 Kg/ha) when compared to the treatment T3 in both the centres (2209 and 4571 Kg/ha respectively). The above result thus indicates that the application of biocontrol agents and the organic manure at the critical stages can help in the management of the disease and also improve the yields (Table 95).

Effect of IDM practices against neck blast disease at different locations

The trial to study the effect of integrated management practices on the incidence of neck blast disease in rice was conducted in two centres viz., Malan and Jagdalpur. Among the two centres the maximum percent disease incidence (56.40%) was observed in the Malan centre, followed by 33.61% DI at Jagdalpur in control. The highest percentage decrease in disease severity over the control was found in the treatment with *T. viride* (T4) in Malan centre (45.39%) when compared to 32.69% in Jagdalpur centre. Among the different treatments, the treatment T4 was found to be the most effective in both the centres viz., Malan and Jagdalpur and had the least incidence of disease (30.80 and 22.62 % DI respectively) followed by the treatment T3 (39.70 and 23.33% DI respectively). The treatment T3 and T1 were found to be statistically on par in Malan and the treatments T3 and T2 were found to be statistically on par at Jagdalpur. In both the centres, the treatment T4 was found to increase the grain yield (2333 and 3073 Kg/ha at Malan and Jagdalpur respectively) over control (1770 and 2040 Kg/ha respectively) (Table 96).

Table 95: Effect of integrated management practices against severity of leaf blast and grain yield at Jagdalpur, Malan and Rewa –Kharif, 2018

T. No	Treatment	Leaf blast								
		JDP			MLN			REW		
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	N3 + M4 + M7	67.78 (55.40)	12.85	2183	38.30 (38.18)	23.92	2017	15.96 (3.99)	31.08	3869
T 2	N1 + N2 + N3 + M4 + M7 + M10	57.04 (49.03)	26.66	2470	30.70 (33.46)	39.80	2014	13.13 (3.62)	43.30	4210
T 3	N1 + N2 + N3 + M5 + M7 + M9 + M10	52.22 (46.25)	32.86	2543	25.40 (30.19)	50.19	2209	11.00 (3.31)	52.50	4571
T 4	N1 + N2 + N3 + M5 + M6 + M8 + M9 + M10	48.89* (44.35)	37.14	3073	19.00* (25.79)	62.74	2333	9.00* (3.00)	61.13	4735
T 5	Control (N3 + M7)	77.78 (61.85)	-	2040	51.00 (45.54)	-	1770	23.16 (4.81)	-	3473
	C.V (%)	1.40		4.49	4.83		5.27	4.58		3.26
	LSD @ 5% ($P=0.05$)	1.11		170	2.58		168	0.32		255
	Transformation	AT			AT			ST		

(* indicates best treatment) (Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Table 96: Effect of integrated management practices against severity of neck blast and grain yield at different locations - Kharif, 2018

T.No	Treatment	Neck Blast					
		MLN			JDP		
		Disease Incidence (%)	% decrease over control	Grain Yield (kg/ha)	Disease Incidence (%)	% decrease over control	Grain Yield (kg/ha)
T 1	N3 + M4 + M7	38.80 (38.52)	31.20	2017	31.74 (34.27)	05.56	2183
T 2	N1 + N2 + N3 + M4 + M7 + M10	49.80 (44.88)	11.70	2014	26.57 (30.86)	20.94	2470
T 3	N1 + N2 + N3 + M5 + M7 + M9 + M10	39.70 (39.01)	29.60	2209	23.33 (28.85)	30.58	2543
T 4	N1 + N2 + N3 + M5 + M6 + M8 + M9 + M10	30.80* (33.60)	45.39	2333	22.62* (28.22)	32.69	3073
T 5	Control (N3 + M7)	56.40 (48.69)	-	1770	33.61 (35.41)	-	2040
	C.V (%)	6.37		5.27	8.18		4.49
	LSD @ 5% ($P= 0.05$)	4.02		168	3.97		170
	Transformation	AT			AT		

(** indicates best treatment) (Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Effect of IDM practices against sheath blight disease at different locations

The trial to study the effect of IDM on sheath blight disease severity was conducted at four locations viz., Faizabad, Chiplima, Pattambi and Maruteru. In general, the severity of the disease was lowest in Chiplima (37.50% in control) followed by 42.22% in Pattambi. Among the four centres, the per cent disease severity (PDS) was highest in Faizabad (67.45%) followed by Maruteru (50.13%), Pattambi (42.22%) and 37.50% in Chiplima. The treatment T4 (N1 + N2 + N3 + M5 + M6 + M8 + M9 + M10) which includes both nursery and main field along with need based management practices was most effective in reducing the PDS in different centres (17.77% to 25.55%). The application of *Trichoderma viride* and organic amendments decreased the disease severity by the highest percentage decrease in disease severity over the control in FZB centre (56.59%) followed by 52.61% in Chiplima, 39.48% in Pattambi and the lowest (10.85%) in Maruteru (Table 97). The treatment T4 involves the incorporation of FYM @ 1 kg/m² in the nursery followed by seed treatment with carbendazim (2 g/kg) alone or along with one application of carbendazim (@1 g/m²) 7 days before uprooting the seedlings and application of DAP @ 108 g/10 m² nursery area (to supply 20 and 50 kg /ha of nitrogen and phosphorus) before sowing the seeds followed by application of muriate of potash (MOP) @ 85 g/10 m² nursery area (to supply 50 kg/ha potassium). In the main field, the field was prepared with the application of FYM during land preparation before transplanting (@ 1 kg/m²) + *Trichoderma* formulation (2 g /kg of FYM). The less incidence of disease may be due to the effect of seed treatment with carbendazim and the application of the biocontrol agent *T. viride*. However the treatments had least effect in Maruteru because of the very favourable conditions prevailing in the region, high humidity coupled with high temperature.

The treatment T2 involves application of DAP @ 108 g/10 m² nursery area (to supply 20 and 50 kg /ha of nitrogen and phosphorus) before sowing the seeds, muriate of potash (MOP) @ 85 g/10 m² nursery area (to supply 50 kg/ha potassium). The main field applications include application of FYM during land preparation before transplanting (@ 1 kg/m² and full dose of recommended fertilizers (N: P: K: Zn-120:60:40:25). The application of additional 25% N at booting to make the plants more prone to the disease in this treatment has made the plants more susceptible for the disease. Further the absence of seed treatment and entire application of fertilizers in one lot (except Nitrogen) might have resulted in the improper utilization of the nutrients by the plants and thus rendering them weak and susceptible for the pathogen to attack.

Thus it is evident that seed treatment followed by clean bunds, optimum dose of fertilizer application in split doses with organic manures, followed by application of *Trichoderma* and also need based application of fungicides prevent the build up of *R. solani* in the soil and healthy plant population leading to the control of the sheath blight disease of rice.

Table 97: Effect of integrated management practices against severity of sheath blight and grain yield at different locations - Kharif, 2018

T.No	Treatment	CHP			FZB			MTU			PTB		
		Disease severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease severity (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	N3 + M4 + M7	36.11 (36.88)	03.70	4312	51.08 (45.60)	24.26	2812	50.38	00.00	4528	38.89 (38.48)	07.88	3937
T 2	N1 + N2 + N3 + M4 + M7 + M10	28.89 (32.37)	22.96	4435	37.40 (37.67)	44.55	3062	46.54	07.16	4609	37.77 (37.89)	10.54	3937
T 3	N1 + N2 + N3 + M5 + M7 + M9 + M10	22.22 (28.04)	40.74	4644	34.45 (35.91)	48.92	3237	49.94	0.37	4623	29.72 (32.94)	29.60	4250
T 4	N1 + N2 + N3 + M5 + M6 + M8 + M9 + M10	17.77* (24.76)	52.61	4896	29.28* (32.71)	56.59	3487	44.69*	10.85	4766	25.55* (30.32)	39.48	4250
T 5	Control (N3 + M7)	37.50 (37.71)	-	4273	67.45 (55.21)	-	2162	50.13	-	4517	42.22 (40.45)	-	3187
C.V (%)		12.65		3.05	4.93		6.93	6.59		20.87	11.80		12.90
LSD @ 5% (P= 0.05)		6.23		212	3.15		315	4.90		14.82	6.55		777
Transformation		AT			AT			-			AT		

(“*” indicates best treatment) (Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Effect of IDM practices against brown spot disease in rice at Gerua and Mandya centres

The nursery application of 75% RDF (i.e. 90 kg N/ha; 45 kg P₂O₅/ha, 30 K₂O/ha and ZnSO₄ @ 18 kg/ha (N:P:K:Zn-90:450:30:18) + micronutrient solution @ 0.5 litre /10 m² area[micronutrient solution should be made by mixing 2 g or 2 ml micronutrient product/litre of water]) and main field application of DAP @ 108 g/10 m² nursery area (to supply 20 and 50 kg /ha of nitrogen and phosphorus) before sowing the seeds, muriate of potash(MOP) @ 85 g/10 m² nursery area (to supply 50 kg/ha potassium) was taken as control (T5). The percent disease incidence of brown spot was lowest (35.40%) in Gerua when compared with Mandya (37.76). The application of *T. viride* along with organic amendments in the nursery and main field reduce the severity of disease to the maximum (38.05 and 33.50%) in Mandya. However the treatments did not have expected suppression of disease in Gerua, with the reduction in disease severity ranging from 03.41 to 11.73%. The treatments with organic amendments and *T. viride* could improve the yield in spite of more disease, the grain yield was high (5412 kg/ha) even with the disease severity of 25.11%. This shows that the organic treatment was able to increase yield in spite of the disease (Table 98) in Mandya.

Effect of IDM practices against bacterial leaf blight disease at different locations

Trials were conducted at three centres viz., Maruteru, Chiplima and Gerua to study the effect of IDM practices on the management of bacterial leaf blight disease in rice. In general, among the three centres, Maruteru had very high disease severity (93.44%) followed by Chiplima (46.67%) and Gerua (36.35%). Due to high disease severity in the crops, the different treatments did not have any effect and all the treatments were found to be on par with each other. This shows that under high disease pressure, the planting of disease resistance varieties would be the best way to manage the bacterial leaf blight of rice. Similar was the case with Gerua, where the different treatments did not have any significant effect on reducing the disease severity and the reduction in disease severity over control ranged from 01.06 to 09.44 % for various treatments. However the treatments did have a significant effect in reducing the severity of the disease by about 54.16% when compared over control, when the plants were treated with *T. viride* and organic amendments in the nursery and main field at Chiplima. Among the different treatments the treatment T4, which contained incorporation of all the cultural practices along with the application of *T. viride* in the nursery and main field was found to have the highest yield among all the treatments (4465 Kg/ha in Gerua, 4273 Kg/ha in Chiplima and 3803Kg/ha in Maruteru) when compared to the control (Table 99).

Conclusion

The treatment T3 which includes both nursery and main field practices along with need based management practices was found to be most effective and consistent in reducing the incidence of leaf blast, neck blast, sheath blight, brown spot and sheath rot and also increasing the grain yield at all the centers. This shows that the IDM practices have significant effect on disease management and also improving yield. Application of FYM both in the nursery and main field, application of *Trichoderma* in the main field, seed treatment with suitable fungicide, application of 75% recommended dose of fertilizers, adoption of general crop protection practices based on the need, have positive effect of reducing the disease and improving the grain yield.

Table 98: Effect of integrated management practices against severity of brown spot and grain yield at Gerua and Mandya - Kharif, 2018

T.No	Treatment	Brown spot					
		GER			MND		
		Disease Incidence (%)	% decrease over control	Grain Yield (kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (kg/ha)
T 1	N3 + M4 + M7	34.35 (35.87)	06.27	4406	32.68 (34.63)	13.45	4975
T 2	N1 + N2 + N3 + M4 + M7 + M10	32.35* (34.64)	11.73	4148	23.29* (28.77)	38.05	5065
T 3	N1 + N2 + N3 + M5 + M7 + M9 + M10	33.30 (35.21)	09.14	4309	25.11 (30.00)	33.50	5412
T 4	N1 + N2 + N3 + M5 + M6 + M8 + M9 + M10	33.33 (35.23)	09.05	4581	35.94 (36.79)	04.81	5101
T 5	Control (N3 + M7)	35.40 (36.47)	03.41	4465	37.76 (37.85)	-	4550
T 6	Control	36.65 (37.24)	-	4317	-	-	
C.V (%)		3.89		12.51	13.72		5.52
LSD @ 5% ($P= 0.05$)		2.10		824	7.10		427
Transformation		AT			AT		

(‘*’ indicates best treatment) (Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Table 99: Effect of integrated management practices against severity of bacterial leaf blight and grain yield - Kharif, 2018

T.No	Treatments	Bacterial leaf blight								
		CHP			GER			MTU		
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/Ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/Ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/Ha)
T 1	N3 + M4 + M7	37.22 (37.56)	20.24	4312	37.48 (37.72)	0.26	4406	90.43 (9.51)	03.22	3835
T 2	N1 + N2 + N3 + M4 + M7 + M10	26.39 (30.71)	43.45	4435	34.03* (35.62)	09.44	4148	90.98 (9.54)	00.00	4081
T 3	N1 + N2 + N3 + M5 + M7 + M9 + M10	29.45 (32.71)	36.89	4644	34.23 (35.75)	08.91	4309	94.81 (9.73)	00.00	3935
T 4	N1 + N2 + N3 + M5 + M6 + M8 + M9 + M10	21.39* (27.43)	54.16	4896	37.18 (37.52)	01.06	4581	90.26 (9.50)	03.40	4122
T 5	Control (N3 + M7)	46.67 (43.04)	-	4273	36.35 (36.96)	03.27	4465	93.44 (9.66)	-	3803
T 6	Control	-	-	-	37.58 (37.73)	-	4317	-	-	-
C.V (%)		11.29		3.05	4.54		12.51	3.75		14.15
LSD @ 5% ($P= 0.05$)		5.97		212	2.53		824	0.55		862
Transformation		AT			AT			ST		

(‘*’ indicates best treatment) (Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Trial No 13: INTEGRATED PEST MANAGEMENT-SPECIAL TRIAL

Considering the environmental pollution and pesticide toxicity issues in the food products, an integrated management trial was formulated with the objective of following a holistic management of the crop, including the management of all biotic stresses and minimizing the use of chemical pesticides. Need based application of fungicides was an important concept in the IPM trials. During *Kharif* 2018, the trial was conducted at 6 different locations viz., Coimbatore, Mandya, Ludhiana, Jagdalpur, Titabar and Sakoli. This was conducted as a coordinated trial, by the experts from different fields of crop science and the data obtained are segregated discipline wise. In the following paragraphs, data with respect to the IPM in disease management are summarized only from the centres where disease stress was observed and recorded. Further only the concise information regarding the per cent disease incidence observed in the IPM and farmers practice plots are given and the readers may please refer the IPM trial report in the entomology portion of this report for more detailed information regarding the yield and cost benefit ratio between the two methods of cultivation.

The area under the disease progress curve (AUDPC) is a useful quantitative assessment of disease intensity over time, for comparison across years, locations, or management tactics. The progression of disease over a time is also studied by AUDPC. By plotting the disease severity values in Y axis and time interval of observations on X axis a curve is obtained. By plotting slopes to the curve at regular intervals will give the area under disease progress curve.

Area under disease progress curve (AUDPC) of leaf blast and neck blast diseases at various locations, *Kharif* – 2018.

AUDPC of leaf blast and neck blast diseases were calculated from the disease severity of IPM trials conducted at four locations viz., Coimbatore, Jagdalpur, Mandya, and Sakoli and compared with the farmers practices. The data revealed that; in general the disease progress was significantly lower in the experimental plots where IPM practices were followed when compared to the farmers practices (Table 100). Further the disease progress of leaf blast disease was more in Sakoli centre when compared to the other three centres viz., Coimbatore, Mandya and Jagdalpur. AUDPC values of 241, 612 and 372 were observed at three locations of Sakoli. Similarly neck blast symptoms were observed in Mandya and Sakoli. The AUDPC values in all the three trial locations of Mandya were higher compared to Sakoli.

Table 100: AUDPC values based on 0-9 scale at different dates/disease severity (%) of leaf blast and neck blast diseases at various locations, *Kharif* – 2018

Treatment	AUDPC values/Locations															
	Leaf Blast												Neck Blast			
	CBT			JDP		MND			Sakoli			MND			Sakoli	
	L1	L2	L3	L1	L2	L1	L2	L3	L1	L2	L3	L1	L2	L3	L1	L2
IPM	24	21	56	22	15	64	58	70	241	612	372	64	30	52	8	14
FP	92	-	-	19	19	166	112	172	195	498	309	104	61	103	9	50

(L- Location)

Area under disease progress curve (AUDPC) of sheath blight and Bacterial leaf blight diseases at various locations, *Kharif* – 2018

Sheath blight disease was recorded at Jagdalpur, Ludhiana, Sakoli and Titabar while BLB at two locations viz., Sakoli and Titabar. It was apparent that the sheath blight progression was more and rapid at Sakoli when compared to other three locations (Table 101). The highest AUDPC values of 199, 146 and 162 under IPM practices; 195, 144 and 255 under farmers practices were recorded at three different experimental locations of Sakoli. At Titabar, sheath blight progression was measured as disease severity at one time at the peak stage of disease and which was varied between 11% to 31% in two locations under IPM and FP.

Disease progression of BLB was recorded at Sakoli; while final disease severity at Titabar as presented in the Table 101. The highest AUDPC values for BLB were observed at second location of Sakoli (2778) under farmers practices. The final disease severity was more under farmers practices at Titabar (35 % and 45 %) when compared to IPM practices (24 % and 22 %).

Table 101: AUDPC values based on 0-9 scale at different dates/disease severity (%) of Sheath blight and bacterial leaf blight diseases at various locations, *Kharif* – 2018

Sheath blight and bacterial leaf blight diseases at various locations, Arunachal Pradesh, 2016													
Treatment	AUDPC values/Locations												
	Sheath Blight								BLB				
	JDP		LDN	Sakoli			TTB*		Sakoli			TTB*	
	L1	L2	L1	L1	L2	L3	L1	L2	L1	L2	L3	L1	L2
IPM	17	17	104	199	146	162	12	11	2318	2476	1487	24	22
FP	-	-	131	195	144	255	31	25	2289	2778	1208	35	45

(L- Location; * Disease was recorded in terms of disease severity)

In general, in all the cases it was observed that the experimental plots where IPM practices were followed had significantly less units of AUDPC value when compared with the farmers practice.

The brown spot disease, sheath rot and stem rot disease were recorded at Sakoli; while false smut was observed at Ludhiana under both IPM and FR trials. The brown spot disease progression was rapid and more in IPM trial as compared to farmer practices at two locations; however in third location FP recorded the highest AUDPC value of 379. The highest AUDPC values of 90 and 435 were recorded at first and third locations of Sakoli for sheath rot under farmers practices. In general the sheath rot disease progression was slow in IPM practices as compared to farmers practices at Sakoli. The false smut progression recorded at Ludhiana revealed that, the disease progression was more under farmers practices (25) compared to IPM practices (13) (Table 102).

Table 102: AUDPC values based on 0-9 scale at different dates/disease severity (%) of brown spot, sheath rot, stem rot and false smut diseases at various locations, Kharif – 2018

Treatment	AUDPC values/Locations									
	Sakoli									LDN
	Brown spot			Sheath rot			Stem rot			FS
	L1	L2	L3	L1	L2	L3	L1	L2	L3	L1
IPM	228	1311	363	39	105	197	180	288	211	13
FP	161	735	379	90	56	435	216	237	143	25

L- Location, FS-False smut

The above studies thus indicated that the IPM practices which integrates all the necessary components for the reduction of disease inoculum, providing necessary nutrients for the development of a healthy host and also creating an atmosphere that is not favourable for the pathogen to survive, helps in the overall condition of less disease development and spread resulting in the reduced AUDPC.

TRIAL NO: 14 SPECIAL TRIAL ON ESSENTIAL OILS

Every year the use of pesticides are increased due to application of inappropriate quantities of pesticides, spurious pesticides, pesticide resistance and emergence of new pests and diseases. The overuse of fungicides for the management of major rice diseases will be a matter of concern and alternative or complementary protection practices are important and need of the hour to reduce the use of pesticides for achieving a sustainable environment. Hence, a special trial was proposed for the management of rice diseases with the use of essential oils. The trial was laid out with ten treatments and a control viz., T1 - Citronella oil @ 2.0ml/l; T2- Eucalyptus oil @ 2.0ml/l; T3- Cedar wood oil@ 2.0ml/l; T4- Nirgundi oil@ 2.0ml/l; T5-Lemon grass oil@2.0ml/l; T6-Clove oil@2.0ml/l; T7-Neem essential oil@2.0ml/l; T8-Emulsifier@2.0ml/l; T9-Carbendazim@0.6g/l and T10-Control.

The trial was proposed at different hot spot locations (17 locations) for different rice diseases viz., 7 locations for leaf blast; 7 locations for sheath blight; 3 locations for brown spot and 7 locations for bacterial blight. In *Kharif* 2018, essential oils were tested for their performance at 14 different locations based on the major diseases of the particular regions *i.e.*, against leaf blast at 3 locations (Hazaribagh, Jagdalpur and Mandya), against neck blast at 2 locations (Jagdalpur, Malan); against sheath blight at 6 locations (Chinsurah, Ludhiana, Pantnagar, Moncompu, Masodha (Faizabad), Maruteru); against bacterial blight at 5 locations (Chinsurah, Karjat, Pantnagar, Pattambi and Maruteru) and against false smut at Gerua, Pantnagar and Maruteru. Trial for the management of brown spot was conducted only at Hazaribagh. The trial details are presented in Table 103. At all the locations disease pressure was created artificially except Jagdalpur, Malan and Moncompu.

Effect of essential oils against leaf blast, neck blast and brown spot disease at different locations

Trial on leaf blast was conducted at Hazaribagh, Mandya; on neck blast at Malan and on both leaf and neck blast the trial was conducted at Jagdalpur. Leaf blast and neck blast was recorded in terms of disease severity at all locations. Leaf blast severity was very high at Jagdalpur (63.33%), Mandya (60.03%); and very low at Hazaribagh (8.95%). With respect to neck blast very high disease severity of 60.3% was recorded at Malan and moderate disease severity of 41.48% was recorded at Jagdalpur. The salient observations of this study are presented on below. Among the different essential oils tested for their efficacy against leaf blast at Mandya, application of two sprays of Clove oil @ 2 ml/l (T6) reduced the disease severity of leaf blast from 60.03% to 28.59% with 52.38% per cent decrease over control. The results were on par with the fungicide treatment (T9 - Carbendazim @0.6g/l) with the disease severity of 29.98%. Both the treatments (T6 and T9) have significantly improved the yield (6650 and 6517 Kg/ha respectively) when compared with the control (3945Kg/ha). At Hazaribagh, even though the disease severity was very low (8.95%), two sprays of Clove oil @ 2 ml/l (T6) reduced the disease severity to 4.21%. At Jagdalpur, two sprays of Neem oil @ 2 ml/l (T7) were found to be more effective and significantly reduced both leaf blast (from 63.33% to 42.59%) and neck blast severity (from 41.48% to 21.48%), increased the grain yield from 2770 kg/ha to 3723 kg/ha

followed by spraying of Cedar wood oil (T3) which recorded disease severity of 45.56%; 21.67% against leaf blast and neck blast respectively along with the grain yield of 3543kg/ha (Table 104 and 105). At IIRR the trial was conducted in UBN (Uniform Blast Nursery) and disease was created artificially. Among the tested essential oils, two spraying of Eucalyptus oil @2.0ml/l (T2) reduced the disease severity up to 32.97% followed by Citronella oil @2.0ml/l (T1) (24.45%).

Brown spot: At Hazaribagh disease pressure was low (8.43%) in spite of artificial inoculation of the pathogen. Among the different oils tested, Citronella Oil @ 2.0ml/l (T1) reduced the disease severity from 8.43% to 3.50% and non significant difference was observed with respect to grain yield (Table 105).

Effect of essential oils against sheath blight disease at different locations

Trial on the effect of essential oils for the management of sheath blight disease severity was conducted at Chinsurah, Ludhiana, Pantnagar, Moncompu, Masodha (Faizabad) and Maruteru. Disease severity was very high at Chinsurah (72.1%), Masodha (71.38%); high at Maruteru (51.69); moderate at, Ludhiana (49%), Pantnagar (46.45%) and Moncompu (30.26%). Among the different essential oils tested, at Chinsurah, the spraying of Neem oil was effective in reducing the disease severity from 72.1% to 64.3% and increased the grain yield up to 4800 kg/ha followed by Citronella oil @ 2.0 ml/l (DS- 64.3%; GY – 4100kg/ha) compared to control. Spraying of Cedar wood oil @ 2.0ml/l (T3) significantly reduced the disease severity both at Ludhiana (T3- 24.8%; Control – 49%) and Faizabad (T3 – 38.85%; control – 71.38%) along with the higher grain yield of 4344 kg/ha and 3071kg/ha respectively. At IIRR, among the tested essential oils, two spraying of Eucalyptus oil @2.0ml/l (T2) reduced the disease severity from 82.58 % to 78.47%. All other treatments showed non-significant effect both on disease severity or grain yield. Nirgundi oil was effective in reducing the disease severity at Pantnagar (T4 – 43.05%; Control – 46.45%) and Maruteru (T4 – 45.19%; Control – 51.69%). At both the locations, significant difference was not observed among other treatments with respect to disease severity and grain yield. At Moncompu, spraying of Eucalyptus oil @ 2.0 ml/l (T2) significantly reduced the disease severity from 30.26% to 6.27% and increased the grain yield from 3214 to 6601 kg/ha (Table 106).

Effect of essential oils against false smut disease at different locations

The trial was conducted at Gerua, Pantnagr and Maruteru for the management of false smut disease. At Gerua, even though artificial inoculation was done, the disease incidence was very low (0.64%). Disease incidence was moderate at Pantnagar (30.57%) and Maruteru (25.89%). At Pantnagar, among the different essential oils spraying of Neem oil @ 2.0 ml/l (T7) reduced the disease up to 18.46% compared to control. However there was no significant difference among the treatments with respect to disease reduction and grain yield. Application of Eucalyptus oil @ 2.0 ml/l (T2) reduced the disease incidence from 25.89% to 18.25% and there was no significant difference among the treatments with respect to grain yield (Table 107).

Table 103: Experimental details of Special trial on essential oils for the management of rice diseases, Kharif-2018

S. No	Location	Disease Recorded	Test Variety	Screening	Date of activities					
					Sowing/ Transplanting	Inoculation	Initial symptom	Spraying	Observation	Harvesting
1	Chinsurah	Sheath Blight	Swarna (MTU 7029)	Artificial	16.07.18 ; 16.08.18	20.09.18	27.09.18	28.09.18 ; 9.10.18	02.11.18	30.11.18
		Bacterial Blight	TN 1	Artificial	17.07.2018	18.09.18	20.09.18	20.09.18; 03.10.18	12.10.18; 26.10.18	14.11.18
2	Faizabad	Sheath Blight	Pusa Basmati-1	Artificial	23.06.18 ; 25.07.18	23.09.18	30.09.18	26.9.18; 03.10.18; 12.10.18	01.10.18, 0.10.18; 31.10.18	17.11.18
3	Gerua	False smut	Tapaswini	Artificial	30.06.18; 12.08.18	13.10.18	07.11.18	15.10.18 ; 02.10.18	14.11.18	10.12.18
4	Hazaribag	Leaf Blast	Sahbhagi Dhan	Artificial	23.07.18	15.09.18	17.09.18	17.09.18 ; 04.09.18	17.09.18	30.10.18
		Brown spot	Sahbhagi Dhan	Artificial	10.07.18	01.09.2018	03.09.18	03.09.18; 10.09.18	03.09.18	20.10.18
5	IIRR	Leaf Blast	TN 1	Artificial	09-11-18	26-11-18	29-11-18	30-11-18; 10-12-18	11-12-18	-
		Sheath blight	TN 1	Artificial	25.06.18	18-09-18	20-09-18	20-09-18; 28.09.18	26.9.18; 03.10.18	17-11-18
		Bacterial blight	TN 1	Artificial	-	15/9/18	18/09/18	18/9/18; 25/09/18	15/10/2018	-
6	Jagdarpur	Leaf blast and Neck blast	Swarna	Natural	06-04-18; 07-08-18	30/09/18	-	20/09/18; 04/10/18; 17/10/18	18/09/18; 8/09/18 15/09/18	12-10-18
7	Karjat	Bacterial Leaf blight	TN 1	Artificial	23/07/18; 08-10-18	30/09/18	4/10/18	02/10/18; 09/10/18	05/10/18	20/11/18
8	Ludhiana	Sheath Blight	PR114	Artificial	01.06. 18; 29.06.18	18.09.18	21.09.18	20.09.18; 30.09.18	12.10.18	21/10/18
9	Malan	Neck Blast	HPU 2216	Natural	20.06.18; 18.07.18	-	-	04.09.18; 11.09.18	22.10.18	02.11.18
10	Mandya	Leaf blast	MTU1001	Artificial	07.08.18; 30.08.18	18.9.18	25.09.18	30.09.18; 07.10.18	29.09.18	24.01.2019
11	Maruteru	Sheath blight, False smut	Swarna (MTU-7029)	Artificial	27.06.18; 28.07.18	23.8.18	28.08.18	25.08.18; 01.09.18	15.09.18; 3.10.18, 17.11.18	23.11.18
	Maruteru	Bacterial leaf blight, False smut	Sridhruthi (MTU-1121)	Artificial	27.06.18; 30.07.18	05.09.18	09.09.18	07.09. 18; 14.09.18	24.09.18; 6.10.18, 28.11.18	04.12.18
12	Moncompu	Sheath blight	UMA(MO 16)	Natural	27/10/18; 20/11/18	-	-	23.01.19; 02-02-19	-	16.03.2019
13	Pantnagar	False Smut	UPRH 191 Hybrid	Artificial	07.07.18; 31.07.18	29.09.18	14.10.18	01.10.18; 08.10.18	23.10.18	19.11.18
		Sheath blight		Artificial	07.07.18; 31.07.18	19.09.18	04.10.18	21.09.18; 28.09.018	14.10.18	19.11.18
		Bacterial leaf blight		Artificial	07.07.18; 31.07.18	24.09.18	01.10.18	26.09.18; 03.10.18	20.10.18	19.11.18
14	Pattambi	Bacterial blight	Annapoorna	Artificial	24.10.18; 13.11.18	24.12.18	28.12.18	26.12.18; 03.01.19	19.01.19	05.02.2019

Table 104: Effect of essential oils against Leaf blast and grain yield at different locations *Kharif*, 2018

T. No	Treatment	Leaf blast										
		HZB			JDP			IIRR		MND		
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	3.95 (1.98)	55.87	2984	58.89	7.01	2810	76.00 (60.35)	24.45	41.75 (40.23)	30.45	4975
T 2	Eucalyptus oil @2.0ml/l	4.72 (2.17)	47.26	2788	57.78	8.76	2880	67.00 (54.93)	32.97	32.98 (35.02)	45.07	6393
T 3	Cedar wood oil @2.0ml/l	5.71 (2.39)	36.20	2594	45.56	28.06	3543	100 (89.96)	0.00	36.00 (36.84)	40.03	5692
T 4	Nirgundi oil @2.0ml/l	6.10 (2.46)	31.84	2425	55.56	12.27	2917	100 (89.96)	0.00	34.88 (36.16)	41.91	6357
T 5	Lemon grass oil @2.0ml/l	5.88 (2.42)	34.30	2576	52.22	17.54	3383	100 (89.96)	0.00	30.06 (33.21)	49.92	6567
T 6	Clove oil @2.0ml/l	4.21 (2.05)	52.96	2994	54.44	14.03	3010	100 (89.96)	0.00	28.59 (32.28)	52.38	6650
T 7	Neem essential oil @2.0ml/l	5.21 (2.28)	41.79	2662	42.59	32.75	3723	100 (89.96)	0.00	32.63 (34.79)	45.65	6527
T 8	Emulsifier @2.0ml/l	6.20 (2.48)	30.73	2230	53.33	15.79	3167	100 (89.96)	0.00	52.22 (46.26)	13.01	4347
T 9	Carbendazim @0.6g/l	3.16 (1.77)	64.69	3370	35.56	43.85	3997	38.00 (38.12)	61.86	29.98 (33.15)	50.07	6517
T10	Control	8.95 (2.99)	-	2190	63.33	-	2770	100 (89.96)	0.00	60.03 (50.79)	-	3945
	C.V (%)	2.36		19.63	2.06		3.11	0.77		6.70		7.28
	LSD @ 5% ($P=0.05$)	0.08		765	1.83		172	1.02		4.35		724
	Transformation	ST			Nil			AT		AT		

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Table 105: Effect of essential oils against Neck blast and Brown spot and grain yield at different AICRIP locations, Kharif, 2018

T. No	Treatment	Neck Blast						Brown spot	
		JDP			MLN			HZB	
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	36.11 (36.92)	12.95	2810	49.5	17.91	2870	3.50 (1.87)	2312
T 2	Eucalyptus oil @2.0ml/l	31.65 (34.08)	23.71	2880	55.7	7.63	2704	4.30 (2.06)	2268
T 3	Cedar wood oil @2.0ml/l	21.67 (27.69)	47.77	3543	54.4	9.78	3080	5.20 (2.28)	2094
T 4	Nirgundi oil @2.0ml/l	33.33 (35.25)	19.65	2917	58.7	2.65	3038	5.55 (2.36)	2162
T 5	Lemon grass oil @2.0ml/l	26.51 (30.98)	36.08	3383	49.4	18.08	3007	5.40 (2.32)	1962
T 6	Clove oil @2.0ml/l	29.63 (32.87)	28.58	3010	58.1	3.65	2679	3.72 (1.93)	2362
T 7	Neem essential oil @2.0ml/l	21.48 (27.59)	48.22	3723	54.8	9.12	2894	4.71 (2.17)	2137
T 8	Emulsifier @2.0ml/l	28.18 (32.05)	32.06	3167	53.5	11.28	3265	5.58 (2.36)	1737
T 9	Carbendazim @0.6g/l	13.89 (21.83)	66.51	3997	48.5	19.57	3516	2.65 (1.63)	2475
T10	Control	41.48 (40.08)		2770	60.3		2458	8.43 (2.90)	1505
	C.V (%)	7.48		3.11	7.34		10.43	2.63	33.37
	LSD @ 5% ($P= 0.05$)	4.09		172	6.84		528	0.08	1017
	Transformation	AT			Nil			ST	

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Table 106: Effect of essential oils against sheath blight and grain yield - Kharif, 2018

T. No	Treatment	Sheath blight										
		CHN			LDN			IIRR		PNT		
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	64.3 (54.52)	10.82	4100	27.6 (31.59)	43.74	4277	84.46 (66.73)	2442	43.15	7.09	5569
T 2	Eucalyptus oil @2.0ml/l	69.6 (56.52)	3.47	3920	29.2 (32.71)	40.34	4229	78.47 (62.35)	4004	44.14	4.97	5563
T 3	Cedar wood oil @2.0ml/l	69.7 (56.56)	3.33	4000	24.8 (29.82)	49.46	4344	83.30 (65.92)	3971	44.17	4.90	5649
T 4	Nirgundi oil @2.0ml/l	68.5 (55.84)	4.99	3950	26.6 (31.00)	45.71	4056	82.63 (65.35)	4004	43.05	7.31	5682
T 5	Lemon grass oil @2.0ml/l	71.9 (57.99)	0.28	4050	29.5 (32.79)	39.73	4122	84.80 (67.03)	4147	43.30	6.78	5686
T 6	Clove oil @2.0ml/l	69.9 (56.75)	3.05	3800	30.2 (33.29)	38.44	3723	82.73 (65.42)	4928	46.51	-0.13	5553
T 7	Neem essential oil @2.0ml/l	64.3 (53.29)	10.82	4800	28.4 (32.18)	42.04	3369	84.31 (66.74)	4928	44.07	5.12	5441
T 8	Emulsifier @2.0ml/l	70.2 (56.87)	2.64	3880	37 (37.42)	24.56	3098	87.02 (68.96)	3476	43.51	6.33	5654
T 9	Carbendazim @0.6g/l	45.2 (42.23)	37.31	5950	19.5 (26.11)	60.27	4876	39.13 (38.66)	4752	33.05	28.84	6218
T10	Control	72.1 (58.12)	-	4020	49 (44.41)	-	2859	82.58 (65.31)	3333	46.45	-	5401
	C.V (%)	2.18		2.53	7.86		9.01	2.51	13.17	7.73		7.00
	LSD @ 5% ($P=0.05$)	2.05		184	4.47		601	3.80	903	5.72		677
	Transformation	AT			AT			AT		Nil		

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

(Cont.,)Table 106: Effect of essential oils against sheath blight and grain yield - *Kharif*, 2018

T. No	Treatment	Sheath blight								
		MNC			MSD(FZB)			MTU		
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	15.9 (23.16)	47.46	5907	41.98 (40.36)	41.19	3058	50.09	3.10	4053
T 2	Eucalyptus oil @2.0ml/l	6.27 (14.41)	79.28	6601	46.73 (43.09)	34.54	2888	45.24	12.48	4001
T 3	Cedar wood oil @2.0ml/l	7.22 (15.49)	76.14	5632	38.85 (38.54)	45.57	3071	45.53	11.92	4414
T 4	Nirgundi oil @2.0ml/l	7.96 (16.28)	73.69	6384	44.53 (41.84)	37.62	3083	45.19	12.57	4190
T 5	Lemon grass oil @2.0ml/l	16.29 (22.90)	46.17	5552	45.95 (42.65)	35.62	2900	48.92	5.36	4143
T 6	Clove oil @2.0ml/l	12.77 (20.76)	57.80	7404	48.8 (44.29)	31.63	2871	51.54	0.29	4550
T 7	Neem essential oil @2.0ml/l	11.48 (19.61)	62.06	8996	50.3 (45.16)	29.53	2838	48.81	5.57	4402
T 8	Emulsifier @2.0ml/l	13.88 (21.26)	54.13	8836	54.05 (47.31)	24.27	2750	47.77	7.58	3762
T 9	Carbendazim @0.6g/l	7.88 (14.99)	73.96	8400	32.95 (35.00)	53.84	3388	45.25	12.46	4717
T10	Control	30.26 (33.31)	-	3214	71.38 (57.68)	-	2213	51.69	-	3707
	C.V (%)	24.87		38.61	4.97		5.74	6.80		22.27
	LSD @ 5% ($P= 0.05$)	8.63		4432	3.15		243	5.60		1602
	Transformation	AT			AT			Nil		

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Table 107: Effect of integrated management practices against severity of False smut and grain yield - Kharif, 2018

T. No	Treatment	False smut							
		GER		PNT			MTU		
		% of infected panicles/m ²	Grain Yield (Kg/ha)	% of infected panicles/m ²	% decrease over control	Grain Yield (Kg/ha)	Disease Incidence (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	0.26 (0.86)	4031	28.86 (32.48)	5.57	5569	25.71 (30.44)	0.70	2999
T 2	Eucalyptus oil @2.0ml/l	0.25 (0.79)	4347	28.57 (32.29)	6.53	5563	18.25 (24.49)	29.51	3684
T 3	Cedar wood oil @2.0ml/l	0.0 (0.50)	4257	28.17 (32.03)	7.85	5649	20.81 (26.87)	19.62	3201
T 4	Nirgundi oil @2.0ml/l	0.0 (0.50)	4058	28.58 (32.30)	6.50	5682	23.57 (28.80)	8.96	3031
T 5	Lemon grass oil @2.0ml/l	0.37 (0.98)	3907	29.31 (32.76)	4.12	5686	24.3 (29.35)	6.14	3205
T 6	Clove oil @2.0ml/l	0.41 (1.09)	4286	29.77 (33.05)	2.61	5553	20.79 (27.02)	19.70	3630
T 7	Neem essential oil @2.0ml/l	0.37 (0.99)	3806	24.92 (29.88)	18.46	5441	23.54 (28.87)	9.08	2923
T 8	Emulsifier @2.0ml/l	0.03 (0.59)	4074	29.8 (33.07)	2.51	5654	22.77 (28.40)	12.05	3530
T 9	Carbendazim @0.6g/l	0.11 (0.77)	4073	20.38 (26.82)	33.32	6218	23.03 (28.62)	11.05	3090
T10	Control	0.64 (1.29)	3231	30.57 (33.55)	-	5401	25.89 (30.56)	0.70	3089
	C.V (%)	35.1	11.28	3.63		7.00	15.40		21.55
	LSD @ 5% (<i>P</i> = 0.05)	0.5	775	1.98		677	7.49		1197
	Transformation	ST		AT			AT		

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Effect of essential oils against bacterial blight disease at different locations

Trial on the management of bacterial blight disease using essential oils was conducted at Chinsurah, Karjat, Pantnagar, Pattambi and Maruteru. Disease severity was very high at Pattambi (82.96%), Maruteru (80.82%), Chinsurah (77.8%); high at Karjat (63.70%); moderate at Pantnagar (48.97%). Among the different oils tested, it was observed that Neem oil @ 2.0 ml/l (T7) reduced the severity by 11.73% and 7.70% at Chinsurah and Pantnagar respectively. With respect to yield, significant increase was recorded at Chinsurah (T7 - 2650kg; Control - 2050kg/ha) and at Pantnagar there was no significant difference among the treatments. At Karjat, application of Eucalyptus oil @2.0ml/l (T2) reduced the disease severity from 63.70% to 40.00% and significantly increased the grain yield (2975kg/ha) when compared to control (2083kg/ha). At Pattambi, treatment T4 i.e spraying of Nirgundi oil @ 2.0 ml/l (T4) reduced the disease severity by 33.04% but there was no increase in grain yield observed among the treatments. Similarly at Maruteru, application of Cedar wood oil @ 2.0 ml/l (T3) reduced the disease severity from 80.82% to 71.41% and there was no significant difference between the treatments (Table 108 a, b). In the trials conducted at IIRR, among the different essentials oils tested, two spraying of Eucalyptus oil @2.0ml/l (T2) and Clove oil @2.0ml/l (T6) reduced the disease severity from 100% to 80.25 % and all other treatments showed non-significant effect on disease severity.

Table 108a: Effect of essential oils against Bacterial blight and grain yield at different locations - Kharif, 2018

T. No	Treatment	Bacterial blight								
		CHN			KJT			PNT		
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	73.1 (8.55)	5.80	2350	45.18	29.07	2846	47.91	2.16	5569
T 2	Eucalyptus oil @2.0ml/l	75.2 (8.67)	3.09	1833	40.00	37.21	2975	48.63	0.68	5563
T 3	Cedar wood oil @2.0ml/l	77.3 (8.79)	0.39	1850	49.26	22.67	2574	48.34	1.28	5649
T 4	Nirgundi oil @2.0ml/l	76.3 (8.73)	1.68	1750	54.81	13.96	2437	47.46	3.08	5682
T 5	Lemon grass oil @2.0ml/l	72.7 (8.52)	6.31	2050	48.89	23.25	2565	47.71	2.56	5686
T 6	Clove oil @2.0ml/l	75.7 (8.70)	2.45	1900	53.33	16.28	2485	47.38	3.23	5553
T 7	Neem essential oil @2.0ml/l	68.5 (8.27)	11.73	2650	57.04	10.46	2352	45.20	7.70	5441
T 8	Emulsifier @2.0ml/l	76.1 (8.72)	1.93	1950	59.63	6.39	2497	46.85	4.33	5654
T 9	Carbendazim @0.6g/l	76 (8.72)	2.06	2000	57.04	10.47	2411	47.11	3.78	6218
T10	Control	77.6 (8.81)	-	2050	63.70		2083	48.97		5401
	C.V (%)	1.91		14.10	3.72		7.36	12.00		7.00
	LSD @ 5% ($P=0.05$)	0.28		492	3.38		318	9.79		677
	Transformation	ST			Nil			Nil		

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

(Cont.)Table 108b: Effect of essential oils against Bacterial blight and grain yield at Pattambi, Maruteru and IIRR - Kharif, 2018

T. No	Treatment	Bacterial blight							
		PTB			MTU			IIRR	
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control
T 1	Citronella oil @2.0ml/l	64.42 (53.50)	22.35	3500	73.03 (58.83)	9.64	2999	100.00 (89.96)	0.00
T 2	Eucalyptus oil @2.0ml/l	57.76 (49.47)	30.38	3583	72.45 (58.36)	10.36	3684	80.25 (71.22)	18.93
T 3	Cedar wood oil @2.0ml/l	64.80 (53.62)	21.89	3550	71.41 (57.72)	11.64	3201	100.00 (89.96)	0.00
T 4	Nirgundi oil @2.0ml/l	55.55 (48.20)	33.04	3583	75.0 (60.21)	7.20	3031	90.12 (80.59)	13.17
T 5	Lemon grass oil @2.0ml/l	68.33 (55.92)	17.64	3500	68.61 (55.90)	15.11	3205	90.12 (80.59)	13.17
T 6	Clove oil @2.0ml/l	67.77 (55.40)	18.31	3500	75.54 (60.94)	6.53	3630	80.25 (71.22)	18.93
T 7	Neem essential oil @2.0ml/l	63.33 (52.87)	23.66	3416	72.44 (58.47)	10.37	2923	100.00 (89.96)	0.00
T 8	Emulsifier @2.0ml/l	80.36 (64.10)	3.13	3333	73.34 (58.97)	9.26	3530	100.00 (89.96)	0.00
T 9	Carbendazim @0.6g/l	85.18 (67.48)	-2.68	3416	70.24 (57.26)	13.09	3090	90.12 (80.59)	13.17
T10	Control	82.96 (65.97)	-	3300	80.82 (65.61)	-	3089	100.00 (89.96)	0.00
	C.V (%)	9.52		11.18	7.88		21.55	11.42	11.42
	LSD @ 5% ($P= 0.05$)	9.26		665	8.00		1197	16.33	16.33
	Transformation	AT			AT			AT	

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Annexure I**Weather conditions at test locations where Plant Pathology Coordinated Trials were conducted, Kharif-2018**

S. No	Location/ Details		Weather data from May-2018 to January-2019								
1	Aduthurai		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		1	1	3	6	3	8	13	5	-
	Rainfall (mm)		12.8	34.8	38.8	69.4	24.8	183.2	362.4	37.4	-
	Temp. (°C)	Maximum	35.2	34.6	33.8	34.9	34.8	31.1	29.1	29.3	-
		Minimum	26.5	25.7	25.7	25.7	25.2	24.3	23.0	21.9	-
	RH (%)	Morning	86	80	78	78	85	92	95	96	-
		Evening	57	53	48	48	53	73	90	75	-
2	Almora		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		6	10	16	21	7	0	-	-	-
	Rainfall (mm)		41.3	80.5	138.6	230	82.5	0	-	-	-
	Temp. (°C)	Maximum	31.12	31.44	29.8	27.36	29.2	27.3	-	-	-
		Minimum	12.37	19.6	21.65	21.17	18.7	11.4	-	-	-
	RH (%)	Morning	60.91	68.94	85.46	87.49	80.5	77.6	-	-	-
		Evening	44.1	53.3	64.89	76.96	63.72	42.1	-	-	-
3	Arundhutanagar		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		-	-	-	-	-	-	-	-	-
	Rainfall (mm)		-	-	-	-	-	-	-	-	-
	Temp. (°C)	Maximum	-	-	-	-	-	-	-	-	-
		Minimum	-	-	-	-	-	-	-	-	-
4	Bankura		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		-	-	-	-	-	-	-	-	-
	Rainfall (mm)		-	-	-	-	-	-	-	-	-
	Temp. (°C)	Maximum	-	-	-	-	-	-	-	-	-
		Minimum	-	-	-	-	-	-	-	-	-
5	Chakdha		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		11	14	25	20	20	0	4	3	-
	Rainfall (mm)		133	107	400.3	134	207	0	10.4	21.4	-
	Temp. (°C)	Maximum	36	34.9	32.8	32.5	32.6	33.7	30.2	25.1	-
		Minimum	24.6	26.4	26.1	26.2	26	22.2	18.7	12.4	-
	RH (%)	Morning	91	90.6	95.2	94.5	93.8	92.5	91.6	92.1	-
		Evening	61.2	67.1	80	78	72	53.7	48.4	47.4	-
6	Chatha		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		-	3	9	11	9	1	1	-	-
	Rainfall (mm)		-	66.2	244.1	470.4	202.4	3.6	14.8	-	-
	Temp. (°C)	Maximum	-	38.1	34.5	34	32.2	29.4	25.6	-	-
		Minimum	-	25.8	26.3	25.9	22.9	13.3	10.1	-	-
	RH (%)	Morning	-	63	85	87	87	85	93	-	-
		Evening	-	37	61	68	63	40	44	-	-
7	Chinsurah		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		7	12	23	20	16	7	0	3	-
	Rainfall (mm)		122.4	238.6	399.5	190.1	121.1	21.9	0	19.2	-
	Temp. (°C)	Maximum	34.05	34.9	32.9	32.8	33.35	31.72	30.64	25.56	-
		Minimum	25.47	27.8	27	27	26.01	22.46	17.45	11.05	-

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	RH (%)	Morning	93.25	89	94	93	98.23	96.83	96.5	95.87	-
		Evening	59.41	64	76	78	73.26	58.09	47.86	44.93	-
8	Chiplima		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		5	9	21	20	7	0	0	4	-
	Rainfall (mm)		80	158	919.2	540.2	262.8	0	0	85.4	-
	Temp. (°C)	Maximum	40.9	38.9	30.5	28.8	32.5	32.5	30.5	26.6	-
		Minimum	21.6	20.5	18.6	17.6	19.5	21.2	18.5	12.6	-
	RH (%)	Morning	78.8	80.4	89.9	90.5	82.2	84.2	89.7	76.3	-
		Evening	39.2	44	71.7	80.8	58.4	64.9	77.5	72.6	-
9	Coimbatore		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		7	2	6	6	6	6	4	2	-
	Rainfall (mm)		162	37	122	98	110	138.2	31.2	8	-
	Temp. (°C)	Maximum	29.5	32	33	31	30.8	30.6	29.6	30	-
		Minimum	21.3	22.7	22	21	20	20	19.2	19.1	-
	RH (%)	Morning	89.6	88.35	85.25	83.6	89.93	89.7	87.76	88.5	-
		Evening	-	-	-	-	-	-	-	-	-
10	Cuttack		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		4	4	10	11	11	5	0	-	-
	Rainfall (mm)		147	190	274	257	440	295	0	-	-
	Temp. (°C)	Maximum	34.6	33.35	31.36	32.34	32.54	31.95	30.63	-	-
		Minimum	25.86	25.5	25.47	23.9	23.34	22.26	18.39	-	-
	RH (%)	Morning	92.4	92.5	97	90.5	90.6	90.8	90.8	-	-
		Evening	50.9	73.7	77	81.5	74	64.2	67.8	-	-
11	Faizabad (Masodha)		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		-	-	-	-	-	-	-	-	-
	Rainfall (mm)		-	18.45	275.5	300.18	131.6	-	-	-	-
	Temp. (°C)	Maximum	-	-	-	-	-	-	-	-	-
		Minimum	-	-	-	-	-	-	-	-	-
	RH (%)	Morning	-	-	-	-	-	-	-	-	-
		Evening	-	-	-	-	-	-	-	-	-
12	Gangavati		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		6	6	2	8	7	2	0	0	-
	Rainfall (mm)		107.9	78.3	23.48	44.5	35.7	42.4	0	0	-
	Temp. (°C)	Maximum	37.67	32.4	31.93	30.03	34.96	30.35	30.76	29.16	-
		Minimum	24.41	23.46	23.48	22.8	21.86	19.83	17.29	15.96	-
	RH (%)	Morning	57.09	89.36	65.74	73.02	73.38	68.8	70.6	71.71	-
		Evening	27.78	43.33	46.5	57.62	48.24	41.24	40.18	36.97	-
13	Gerua		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		16	14	16	14	14	5	3	2	
	Rainfall (mm)		335.8	395.7	233.3	120.6	159	60.6	30.5	9.7	
	Temp. (°C)	Maximum	31.1	35	34.5	34.7	33.8	31.4	27.3	24.4	
		Minimum	20.3	24.6	25.9	25.5	24.4	19.9	12.3	10.9	
	RH (%)	Morning	89.4	89.5	87.9	90	91.5	92.8	90.8	89.1	-
		Evening	77.6	69.1	67.7	65	68.5	69.8	68.03	63.3	-
14	Ghaghrahat		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19

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	Rainy days (No.)		01	06	14	19	09	-	-	-	-
	Rainfall (mm)		3.4	41.0	323.0	330.6	246.0	-	-	-	-
	Temp. (°C)	Maximum	38.65	36.00	33.65	32.19	31.63	31.87	28.90	23.23	-
		Minimum	24.35	26.27	26.42	26.52	25.73	21.71	14.60	8.84	-
	RH (%)	Morning	-	-	-	-	-	-	-	-	-
		Evening	-	-	-	-	-	-	-	-	-
15	Gudalur		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		17	24	26	26	10	16	4	1	-
	Rainfall (mm)		351.4	694.6	680.6	714.2	211	170	24.6	6.6	-
	Temp. (°C)	Maximum	22.7	20.5	19.8	19.6	21.3	21.2	20.4	19.9	-
		Minimum	27.4	23.7	22.7	22.6	26.3	26.2	26.3	25.9	-
	RH (%)	Morning	93.5	97.5	98.2	97.9	92.3	90.2	89.6	88.1	-
		Evening	79.5	90.2	91.4	90.2	66.9	71.8	62.6	68.1	-
16	Hazaribagh		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		4	13	20	24	12	2	0	3	
	Rainfall (mm)		23.6	152.7	211.2	267.2	135.8	21.4	0	22.6	
	Temp. (°C)	Maximum	36.4	34.3	29.6	28.9	29.3	28.7	26.2	21	
		Minimum	22.3	22.6	22.4	21.7	20.9	15.1	10	4.8	
	RH (%)	Morning	59.2	66.3	83.2	88.3	83.8	69.8	69.4	74.3	
		Evening	37.3	55.6	72.3	79.1	68.8	44	42.4	42	
17	IIRR		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		1	6	6	10	3	2	0	1	-
	Rainfall (mm)		37.9	51.6	87.6	159.6	43.4	43.2	0	13.6	-
	Temp. (°C)	Maximum	39.2	34.7	30.6	29.4	31.4	32.4	31.3	27.9	-
		Minimum	24.1	22.6	21.4	20.8	19.9	16.5	13.7	12.7	-
	RH (%)	Morning	67.4	85.3	88.8	88.4	90.2	86.1	87.2	90.1	-
		Evening	33.4	51.6	70.1	71.0	58.1	39.0	38.1	47.4	-
18	Imphal		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		20	22	21	19	9	8	1	4	-
	Rainfall (mm)		212.3	365.7	214.7	180.8	27.9	119.1	0.4	24.3	-
	Temp. (°C)	Maximum	28	29.4	30	29.7	30.3	27.4	25.7	22.9	-
		Minimum	19	21.9	22.6	22.1	20.9	16.5	9.4	7.4	-
	RH (%)	Morning	88.4	88.4	88.6	92.3	90	89.5	86.4	89.5	-
		Evening	64	69.7	67.5	71.1	65.9	59.3	47.1	47.8	-
19	Jagdalpur		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		6	11	17	20	11	1	0	2	-
	Rainfall (mm)		88.5	178.1	269.4	421.4	233.9	6.2	0	39.6	-
	Temp. (°C)	Maximum	35.3	32.2	27.9	27.4	29.8	30.7	30.3	25.8	-
		Minimum	22.9	23.4	21.9	21.2	20.7	16.4	12.6	11.7	-
	RH (%)	Morning	79	84.1	92.1	93.4	91.6	93.6	94.2	95.1	-
		Evening	50	62.8	79.5	82.5	69.2	44.6	32.6	50.1	-
20	Jagtial		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		0	9	11	11	9	0	0	2	-
	Rainfall (mm)		1.75	137.4	182	250.6	109.8	0	0	15	-
	Temp. (°C)	Maximum	41.86	35.99	30.70	30.25	32.61	34.12	33.27	28.04	-

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		Minimum	26.87	25.22	23.97	23.47	23.02	20.27	17.29	14.75	-
	RH (%)	Morning	74.03	78.80	86.29	91.68	93.40	93.35	82.97	82.74	-
		Evening	34.77	54.60	75.13	82.42	78.70	71.39	39.30	49.00	-
21	Karjat		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		0 (6)*	18 (29)	26 (24)	30 (28)	10 (2)	2 (2)	1 (0)	0 (0)	-
	Rainfall (mm)		0 (4.7)	885.7 (2051.2)	1605.4 (666.6)	816.7 (407.3)	199.7 (45.2)	21.8 (50.3)	29 (0)	0 (0)	-
	Temp. (°C)	Maximum	39.3 (34.9)	32.7 (31.6)	28.6 (30.2)	28.7 (29.7)	30.9 (31.7)	35.5 (35.1)	35.5 (35.8)	33.1 (31.2)	-
		Minimum	25.9 (26.5)	25 (24.9)	24.1 (24.8)	23.8 (24.4)	22.9 (23.2)	24.7 (23.1)	17.4 (21.0)	13.9 (16.8)	-
	RH (%)	Morning	68.71 (88.4)	86.73 (93.3)	90.5 (91.5)	95.5 (95.4)	90.5 (96.2)	88.35 (92.6)	88.1 (90.0)	86.45 (89.2)	-
		Evening	37.55 (76.8)	69.23 (91.0)	88 (90.8)	84.8 (90.8)	66.23 (89.0)	44.9 (81.4)	34.1 (61.2)	29.58 (59.0)	-
22	Kaul		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		2	6	8	5	7	0	0	-	-
	Rainfall (mm)		19	168.9	281.5	207.9	185.2	0	0	-	-
	Temp. (°C)	Maximum	39.8	36.9	33.7	32.7	31.2	30.9	27	-	-
		Minimum	21.7	25.3	25.9	25.4	22.7	15.9	10.9	-	-
	RH (%)	Morning	62	77	91	91	94	94	88	-	-
		Evening	31	52	75	81	79	45	41	-	-
23	Khudwani		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		11	8	10	15	7	6	4	-	-
	Rainfall (mm)		160.3	50.8	61.6	134.2	120.6	0.76	0.34	-	-
	Temp. (°C)	Maximum	21.41	24.65	28.33	28.84	30.74	27.98	21.74	-	-
		Minimum	6.82	9	13.45	17.16	16.58	11.93	2.89	-	-
	RH (%)	Morning	77.5	70.55	70.77	84.97	81.65	81.2	84.04	-	-
		Evening	51.47	52.03	58.17	60.03	51.87	50.33	55.55	-	-
24	Lonavala		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		0	24	31	31	19	4	3	-	-
	Rainfall (mm)		0	730.4	2532.6	1328	234	32.8	41	-	-
	Temp. (°C)	Maximum	36.8	34.1	25.4	25	27.9	32	34	-	-
		Minimum	21.3	21.8	21.1	20.7	19.8	19.9	15.6	-	-
	RH (%)	Morning	85.5	94.8	95.7	94.7	90.4	78	78.8	-	-
		Evening	39.7	86.6	90.2	89.2	77.9	57.7	40	-	-
25	Ludhiana		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		3	6	10	5	7	0	0	-	-
	Rainfall (mm)		19	141.8	376.6	74	250.6	0	2.6	-	-
	Temp. (°C)	Maximum	39.1	37.6	34.3	34.1	32.1	31.3	26.8	-	-
		Minimum	24.1	27.2	26.6	27.3	24	17.1	11.8	-	-
	RH (%)	Morning	47	64	83	84	88	89	90	-	-
		Evening	22	41	64	67	63	39	36	-	-
26	Malan		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		4	4	13	11	9	0	-	-	-
	Rainfall (mm)		25.8	74.8	426.9	586.6	348.3	0	-	-	-
	Temp. (°C)	Maximum	34	37.1	32.9	31.4	30.7	28.7	-	-	-
		Minimum	16.7	18.8	18.3	19.1	19.1	13	-	-	-

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	RH (%)	Morning	74.6	75	77.2	78.4	78.3	74.9	-	-	-
		Evening	70.5	70.9	79.6	78.4	80.6	77.1	-	-	-
27	Mandya		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		12	4	5	3	9	8	0	0	-
	Rainfall (mm)		249.9	36.3	26.4	16	177.8	100.1	0	3.8	-
	Temp. (°C)	Maximum	32.3	31.5	31.2	31.3	30.5	31.5	28.3	27.4	-
		Minimum	21	20.1	20.1	19.3	22.4	19.2	17.3	16.7	-
	RH (%)	Morning	92	89	91	94	93	94	84	82	-
		Evening	78	85	76	78	79	80	70	68	-
28	Maruteru		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		1	11	14	17	7	2	2		
	Rainfall (mm)		66.6	296.8	250.2	374	114	16.4	9.4		
	Temp. (°C)	Maximum	34.56	34.05	29.64	29.18	31.3	31.94	30.97		
		Minimum	27.24	27.45	26.06	25.65	26.4	25.4	23.2		
	RH (%)	Morning	83.22	84.8	84.51	87.71	81	84.52	81.27		
		Evening	72.96	69.26	76.38	76	75.2	72	77.7		
29	Moncompu		Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19
	Rainy days (No.)		-	-	-	17	9	9	0	0	3
	Rainfall (mm)		-	-	-	273.9	88.2	67.2	0	0	58.4
	Temp. (°C)	Maximum	-	-	-	34.48	34	33.7	34	33.9	34
		Minimum	-	-	-	24.2	25.3	25.1	22	25.3	25.1
	RH (%)	Morning	-	-	-	91.45	87.45	87.9	88.4	90	86.8
		Evening	-	-	-	90	91.45	90.83	85.41	89.1	84.2
30	Mugad		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		11	10	24	21	6	6	1	1	-
	Rainfall (mm)		238.6	183.4	248.4	183.1	172.8	72	41.8	25	-
	Temp. (°C)	Maximum	35.6	28.8	25.8	25.9	29.6	31.6	30.7	29.5	-
		Minimum	21.5	21	20.6	20.2	18.9	18.3	16.3	12	-
	RH (%)	Morning	77.3	87.7	90.1	89.7	83.7	73.3	66	61.3	-
		Evening	49.6	79.3	84.8	84.7	67.6	57.6	41.4	40.2	
31	Navsari		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		0.0	6.0	22.0	16.0	4.0	0.0	0.0	0.0	-
	Rainfall (mm)		0.0	120.0	1282.0	209.0	64.0	0.0	0.0	0.0	-
	Temp. (°C)	Maximum	35.2	33.7	28.8	29.8	31.6	36.6	35.1	30.2	-
		Minimum	25.8	26.3	24	23.9	21.9	19.9	15.2	11.6	-
	RH (%)	Morning	85	92	96	93	91	82	87	84	-
		Evening	57	74	93	82	65	52	56	53	-
32	Nawagam		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		0	1	9	9	3	0	0		-
	Rainfall (mm)		0.00	25.80	140.40	186.20	35.60	0.00	0.00		-
	Temp. (°C)	Maximum	42.60	38.80	32.04	30.90	32.60	36.40	33.40		-
		Minimum	25.00	27.60	25.60	25.00	23.30	20.60	15.70		-
	RH (%)	Morning	64.0	66.0	85.0	89.0	90.0	76.0	60.0		-
		Evening	24.0	39.0	72.0	74.0	61.0	38.0	29.0		-
33	Nellore		May-18	Jun-18	Jul-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19

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S. No	Location/ Details		Weather data from May-2018 to January-2019								
	Rainy days (No.)		-	-	-	2	1	9	4	1	0
	Rainfall (mm)		-	-	-	28.8	31.2	145.7	121.2	7	2.4
	Temp. (°C)	Maximum	-	-	-	34.21	33.13	31.75	29.7	27.2	29.5
		Minimum	-	-	-	25.6	24.8	24.25	22.7	19.2	21.9
34	New Delhi		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		3	6	15	12	14	0	2	-	-
	Rainfall (mm)		27.2	75	270.8	220.1	244.5	0	4	-	-
	Temp. (°C)		32.8	33	29.9	29.2	26.9	23.5	19.6		
		Maximum	39.5	39.2	34.2	33.6	31.5	32.5	27.4	-	-
		Minimum	23.3	27	25.4	24.8	29.4	14.9	11.7	-	-
	RH (%)		48.3	57.2	75.5	77.6	79.4	68.8	73.4		
		Morning	64.6	69.4	84.5	85.7	88.8	89.2	89.2	-	-
		Evening	31.4	44.6	66.2	69.3	69.6	49.1	57.6	-	-
35	Pantnagar		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		3	8	15	20	11	1	1		-
	Rainfall (mm)		22.80	172.80	649.10	616.40	224.60	2.60	4.20		-
	Temp. (°C)	Maximum	36.90	37.00	32.30	32.00	31.60	30.80	27.30		-
		Minimum	22.30	25.90	26.00	25.30	23.70	15.30	11.70		-
	RH (%)	Morning	69.10	80.20	87.90	92.40	91.20	87.00	92.60		-
		Evening	41.60	59.20	76.40	79.60	74.40	57.00	57.30		-
36	Patna		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		1	5	17	18	9	0	0	0	-
	Rainfall (mm)		12	84	145	170	154	0	0	0	-
	Temp. (°C)	Maximum	40	40	35	33	33	35	30	25	-
		Minimum	26	29	27	26	25	21	15	10	-
	RH (%)	Morning	-	-	-	-	-	-	-	-	-
		Evening	-	-	-	-	-	-	-	-	-
37	Pattambi		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		16	24	23	21	3	10	1	0	-
	Rainfall (mm)		407.1	790.2	713	670.5	38.3	185.9	10.6	1.4	-
	Temp. (°C)	Maximum	32.3	29.7	29.3	28.6	32.3	32.3	32.5	32.8	-
		Minimum	22.2	22.6	22.2	22.1	22.1	22.2	21.9	20.9	-
	RH (%)	Morning	92.6	93.5	96.5	93.6	93.5	89.8	84.7	85.1	-
		Evening	69.5	81.6	85.8	75.6	55.8	59.9	55.7	52.9	-
38	Ponnampet		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		208.80	946.10	576.30	620.90	170.80	200.20	0.00	0.00	-
	Rainfall (mm)		11	23	24	22	6	10	0	0	-
	Temp. (°C)	Maximum	-	-	-	-	-	-	-	-	-
		Minimum	-	-	-	-	-	-	-	-	-
	RH (%)	Morning	-	-	-	-	-	-	-	-	-
		Evening	-	-	-	-	-	-	-	-	-
39	Portblair		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		-	-	-	-	-	-	-	-	-
	Rainfall (mm)		-	-	-	-	-	-	-	-	-
	Temp. (°C)	Maximum	-	-	-	-	-	-	-	-	-

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S. No	Location/ Details		Weather data from May-2018 to January-2019									
		Minimum	-	-	-	-	-	-	-	-	-	-
	RH (%)	Morning	-	-	-	-	-	-	-	-	-	-
		Evening	-	-	-	-	-	-	-	-	-	-
40	Pusa		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	
	Rainy days (No.)		-	4.0	13.0	17.0	9.0	1.0	0.0	0.0	-	
	Rainfall (mm)		-	44.4	170.0	388.4	118.6	12.6	0.0	0.0	-	
	Temp. (°C)	Maximum	-	36.0	26.0	32.1	33.3	32.0	29.0	24.3	-	
		Minimum	-	26.5	87.0	26.1	25.4	19.0	13.3	8.8	-	
	RH (%)	Morning	-	81.0	87.0	89.0	87.0	85.0	83.0	82.0	-	
		Evening	-	60.0	71.0	74.0	73.0	56.0	59.0	55.0	-	
41	Raipur		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	
	Rainy days (No.)		-	-	-	-	-	-	-	-	-	
	Rainfall (mm)			141.5	328	560.2	85.4	0	0	47.2	-	
	Temp. (°C)	Maximum		36.9	31.2	29.8	31.3	32.9	31.3	25.9	-	
		Minimum		26.3	25.3	24.8	24.5	21.4	16	12.4	-	
	RH (%)	Morning		78	89	93	92	88	87	88	-	
		Evening		46	74	81	65	45	33	42	-	
42	Rajendranagar		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	
	Rainy days (No.)		1	6	6	10	3	2	0	1	-	
	Rainfall (mm)		37.9	51.6	87.6	159.6	43.4	43.2	0	13.6	-	
	Temp. (°C)	Maximum	39.2	34.7	30.6	29.4	31.4	32.4	31.3	27.9	-	
		Minimum	24.1	22.6	21.4	20.8	19.9	16.5	13.7	12.7	-	
	RH (%)	Morning	67.4	85.3	88.8	88.4	90.2	86.1	87.2	90.1	-	
		Evening	33.4	51.6	70.1	71.0	58.1	39.0	38.1	47.4	-	
43	Rewa		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	
	Rainy days (No.)			4	14	20	5	0	0	0	-	
	Rainfall (mm)			116.8	174	404.4	99	0	0	0	-	
	Temp. (°C)	Maximum		39.6	33.5	31.3	32.3	34.3	30.4		-	
		Minimum		27.1	25.2	24.3	22.7	17.1	11.8		-	
	RH (%)	Morning		49	78	85	79	62	62		-	
		Evening		32	61	79	66	45	50		-	
44	Sabour		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	
	Rainy days (No.)		4	7	18	20	8	2	0	2	-	
	Rainfall (mm)		61	118	254.9	234.2	66.3	76.2	0	11.2	-	
	Temp. (°C)	Maximum	34.4	35.3	33.3	32.9	33.2	31.2	29.6	24.2	-	
		Minimum	22.8	25.3	24.8	25.3	24.8	19.7	12.9	7.4	-	
	RH (%)	Morning	83.9	85.1	90	88.7	85.9	89.6	88.4	89.3	-	
		Evening	58	60.6	75.1	75.5	74.7	73	61.3	59.6	-	
45	Titabar		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	
	Rainy days (No.)		16.0	15.0	15.0	14.0	16.0	17.0	2.0		-	
	Rainfall (mm)		119.2	275.8	160.2	317.0	248.0	39.4	8.6		-	
	Temp. (°C)	Maximum	31.2	31.1	33.4	33.1	32.9	30.4	28.2	-	-	
		Minimum	20.9	23.8	24.6	24.4	23.3	18.9	14.7	-	-	
	RH (%)	Morning	92.0	93.0	92.0	95.0	95.0	97.0	95.0	-	-	

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S. No	Location/ Details		Weather data from May-2018 to January-2019								
		Evening	67.0	71.0	72.0	79.0	79.0	77.0	65.0	-	-
46	Umiam (Barapani)		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		20	18	16	20	15	12	1	3	-
	Rainfall (mm)		281.3	424.3	354.7	435.7	258.6	214.9	7.3	28.6	-
	Temp. (°C)	Maximum	26.1	27.9	28.3	29	28.4	25.5	24.2	21.3	-
		Minimum	7	20	21	20.8	19.1	15.1	10.8	8.1	-
	RH (%)	Morning	87.4	88.5	87.5	86.7	88.3	86.5	83.9	84.3	-
		Evening	75.7	79.5	77.4	72.7	74.4	68.5	56.3	55.5	-
47	Upper Shillong		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		-	13	21	16	12	3	2	-	-
	Rainfall (mm)		-	186	231	233	92	10	2	-	-
	Temp. (°C)	Maximum	-	35	35	34	34	32	29	-	-
		Minimum	-	25	25	26	25	21	16	-	-
	RH (%)	Morning	-	72	78	77	64	70	65	-	-
		Evening	-	81	89	90	76	80	78	-	-
48	Varanasi		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		-	3	8	14	7	0	0	0	-
	Rainfall (mm)		-	35.7	245.7	249.42	223	0	0	0	-
	Temp. (°C)	Maximum	-	43	39	35	34	35.2	30.6	25.6	-
		Minimum	-	22.4	21.6	22	20.4	13.4	8.8	6.2	-
	RH (%)	Morning	-	97	98	98	94	94	98	97	-
		Evening	-	85	98	95	98	71	60	52	-
49	Wangbal		May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19
	Rainy days (No.)		-	-	-	-	-	-	-	-	-
	Rainfall (mm)		-	-	-	-	-	-	-	-	-
	Temp. (°C)	Maximum	-	-	-	-	-	-	-	-	-
		Minimum	-	-	-	-	-	-	-	-	-
	RH (%)	Morning	-	-	-	-	-	-	-	-	-
		Evening	-	-	-	-	-	-	-	-	-

Note: (-) data is not received

Annexure - II

Details on the locations where Coordinated Pathology Screening trials were conducted during, *Kharif 2018*

S. No.	Location	Latitude (North)	Longitude (East)	Elevation (m. from MSL)	Ecosystem	Sowing (Year, 2018)	Fertilizer Basal - NPK (Kg/ha)	Fertilizer top dressing (Kg/ha)
1	Aduthurai	10° N	79°E	19.5 m	Irrigated	07.09.2018	37.5:50:25	112.5:0:25 (NPK)
2	Almora	29°36'N	79°40'E	1250 m	Upland	19.07.18	60:60:40 20kg/ha	40 N
3	Arundatinagar	22°56'N	91°10'E	12.6 m	Irrigated	-	-	-
4	Barapani (Umiam)	25.6820 N	91.9149 E	958.61 m	Rainfed lowland	10.07.2018	1	1
5	Bankura	23°24' N	87°05'E	84 m	Upland (Rainfed)	23/07/2018	NPK @ 120:50:30 Kg/ha (Basal 10:26:26 18Kg+SSP 9Kg+Urea 10Kg;	1st top dressing at 21 DAT urea10Kg-and 2nd top dressing at 42 DAT urea 10 Kg
6	Chakdha	23°08' N	88°52' E	13 m	Irrigated	05.07.2018	60:30:30	60 N
7	Chatha	32°40'N	74°18'E	293 m	Irrigated	06-07-18	120:60:30	40N, 40+40 N (1 st and 2 nd top dressing)
8	Chinsurah	22°52'N	88°24'E	8.62 m	Irrigated	23-07-2018	60:50:30	60 N
9	Chiplima	20°21'N	80°55'E	178.8 m	Irrigated	09-07-2018	80:40:40 40:40:20	15:0:15 (25 DAP) 15:0:0 (45 DAP)
10	Coimbatore	11° N	77°E	409 m	Irrigated	10-12-2018	45:0:4	45 N and 4P
11	Cuttack (NRRI)	20°23'N	85°17'E	36 m	Irrigated Shallow lowland	07-06-2018	120	-
12	Faizabad (Masodha)	26°47'N	82°12'E	113 m	Irrigated	23-06-2018	60:60:60	60 kg/h (20DAP)
13	Gangavati	15°43'N	76°53'E	419 m	Irrigated	18-07-2018	250:75:75	75N
14	Gerua	26°14'N	91°33'E	49 m	Rainfed lowland	24-07-2018	150:30:30	120 N
15	Ghaghraghat	27°50'N	81°20'E	112 m	Rainfed lowland	26-06-2018	100:60:20	
16	Gudalur	11°30'N	76°30'E	950 m	Irrigated	13.08.2018	-	-
17	Hazaribagh	23° 95'91'' N	85° 37'20'' E	614 m	Rainfed Upland	24-07-2018	N:P2O5:K2O = 50:50:50	50+50 N
18	IIRR	17°19' N	78°23'E	542 m	Irrigated	15-06-2018	60:60:40 kg/ha	40 N
19	Imphal	24°45' N	93°54' E	774 m	Rainfed lowland	10-07-2018	80:60:40 NPK	40 N
20	Jagdalpur	19°05' N	81°57'E	556 m	Upland/	30-07-2018	60:60:60	30:30:0 (NPK)

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S. No.	Location	Latitude (North)	Longitude (East)	Elevation (m. from MSL)	Ecosystem	Sowing (Year, 2018)	Fertilizer Basal - NPK (Kg/ha)	Fertilizer top dressing (Kg/ha)
					Irrigated			
21	Jagtial	18.830713	78.959899	264 m	Irrigated	17-07-2018	120 Nitrogen	(40+40)
22	Karjat	18°55' N	73°15'E	51.7 m	Rainfed lowland	23-07-2018	-	70N
23	Kaul	29°51'N	76°39'E	230.7 m	Irrigated	16-07-2018	22.5 N + 57.5 P ₂ O ₅ + 25 Zinc sulphate/ha	57.5+57.5 N in two splits
24	Khudwani	33.73°N	75.15°E	1601 m	Irrigated	31/07/2018	60: 60: 30 (NPK)	60 N
25	Lonavala	18.9°N	73.5°E	622m	Rainfed lowland	17.08.2018	120:50:50 60:50:50	60N
26	Ludhiana	30°90'N	75° 85'E	262 m	Irrigated	20-07-2018	Urea 37kg/Acre	Urea 74kg/acre
27	Malan	32°1'N	76.2°E	950 m	Irrigated/ Upland	16-08-2018	120:40:40 60:40:40	60N
28	Mandya	12°36'N	76°15'E	694.64 m	Irrigated	30-10-2018	150:50:50 75:50:50	75:0:0
29	Maruteru	16°38'N	81°44'E	5m	Irrigated	06-07-2018	150:40:40 50:40:20	50:0:0 (NPK) 50:0:20
30	Moncompu	9°51'N	76°5'E	10 m	Irrigated	10-07-2018	120:45:45 Kg/ha 1/2N,1/2P&K	15DAP-1/4N, 1/4P&K, 40DAP-1/4N, 1/4P&K
31	Mugad	15°26'11"N	74°54'50"E	685.00m /2247.38ft	Upland	01-09-2018	40-20-20-8	20-0-0-0
32	Navsari	20°57'N	72°29'E	10 m	Irrigated	09-07-2018	75:50:0	75N
33	Nawagam	22°48'N	71°38'E	32.4 m	Irrigated	10-07-2018	120:30:0 60 N + 30 P ₂ O ₅ .	60 N + 20 ZnSO ₄
34	Nellore	14°27'N	79°59'E	20 m	Irrigated	20-09-2018	-	32 24 16 kg/acre NPK
35	New Delhi	28°08'N	77°12'E	216 m	Irrigated	28-06-2018	N:P:K 60:60:40 Kg per ha	20 kg N per ha
36	Pantnagar	29°N	79°30'E	343.84 m	Irrigated	06-07-2018	60:60:40-15Kg (ZnSO ₄)	60N +5.0 (ZnSO ₄)
37	Patna	25013.25ft	84014.405ft.	77 m	Upland/Irrigated	06-07-2018	120:60:40	60N
38	Pattambi	10°48'N	76°12'E	25.35 m	Upland/Rainfed Lowland	14-08-2018	120:30:30 80:30:15	40:0:15 (NPK)
39	Ponnampet	12°29'N	75°56'E	856 m	Rainfed	17/07/2018	75:75:90	37.5 N:0:45

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S. No.	Location	Latitude (North)	Longitude (East)	Elevation (m. from MSL)	Ecosystem	Sowing (Year, 2018)	Fertilizer Basal - NPK (Kg/ha)	Fertilizer top dressing (Kg/ha)
					Lowland		37.5:75:45	
40	Portblair	6°14'N	92°94'E	5 m	Rainfed lowland	-	-	-
41	Pusa	25.98 N	85.67 E	51.8 m	Irrigated	04.07.2018	40:40:20	40N:40N
42	Raipur	21° 16'N	81°36'E	681 m	Irrigated	20-07-2018	60Kg N	60N
43	Rajendranagar	17° 19'N	78°23'E	542 m	Irrigated	16-07-2018	180:60:40 45:60:40	135N IN 3 Splits
44	Rewa	24°30'N	81°15'E	360 m	Upland Irrigated	07-08-2018	20:60:40	60N
45	Sabour	25° 23'N	87°07'E	37.19m	Rainfed lowland	21-06-2018	40:40:20	20N
46	Titabar	26°N	93°E	99 m	Lowland	10-07-2018	60:20:40	20N
47	Upper Shillong	25° 32'6"N	92° 03' 23" E	869 m	Upland / Rainfed lowland	17-10- 2018	100:40:40 50:40:50	25N:25N
48	Varanasi	25°20'N	23°03'E	75.7 m	Irrigated	03-08-2018	120:60:60	30N
49	Wangbal	24°8'N	94'E	781 m	Irrigated	-	-	-

Note: (-) data is not received

Annexure – III (Abbreviations)

Name of the centre	Code	Details	Code
Aduthurai	ADT	(-)	Data not available
Almora	ALM	A	Artificial Inoculation
Arundhatinagar	ARD	AVTs	Advanced variety trials
Bankura	BAN	BLB	Bacterial leaf blight
Chakdha (Mohanpur)	CKD	BS	Brown spot
Chatha	CHT	CV	Co-efficient of variation
Chinsurah	CHN	DSN	Donor Screening Nursery
Chiplima	CHP	FS	False Smut
Coimbatore	CBT	GD	Glume discoloration
Cuttack (NRRRI)	NRRRI	GSN	Germplasm Screening Nursery
Gangavati	GNV	IC No.	Indigenous collection Number
Gerua	GER	IET No.	Initial Evaluation Trial Number
Ghagraghat	GGT	IVTs	Initial variety trials
Gudalur	GDL	LB	Leaf blast
Hazaribagh	HZB	LSD	Least significant difference
Imphal	IMP	LSI	Location Severity Index
Indian Institute of Rice Research	IIRR	MSL	Mean sea level
Jagdarpur	JDP	N	Natural Infection
Jagtial	JGT	NB	Neck blast
Karjat	KJT	NdB	Node blast
Kaul	KUL	NHSN	National Hybrid Screening Nursery
Kudhwani	KHD	NSN-1	National Screening Nursery 1
Lonavala	LNV	NSN -2	National Screening Nursery 2
Ludhiana	LDN	NSN-H	National Screening Nursery- Hills
Malan	MLN	PI	Promising index
Mandya	MND	RTD	Rice Tungro Disease
Maruteru	MTU	RTV	Rice Tungro Virus
Masodha (Faizabad)	MSD	SE	Standard error
Moncompu	MNC	ShB	Sheath blight
Mugad	MGD	ShR	Sheath rot
Navsari	NVS	SI	Susceptibility Index
Nawagam	NWG	StR	Stem rot
Nellore	NLR		
New Delhi (IARI)	NDL		
Pantnagar	PNT		
Patna	PTN		
Pattambi	PTB		
Ponnampet	PNP		
Portblair	POB		
Pusa	PSA		
Raipur	RPR		
Rajendranagar	RNR		
Rewa	REW		
Sabour	SBR		
Titabar	TTB		
Umiyam (Barapani)	UMM		
Upper Shillong	USG		
Varanasi	VRN		
Wangbal	WGL		

**Progress Report-2018 report was compiled by the following scientists of
Department of Plant Pathology, ICAR-IIRR, Hyderabad.**

**Drs. M. Srinivas Prasad, G. S. Laha, D. Krishnaveni, C. Kannan,
D. Ladhalakshmi, V. Prakasam, K.Basavaraj and G.S Jasudasu**

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