SOIL SCIENCE

Progress Report of Soil Science Coordinated Program
(*Rabi* and *Kharif* 2019)

SOIL SCIENCE

CONTENTS

5. SOIL SCIENCE

Summary

The coordinated program in soil science addressed the issues related to sustaining productivity of soil and crop systems on long-term basis, soil quality and productivity assessment for bridging the gap in farmers' fields, germplasm screening in sodic and acid soils and their management, testing/validation of computer based nutrient management tool, Nutrient Expert, developed by IPNI for site specific nutrient management in farmers' fields, residue management in rice based cropping systems, identification of genotypes having high nitrogen use efficiency and collaborative trials with Agronomy and Entomology in nutrient management and bio intensive pest management under organic farming. A total of 8 trials were conducted during *rabi* 2018-19 and *kharif* 2019 in 18 locations (funded as well as voluntary centres and at IIRR) representing typical soil and crop systems and important rice growing regions.

5.1. Long-term soil fertility management in rice-based cropping systems

In the 31st year of study on long term soil fertility management in RBCS, the treatments RDF+ FYM and RDF were at par and significantly superior to other treatments in both seasons at MTU and in *kharif* at TTB. Whereas, RDF+FYM was superior to all other treatments at MND during *kharif* and at TTB during *rabi*. FYM alone treatment was on par to RDF in *kharif* at MND and in both seasons at TTB. Nutrient omission and reduction to 50% resulted in yield reduction at all three centres in both seasons. At the end of *kharif* 2019, there was an improvement in important soil properties with INM and organics and with a significant reduction of NPK values in omission plots compared to RDF plots at all three locations. Supplementary use of organics recorded highest number of microbial populations as well as enzymatic activities. Additional dose of FYM @5t/ha along with RDF improved the productivity growth rate substantially at all three locations.

5. 2. Soil quality and productivity assessment for bridging the yield gaps in farmers' Fields

This trial in the form of a survey was conducted in farmers' fields around few selected centres – Chinsurah, Titabar, Karaikal and Pantnagar) representing Indo gangetic plains and the plateau region collected from farmer fields in *Kharif* 2019 to assess the variability in nutrient supply, its relationship with rice yields at farmers' fertilizer practices in some new farm sites. The *kharif* 2019 data received representing the irrigated and shallow lowland rice ecosystems revealed wide variations. Soil nutrient uptake varied between the sites matching with the grain yields. Sharp variations in grain yields recorded varied from 2.39 t /ha among low yielders to 5.0 t /ha among high yielders at Chinsurah, from 3.59 t /ha among low yielders to 4.67 t /ha among high yielders at Karaikal, varied from 2.63 t /ha among low yielders to 4.87 t /ha among high yielders at Titabar, 5.7 t/ha among high yielders at Pantnagar. Soil Parameters data were pooled in different categories and the resulting soil quality index generated showed variations in the quality and health of the soil across different farmers categories.

5.3 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS

The trial on gypsum application in conjunction with NPK fertilization improved rice yields at Kanpur. The genotypes SRL-3, SRL-2, RMS-1, SRL-1 and MTP-1 produced the highest grain yields of 3.53 -3.76 t/ha, at Kanpur, under recommended NPK + 100% GR fertilization. Under native sodic conditions without gypsum amendment, the yields were higher in the following genotypes viz., SRL-3 (2.81 kg/ha), SRL-2 (2.7 kg/ha), RMS-1 (2.7 kg/ha) and SRL-1 (2.67 kg/ha) and MTP-1 (2.62 kg/ha). In unamended native sodic soils of Faizabad, the genotypes that produced the highest yields were recorded in RMS -2, RMS -7, RMS -6, RMS -8 and SRL -1 (5.06-6.5 t/ha). The genotypes MTP-1, Varadhan, VR-181, KRH-4 and RMS-5 exhibited better tolerance to sodicity at Mandya compared to other genotypes as demonstrated by their significantly higher yields (6.59-7.42 t/ha) without gypsum amendment. In Pusa, the genotypes GPV 2, GPV 1, GPV 3 SRL 1 and CNN 2 demonstrated tolerance to sodicity with yields ranging from 3.45 t/ha-3.92 t/ha.

5.4 Screening of rice genotypes for tolerance to soil acidity

The genotypes which performed better with yields ranging from 2-2.43 t/ha in unlimed acid soils of Harizibagh were: PUP-221, SRL-3, PS-344, SRL-2 and MTP-1. At Moncompu, RMS 4, KRH 4, RMS 5, PS 344 and RMS 1 recorded comparitively higher yields in unlimed tereatment (9.48 t/ha, 8.28 t/ha, 7.68 t/ha, 7.63 t/ha and 7.62 t/ha respectively). The highest grain yields at Ranchi in the treatment without liming was observed in RMS-4, RMS-5, RMS-1, GPV-2 and GPV-1 (6.99 t/ha , 6.94 t/ha, 6.87 t/ha , 6.86 t/ha) and 6.23 t/ha respectively). At Titabar, the genotypes with high yields in the treatment without liming and with recommended NPK alone were PUP-221, Varadhan, RMS-1, MTP-1, and GPV-1 (3.87 t/ha - 4t/ha). A 12.48% and 19.11% increase in yields were observed at Ranchi and Titabar due to liming. The genotypes responsive to liming at Ranchi were RMS-, GPV-1, RMS-5, Varadhan and RMS-1 with yields in the range of 7.3- 7.67 t/ha, while the highest yields of 4.63, 4.5, 4.43, and 4.4 t/ha, respectively, were recorded in the genotypes KRH-4, Varadhan, RMS-8, GPV-3 and MTP-1due to liming in Titabar.

5.5 Yield maximization in farmers' fields using Nutrient Expert software

A multi-locational trial was conducted to study the response of rice crop to varied degrees of edaphic factors derived from farmers' practices (T1), recommended dosages of fertilisers (T2) and recommendations emanated from Nutrient Expert software (T3). Testing centers included Chinsurah, Faizabad, Karaikal, Khudwani, Mandya, Maruteru, Pantnagar, Puducherry and Purulia with varied number of test sites.The analysis indicated the effect of sites, treatments and their interactions obtained through two factor analysis. In majority of sites the impact of treatments was insignificant except in three locations (Faizabad, Purulia and Khudwani) in which T3 was superior than the otherwith reference to rice grain yield. In two centers (Faizabad and Chinsurah) the effect of treatments could be seen with regards to straw yield where T3 was better in Faizabad, RFD proved better in Chinsurah. It is interesting to note the significant effects of site x treatment interactions in majority attributes when compared to individual effects of sites and treatments, which highlights inclusion in Site-Specific Nutrient Management. There is another dimension added to the performance is about different varieties leading to permutations and combinations of effects that required further experimentation at multiple locations. Probably, all these facts are needed to be included in realizing the best from SSNM.

5.6 Bio - Intensive Pest Management (BIPM) in rice under Organic Farming

From the fourth year of study on “Bio-intensive pest management”, it can be summarized that out of three locations (CHN, IIRR and TTB), BIPM was significantly superior to FP at CHN and TTB, while at IIRR, farmer's practice of nursery and main field with insecticide schedule was significantly superior to all other treatments. Similar to previous years, in this fourth year also, most of the soil properties improved with organics in BIPM compared to FP.

5. 7 Residue management in rice based cropping systems

The disposal of huge quantity of paddy residues has become a big problem, particularly in North-West Indian states, resulting in farmers preferring to burn the residues *in-situ* leading to air pollution, smog and loss of appreciable amount of plant essential nutrients besides being deleterious to soil microbes. Keeping this in view, the present trial initiated in last *kharif* was conducted this year at ten centres. The results show that the crop residues can be deployed to substitute half of the recommended nitrogen without yield penalty. Nutrient uptake was highest under RDF [N (72-133 kg/ha), P (13-42 kg/ha) and K (43-170 kg/ha)]. The crop residue treatments were at par and didn’t vary much in terms of grain yield, nutrient uptake and maintained higher nutrient use efficiencies over RDF. Post-harvest soil nutrient status was not influenced much by various residue treatments which were at par with each other.

5.8 Screening of rice germplasm for Nitrogen use efficiency (NUE)

In the first year of study on “Screening of rice germplasm for NUE, ten genotypes were evaluated at three nitrogen levels (0, 50 and 100% of recommended N) at nine locations. At all locations, grain yield was significantly higher at 100% RDN and the increase was in the range of 5-36% over 50% RDN and 21-110% over no N applilcation. Among the varieties, out of nine locations, ARRH7576, CNN5, CNN4 and Varadhan recorded higher yields of around 5.0 t/ha. Yield parameters and nutrients uptake almost followed similar trend as that of grain yield trend and no spectacular differences were noticed in soil properties after harvest.

DETAILED REPORT

5.1 Long term soil fertility management in rice-based cropping systems (RBCS)

Long-term studies with well-defined nutrient management treatments and cropping systems were initiated in 1989-90 at four selected locations representing major rice growing regions and cropping systems *viz*., Mandya (MND) in Karnataka (rice-cowpea, Deccan Plateau), Maruteru (MTU) in Andhra Pradesh (rice-rice, Delta system), Titabar (TTB) in Assam (rice-rice, Alluvial soils) and Faizabad (FZB) in Uttar Pradesh (rice – wheat, Indo Gangetic plains) to study the dynamics of soil and crop productivity in relation to management for identifying the constraints that affect the sustainability of a given production system. The trial at Faizabad was discontinued during 2007-08 for lack of manpower support and being continued at 3 centres only. Hence, the results of 31st year of cropping i.e., *rabi* 2018-19 and *kharif* 2019 are presented in Tables 5.1.1 to 5.1.11 and Figs. 5.1.1 to 5.1.4.

Crop productivity and soil fertility during *rabi* 2018-19

Grain and straw yields of *rabi* rice at MTU and TTB are presented in Table 5.1.2. At MTU, grain yield ranged from 3.99 (control) to 6.24 t/ha (RDF+FYM) with a mean of 5.26 t/ha. RDF and RDF+FYM treatments were at par. Omission of P,K,Zn and S resulted in yield reduction by 0.41 t/ha in -Zn to 1.08 t/ha in -P plots over RDF. At Titabar, grain yield ranged from 1.65 t/ha in control to 4.63 t/ha in RDF+FYM which was significantly superior to all other treatments while FYM alone treatment (3.95 t/ha) was on par to RDF (4.25 t/ha). Here also, omission of nutrients resulted in grain yield reduction by 20% in -S to 21% in - K plots over RDF. 50% reduction in RDF resulted in 78% yield reduction in silty clay soil of TTB compared to 20% reduction in clay loam soil of MTU over RDF. STCR recommendation was at par to 100% RDF at TTB and significantly lower than RDF at MTU. At MND, *rabi* crop, cowpea, grown on residual soil fertility recorded higher yields in plots where organics were added during *kharif*.

Total nutrient (NPK) uptake followed similar trend as that of grain yield with maximum uptake in RDF+ 5t FYM/ha at both centres, MTU and TTB (Table 5.1.3). With regard to soil fertility status, soil organic carbon and available nutrient status after harvest at Maruteru were higher when organic manures were added as a supplementary dose and control treatment recorded lowest values in most of the parameters (Table 5.1.4). In nutrient omission plots (-P and -K), there was a significant reduction in available P and K compared to plots with RDF+FYM .

Crop productivity and soil fertility status during *kharif* 2019

At MTU, RDF+FYM recorded maximum grain yield (6.63 t/ha) that was on par to RDF, FYM alone and 50% NPK+50% FYM (5.72-5.95 t/ha) (Table 5.1.5). Omission of major and micro nutrients resulted in significant yield loss (1.71 to 2.26 t/ha) compared to RDF. At TTB also, RDF+FYM (5.57 t/ha) recorded maximum yield and was at par with RDF(5.33 t/ha) and

FYM alone (5.23 t/ha). Here, response to NPKZn and S was significant with maximum yield loss due to omission of major nutrients. At MND, RDF+FYM recorded maximum yield (6.40 t/ha) which was on par to 50% NPK+25% GM-N+ 25% FYM-N (6.14 t/ha) and these two treatments were significantly superior to other treatments. Here also, omission plots recorded significantly lower yields by 8% in –Zn to 96% in –N than RDF except –Zn which was on par to RDF. Whereas, FYM alone (4.52 t/ha) was on par to RDF (4.48 t/ha). STCR recommendation resulted in significant yield reduction at MTU and TTB compared to RDF while at MND, STCR was on par to RDF. With regard to straw yield, the trend was almost similar to grain yield trend at all locations. The total nutrients (NPK) uptake by the above ground biomass was almost similar to that of grain yield trend at all locations (Table 5.1.6). Soil fertility status at the end of *kharif* 2019 (Table 5.1.7 and 5.1.8 and Fig. 5.1.4) indicated an improvement in most of the soil properties with addition of organics and omission plots recorded reduction in NPK values compared to RDF at all 3 locations. Higher OC values were observed with RDF+FYM, INM and FYM alone treatments at all 3 locations (0.59 – 1.62%) and control recorded the lowest values at all locations (0.18-1.05%).

Long term changes in crop productivity and soil fertility over a period of 31 years

The trends in mean grain yields over 31 years (1989-2019) of *kharif* and *rabi* rice at MND, MTU and TTB by fitting to linear function using actual yields and the per cent change in important soil properties in some important treatments were analysed and presented below.

Linear trends in crop productivity (Tables 5.1.9 and 5.1.10 and figs.5.1.1-5.1.3)

During *kharif* 2019, the treatment, RDF+5 t FYM/ha recorded maximum mean yield at all 3 locations (MND- 5.26; MTU-5.15 and TTB- 4.94 t/ha) with an average increase of 11, 4 and 14%, respectively, at MND, MTU and TTB by this treatment over RDF. Linear trends of productivity over the years with current RDF indicated slightly positive growth in the delta soils of MTU (6.0 kg grain/ha/year) and more positive growth in the acid alluvial soils of TTB (35 kg/ha/year). Additional dose of FYM @5t/ha along with RDF improved the growth rate substantially with 66 kg/ha/year at MTU and 79 kg/ha/year at TTB. Whereas, at MND, RDF recorded –ve growth rate (-38 kg/ha/yr) and RDF+FYM recorded more positive growth rate (86 kg/ha/yr).

During *rabi* (Table 5.1.10) also, RDF+5t FYM recorded maximum mean grain yield both at MTU (6.28 t/ha) and TTB (4.34 t/ha) and this treatment recorded growth rate of 18 and 54 kg/ha/year at MTU and TTB, respectively. Higher growth rate was observed in *kharif* season compared to *rabi* season.

Changes in soil fertility compared to initial values (Table 5.1.11)

The Organic carbon (OC) content increased in all treatments at MTU compared to initial values. At MND, it decreased in control and RDF but increased in INM treatments. At TTB, OC decreased in control but increased in RDF and other treatments. Maximum increase in OC was in FYM alone treatment at MTU and TTB while in INM treatment at MND. Available N decreased in all treatments at MTU but at MND, it decreased in control with an increase in INM and FYM alone treatments. With regard to available P, there was a build up in all treatments except control compared to initial value at MND and TTB and at MTU, there was a build up in P in all treatments including control. In case of available K, at MTU, there was a decrease in all treatments compared to initial value. But, at MND and TTB, decrease was seen in control and with accumulation in other treatments.

The per cent change in important soil fertility parameters compared to the initial values were presented in Table 5.1.11 for three locations. There was a maximum decline in OC in control treatment at MND (-49%) and TTB (-41%) and INM treatments recorded accumulation of OC with maximum value in FYM alone (35%) treatment at MTU (35%) and TTB (68%) and 50%NPK+25%GM+25%FYM at MND (69%). With regard to N, there was a decline in all treatments (-5 to -24.5%) at MTU and at MND, decline was in control only (-36%). P accumulation was very high at all three locations in P addition treatments (87-398%). In case of K also, change was -ve in all treatments at MTU (-4 to -26 %) and in control alone at MND (-43%) and TTB (-47%) with a positive change in other treatments.

Summary

From the results of 31st year of study on long term soil fertility management in RBCS, superior performance of RDF+FYM was noticed over other treatments in both seasons at all three locations (MND, MTU and TTB). FYM alone treatment was on par to RDF in both seasons at TTB and in *kharif* at MND and MTU. Omission of major nutrients resulted in maximum yield reduction compared to micronutrients at all three locations. In general, INM and organics alone treatments resulted in improvement of soil fertility parameters which had reflected positively in rice productivity at all locations. Microbial populations as well as soil enzyme activities were higher with addition of organics. In general, compared to initial values, changes in soil fertility showed –ve values in control at all 3 locations in all parameters and +ve in INM and organics alone treatments except at MTU where N and K values are –ve in all treatments.

Table 5.1.1: Long term soil fertility management in RBCS, 2019 -Soil and crop characteristics

Cropping system	Maruteru	Titabar	Mandya
	Rice-Rice	**Rice-Rice**	**Rice-Rice**
Variety - ***Kharif***	MTU-1061	Gitesh	Thanu (KMP101)
Rabi	MTU-1010	Lachit	-
Recommended Fertilizer Dose (kg NPK /ha)			
Kharif	90:60:60:50 (Zn)	40:20:20	100:50:50:20 (Zn)
Rabi	180:90:60:50	40:20:20	-
STCR	112:60:40	-	-
Crop growth: ***Kharif***	Satisfactory	-	Satisfactory
Rabi	Satisfactory	Good	Satisfactory
% Clay	38	42.0	11.1
% Silt	28	28.0	18.1
% Sand	34	30.0	62.8
Texture	Clay loam	Silty Clay	Sandy loam
pH (1:2)	6.10	5.4	5.87
Organic carbon (%)	1.24	1.1	0.30
CEC (cmol (p^+)/kg)	48.6	12.5	-
EC (dS/m)	0.64	0.10	0.28
Avail. N (kg/ha)	234	495	208
Avail. P_2O_5 (kg/ha)	61.2	22.4	19.7
Avail. K_2O (kg/ha)	294	112	118

Table 5.1.2: Long term soil fertility management in RBCS, *rabi* 2019 Grain and straw yields of rice and cowpea

Treatments	Grain yield (t/ha)			Straw yield (t/ha)	
	Mandya (cowpea-kg/ha)	**Maruteru**	**Titabar**	**Maruteru**	**Titabar**
Control	473.0	3.99	1.65	4.99	3.12
100% PK	437.0	6.24	3.65	7.86	5.77
100% NK	428.5	5.13	3.75	6.93	5.82
STCR recommendation	643.5	5.19	4.17	7.01	6.20
100% NP	522.0	5.58	3.53	7.81	5.63
100% NPKZnS6	672.5	6.21	4.25	7.77	6.17
100% NPKZnS + FYM/PM @ 5t/ha	719.0	6.24	4.63	7.86	6.73
100% NPK –Zn	625.5	5.80	3.62	7.82	5.70
100% NPK – S	597.0	5.63	-	8.16	-
100%NPK-S+1tlime/ha	-	-	3.55	-	5.70
100% N+50% PK	497.0	4.87	3.83	5.36	5.70
50 % NPK	440.0	5.18	3.53	6.21	5.50
50 % NPK + Biofertilizer	442.5	4.23	2.38	5.72	4.67
50%NPK+ 50% GM-N	748.5	5.37	3.67	6.77	5.70
50% NPK + 50% FYM-N	780.0	5.65	3.93	7.06	5.23
50% NPK + 25% GM-N+25% FYM-N	791.5	5.40	3.83	7.28	5.70
FYM @ 10 t/ha	757.5	4.23	3.95	5.71	5.92
FYM @ 10 t/ha + Split application	768.5	4.50	3.95	6.06	5.83
Expt. Mean	**608.5**	**5.26**	**3.64**	**6.84**	**5.59**
CD (0.05)	**97.3**	**0.36**	**0.33**	**0.47**	**0.58**
CV (%)	**7.5**	**4.2**	**5.59**	**4.2**	**6.3**

Table 5.1.3: Long term soil fertility management in RBCS, *rabi* 2019- Total Nutrient uptake (kg/ha)

Treatments	Maruteru			Titabar		
	N	P	K	N	P	K
Control	85.7	15.0	49.4	26.3	4.8	26.7
100% PK	134.5	26.5	91.1	58.9	13.7	56.4
100% NK	138.9	19.3	71.1	60.4	13.8	59.8
STCR recommendation	140.5	21.0	90.6	71.0	18.5	70.8
100% NP	145.4	24.4	84.2	55.5	12.9	49.2
100% NPKZnS	166.7	23.8	76.0	76.1	16.2	74.3
100% NPKZnS + FYM/PM @ 5t/ha	174.4	27.1	108.4	82.6	18.3	83.8
100% NPK – Zn	149.4	25.5	81.8	61.5	11.6	62.7
100% NPK – S	140.2	26.5	87.2	-	-	-
100%NPK-S+1tlime/ha	-	-	-	56.3	12.4	65.4
100% N+50% PK	116.1	21.1	63.9	63.8	13.2	65.7
50 % NPK	119.3	21.6	62.5	55.4	11.5	62.2
50% NPK + Biofertilizer	99.7	19.0	72.9	40.7	8.7	49.2
50% NPK+ 50% GM-N	123.7	23.2	82.9	58.8	12.2	67.0
50% NPK + 50% FYM-N	123.3	23.3	89.6	61.0	11.9	62.4
50% NPK + 25% GM-N+ 25% FYM-N	104.7	23.2	88.3	65.4	14.3	69.5
FYM @ 10 t/ha	89.0	18.6	71.9	62.0	14.0	70.2
FYM @ 10 t/ha + Split Vermi	97.3	20.2	73.1	68.5	17.8	74.1
Expt. Mean	126.4	22.3	79.1	60.3	13.3	62.9
CD (0.05)	**18.3**	**2.0**	**11.0**	**9.8**	**3.3**	**7.4**
CV (%)	**8.8**	**5.6**	**8.4**	**9.8**	**14.9**	**7.2**

Table 5.1.4: Long term soil fertility management in RBCS, *rabi* 2019 - Soil fertility status at harvest

Treatments	Maruteru					
	pH	EC	Org C (%)	Avail. N (kg/ha)	Avail. P_2O_5 (kg/ha)	Avail. K_2O (kg/ha)
Control	5.91	0.70	1.20	174	63.3	409
100% PK	5.64	0.67	1.30	198	87.4	390
100% NK	5.72	0.73	1.17	147	80.6	421
STCR recommendation	5.54	0.73	1.23	174	96.8	435
100% NP	5.58	0.67	1.20	184	73.1	294
100% NPKZnS	5.63	0.73	1.13	140	77.8	359
100% NPKZnS + FYM/PM @ 5t/ha	5.75	0.67	1.30	189	97.2	368
100% NPK – Zn	5.94	0.73	1.30	133	93.9	368
100% NPK – S	5.75	0.70	1.30	169	98.5	316
100%NPK-S+1t lime/ha	-	-	-	-	-	-
100% N+50% PK	5.46	0.67	1.30	153	97.6	358
50 % NPK	5.61	0.67	1.30	171	81.7	370
50% NPK + Biofertilizer	5.84	0.70	1.27	161	94.6	334
50% NPK+ 50% GM-N	5.72	0.67	1.27	180	85.2	401
50% NPK + 50% FYM-N	5.54	0.73	1.33	128	69.0	491
50% NPK + 25% GM-N+ 25% FYM-N	5.70	0.70	1.33	156	80.6	494
FYM @ 10 t/ha	5.71	0.67	1.30	177	70.0	324
FYM@10 t/ha + 3.0 t/ha Vermicompost +200 kg/ha oil cakes	5.98	0.70	1.33	160	100.1	329
Expt. Mean	5.70	0.70	1.26	164	85.1	380
CD (0.05)	**0.41**	**0.11**	**0.11**	**34**	**4.8**	**60**
CV (%)	**4.33**	**9.99**	**5.06**	**13**	**3.4**	**9**

Table 5.1.5: Long term soil fertility management in RBCS, *kharif* 2019 - Yield and yield parameters of rice

Treatments	Grain yield (t/ha)			Straw yield (t/ha)			Panicles/m^2	
	MTU	**TTB**	**MND**	**MTU**	**TTB**	**MND**	**MTU**	**MND**
Control	2.61	1.68	1.82	5.36	3.80	2.05	300	215
100% PK	3.96	4.30	2.29	6.24	6.68	2.56	302	236
100% NK	3.71	4.45	2.62	5.54	6.52	2.87	310	273
STCR recommendation	4.12	4.78	3.94	6.72	6.73	4.10	295	437
100% NP	3.69	4.33	2.84	6.50	6.23	3.00	324	323
100% NPKZnS	5.95	5.33	4.48	9.82	6.83	4.88	307	460
100% NPKZnS + FYM/PM @ 5 t/ha	6.63	5.57	6.40	9.53	7.20	6.31	299	539
100% NPK –Zn	3.87	4.47	4.16	6.66	6.40	4.32	315	442
100% NPK – S	4.24	-	3.84	6.31	-	3.93	309	430
100%NPK-S+ 1timelime/ha	-	4.42	-	-	6.30	-	-	-
100% N+50% PK	4.09	4.52	3.33	6.23	6.00	3.76	310	411
50 % NPK	4.16	3.53	3.16	6.26	5.43	3.33	304	343
50 % NPK + Biofertilizer	4.14	2.48	3.86	6.93	4.70	4.10	333	365
50% NPK+ 50% GM-N	5.16	4.13	5.38	6.33	6.00	5.70	308	507
50% NPK + 50% FYM-N	5.72	4.62	5.23	7.90	6.60	5.53	322	501
50% NPK + 25% GM-N+25% FYM-N	4.25	4.72	6.14	7.46	6.57	6.55	336	529
FYM @ 10 t/ha	5.74	4.85	4.52	9.04	6.63	4.85	325	462
FYM@10 t/ha + 3.0 t/ha Vermicompost +200 kg/ha oil cakes	3.97	5.23	5.07	5.67	6.96	5.49	298	485
Expt. Mean	4.47	**4.32**	4.06	6.98	**6.21**	4.31	311	409
CD (0.05)	**1.07**	**0.43**	**0.70**	**1.41**	**0.46**	**0.72**	**56**	**55**
CV (%)	**14.6**	**6.01**	**8.2**	**12.2**	**4.49**	**7.9**	**11**	**6.4**

MTU-Maruteru TTB-Titabar MND- Mandya

Table 5.1.6: Long term soil fertility management in RBCS, *kharif 2019*
Total Nutrient uptake (kg/ha) in total dry matter

Treatments	Maruteru			Titabar			Mandya		
	N (kg /ha)	P (kg /ha)	K (kg /ha)	N (kg /ha)	P (kg /ha)	K (kg /ha)	N (kg /ha)	P (kg /ha)	K (kg /ha)
Control	50.9	11.5	55.2	26.3	4.8	26.7	25.9	4.8	30.0
100% PK	75.8	14.9	65.1	58.9	13.7	56.4	34.6	6.8	42.5
100% NK	64.4	16.1	71.4	60.4	13.8	59.8	42.9	6.7	50.8
STCR recommendation	80.4	17.4	88.3	71.0	18.5	70.8	67.4	12.8	74.1
100% NP	67.0	17.9	84.8	55.5	12.9	49.2	47.7	9.0	45.8
100% NPK + Zn + S	91.0	29.2	128.1	76.1	16.2	74.3	80.4	15.8	92.6
100% NPK + Zn + S + FYM/PM @ 5 t/ha	119.4	30.7	137.0	82.6	18.3	83.8	114.4	23.6	128.4
100% NPK –Zn	69.5	18.2	78.4	61.5	11.6	62.7	71.9	14.4	82.1
100% NPK – S	77.8	19.1	76.8	-	-	-	65.4	13.2	74.5
100%NPK-S+ 1timelime/ha	-	-	-	56.3	12.4	65.4	-	-	-
100% N+50% PK	74.8	17.7	66.5	63.8	13.2	65.7	57.7	10.4	62.5
50 % NPK	71.5	18.4	78.5	55.4	11.5	62.2	50.0	9.7	54.3
50 % NPK + Biofertilizer	76.9	19.5	90.8	40.7	8.7	49.2	62.3	11.7	68.3
50% NPK+ 50% GM-N	90.3	21.1	84.3	58.8	12.2	67.0	95.3	19.2	110.2
50% NPK+ 50% FYM-N	101.0	25.3	108.6	61.0	11.9	62.4	93.0	18.7	108.1
50% NPK +25% GM-N +25% FYM-N	75.0	19.0	104.3	65.4	14.3	69.5	111.3	23.1	127.3
FYM @ 10 t/ha	99.4	27.4	99.4	62.0	14.0	70.2	80.6	15.3	93.7
FYM@10t/ha +3.0 t/ha Vermi+200 kg/ha oil cakes	63.6	18.1	61.2	68.5	17.8	74.1	91.9	17.7	105.8
Expt. Mean	**79.3**	**20.1**	**87.0**	**60.3**	**13.3**	**62.9**	70.2	**13.7**	**79.5**
CD (0.05)	**15.6**	**3.3**	**17.9**	**9.8**	**3.3**	**7.4**	**10.9**	**4.6**	**16.7**
CV (%)	**11.9**	**10.1**	**12.5**	**9.9**	**14.9**	**7.2**	**7.3**	**15.7**	**9.9**

Table 5.1.7: Long term soil fertility management in RBCS, *Kharif* 2019

Soil fertility status at harvest

Treatments	Maruteru				Titabar				
	Org. C (%)	Avail. N (kg/ha)	Avail P_2O_5 (kg/ha)	Avail. K_2O (kg/ha)	Soil pH	Org. C (%)	Avail. Zn (mg/kg)	Avail. P_2O_5 (kg/ha)	Avail. K_2O (kg/ha)
Control	1.05	228	55.6	301	5.37	0.56	0.56	11.6	78
100% PK	1.21	234	75.2	383	5.63	0.80	0.70	23.2	94
100% NK	1.11	243	67.1	267	5.73	0.88	0.83	26.6	112
STCR recommendation	1.09	270	74.8	306	5.67	0.95	0.87	35.2	96
100%NP	1.10	280	94.8	315	5.73	1.00	0.82	34.3	95
100% NPKZnS	1.08	273	101.6	353	5.77	1.22	0.95	39.2	151
100% NPKZnS + FYM/PM @ 5t/ha	1.18	283	99.9	390	5.63	1.52	1.22	41.2	161
100% NPK –Zn	1.09	316	77.6	354	5.63	1.62	0.82	37.7	148
100% NPK – S	1.13	295	81.1	378	-	-	-	-	-
100%NPK-S+ 1timelime/ha	-	-	-	-	5.93	0.86	0.88	36.5	151
100% N+50% PK	1.10	297	65.4	343	5.63	1.22	0.87	33.6	157
50 % NPK	1.11	252	82.6	336	5.70	0.73	0.75	26.8	161
50 % NPK + Biofertilizer	1.22	249	71.9	284	5.87	1.20	0.83	36.2	158
50% NPK+ 50% GM-N	1.16	191	90.1	356	5.60	1.38	0.85	36.4	168
50% NPK + 50% FYM-N	1.11	224	99.5	345	5.70	1.47	0.88	36.8	160
50% NPK + 25%GM-N+25%FYM-N	1.15	260	93.7	341	5.90	1.50	0.91	38.0	168
FYM @ 10 t/ha	1.20	225	89.6	373	5.90	1.50	1.00	38.8	168
FYM@10 t/ha +3.0 t/ha Vermicompost +200 kg/ha oil cakes	1.11	245	95.4	277	5.93	1.60	1.07	40.5	170
Expt. Mean	**1.13**	**256**	**83.3**	**335**	**5.74**	**1.18**	**0.87**	**33.7**	**141**
CD (0.05)	**0.15**	**27**	**6.3**	**36**	**0.33**	**0.18**	**0.15**	**2.5**	**14**
CV (%)	**8.1**	**6.4**	**4.6**	**6.4**	**3.46**	**9.12**	**10.1**	**4.4**	**5.9**

Table 5.1.8: Long term soil fertility management in RBCS, *Kharif* 2019
Soil fertility status at harvest (Mandya)

Treatments	Soil O.C. (%)	Avail. N ($Kg\ ha^{-1}$)	Avail. P_2O_5 ($Kg\ ha^{-1}$)	Avail. K_2O ($Kg\ ha^{-1}$)
Control	0.18	185	10.1	100
100% PK	0.24	231	28.2	257
100% NK	0.29	235	16.2	246
STCR	0.34	264	30.8	270.5
100% NP	0.28	257	29.2	141
100% NPK + Zn + S	0.35	302	33.0	266
100% NPKZnS + FYM/PM	0.40	272	54.4	312
100% NPK – Zn	0.34	296	32.4	273
100% NPK – S	0.34	284	33.7	271
100% N + 50% PK	0.30	278	28.3	245
50% NPK	0.31	266	25.6	254
50% NPK + 50% GM-N	0.49	334	44.3	297
50% NPK + 50% FYM-N	0.49	339	46.7	315
50% NPK + 25% GM-N + 25% FYM-N	0.59	380	51.0	325
FYM @ 10 t/ha	0.54	342	39.9	292
FYM @ 10t.ha + 3 t/ha Vermi + 200 kg/ha oil cakes	0.55	347	39.4	297
Exp. Mean	**0.37**	**294**	**33.6**	**260**
CD (0.05)	**0.05**	**16.0**	**2.8**	**11.0**
CV (%)	**6.42**	**2.6**	**4.0**	**2.0**

Table 5.1.9: Long term soil fertility management in RBCS
Linear trends of changes in *kharif rice* yields (t/ha) from 1989 to 2019

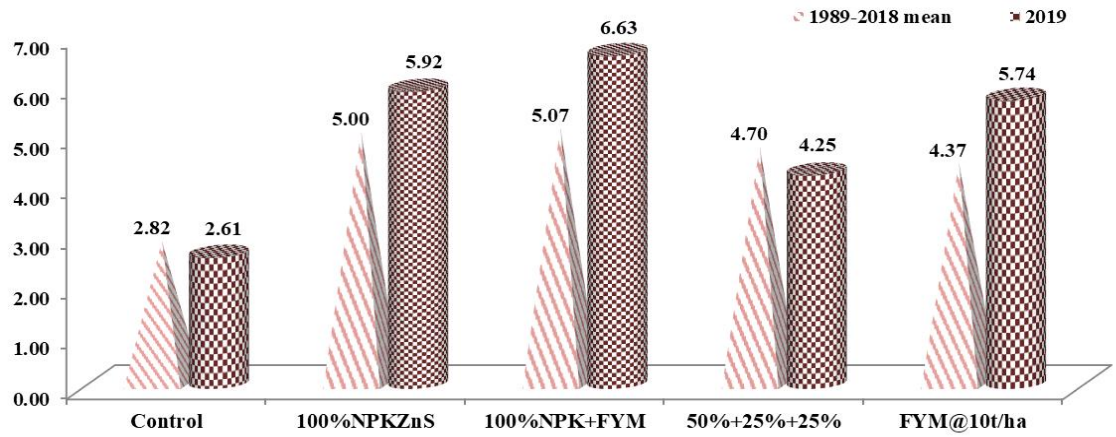
Treatments	MTU			TTB			MND		
	Mean yield (t/ha)	Slope (kg/ha/yr)	Intercept (t/ha)	Mean yield (t/ha)	Slope (kg/ha/yr)	Intercept (t/ha)	Mean yield (t/ha)	Slope (kg/ha/yr)	Intercept (t/ha)
Control	2.85	12.0	2.59	2.01	-60.0	3.00	2.25	-68.0	3.27
100% PK	3.59	38.0	2.85	3.18	39.0	2.56	2.78	-38.0	3.36
100% NK	3.96	-7.0	4.18	3.52	20.0	3.19	3.48	-84.0	4.75
100% NP	4.32	-20.0	4.78	3.72	17.0	3.45	3.89	-93.0	5.30
100% NPK + Zn + S	4.93	6.0	4.93	4.35	35.0	3.79	4.72	-38.0	5.30
100% NPKZnS + FYM	5.15	66.0	3.73	4.94	79.0	3.24	5.26	86.0	3.45
100% NPK – Zn	4.54	-17.0	4.92	4.14	20.0	3.82	4.55	-59.0	5.43
100% NPK – S	4.67	-2.0	4.76	4.12	3.0	4.08	4.46	-53.0	5.26
100% N + 50% PK	4.32	-7.0	4.53	3.64	-8.0	3.76	4.06	-84.0	5.33
50% NPK	4.27	-2.0	4.32	3.19	-40.0	3.83	3.77	-51.0	4.55
50% NPK + 50% GM-N	4.41	2.0	4.41	3.78	19.0	3.46	4.80	0.02	4.77
50% NPK + 50% FYM-N	4.75	12.0	4.54	3.92	28.0	3.47	4.87	0.15	4.64
50% NPK + 25% GM-N + 25% FYM-N	4.51	6.0	4.41	3.98	27.0	3.55	5.42	0.20	5.12
FYM @ 10 t/ha	4.38	5.0	4.34	4.04	53.0	3.19	4.17	0.29	3.73

Table 5.1.10: Long term soil fertility management in RBCS
Linear trends of changes in *rabi rice* yields (t/ha) from 1989 to 2019

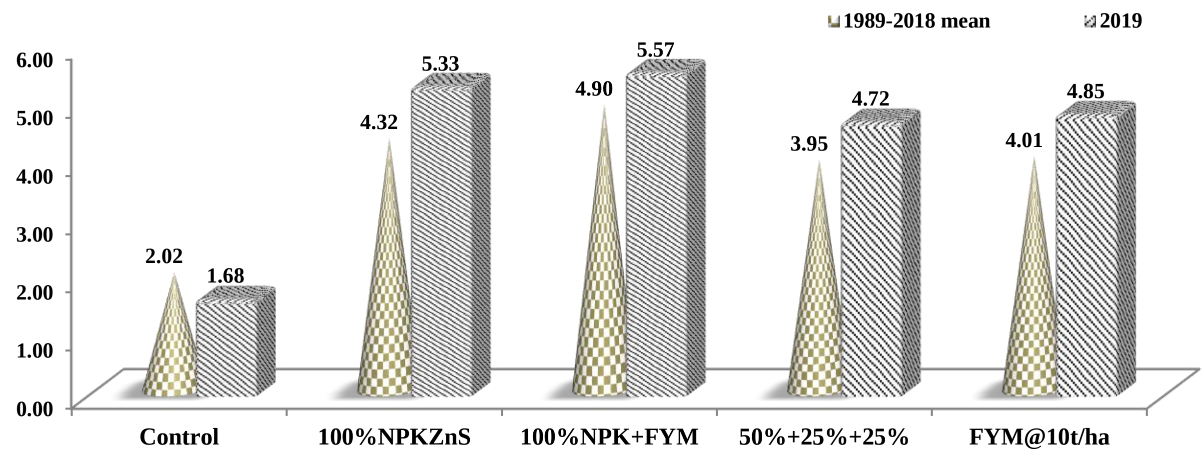
Treatments	MTU			TTB		
	Mean yield (t/ha)	Slope (kg/ha/yr)	Intercept (t/ha)	Mean yield (t/ha)	Slope (kg/ha/yr)	Intercept (t/ha)
Control	2.23	40.0	1.44	1.71	-36.0	2.24
100% PK	2.93	72.0	1.76	2.99	64.0	2.06
100% NK	4.08	34.0	3.53	3.25	31.0	2.80
100% NP	4.98	34.0	4.76	3.40	0.15	3.19
100% NPK + Zn + S	5.68	43.0	4.98	3.86	34.0	3.37
100% NPKZnS + FYM/PM	6.28	-18.0	6.66	4.34	54.0	3.30
100% NPK – Zn	5.18	24.0	4.78	3.64	17.0	3.40
100% NPK – S	5.28	26.0	4.85	3.53	15.0	3.32
100% N + 50% PK	5.17	25.0	4.77	3.33	5.0	3.27
50% NPK	4.26	18.0	3.96	2.83	0.0	2.84
50% NPK + 50% GM-N	4.85	-6.0	4.95	3.35	26.0	2.98
50% NPK + 50% FYM-N	5.12	31.0	4.62	3.45	37.0	2.91
50% NPK + 25% GM-N + 25% FYM-N	4.99	11.0	4.80	3.47	37.0	2.93
FYM @ 10 t/ha	4.03	25.0	3.62	3.48	42.0	2.87

Table: 5.1.11: Long term soil fertility management in RBCS
Changes (%) in soil fertility parameters over 1989 to 2019

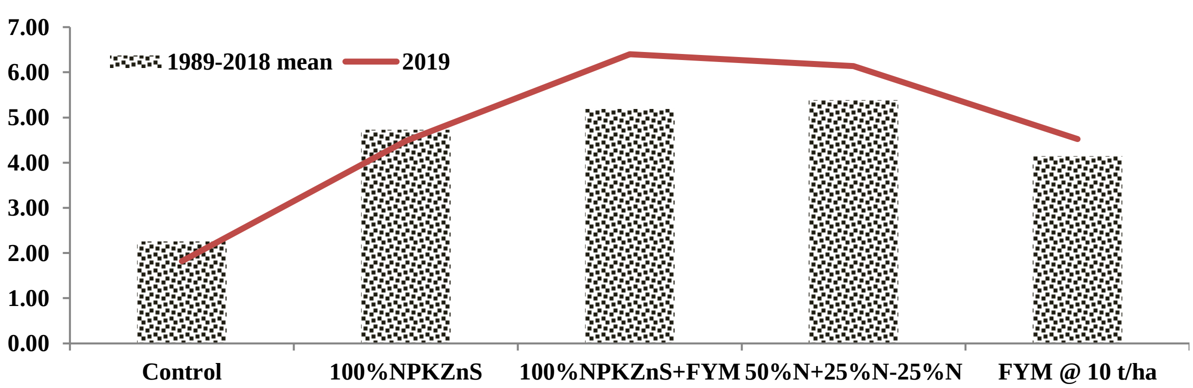
Treatments	Maruteru				Titabar			Mandya			
	OC	N	P	K	OC	P	K	O.C.	N	P	K
Control	18.0	-23.5	173	-25.9	-41.1	-12.1	-46.6	-48.6	-36.2	-42.6	-43.2
100% NPK + Zn + S	21.3	-8.4	398	-13.1	28.4	197.0	3.4	0.00	4.1	87.5	51.1
100% NPK + Zn + S + 5 t/ha FYM	32.6	-5.0	390	-3.9	60.0	212.1	10.3	14.3	-6.2	209.1	77.3
50% NPK + 25% GM-N + 25% FYM-N	29.2	-12.8	359	-16.0	57.9	187.9	15.1	68.6	31.0	189.8	84.7
FYM @ 10 t/ha	34.8	-24.5	339	-8.1	68.4	193.9	15.1	54.3	17.9	126.7	65.9



Grain Yield (t ha^{-1}) at Maruteru

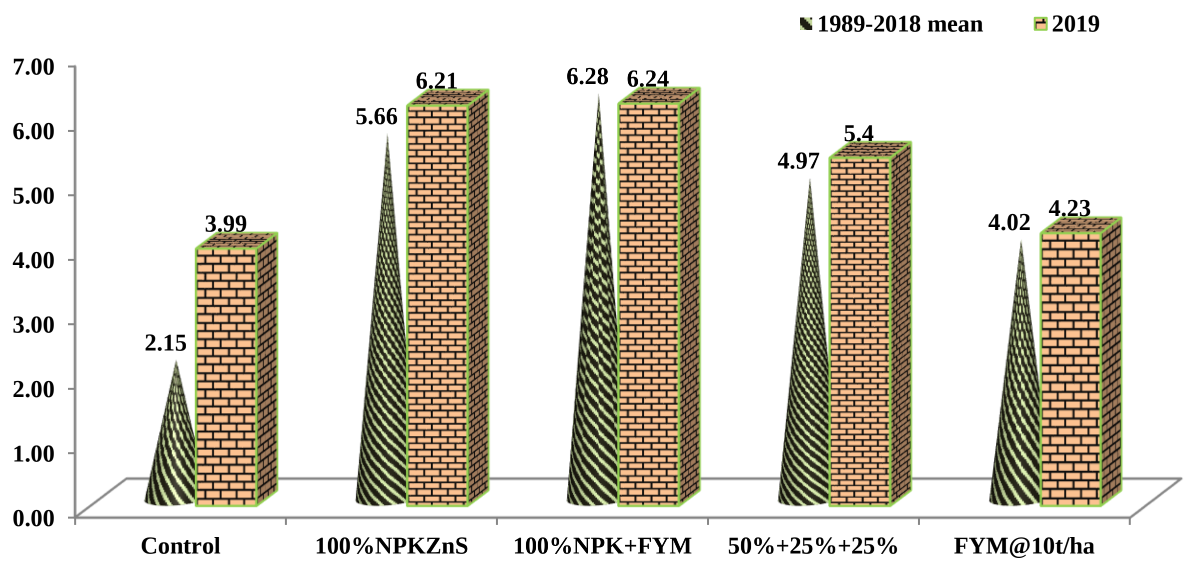


Grain Yield (t ha^{-1}) at Titabar

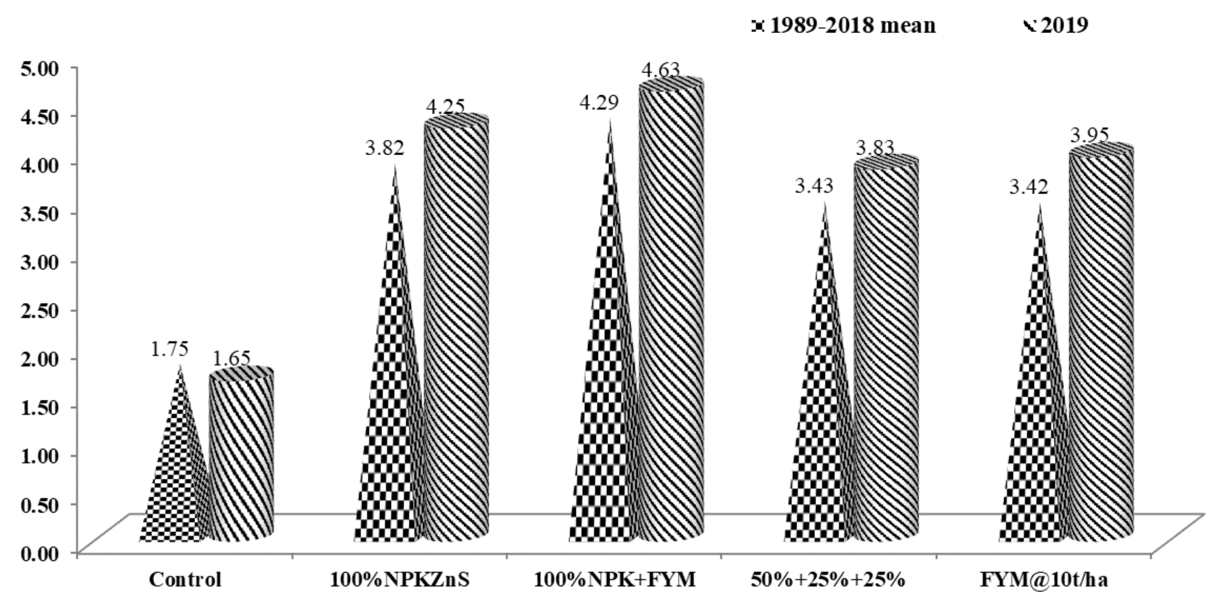


Grain Yield (t ha^{-1}) at Mandya

Fig. 5.1.1. Long term effect of nutrient management on rice grain yield –*Kharif*
(Mean of previous 30 years and current year grain yield)

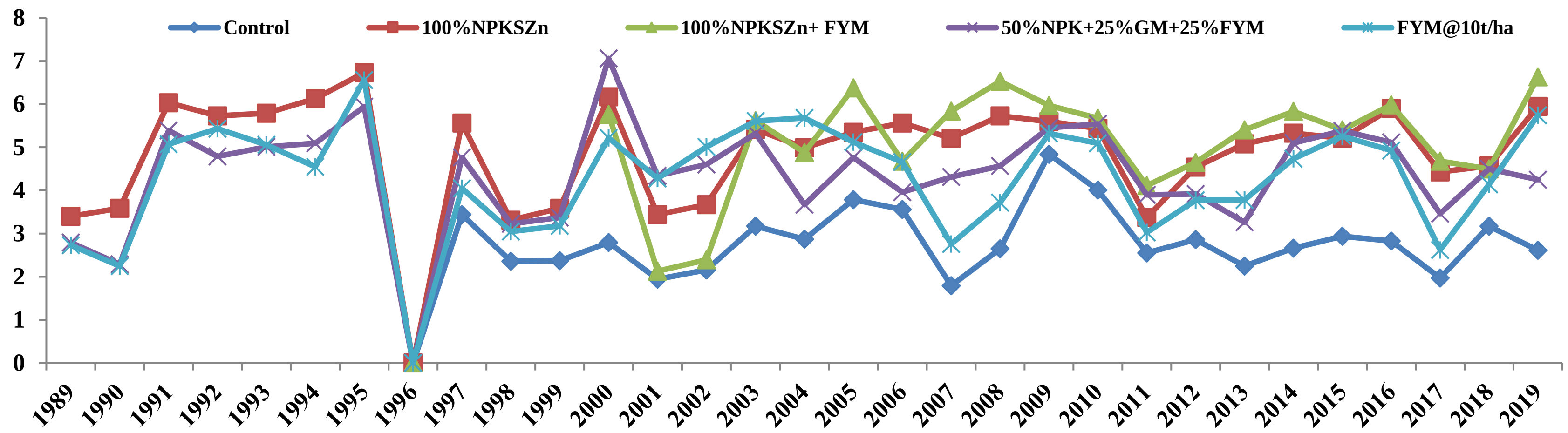


Grain Yield (t ha^{-1}) at Maruteru

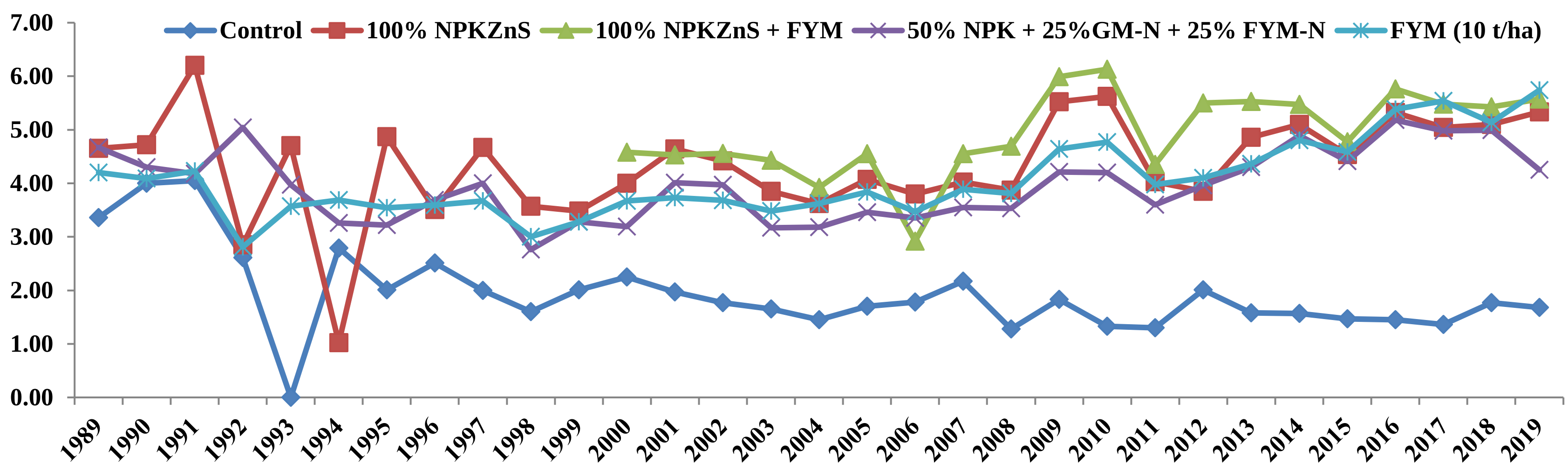


Grain Yield (t ha^{-1}) at Titabar

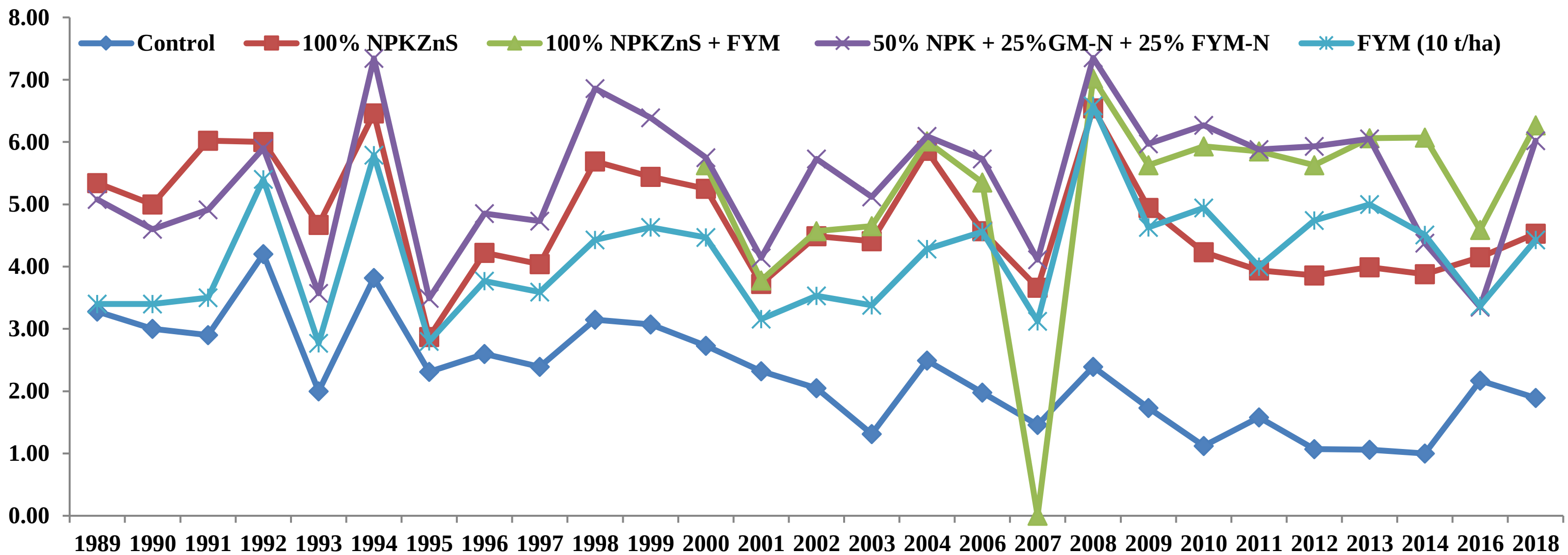
Fig. 5.1.2. Long term effect of nutrient management on rice grain yield –*Rabi*
(Mean of previous 30 years and current year grain yield)



Maruteru Kharif

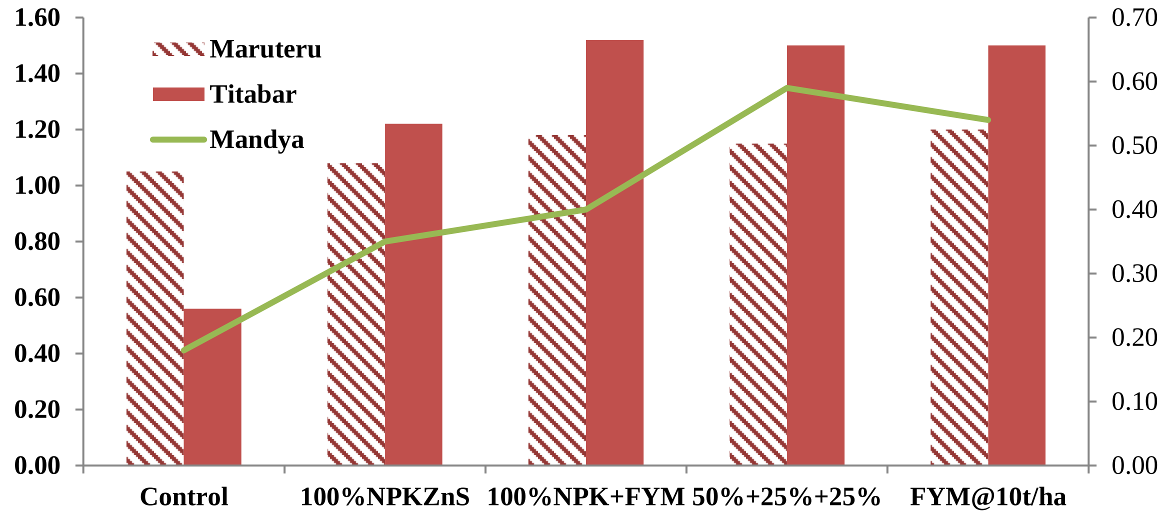


Titabar-Kharif

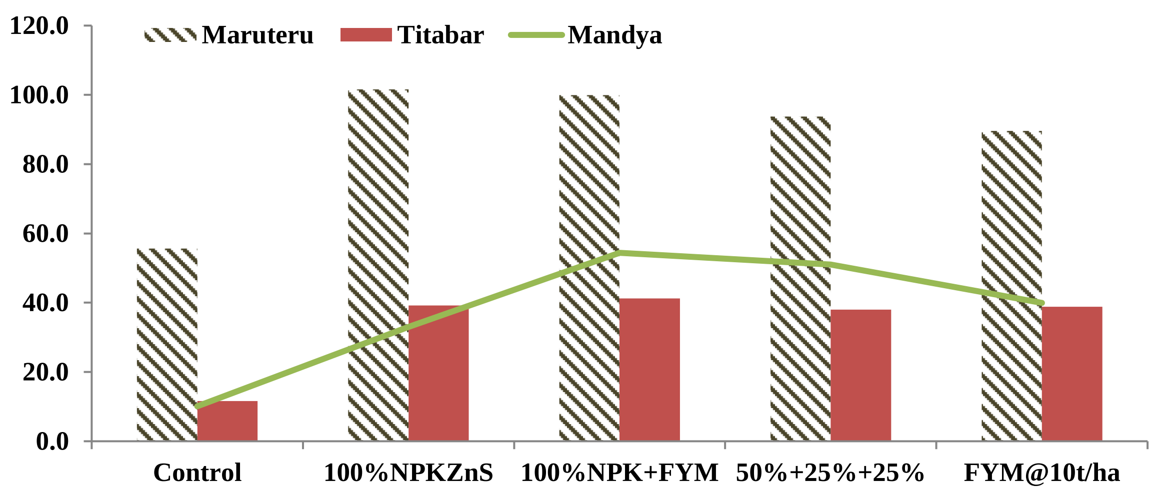


Mandya-Kharif

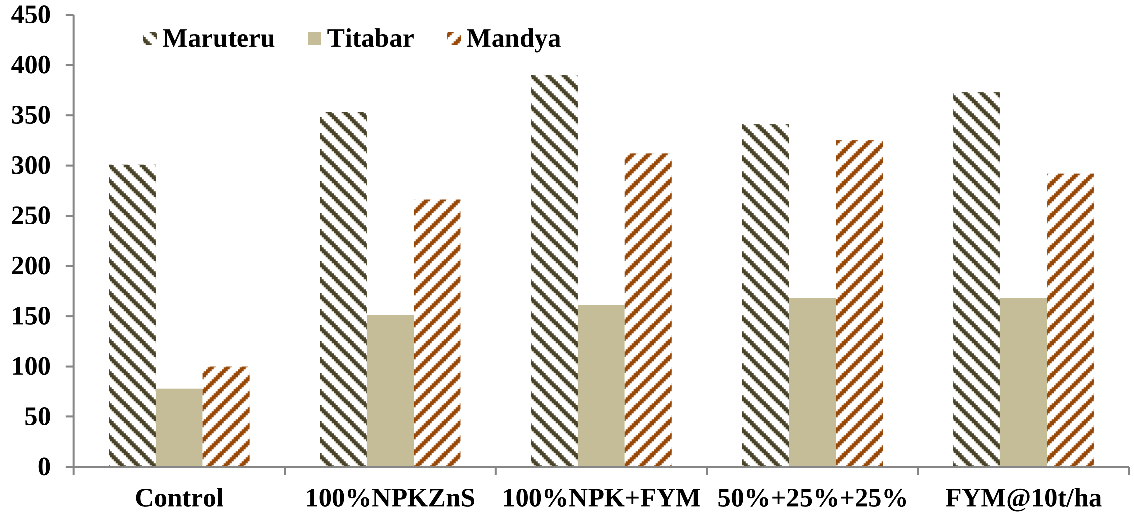
5.1.3. Long term effect of nutrient management on yield trend (Kharif)



Organic Carbon Content (%)



Available P_2O_5 Content (kg ha^{-1})



Available K_2O content

5.1.4. Long term effect of nutrient management on soil nutrient status (*Kharif* 2019)

5. 2. *Soil quality and productivity assessment for bridging the yield gaps in farmers' Fields*

Yield and Technology gap is a major problem in increasing paddy production in the diverse rice agro ecosystems in India. Farm yields and farmers income swing widely in irrigated ecosystems of the states. Usually, poor yielding farms are marginal lands which are defined as low fertility, resource poor, fragile, vulnerable or degraded lands. However, in real sense a land could be marginal or highly productive depending upon its cropping history, use of technologies in farming, levels of inputs applied to maintain fertility, other biophysical/institutional and socio-economic factors of the farmers. A tract of low fertile land is marginal for crop production for poor farmers and hence decline in yield is common, but highly productive for resource rich farmers . The nature, composition and interaction of the soil factors, can also differ widely. Also, there are number of soil factors that may make land from low fertility category to high fertility category. Hence, marginality is a dynamic process - a land unsuitable for poor rice growers due to low level of inputs/technologies adoption, lack of irrigation, could be made highly productive for the same farmers by utilizing all the resources and technological interventions .

A study was, therefore, proposed in *Kharif*, 2019, at few locations representing major rice growing regions to assess the nutritional status and productivity of the crop under farmer's current management practices in selected farmer fields for further improvement in rice productivity. Participatory rural appraisal, group discussion and transect walk were followed to explore the detail information of study area. The study, involved survey and record of all the package of fertilizer and crop management practices of the farmer, besides information about the nutrient status of the soils before cropping and the crop at maximum tillering stage including the crop productivity and dry matter yield. Simultaneously, the nutrient supply potential of the soil was also assessed at the research farm representing the area of study. Data received from four locations (Chinsurah, Titabar, Karaikal and Pantnagar) representing Indo gangetic plains and the plateau region collected from farmer fields in *Kharif* 2019 are presented in the Tables 5.2.1 to 5.2.3 and briefly discussed. The farmers from 46 farm sites of Gangetic Alluvial around Damra and Bishpara, Chandrahati-I, Hooghly from Chinsurah Centre cultivated Khitish, Shatabdi, Swarna applying a range of nutrient management levels of varying- 50-25-25, 60-30-30, 70-35-35, 80-40-40, 90-45-45, 120-80-80. Forty one farmers Golaghta district from Titabar centre representing Indo Gangetic and Brahamputra plains cultivated Ranjit sub 1, bahadur sub 1,Sharaboni applying 60:20:40 levels of NPK.

The questioner-based survey was conducted in twenty-four farmer's field spread across five villages of Karaikal at the end of the harvest season rabi (Samba), 2019-20 cultivating CR1009, BPT5204, ADT46,White Ponni, Kichadi samba, TKM 13 and applying Varying levels of NPK as -80:58:19, 80:58:10, 80:58:00,80:58:37,120:80:57,40:29:00,90:58:37, 90:53:75, 40:58:37, 90:10:29, 160:44:60. Sixty farmer's field from the tarai belt of Uttrakhand namely

Pantnagar cultivated PR1509,PR121,PR126,PD-10,PD-12,,PUSA-150,PUSA-154,HR-47, ,HR 147, Pusa Basmati,Sarjoo-52,Sarbati,Indrasan,Hybrid applying varying levels of NPK as - 180,60,40, 180,60,0 150,60,40, 200,60,40, 150,50,30, 150,0,40 (Table 5.2.1). The initial, post-harvest soil samples along with grain and straw samples were collected and analyzed for their soil characteristics and nutrient content, respectively. The co-ordinates of the farmers field selected for soil quality and productivity assessment were also recorded. For grouping the data for yield, two categories were formed as low yielders having below 4t/ha productivity and high yielders having >4t/ha productivity. Simultaneously the nutrient supply potential of the soil was also assessed at the research farm representing the study area to assess the variability in nutrient supply, its relationship with rice yields at current recommended and farmers' fertilizer practices.

Table 5.2.2 gives information collected in the new farm sites on yields obtained, nutrient uptake and Soil quality index calculated from all the soil samples collected from the farmers fields. Sharp variations in grain yields recorded varied from 2.39 t /ha among low yielders to 5.0 t /ha among high yielders at Chinsurah, from 3.59 t /ha among low yielders to 4.67 t /ha among high yielders at Karaikal, varied from 2.63 t /ha among low yielders to 4.87 t /ha among high yielders at Titabar, 5.7 t/ha among high yielders at Pantnagar. Soil Parameters data were pooled in different categories and the resulting soil quality index generated showed variations in the quality and health of the soil across different farmers categories. The poorest soil quality index was calculated for farmers from Pantnagar, due to considerable variation among the farm sites and soil test values. The soil quality index was much superior at Chinsurah and were at par for all other centers. Large variations were obtained for nutrient uptake between low yielders and high yields across the centres. Soil nutrient uptake for major nutrients varied widely among the sites. At all these locations wide variations in grain yields and nutrient uptake were recorded (Table 5.2.3), while soil test values did not match the yields recorded with rice yield and nutrient uptake at both the locations, suggesting perhaps less suitability of current soil testing methods for flooded soils. However, some centres reported soil quality index at par with their resulting grain yield and nutrient uptake patterns. Table 5.2.3 recorded the nutrient requirement per ton grain yield variations obtained at all the centres. Nutrient requirement calculations were an useful tool to know how the responses were for fertilizers applied per ton of the grain yield obtained. In the scenario of ever changing fertilizer management practices followed across rice fields in India, there cannot be a single blanket fertilizer formulations followed for diverse soil ecosystems with less importance given to management induced site variations which has been the major reason for nutrient imbalances and unsustainability. Fertilizer nutrient management not matching with the variability in soil fertility in the farmer fields is one of the important factors responsible for low rice productivity, imbalanced nutrition and unsustainability of the production system in some of the poor yielding farms. Variability in nutrient acquisition and its utilization by genotypes for yield expression is coupled with nutrient application in right proportions to meet the growth requirements of a genotype is vital for realizing the yield potential in any given farming situation. The study, thus indicated ample scope for improvement in nutrient use efficiency, precise assessment of nutrient requirements of such varieties and under each farmer's condition for arriving at the fertilizer prescriptions to ensure harvestable yield potential on sustainable basis besides optimizing input use.

Summary: This trial in the form of a survey was conducted in farmers' fields around few selected centres – Chinsurah, Titabar, Karaikal and Pantnagar) representing Indo gangetic plains and the plateau region collected from farmer fields in *Kharif* 2019 to assess the variability in nutrient supply, its relationship with rice yields at farmers' fertilizer practices in some new farm sites. The *kharif* 2019 data received representing the irrigated and shallow lowland rice ecosystems revealed wide variations. Soil nutrient uptake varied between the sites matching with the grain yields. Sharp variations in grain yields recorded varied from 2.39 t /ha among low yielders to 5.0 t /ha among high yielders at Chinsurah, from 3.59 t /ha among low yielders to 4.67 t /ha among high yielders at Karaikal, varied from 2.63 t /ha among low yielders to 4.87 t /ha among high yielders at Titabar, 5.7 t/ha among high yielders at Pantnagar. Soil Parameters data were pooled in different categories and the resulting soil quality index generated showed variations in the quality and health of the soil across different farmers categories.

Table 5.2.1 Rice productivity in relation to internal supply capacity of nutrients in farmers' fields, *kharif* 2019 - Soil, crop and weather data recorded prior to cultivation

Parameter	**Chinsurah**	**Karaikal**	**Titabar**	**Pantnagar**
Variety	**Khitish, Shatabdi, Swarna**	CR1009, BPT5204, ADT46,White Ponni, Kichadi samba, TKM 13	Ranjit sub 1, bahadur sub 1,Sharaboni	PR1509,PR121,PR126,PD-10,PD-12,,PUSA-150,PUSA-154,HR-47, ,HR 147, Pusa Basmati,Sarjoo-52,Sarbati,Indrasan,Hybrid
Crop growth	Good	Good	Good	Good
RFD (kg NPK/ha)	Varying- 50-25-25, 60-30-30, 70-35-35, 80-40-40, 90-45-45, 120-80-80	Varying-80:58:19, 80:58:10, 80:58:00, 80:58:37, 120:80:57, 40:29:00, 90:58:37, 90:53:75, 40:58:37, 90:10:29, 160:44:60	60:20:40	Varying-180,60,40, 180,60,0 150,60,40, 200,60,40, 150,50,30, 150,0,40
Soil Texture	Clay Loam	Sandy Loam, Loamy sand, Sandy Clay Loam		
pH	6.49-7.66	6.52-8.18	4.9-5.8	7.0-7.9
EC(dS/m)	0.2-0.29	0.01-1.79	0.02-0.18	0.2-0.55
Org. carbon (%)	0.85-1.1	0.32-0.85	0.63 – 1.25	0.2-0.65
Avai.N (kg/ha)	341-461	116.03-235.20	-	120-217
Avai.P_2O_5 (kg/ha)	81-99	28.18-79.15	18-29	5.9-23.6
Avai.K_2O (kg/ha)	255-296	147.84-635.04	75-95	105-230

Table 5.2.2 Rice productivity in relation to internal supply capacity of nutrients in farmers' fields, *kharif* 2019 - Soil nutrient supply potential vis a vis nutrient uptake assessed among different farmers categories

Categories/ Nutrient	**Chinsurah (total of 46 sites,** 12 low yielders and 34 high yielder sites)			**Karaikal** (Out of 40,30 sites, low yielders 10 and 20 high yielder sites)		
	Minimum	**Maximum**	**Mean***	**Minimum**	**Maximum**	**Mean****
Grain yield (t/ha)						
Low Yielders	1.76	3.1	2.39	3.41	3.72	3.59
High Yielders	4.1	5.62	5.00	4.03	6.20	4.67
Nutrient uptake (kg/ha)						
	Low Yielders					
N	-	-	-	45.6	56.0	49.5
P	-	-	-	39.2	60.8	47.3
K	-	-	-	67.8	128.6	98.9
	High Yielders					
N	-	-	-	**23.7**	**76.4**	**41.4**
P	-	-	-	**23.4**	**60.9**	**37.5**
K	-	-	-	**11.3**	**52.7**	**21.3**
Soil Quality Index						
Low Yielders	0.8 (High)	1.0 (High)	0.9 (High)	0.4 (Poor)	0.5 (Average)	0.45 (Poor)
High Yielders	0.8 (High)	1.0 (High)	0.9 (High)	0.5 (Average)	0.6 (Average)	0.55 (Average)

Categories/ Nutrient	**Titabar** (Out of 40,23 low yielders,7 high yielders)			**Pantnagar** (Out Of 60,60 high yielders)		
	Minimum	**Maximum**	**Mean***	**Minimum**	**Maximum**	**Mean****
Grain yield (t/ha)						
Low Yielders	1.8	3.8	2.63	-	-	-
High Yielders	4.26	5.6	4.87	4.0	7.0	5.7
Nutrient uptake (kg/ha)						
	Low Yielders					
N	8.51	27.42	18.24	-	-	-
P	6.43	12.83	9.97	-	-	-
K	38.93	190.91	116.63	-	-	-
	High Yielders					
N	30.12	55.84	42.31	**34.13**	**121.05**	**80.33**
P	17.15	21.73	19.13	**5.57**	**28.46**	**16.77**
K	274.64	410.	344.87	**46.21**	**108**	**72.70**
Soil Quality Index						
Low Yielders	0.4 (Poor)	0.5 (Average)	0.45 (Poor)	-	-	-
High Yielders	0.4 (Average)	0.6 (Average)	0.55 (Average)	0.2 (Poor)	0.6 (Medium)	0.4 (Average)

Table 5.2.3 Rice productivity in relation to internal supply capacity of nutrients in farmers' fields, *kharif* 2019 - Nutrient Requirement per ton grain yield

Farmers categories	Chinsurah			Karaikal		
	Mean yield (t/ha)	Mean uptake (kg/ha)	Nutrient Requirement (kg/t grain)	Mean yield (t/ha)	Mean uptake (kg/ha)	Nutrient Requirement (kg/t grain)
Low Yielders (12 sites)	2.4	-	-	3.59		
N		-	-		49.5	**13.7**
P		-	-		47.3	**13.17**
K		-	-		98.9	**27.54**
High Yielders (34 sites)	5.0	-	-	4.67		
N		-	-		**41.4**	**8.86**
P		-	-		**37.5**	**8.02**
K		-	-		**21.3**	**4.56**
Farmers categories	**Titabar**			**Pantnagar**		
	Mean yield (t/ha)	**Mean uptake (kg/ha)**	**Nutrient Requirement (kg/t grain)**	**Mean yield (t/ha)**	**Mean uptake (kg/ha)**	**Nutrient Requirement (kg/t grain)**
Low yielders	2.63			-		
N		18.24	6.93			
P		9.97	3.79			
K		116.63	44.34			
High yielders	4.87	-		5.7		
N		42.31	8.68		**80.33**	14.09
P		19.13	3.92		**16.77**	2.94
K		344.87	70.81		**72.70**	12.75

5.3 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS

Sodic soils have high soil pH (8.5 - 11.0) and exchangeable sodium percentage (ESP) of greater or equal to 15, low organic matter content and a preponderance of carbonates and bicarbonates of sodium or excess salt content. These soil characteristics strongly modify the availability of micronutrients and thereby crop productivity. Such soils can be managed in two ways viz. either by growing a crop variety suitable for a particular soil or by ameliorating the soil through the application of soil amendments. Keeping these points in view, a trial was initiated in *kharif* 2014 to screen germplasm for tolerance to sodicity and increased rice productivity under three levels of ameliorative gypsum application {(0, 50 and 100% gypsum recommendation (GR)] in addition to the recommended dose of NPK. From *kharif* 2019, the trial was modified to germplasm screening only. But, Kanpur followed as per the old treatments only. The results of the trial conducted in *rabi* 2018-19 and *kharif* 2019 at Faizabad, Kanpur, Mandya and Pusa are presented in Tables 5.3.1 to 5.3.9.

Wheat yields (*rabi* 2018-19)

Gypsum application increased rabi wheat yields at Kanpur (Table 5.3.2). The highest grain and straw yields were observed in 100% GR (4.18 and 5.01 t/ha) followed by 50% GR (3.10 and 3.68 t/ha). The lowest grain and straw yields were observed in the treatment without gypsum (1.56 t/ha and 1.83 t/ha, respectively).

Yield parameters (*kharif* 2019)

Significant differences were observed among rice genotypes for all the yield parameters when cultivated under natural sodic conditions at Faizabad (Table 5.3.3). Highest tillers/m^2 (326-353) and panicles /m^2 (322-349) were produced by genotypes RMS -8, RMS -7, SRL -1, RMS -6 and PS -344.

Gypsum application at 50% GR (437 panicles/m^2 and 1.60 g respectively) and 100% GR (465 panicles/m^2 and 1.76 g respectively) increased the panicles/m^2 and panicle weight of the genotypes (Table 5.3.4) evaluated at Kanpur compared to the treatment without gypsum (367 panicles/m^2 and 1.26 g respectively). The genotype SRL-3 produced the highest number of panicles (554/m^2) and also produced panicles with the highest weight (1.90 g) after application of gypsum at 100 % GR.

The yield parameters at Mandya were significantly influenced by varietal differences (Table 5.3.3). Highest tillers/m^2 and panicles/m^2 were observed in genotypes RMS-2, GPV-1, MTP-1, Varadhan, GPV-2 (652, 572, 564, 525, 514 tillers/m^2 and 587, 515, 508, 473, 463 panicles/m^2 respectively while the highest 1000 grain weights were recorded with MTU-1010 (27.99 g), PUP-221(27.4 g), CSR-23 (26.74g), VR-181(25.33g) and PS-344 (24.66 g). At Pusa, among the genotypes evaluated, GPV 2, GPV 3, GPV 1, RMS 3 and SRL 3 recorded the highest tillers/m^2 (11-14 tillers/m^2), while Varadhan, SRL 1, RMS 7, RMS 5 and KRH 4 produced highest (97-137) filled grains /panicle (Table 5.3.6). The genotypes that recorded the highest 1000 grain weight were RMS 1, RMS 6, CSR 23, GPV 2 and MTU 1010 (24.22-28.26 g).

Grain and Straw yields (*kharif* 2019)

Grain and straw yields of the genotypes were significantly influenced by the sodic conditions at Faizabad (Table 5.3.3). Among the genotypes evaluated, the highest grain and straw yields were recorded with the genotypes RMS -2 (6.5 and7.38 t/ha respectively), RMS -7

(6.33 and 7.16 t/ha respectively), RMS -6 (6.07 and 6.85 t/ha respectively), RMS -8 (6.04 and 6.8 t/ha respectively) and SRL -1 (5.06 and 5.73 t/ha respectively).

Application of gypsum in conjunction with recommended dose of NPK significantly influenced yields of *kharif* rice at Kanpur (Table 5.3.5). Grain and straw yields at 50% GR (3.25 and 3.87 t/ha) and 100% GR (3.77and 4.59 t/ha) increased over control without gypsum amendment (2.19 and 2.56 t/ha). The highest grain yields of 3.76, 3.65, 3.64, 3.58 and 3.53 t/ha were observed with SRL-3, SRL-2, RMS-1, SRL-1 and MTP-1, respectively under recommended NPK + 100% GR fertilization. Straw yield (4.16 -4.48 t/ha) also followed similar trends as grain yields. The same genotypes recorded the highest yields in unamended sodic soils of Kanpur (2.62-2.81t/ha).

Among the 26 genotypes (Table 5.3.3) evaluated at Mandya, MTP-1 (7.42 t/ha), Varadhan (7.17 t/ha), VR-181 (6.87 t/ha), KRH-4 (6.72 t/ha), and RMS-5 (6.59 t/ha) produced the highest yields. The straw yields generally followed the grain yield trends.

The genotypes viz., GPV 2 (3.92 t/ha), GPV 1 (3.79 t/ha), GPV 3 (3.76 t/ha), SRL 1 (3.5 t/ha) and CNN 2 (3.45 t/ha) recorded highest grain yields in sodic soils of Pusa (Table 5.3.6). The highest straw yields were observed in GPV 1 (5.48 t/ha), SRL 1 (5.48 t/ha), GPV 2 (5.32 t/ha), GPV 3 (4.87 t/ha), MTU 1010 (4.75 t/ha) and CNN 2 (4.65 t/ha) genotypes.

Nutrient uptakes (kharif 2019)

Nutrient uptake varied significantly between genotypes at Faizabad (Table 5.3.8). The genotypes that recorded the highest N uptake were RMS -7 (131.51kg N/ha), RMS -8 (128.86 kg N/ha) and RMS -2 (126.08 kg N/ha), while RMS -7 (50.2 kg P/ha), RMS -2 (45.93 kg P/ha), RMS -6 (43.13 kg P/ha) and RMS -2 (91.58 kg K/ha), RMS -7 (87.38 kg K/ha), RMS -6 (77.71 kg K/ha) showed the highest P and K uptake

Gypsum application and varietal differences contributed to the differences in nutrient uptake observed at Kanpur (Table 5.3.7). Gypsum applied at 50% GR and 100% GR rates in addition to the recommended doses of NPK increased nitrogen uptake (75.46 and 89.73 kg/ha respectively), phosphorus uptake (18.87 and 21.70 kg/ha respectively) potassium uptake (75.43 and 89.21 kg/ha respectively) and zinc uptake (41.41 and 41.75 g/ha respectively) compared to the control that received only NPK fertilization (N, P, K and Zn uptake of 49.93, 11.61, 49.52 kg/ha and 41.03 g/ha respectively). The genotype SRL-3 at 100% GR application, exhibited the highest N, P and K uptake of 112.96 kg N/ha, 28.97 kg P/ha, 111.41 kg K/ha and 42.98 g Zn//ha.

At Mandya, significant differences were observed among genotypes in nutrient uptake. The highest N, P and K uptake was observed in the genotype MTP-1 with values of 145.39, 23.08 and 163.60 8. kg/ha respectively. (Table 5.3.8).

Post harvest soil characteristics

Available N, P and K status (Table 5.3.9) of the soils at Mandya did not show significant differences due to cultivation of different genotypes, although an increase was observed compared to initial soil availability. No changes in pH and ESP (%) were observed at Mandya while marginal improvement in OC% and EC were observed after cultivation of 26 genotypes (Table 5.3.9). Soil OC% and pH did not vary significantly due to genotypes at Pusa (Table 5.3.9).

To summarize, gypsum application in conjunction with NPK fertilization improved rice yields at Kanpur. The genotypes SRL-3, SRL-2, RMS-1, SRL-1 and MTP-1 produced the highest grain yields of 3.53 -3.76 t/ha, at Kanpur, under recommended NPK + 100% GR fertilization. Under native sodic conditions without gypsum amendment, the yields were higher in the following genotypes viz., SRL-3 (2.81 kg/ha), SRL-2 (2.7 kg/ha), RMS-1 (2.7 kg/ha) and SRL-1 (2.67 kg/ha) and MTP-1 (2.62 kg/ha). In unamended native sodic soils of Faizabad, the genotypes that produced the highest yields were recorded in RMS -2, RMS -7, RMS -6, RMS -8 and SRL -1 (5.06-6.5 t/ha). The genotypes MTP-1, Varadhan, VR-181, KRH-4 and RMS-5 exhibited better tolerance to sodicity at Mandya compared to other genotypes as demonstrated by their significantly higher yields (6.59-7.42 t/ha) without gypsum amendment. In Pusa, the genotypes GPV 2, GPV 1, GPV 3 SRL 1 and CNN 2 demonstrated tolerance to sodicity with yields ranging from 3.45 t/ha-3.92 t/ha.

Table 5.3.1 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS -Soil and Crop Characteristics

Parameter	**Faizabad**	**Kanpur**	**Mandya**	**Pusa**
Cropping system	**Rice- Wheat**	**Rice - Wheat**	**Rice**	**Rice**
Variety				
Kharif (Rice)	25	25	26	25
Rabi (Wheat)	-	PBW-343	-	-
Kharif RFD (Kg NPKZn/ ha)	120:60:60:25	150:60:40:50	125:50:50:40	120:60:40:25
Gypsum requirement	-	16.0 t ha^{-1}		
% Clay	21	17	54.32	17.5
% Silt	55	34	31.42	31
% Sand	24	49	14.26	51.5
Soil Texture	Silty Clay	Clay Loam	Clay	Sandy loam
pH (1:1)	9.5	10.0	9.36	8.49
Organic carbon (%)	0.39	0.22	0.479	0.65
CEC [c mol(p^+)/kg]		12.57	36.4	-
EC (dS/m)	2.86	0.94	0.614	0.14
ESP (%)			28.95	
Available N (kg/ha)	215	146.8	347.5	197
Available P_2O_5 (kg/ha)	23.5	29.5	26.8	38
Available K_2O (kg/ha)	235.5	245.7	214.7	211
DTPA Zn (mg/kg)	-	0.23		0.48
Bulk density	-	1.44 mg m^{-3}		

Table 5.3.2 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS, (Kanpur- *Rabi 2018-19)* - Grain and Straw Yield of Rabi Wheat

Gypsum Req.	Grain yield (t/ha)	Straw yield (t/ha)
T1-No amendment	1.56	1.83
T2- 50% GR	3.10	3.68
T3- 100% GR	4.18	5.01

***T1-No amendment;T2- 50% GR; T3- 100% GR**

Table 5.3.3 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS Yield and yield parameters (Kharif 2019)

Variety/ Gypsum requirement	Faizabad				Mandya				
	Tillers/ m^2	Panicles /m^2	Grain yield (t/ha)	Straw yield (t/ha)	Tillers/m^2	Panicles/m^2	1000 grain weight(g)	Grain yield (t/ha)	Straw yield (t/ha)
	T1*	T1*	T1*	T1*	T1*	T1*	T1*	T1*	T1*
RMS -1	272	268	2.47	2.74	438	395	20.16	5.88	6.28
RMS -2	323	320	6.50	7.38	652	587	17.32	4.28	6.41
RMS -3	295	290	5.04	5.40	384	346	24.40	4.10	5.44
RMS -4	173	169	1.87	2.31	498	449	20.40	6.39	6.89
RMS -5	233	229	3.32	3.83	380	342	22.67	6.59	7.68
RMS -6	337	333	6.07	6.80	285	257	21.97	5.49	7.51
RMS -7	352	349	6.33	7.16	346	312	22.29	5.17	7.48
RMS -8	353	349	6.04	6.85	404	364	21.34	5.10	7.61
GPV -1	323	319	4.94	5.80	572	515	19.53	4.96	6.57
GPV -2	315	311	5.03	5.66	514	463	18.29	3.76	5.58
GPV -3	285	279	4.83	5.50	485	437	19.62	4.20	5.70
PUP -221	263	258	4.14	4.76	432	389	27.40	6.59	5.51
KRH -4	292	288	4.66	5.24	384	346	19.08	6.72	7.22
MTP -1	221	217	3.25	3.88	564	508	24.32	7.42	8.20
VR -181	244	242	4.23	4.88	512	461	25.33	6.87	6.94
PS -344	326	322	4.79	5.39	317	286	24.66	5.95	6.41
SRL -1	344	339	5.06	5.73	421	379	23.26	6.01	5.49
SRL -2	234	229	4.25	4.60	486	438	20.52	5.05	6.22
SRL -3	223	219	3.18	3.65	462	416	22.99	5.76	7.06
Varadhan	200	195	2.70	2.95	525	473	24.38	7.17	8.07
Rasi	205	200	2.42	2.80	402	362	23.13	6.05	6.38
MTU -1010	249	244	3.84	4.54	450	405	27.99	6.11	7.74
CSR -23	226	221	2.57	2.90	464	418	26.74	6.07	6.92
CNN -1	237	233	2.17	2.44	414	373	18.47	5.89	6.97
CNN -2	179	173	2.05	2.30	453	408	23.07	5.46	5.41
IR-30864					455	410	24.18	5.71	6.01
Mean	268	264	4.07	4.62	450	405	22.44	5.72	6.68
CD (0.05)	13.14	13.17	0.26	0.31	57.90	53.8	3.57	1.26	1.21
CV %	3.48	3.55	4.50	4.78	6.25	6.44	7.73	10.71	8.80

***T1-No amendment**

Table 5.3.4 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS - *(Kanpur- Kharif 2019)*

Yield Parameters

	Panicles /m^2				Panicle wt (g)			
Variety/ Gypsum requirement	**T1***	**T2**	**T3**	**Mean**	**T1***	**T2**	**T3**	**Mean**
SRL-3	458	506	554	506	1.30	1.65	1.81	1.59
SRL-2	441	487	544	491	1.29	1.65	1.81	1.58
RMS-1	442	492	539	491	1.29	1.64	1.80	1.58
SRL-1	439	482	532	485	1.29	1.64	1.80	1.57
MTP-1	432	475	524	477	1.28	1.64	1.79	1.57
PS-344	425	474	525	475	1.28	1.63	1.79	1.57
Rasi	421	475	515	470	1.28	1.63	1.78	1.56
RMS-6	411	467	514	464	1.28	1.62	1.77	1.56
GPV-2	425	462	503	464	1.27	1.62	1.77	1.55
Varadhan	394	451	489	445	1.27	1.61	1.77	1.55
CNN-1	401	446	479	442	1.27	1.61	1.76	1.54
PYP-221	392	442	471	435	1.26	1.60	1.75	1.54
RMS-4	391	434	455	427	1.26	1.60	1.77	1.54
GPV-3	350	431	443	408	1.26	1.60	1.76	1.54
RMS-2	352	431	435	406	1.26	1.59	1.76	1.53
RMS-5	330	420	428	393	1.25	1.59	1.75	1.53
RMS-3	328	418	423	390	1.25	1.58	1.74	1.52
RMS-8	312	415	419	382	1.25	1.58	1.74	1.52
GPV-1	306	411	418	378	1.24	1.57	1.74	1.52
CNN-2	303	406	413	374	1.24	1.57	1.73	1.51
KRH-4	266	388	412	362	1.24	1.57	1.73	1.51
VR-181	293	382	410	357	1.23	1.56	1.72	1.50
RMS-7	287	380	403	355	1.23	1.56	1.71	1.50
CSR-23	290	373	400	354	1.23	1.56	1.71	1.50
MTU-1010	278	367	382	342	1.22	1.55	1.70	1.49
Mean	367	437	465	423	1.26	1.60	1.76	1.54
CD (0.05)								
Main	6.17				0.002			
Sub	13.78				0.002			
Main x Sub	23.86				0.003			
Sub x Main	24.12				0.004			
CV %								
Main	3.22				0.29			
Sub	3.50				0.15			

***T1-No amendment, T2- 50% GR , T3- 100% GR**

Table 5.3.5 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS -(Kanpur- *Kharif 2019)*

Grain and Straw Yield

	Grain yield (t/ha)				Straw Yield (t/ha)			
Variety/ Gypsum requirement	**T1***	**T2**	**T3**	**Mean**	**T1***	**T2**	**T3**	**Mean**
SRL-3	2.81	3.86	4.62	3.76	3.26	4.63	5.54	4.48
SRL-2	2.70	3.71	4.54	3.65	3.13	4.45	5.40	4.33
RMS-1	2.70	3.75	4.47	3.64	3.13	4.46	5.36	4.32
SRL-1	2.67	3.66	4.40	3.58	3.11	4.38	5.28	4.26
MTP-1	2.62	3.59	4.38	3.53	3.05	4.29	5.13	4.16
PS-344	2.58	3.58	4.32	3.49	3.00	4.28	5.18	4.15
Rasi	2.54	3.58	4.23	3.45	2.97	4.28	5.07	4.11
RMS-6	2.47	3.51	4.20	3.40	2.89	4.21	5.04	4.05
GPV-2	2.45	3.47	4.11	3.34	2.86	4.14	4.93	3.98
Varadhan	2.37	3.38	3.98	3.24	2.76	4.02	4.78	3.85
CNN-1	2.39	3.35	3.89	3.21	2.81	3.96	4.67	3.81
PYP-221	2.34	3.30	3.78	3.14	2.73	3.92	4.61	3.76
RMS-4	2.30	3.24	3.69	3.08	2.75	3.84	4.50	3.70
GPV-3	2.08	3.20	3.57	2.95	2.43	3.80	4.36	3.53
RMS-2	2.00	3.19	3.50	2.90	2.45	3.79	5.27	3.84
RMS-5	1.97	3.10	3.47	2.85	2.30	3.69	4.16	3.38
RMS-3	1.94	3.08	3.40	2.81	2.27	3.66	4.12	3.35
RMS-8	1.85	3.05	3.38	2.76	2.16	3.63	4.05	3.28
GPV-1	1.81	3.00	3.35	2.72	2.12	3.57	4.04	3.24
CNN-2	1.79	2.97	3.30	2.69	2.09	3.52	3.98	3.20
KRH-4	1.76	2.82	3.26	2.61	2.05	3.35	3.98	3.13
VR-181	1.72	2.78	3.23	2.58	2.01	3.30	3.94	3.08
RMS-7	1.68	2.74	3.17	2.53	1.97	3.26	3.87	3.03
CSR-23	1.65	2.71	3.12	2.49	1.92	3.22	3.84	2.99
MTU-1010	1.61	2.65	2.99	2.42	1.91	3.16	3.64	2.90
Mean	2.19	3.25	3.77	3.07	2.56	3.87	4.59	3.67
CD (0.05)								
Main	0.03				0.12			
Sub	0.08				0.21			
Main x Sub	0.14				0.37			
Sub x Main	0.14				0.38			
CV %								
Main	2.44				7.11			
Sub	2.92				6.21			

***T1-No amendment, T2- 50% GR , T3- 100% GR**

Table 5.3.6 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS - *(*Pusa- *Kharif 2019)*

Yield and Yield Parameters

Variety/ Gypsum requirement	Tillers/m^2	Filled grains/panicle	1000 grain weight(g)	Grain yield (t/ha)	Straw yield (t/ha)
	T1*	T1*	T1*	T1*	T1*
GPV 1	12	79	23.25	3.79	5.48
GPV 2	14	93	24.26	3.92	5.32
GPV 3	13	48	23.34	3.76	4.87
SRL 3	11	50	22.07	3.35	4.42
RMS 4	9	59	20.01	2.74	4.14
RMS 5	8	102	19.35	2.61	3.74
CSR 23	8	66	24.55	2.51	3.33
KRH 4	8	97	21.85	3.01	4.34
Rasi	7	53	23.27	1.79	3.06
Varadhan	9	137	22.44	2.87	3.75
RMS 6	9	76	25.00	2.60	4.17
RMS 7	11	108	19.27	3.13	4.62
RMS 8	8	53	23.09	3.19	3.64
PVP 221	8	63	22.92	2.86	3.62
RMS 3	12	45	19.83	2.56	3.69
MTU 1010	9	73	24.22	3.10	4.75
CNN 1	9	84	19.97	2.94	4.59
CNN 2	9	81	23.47	3.45	4.65
VR 181	10	76	23.14	2.29	3.41
RMS 2	10	77	17.70	2.92	3.75
SRL 1	9	124	19.97	3.50	5.48
RMS 1	9	52	28.26	2.22	3.23
PS 344	10	86	18.83	2.98	4.65
MTP 1	9	45	18.29	2.52	3.60
SRL 2	8	63	20.04	2.16	3.28
Mean	10	76	21.94	2.91	4.14
CD (0.05)	2.84	2.93	1.64	1.16	1.57
CV %	18.10	2.36	4.56	24.27	23.02

***T1-No amendment**

Table 5.3.7 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS – *(Kanpur -Kharif 2019)* N, P, K, Zn Uptake

Variety/ GR	N uptake (kg/ha)				P uptake (kg/ha)				K uptake (kg/ha)				Zn uptake (g/ha)			
	T1*	T2	T3	Mean	T1*	T2	T3	Mean	T1*	T2	T3	Mean	T1*	T2	T3	Mean
SRL-3	65.57	93.18	112.96	90.57	15.82	24.34	28.97	23.44	64.48	92.37	111.41	89.42	41.91	42.46	42.98	42.45
SRL-2	62.82	89.31	110.23	87.45	15.11	23.22	28.17	22.17	61.87	88.69	107.92	86.16	41.84	42.36	42.84	42.35
RMS-1	62.63	89.64	108.47	86.91	15.01	23.26	27.58	21.95	61.71	88.91	107.21	85.95	41.78	42.27	42.77	42.27
SRL-1	61.86	87.47	106.55	85.30	14.82	22.49	26.92	21.41	61.01	86.97	105.39	84.46	41.71	42.19	42.65	42.18
MTP-1	60.45	85.56	104.60	83.53	14.42	21.92	26.35	20.89	60.72	85.16	102.65	82.84	41.55	42.09	42.55	42.06
PS-344	59.36	84.91	103.90	82.72	14.05	21.63	25.94	20.54	58.68	84.66	102.86	82.07	41.48	42.01	42.45	41.98
Rasi	58.70	84.65	101.38	81.58	13.83	21.44	25.19	20.15	57.88	84.52	100.39	80.93	41.42	41.92	42.33	41.89
RMS-6	56.99	82.81	100.49	80.10	13.36	20.94	24.84	19.71	56.23	82.84	99.50	79.52	41.36	41.82	42.22	41.80
GPV-2	56.24	81.39	97.85	78.49	13.18	20.45	24.14	19.26	55.60	81.36	96.92	77.96	41.28	41.73	42.12	41.71
Varadhan	54.12	78.94	94.60	75.88	12.62	24.11	23.12	19.95	53.48	78.81	93.70	75.33	41.22	41.65	42.00	41.62
CNN-1	54.78	77.70	92.13	74.87	12.83	19.41	22.40	18.21	54.29	77.37	91.31	74.32	41.16	41.57	41.92	41.55
PYP-221	53.38	76.52	89.93	73.27	12.40	18.90	21.74	17.68	52.78	76.39	89.73	72.97	41.09	41.48	41.80	41.46
RMS-4	52.79	74.82	87.38	71.66	12.19	18.44	21.03	17.22	52.77	74.72	87.20	71.57	41.02	41.40	41.71	41.38
GPV-3	47.18	73.77	84.47	68.48	10.92	18.09	20.19	16.40	46.82	73.75	84.29	68.29	40.95	41.32	41.62	41.30
RMS-2	46.15	73.30	92.45	70.63	10.58	17.88	21.17	16.55	46.53	73.34	97.94	72.60	40.90	41.24	41.51	41.22
RMS-5	44.30	71.04	80.87	65.40	10.15	17.25	19.15	15.52	43.91	71.13	80.22	65.09	40.80	41.15	41.41	41.12
RMS-3	43.59	70.26	79.41	64.42	9.96	16.96	18.72	15.22	43.26	70.52	78.98	64.26	40.75	41.06	41.30	41.04
RMS-8	41.42	69.52	78.36	63.10	9.41	16.75	18.34	14.83	41.12	69.65	77.54	62.77	40.70	40.98	41.20	40.96
GPV-1	40.39	68.08	77.76	62.08	9.15	16.33	18.08	14.52	40.14	68.29	77.04	61.82	40.62	40.89	41.09	40.87

CNN-2	39.79	67.05	76.35	61.07	8.99	15.98	17.66	14.21	39.51	67.34	75.71	60.85	40.55	40.81	41.00	40.79
KRH-4	39.06	63.48	75.57	59.37	8.77	15.03	17.34	13.72	38.79	63.86	75.21	59.29	40.48	40.73	41.88	41.03
VR-181	38.03	62.40	74.63	58.36	8.52	14.72	17.07	13.44	37.81	62.79	74.35	58.32	40.21	40.64	40.79	40.54
RMS-7	37.11	61.28	72.95	57.12	8.28	14.39	16.57	13.08	36.92	61.78	72.81	57.17	40.36	40.56	40.68	40.53
CSR-23	36.15	60.35	71.83	56.11	8.04	14.13	16.38	12.85	36.02	60.84	71.91	56.26	40.31	40.49	40.57	40.46
MTU-1010	35.52	59.03	68.24	54.26	7.84	13.78	15.62	12.41	35.60	59.60	68.14	54.45	40.21	40.40	40.47	40.36
Mean	49.93	75.46	89.73	71.71	11.61	18.87	21.7	17.39	49.52	75.43	89.21	71.38	41.03	41.41	41.75	41.39
CD (0.05)																
Main	1.40				0.45				1.94				0.10			
Sub	2.46				0.94				3.50				0.20			
MxS	4.27				1.63				6.07				0.34			
SxM	4.39				1.66				6.23				0.35			
CV % Main	4.30				5.76				6.00				0.54			
Sub	3.69				5.82				5.27				0.51			

***T1-No amendment, T2- 50% GR , T3- 100% G**

Table 5.3.8 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS

Nutrient Uptake (kg/ha)

Variety/ Gypsum requirement	Faizabad			Mandya		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
	T1*	T1*	T1*	T1*	T1*	T1*
RMS-1	39.40	15.43	26.86	111.81	18.10	130.12
RMS-2	126.08	45.93	91.58	94.02	14.81	127.44
RMS-3	95.02	32.60	59.39	86.36	13.76	109.59
RMS-4	31.54	10.87	22.28	122.39	18.73	143.50
RMS-5	65.84	24.79	46.02	131.12	20.10	150.74
RMS-6	110.70	43.13	77.71	113.92	18.25	150.02
RMS-7	131.51	50.20	87.38	114.27	17.68	148.78
RMS-8	128.86	40.69	75.33	111.68	17.99	149.62
GPV-1	99.51	36.29	68.18	102.93	16.98	129.85
GPV-2	99.33	35.82	68.36	84.06	12.64	111.74
GPV-3	97.63	35.35	61.96	88.17	13.98	111.80
PUP-221	82.43	31.28	52.78	114.64	18.60	118.64
KRH-4	95.74	33.56	64.54	130.60	21.35	144.41
MTP-1	57.80	22.09	39.04	145.39	23.08	163.60
VR-181	83.31	30.79	62.34	128.96	20.68	144.60
PS-344	92.68	33.03	59.73	111.97	18.08	129.17
SRL-1	94.13	35.51	56.96	108.53	16.09	112.64
SRL-2	83.23	28.12	50.76	101.33	15.87	125.36
SRL-3	55.42	21.11	35.12	115.45	17.94	138.69
Varadhan	46.45	17.97	31.22	141.95	23.22	163.20
Rasi	41.86	15.86	27.76	114.51	17.87	127.05
MTU-1010	77.49	30.53	54.63	125.52	19.45	157.56
CSR-23	54.95	21.19	32.63	119.14	18.36	136.91
CNN-1	39.61	15.35	24.93	116.89	17.48	142.44
CNN-2	35.21	13.67	22.66	101.78	16.94	108.80
IR-30864				107.46	17.21	123.31
Mean	78.63	28.84	52.00	113.26	17.89	134.60
CD (0.05)	8.67	4.92	6.74	17.02	2.98	21.49
CV %	7.82	12.10	9.20	7.30	8.10	7.75

***T1-No amendment**

Table 5.3.9 Screening of Germplasm for Sodicity and Management of Sodic Soils in RBCS - Post Harvest Soil Characteristics

Variety/ Gypsum requirement	Mandya							Pusa	
	Available Nitrogen	Available Phosphorus	Available Potassium	OC(%)	pH	EC(dS/m)	ESP (%)	OC(%)	pH
	T1*	T1*	T1*	T1*	T1*	T1*	T1*	T1*	T1*
RMS-1	361.30	35.40	225.65	0.49	9.19	0.53	26.41	0.47	9.19
RMS-2	370.55	36.40	226.65	0.49	9.24	0.43	27.36	0.47	9.37
RMS-3	364.15	35.65	227.35	0.49	9.20	0.53	25.53	0.49	9.29
RMS-4	367.25	36.40	225.70	0.49	9.24	0.50	27.83	0.48	9.35
RMS-5	366.10	36.15	226.45	0.49	9.28	0.50	26.51	0.49	9.26
RMS-6	362.05	37.40	227.70	0.48	9.23	0.59	26.54	0.47	9.35
RMS-7	360.45	35.15	225.80	0.49	9.20	0.54	25.36	0.46	9.27
RMS-8	357.00	35.70	226.75	0.49	9.19	0.48	27.02	0.48	9.16
GPV-1	368.60	36.65	224.75	0.49	9.26	0.46	27.06	0.48	9.28
GPV-2	366.80	37.60	225.55	0.49	9.26	0.43	26.22	0.47	9.24
GPV-3	371.05	38.50	227.35	0.49	9.29	0.43	26.29	0.49	9.34
PUP-221	367.45	36.45	225.70	0.49	9.25	0.47	27.67	0.48	9.39
KRH-4	360.60	37.50	227.70	0.49	9.25	0.49	27.17	0.46	9.11
MTP-1	367.85	31.75	228.50	0.49	9.18	0.52	26.90	0.46	9.27
VR-181	365.75	32.60	225.65	0.49	9.24	0.49	25.91	0.48	9.43
PS-344	361.10	31.80	226.65	0.49	9.23	0.51	25.74	0.47	9.24
SRL-1	360.10	32.75	228.55	0.49	9.29	0.43	25.74	0.50	9.30
SRL-2	367.65	36.15	226.10	0.49	9.28	0.49	25.88	0.47	9.34
SRL-3	360.80	36.95	224.75	0.49	9.27	0.46	27.58	0.47	9.03
Varadhan	365.95	36.55	225.55	0.49	9.20	0.47	25.83	0.47	9.37
Rasi	367.20	37.55	225.80	0.48	9.19	0.49	26.64	0.49	9.42
MTU-1010	374.85	38.70	226.75	0.49	9.25	0.53	26.93	0.48	9.44
CSR-23	365.60	34.85	227.50	0.49	9.20	0.47	27.81	0.46	9.07
CNN-1	362.70	35.80	226.55	0.48	9.25	0.47	25.59	0.48	9.25
CNN-2	358.40	32.55	227.35	0.49	9.25	0.50	26.98	0.47	9.07
IR-30864	365.40	33.70	225.70	0.48	9.20	0.46	25.94		
Mean	364.87	35.640	226.48	0.49	9.23	0.49	26.55	0.48	9.27
CD (0.05)	NS	NS	NS	0.002	NS	0.04	NS	NS	NS
CV %	1.82	6.77	0.70	0.24	0.48	3.89	3.99	5.90	2.38

***T1-No amendment**

5.4 Screening of rice genotypes for tolerance to soil acidity

Acid soils are wide spread in Eastern, North Eastern and coastal regions of the Indian Peninsula. These soils are poor in soil fertility and are associated with toxicity of iron in lowlands, aluminum in the uplands, with depletion of Ca, Mg and K, deficiency of B, Mo and Si. The soils also fix large quantities of soluble P which lead to sub optimal productivity of crops. Management options include using amendments such as lime and growing acid tolerant genotypes to stabilize rice productivity. The trial was, therefore, conducted at four centres *viz.,* Moncompu (Kuttanad, Kerala), Ranchi (Dumka, Jharkhand), and Titabar (Assam) under low land conditions and at Hazaribagh (Jharkhand), under upland conditions during *kharif* 2019, screening between 14-23 genotypes at different centers. The results are presented in Tables 5.5.1 – 5.5.13.

Yield Parameters

Liming did not significantly influence crop characteristics (Days to 50% flowering and Toxicity score) and yield parameters at Hazaribagh and Moncompu (Table 5.4.2-5.4.4) though significant genotypic differences were observed at the centers. At Hazaribagh, the highest grains per panicle was observed in PS-344, GPV-1 and MTP-1 (84.67 -123.3) and the lowest number of chaffy grains in recorded in PUP-221,SRL-2 and SRL-3 (15.6 -22). The highest grains per panicle was observed in the genotypes RMS 7, RMS 4 and KRH 4 (220 - 225) and the lowest number of chaffy grains were recoreded with RMS 1, RMS 6 and GPV 1 (10.5 -14.33) at Moncompu.

Grain and straw yields

Grain yields at Harizibagh and Moncompu were not influenced by liming (Table 5.4.5-5.4.6). The highest grain yields at Harizibagh was observed in PUP-221, SRL-3, PS-344, SRL-2 and MTP-1 with grain yields of 2.43, 2.4, 2.33, 2.1 and 2t/ha while at Moncompu, the genotypes with higher grain yields were RMS 4 (9.48 t/ha), KRH 4 (8.28 t/ha), RMS 5 (7.68 t/ha), PS 344 (7.63 t/ha) and RMS 1 (7.62 t/ha). Lime application significantly influenced the grain yields at Ranchi and Titabar (Table 5.4.7-5.4.8) by enchancing the yields by 12.48% and 19.11% over unlimed control treatment. The genotypes with highest grain yield due to liming at Ranchi were RMS-4, GPV-1, RMS-5, Varadhan and RMS-1 with yields of 7.67, 7.62, 7.59, 7.5 and 7.3 t/ha respectively. Among the 14 genotypes evaluated, the genotypes RMS-4 (6.99 t/ha), RMS-5 (6.94 t/ha), RMS-1(6.87 t/ha), GPV-2(6.86 t/ha) and GPV-1(6.23 t/ha) recorded the highest grain yields in unlimed soils of Ranchi. The genotypes KRH-4, Varadhan, RMS-8, GPV-3 and MTP-1 recorded the highest yields due to liming (4.63, 4.5, 4.43, and 4.4 t/ha respectively) in Titabar. The genotypes that yielded higher in the unlimed acid soils of Titabar were PUP-221 (4 t/ha), Varadhan (3.97 t/ha), RMS-1 (3.9 t/ha), MTP-1 (3.9 t/ha) and GPV-1 (3.87 t/ha).

Nutrient uptakes

N, P and K uptake by crop at Titabar significanlty increased by 27.7%, 31.9% and 32.5% respectively due to supplementation of lime along with recommended NPK (Table 5.4.9). Genotypic differences were also observed for nutrient uptake at Titabar. Similarly, recommended NPK + liming also increased the grain Fe and Zn content by 40.4% and 8.3% respectively (Table 5.4.10).

Post harvest soil characteristics

Post harvest soil characteristics viz., available P, K, S, Fe, Zn, B, pH and OC% was not significantly influenced by liming and genotypes at Moncompu (Table 5.4.11-5.4.13).

Summary

The genotypes which performed better with yields ranging from 2-2.43 t/ha in unlimed acid soils of Harizibagh were: PUP-221, SRL-3, PS-344, SRL-2 and MTP-1. At Moncompu, RMS 4, KRH 4, RMS 5, PS 344 and RMS 1 recorded comparitively higher yields in unlimed tereatment (9.48 t/ha, 8.28 t/ha, 7.68 t/ha, 7.63 t/ha and 7.62 t/ha respectively). The highest grain yields at Ranchi in the treatment without liming was observed in RMS-4, RMS-5, RMS-1, GPV-2 and GPV-1 (6.99 t/ha , 6.94 t/ha, 6.87 t/ha , 6.86 t/ha) and 6.23 t/ha respectively). At Titabar, the genotypes with high yields in the treatment without liming and with recommended NPK alone were PUP-221, Varadhan, RMS-1, MTP-1, and GPV-1 (3.87 t/ha - 4t/ha). A 12.48% and 19.11% increase in yields were observed at Ranchi and Titabar due to liming. The genotypes responsive to liming at Ranchi were RMS-, GPV-1, RMS-5, Varadhan and RMS-1 with yields in the range of 7.3-7.67 t/ha, while the highest yields of 4.63, 4.5, 4.43, and 4.4 t/ha, respectively, were recorded in the genotypes KRH-4, Varadhan, RMS-8, GPV-3 and MTP-1due to liming in Titabar.

Table 5.4.1 Screening of rice genotypes for tolerance to soil acidity (*kharif* 2019)

Soil and Crop data

Parameters	**Hazaribagh**	**Moncompu**	**Ranchi (Dumka)**	**Titabar**
Number of varieties evaluated	20	23	14	20
Treatments	• NPK (RD) • NPK (RD) + Lime@ 5 Q/ha	• NPK (RD) • NPK (RD) + Lime@ 6Q /ha	• NPK (RD) • NPK (RD) + Lime @ 4 Q/ha	• NPK (RD) • NPK (RD) + Lime @ 1t/ha • N (RD) + double PK
Rec. fert. Dose (kg N,P_2O_5 and K_2O/ha)	60-30-30	90-45-45	100-50-25	40-20-40
Soil				
% Clay			23	42
% Silt			34	28.5
% Sand			43	29.5
Soil texture			-	Silty clay
pH	4.8	4.3	5.2	5.2
Org.carbon (%)	0.4	3.73	0.65	1.05
CEC (me/100g)			16	
EC ds/m			-	0.05
Avail.N (kg/ha)			320	405
Avail. P_2O_5 (kg/ha)		19.09	28.4	18
Avail. K_2O (kg/ha)		218.4	185	145
Avail.S (mg/kg)				12
DTPA –Zn (mg/kg)				0.9
DTPA –Fe (mg/kg)				28.5
DTPA –Mn (mg/kg)				12.5
DTPA –Cu (mg/kg)				
1 M HCl –Zn (mg/kg)		6.11		
1 M HCl –Fe (mg/kg)		452.6		
1 M HCl –Mn (mg/kg)		3.97		
1 M HCl –Cu (mg/kg)		0.379		

Table 5.4.2. Screening of rice genotypes for tolerance to soil acidity (Hazaribagh- *kharif* 2019)

Crop Characteristics

Variety	**Days to 50% flowering**			**Toxicity Score**		
	T1*	**T2**	**Mean**	**T1***	**T2**	**Mean**
RMS-1	106	104	105	3.67	3.33	3.50
RMS-2	116	116	116	3.00	4.00	3.50
RMS-3	99	97	98	3.67	3.33	3.50
RMS-4	117	113	115	2.33	3.33	2.83
RMS-5	119	117	118	2.67	4.00	3.33
RMS-6	118	118	118	2.33	3.33	2.83
RMS-7	118	118	118	2.67	3.33	3.00
RMS-8	116	116	116	2.67	3.67	3.17
GPV-1	92	98	95	2.67	4.00	3.33
GPV-2	116	116	116	3.67	4.33	4.00
GPV-3	118	117	117	2.67	4.00	3.33
PUP-221	80	81	81	4.33	4.33	4.33
KRH-4	100	116	108	4.00	3.33	3.67
MTP-1	87	84	85	3.67	3.00	3.33
VR-181	86	86	86	3.67	3.67	3.67
PS-344	86	87	87	4.33	3.67	4.00
SRL-1	97	97	97	3.00	3.67	3.33
SRL-2	78	76	77	4.67	3.33	4.00
SRL-3	72	78	75	5.00	3.67	4.33
Varadhan	91	96	93	3.67	3.00	3.33
Mean	101	102	101	3.42	3.62	3.52
CD (0.05)						
Main	NS			NS		
Sub	2.5			0.82		
Main x Sub	3.54			1.17		
Sub x Main	4.94			1.20		
CV%						
Main	5.06			16.21		
Sub	2.15			20.51		

T1=Recommended NPK, T2= Recommended NPK + Lime

Table 5.4.3. Screening of rice genotypes for tolerance to soil acidity (Hazaribagh- *kharif* 2019)

Yield Parameters

Variety	No of Grains/panicle			No of Chaff/panicle			1000 Grain weight (g)		
	T1*	T2	Mean	T1*	T2	Mean	T1*	T2	Mean
RMS-1	53.33	56.20	54.77	64.47	53.20	58.83	17.67	17.55	17.61
RMS-2	54.07	53.40	53.73	47.07	69.67	58.37	14.82	12.16	13.49
RMS-3	74.33	54.00	64.17	39.60	42.53	41.07	18.31	17.77	18.04
RMS-4	82.40	50.80	66.60	60.40	147.67	104.03	16.92	14.76	15.84
RMS-5	37.80	40.00	38.90	122.73	111.73	117.23	12.54	16.19	14.37
RMS-6	43.87	7.00	25.43	106.40	86.73	96.57	15.69	12.36	14.03
RMS-7	15.60	16.60	16.10	131.07	120.80	125.93	11.39	11.11	11.25
RMS-8	46.33	66.47	56.40	72.47	76.13	74.30	16.34	15.93	16.13
GPV-1	89.47	96.00	92.73	55.67	48.93	52.30	17.02	18.36	17.69
GPV-2	68.33	9.87	39.10	77.07	164.33	120.70	15.55	13.29	14.42
GPV-3	4.00	15.87	9.93	129.07	125.13	127.10	9.56	14.29	11.92
PUP-221	66.33	89.00	77.67	21.80	22.20	22.00	24.20	24.63	24.41
KRH-4	97.67	58.73	78.20	74.20	91.60	82.90	16.74	15.30	16.02
MTP-1	94.67	74.67	84.67	23.47	30.13	26.80	21.05	22.34	21.69
VR-181	62.00	82.00	72.00	32.20	22.27	27.23	21.41	22.16	21.79
PS-344	120.33	126.27	123.30	33.07	28.00	30.53	20.97	21.99	21.48
SRL-1	87.87	47.13	67.50	38.53	49.33	43.93	19.87	21.20	20.54
SRL-2	89.87	70.80	80.33	14.80	22.93	18.87	20.52	24.34	22.43
SRL-3	82.33	72.00	77.17	18.93	12.27	15.60	20.42	21.79	21.10
Varadhan	70.93	76.67	73.80	30.47	37.53	34.00	20.86	22.92	21.89
Mean	67.08	58.17	62.62	59.67	68.16	63.91	17.59	18.02	17.80
CD (0.05)									
Main	NS			NS			NS		
Sub	15.9			17.21			1.8		
Main x Sub	22.61			24.35			2.59		
Sub x Main	23.61			28.47			2.89		
CV%									
Main	20.26			36.31			11.71		
Sub	22.21			23.43			8.96		

T1=Recommended NPK, T2= Recommended NPK + Lime

Table 5.4.4 Screening of rice genotypes for tolerance to soil acidity (Moncompu- *kharif* 2019)

Yield Parameters

Variety	Grains/panicle			Chaff/panicle			Test weight of grain (g)		
	T1*	**T2**	**Mean**	**T1***	**T2**	**Mean**	**T1***	**T2**	**Mean**
RMS 1	160	190	175	14.33	6.67	10.50	2.20	2.20	2.20
RMS 2	115	241	178	15.00	22.00	18.50	1.77	1.81	1.79
RMS 3	119	166	142	16.67	16.67	16.67	2.23	2.05	2.14
RMS 4	207	235	221	18.00	18.67	18.33	2.19	1.89	2.04
RMS 5	200	189	195	15.33	15.67	15.50	2.44	2.29	2.37
RMS 6	188	203	196	12.33	16.00	14.17	2.38	2.29	2.33
RMS 7	225	226	225	19.67	14.67	17.17	2.47	1.99	2.23
RMS 8	170	222	196	21.00	19.00	20.00	2.14	2.26	2.20
GPV 1	206	168	187	13.67	15.00	14.33	1.96	2.36	2.16
GPV 2	159	189	174	24.00	25.33	24.67	2.01	2.12	2.06
GPV 3	174	196	185	35.33	45.00	40.17	1.94	2.01	1.97
PUP 221	168	161	165	24.00	27.33	25.67	2.27	2.19	2.23
KRH 4	211	229	220	15.67	37.00	26.33	1.94	2.02	1.98
MTP 1	122	212	167	16.67	23.33	20.00	2.35	2.50	2.43
VR 181	107	119	113	8.33	20.67	14.50	2.14	2.10	2.12
PS 344	121	145	133	10.00	27.33	18.67	2.45	2.17	2.31
SRL 1	144	156	150	14.00	19.00	16.50	2.33	2.51	2.42
SRL 2	155	116	136	23.67	24.67	24.17	2.20	2.19	2.20
SRL 3	115	84	99	11.33	22.00	16.67	2.40	2.09	2.24
Varadhan	116	140	128	20.00	18.67	19.33	2.48	2.85	2.67
Pratyasa	163	251	207	17.00	16.00	16.50	2.55	2.64	2.60
Uma	130	175	152	17.67	14.33	16.00	2.56	2.57	2.57
Pournami	136	157	147	11.67	8.67	10.17	2.46	2.46	2.46
Mean	157	181	169	17.19	20.59	18.89	2.25	2.24	2.25
CD (0.05)									
Main	NS			NS			NS		
Sub	52.4			13.3			0.32		
Main x Sub	NS			NS			NS		
Sub x Main	NS			NS			NS		
CV%									
Main	31.76			86.95			12.98		
Sub	27.02			61.37			12.36		

T1=Recommended NPK, T2= Recommended NPK + Lime

Table 5.4.5. Screening of rice genotypes for tolerance to soil acidity (Hazaribagh- *kharif* 2019)

Grain and Straw Yields

Variety	**Grain yield (t/ha)**			**Straw yield (t/ha)**		
	T1*	**T2**	**Mean**	**T1***	**T2**	**Mean**
RMS-1	2.59	0.30	1.44	8.90	8.51	8.70
RMS-2	0.36	1.31	0.83	7.77	6.85	7.31
RMS-3	0.65	0.35	0.50	10.18	5.22	7.70
RMS-4	1.50	0.26	0.88	6.68	6.22	6.45
RMS-5	0.40	0.04	0.22	6.48	7.18	6.83
RMS-6	0.21	0.04	0.12	7.77	9.07	8.42
RMS-7	0.67	0.09	0.38	7.29	8.33	7.81
RMS-8	0.50	0.33	0.41	9.25	8.88	9.07
GPV-1	1.49	0.81	1.15	7.47	9.27	8.37
GPV-2	1.16	0.35	0.75	9.44	8.55	8.99
GPV-3	0.48	0.70	0.59	7.96	7.88	7.92
PUP-221	2.90	1.96	2.43	7.29	7.62	7.46
KRH-4	1.00	0.10	0.55	6.66	6.29	6.48
MTP-1	2.25	1.75	2.00	7.75	7.42	7.59
VR-181	1.48	1.30	1.39	10.58	8.99	9.79
PS-344	2.37	2.29	2.33	10.23	8.40	9.31
SRL-1	0.89	0.47	0.68	11.58	3.74	7.66
SRL-2	1.96	2.24	2.10	10.06	9.49	9.78
SRL-3	2.74	2.05	2.40	10.06	6.97	8.52
Varadhan	1.28	0.94	1.11	7.64	6.36	7.00
Mean	1.34	0.88	1.11	8.55	7.56	8.06
CD (0.05)						
Main	NS			NS		
Sub	0.42			1.62		
Main x Sub	0.60			2.30		
Sub x Main	0.77			2.57		
CV%						
Main	66.54			23.06		
Sub	32.93			17.55		

T1=Recommended NPK, T2= Recommended NPK + Lime

Table 5.4.6. Screening of rice genotypes for tolerance to soil acidity (Moncompu- *kharif* 2019)

Grain and Straw Yields

Variety	**Grain yield (t/ha)**			**Straw yield (t/ha)**		
	T1*	**T2**	**Mean**	**T1***	**T2**	**Mean**
RMS 1	8.11	7.13	7.62	12.59	12.95	12.77
RMS 2	5.64	5.42	5.53	7.03	8.26	7.64
RMS 3	6.30	6.81	6.55	13.03	9.51	11.27
RMS 4	9.04	9.93	9.48	12.57	11.72	12.14
RMS 5	7.24	8.13	7.68	11.33	10.98	11.15
RMS 6	5.11	4.85	4.98	10.49	9.99	10.24
RMS 7	5.04	5.20	5.12	11.14	8.22	9.68
RMS 8	5.67	6.13	5.90	14.17	10.60	12.38
GPV 1	6.35	6.58	6.47	14.33	13.63	13.98
GPV 2	6.25	6.69	6.47	11.25	8.43	9.84
GPV 3	6.39	6.28	6.33	13.11	9.94	11.53
PUP 221	5.80	6.56	6.18	6.23	9.96	8.10
KRH 4	7.75	8.81	8.28	18.92	12.58	15.75
MTP 1	6.92	6.19	6.55	10.38	11.42	10.90
VR 181	6.19	5.54	5.87	8.18	6.33	7.25
PS 344	7.83	7.42	7.63	11.03	7.93	9.48
SRL 1	5.68	5.91	5.79	8.68	6.91	7.80
SRL 2	4.78	4.38	4.58	9.42	7.33	8.38
SRL 3	4.28	3.22	3.75	5.64	4.69	5.17
Varadhan	7.08	6.37	6.73	10.21	11.84	11.03
Pratyasa	7.19	7.34	7.27	12.76	10.60	11.68
Uma	7.64	6.23	6.94	12.49	14.41	13.45
Pournami	5.85	5.96	5.90	14.10	13.81	13.95
Mean	6.44	6.39	6.42	11.26	10.09	10.68
CD (0.05)						
Main	NS			NS		
Sub	1.55			3.8		
Main x Sub	NS			NS		
Sub x Main	NS			NS		
CV%						
Main	16.43			30.07		
Sub	21.03			31.04		

****T1=Recommended NPK, T2= Recommended NPK + Lime***

Table 5.4.7. Screening of rice genotypes for tolerance to soil acidity

(Ranchi -*kharif* 2019)

Grain and Straw Yields

Variety	Grain yield (t/ha)			Straw yield (t/ha)		
	T1*	T2	Mean	T1*	T2	Mean
RMS-1	6.87	7.30	7.08	7.90	8.29	8.10
RMS-2	5.18	6.40	5.79	5.29	6.67	5.98
RMS-3	5.46	6.52	5.99	5.76	6.74	6.25
RMS-4	6.99	7.67	7.33	7.23	7.90	7.56
RMS-5	6.94	7.59	7.27	7.47	7.94	7.71
GPV-1	6.23	7.62	6.92	6.64	8.39	7.51
GPV-2	6.86	7.27	7.06	9.12	10.10	9.61
GPV-3	6.02	6.31	6.16	8.79	9.40	9.09
PUP-221	5.28	5.78	5.53	7.57	8.67	8.12
KRH-4	4.90	5.04	4.97	5.53	5.66	5.60
MTP-1	4.79	5.68	5.23	5.13	6.07	5.60
PS-344	5.38	6.23	5.81	5.65	6.54	6.10
Varadhan	6.19	7.50	6.85	6.50	8.03	7.27
MTU 7029	4.86	5.28	5.07	5.01	5.44	5.23
Mean	5.85	6.58	6.22	6.69	7.56	7.12
CD (0.05)						
Main	0.55			0.69		
Sub	0.56			0.63		
Main x Sub	NS			NS		
Sub x Main	NS			NS		
CV%						
Main	9.37			10.27		
Sub	7.76			7.68		

T1=Recommended NPK, T2= Recommended NPK + Lime

Table 5.4.8. Screening of rice genotypes for tolerance to soil acidity (Titabar- *kharif* 2019)

Grain and Straw Yields

	Grain yield (t/ha)				Straw yield (t/ha)			
	T1*	**T2**	**T3**	**Mean**	**T1***	**T2**	**T3**	**Mean**
RMS-1	3.90	4.03	3.17	3.70	5.77	6.00	5.20	5.66
RMS-2	3.27	3.57	2.53	3.12	5.17	5.67	4.50	5.11
RMS-3	3.45	3.97	2.97	3.46	5.53	6.03	4.87	5.48
RMS-4	2.97	3.80	3.17	3.31	5.07	5.83	5.03	5.31
RMS-5	2.48	3.97	3.07	3.17	4.68	6.03	4.93	5.22
RMS-6	3.53	4.08	2.60	3.41	5.70	5.53	4.60	5.28
RMS-7	2.83	4.10	3.10	3.34	4.60	6.03	5.07	5.23
RMS-8	3.37	4.43	2.97	3.59	5.57	6.33	4.97	5.62
GPV-1	3.87	4.27	3.50	3.88	5.97	6.27	5.40	5.88
GPV-2	3.27	3.90	3.33	3.50	5.37	6.00	5.53	5.63
GPV-3	2.97	4.43	3.00	3.47	5.03	6.37	4.97	5.46
PUP-221	4.00	4.10	3.77	3.96	6.03	5.70	5.77	5.83
KRH-4	3.80	4.63	3.93	4.12	5.90	6.13	5.70	5.91
MTP-1	3.90	4.40	3.30	3.87	5.77	6.07	5.20	5.68
VR-181	2.70	3.83	3.37	3.30	4.73	5.77	5.27	5.26
PS-344	3.83	3.90	3.43	3.72	5.93	5.80	5.57	5.77
SRL-1	2.80	3.63	3.10	3.18	4.90	5.40	5.13	5.14
SRL-2	3.80	3.77	3.20	3.59	5.80	5.67	5.17	5.54
SRL-3	3.20	3.60	3.20	3.33	4.97	5.50	5.17	5.21
Varadhan	3.97	4.50	4.02	4.16	5.97	6.43	5.60	6.00
Mean	3.40	4.05	3.24	3.56	5.42	5.93	5.18	5.51
CD (0.05)								
Main	0.26				0.16			
Sub	0.32				0.35			
Main x Sub	0.56				0.61			
Sub x Main	0.60				0.61			
CV%								
Main	14.38				5.62			
Sub	9.74				6.82			

T1=Recommended NPK, T2= Recommended NPK + Lime, T3= Recommended N + double PK

Table 5.4.9. Screening of rice genotypes for tolerance to soil acidity (Titabar- *kharif* 2019)

Uptake of N, P and K

	Total N uptake (kg/ha)				Total P uptake (kg/ha)				Total K uptake (kg/ha)			
	T1*	**T2**	**T3**	**Mean**	**T1***	**T2**	**T3**	**Mean**	**T1***	**T2**	**T3**	**Mean**
RMS-1	52.40	58.79	40.36	50.52	8.65	9.94	8.59	9.06	66.99	69.81	51.33	62.71
RMS-2	47.27	55.61	31.35	44.74	8.40	9.28	7.05	8.24	56.85	68.48	42.38	55.90
RMS-3	54.84	58.77	33.29	48.97	7.68	10.77	8.36	8.94	63.22	72.54	47.30	61.02
RMS-4	48.53	60.46	36.98	48.66	7.10	9.88	8.99	8.66	55.27	66.07	52.21	57.85
RMS-5	39.97	60.43	35.87	45.42	6.61	10.44	9.37	8.81	51.83	72.27	49.52	57.87
RMS-6	51.79	61.90	31.98	48.56	8.69	10.48	7.90	9.03	57.85	67.43	47.41	57.56
RMS-7	41.54	71.08	38.33	50.32	6.78	10.98	9.43	9.07	46.29	74.50	50.53	57.10
RMS-8	50.24	72.80	37.91	53.65	7.74	11.41	9.28	9.48	54.50	76.40	46.88	59.26
GPV-1	59.15	69.61	42.48	57.08	9.00	11.37	11.10	10.49	57.78	80.02	53.77	63.86
GPV-2	49.93	64.73	41.84	52.17	8.64	10.07	9.40	9.37	53.40	74.67	52.34	60.13
GPV-3	46.58	74.08	37.24	52.63	7.52	11.43	10.01	9.65	48.54	80.02	52.19	60.25
PUP-221	57.56	67.61	43.96	56.38	9.68	11.44	12.46	11.19	58.57	72.85	61.00	64.14
KRH-4	54.89	71.34	49.24	58.49	9.13	12.33	13.74	11.74	58.78	76.40	63.93	66.37
MTP-1	55.45	69.28	40.78	55.17	9.81	12.68	10.30	10.93	59.95	80.20	57.81	65.99
VR-181	42.15	62.03	39.29	47.83	7.54	11.25	9.90	9.56	45.66	72.02	54.82	57.50
PS-344	59.02	65.25	45.12	56.46	10.16	12.31	10.07	10.85	60.53	73.85	62.88	65.76
SRL-1	44.42	58.79	41.84	48.35	7.38	8.66	9.48	8.50	47.26	69.28	54.27	56.94
SRL-2	55.89	60.68	40.36	52.31	9.58	11.34	10.64	10.52	58.77	71.77	52.09	60.87
SRL-3	47.84	58.22	42.86	49.64	7.71	10.17	10.95	9.61	48.17	68.92	52.09	56.39
Varadhan	60.49	77.85	52.89	63.75	10.04	15.07	15.02	13.38	62.53	86.62	65.93	71.69
Mean	51.00	64.97	40.20	52.05	8.39	11.07	10.10	9.85	55.64	73.71	53.53	60.96
CD (0.05)												
Main	2.86				0.70				2.46			
Sub	4.42				1.04				5.07			
Main x Sub	7.66				1.80				8.80			
Sub x Main	7.95				1.88				8.90			
CV%												
Main	10.83				13.94				7.97			
Sub	9.10				11.32				8.92			

T1=Recommended NPK, T2= Recommended NPK + Lime, T3= Recommended N + double PK

Table 5.4.10. Screening of rice genotypes for tolerance to soil acidity

(Titabar- *kharif* 2019)

Zn and Fe content in grain (g/ha)

	Zn				Fe			
	T1*	**T2**	**T3**	**Mean**	**T1***	**T2**	**T3**	**Mean**
RMS-1	71.60	83.20	53.90	69.57	996	975	796	922
RMS-2	59.10	82.50	41.93	61.18	763	835	643	747
RMS-3	58.97	86.03	56.43	67.14	829	913	742	828
RMS-4	50.63	89.73	57.50	65.96	751	886	794	810
RMS-5	48.77	78.20	53.37	60.11	632	954	807	798
RMS-6	70.40	80.12	47.50	66.01	940	899	656	831
RMS-7	53.30	84.73	47.63	61.89	709	964	776	816
RMS-8	66.03	101.90	52.43	73.46	883	1020	741	881
GPV-1	74.80	88.60	66.53	76.64	971	963	897	944
GPV-2	76.93	88.13	65.70	76.92	893	912	880	895
GPV-3	54.37	90.97	63.40	69.58	772	1055	777	868
PUP-221	67.20	90.60	73.87	77.22	1051	1001	976	1009
KRH-4	63.07	94.27	81.53	79.62	1011	1065	979	1018
MTP-1	62.77	95.23	56.30	71.43	972	995	795	921
VR-181	44.93	87.73	64.67	65.78	694	916	791	800
PS-344	55.10	94.60	56.20	68.63	1002	878	823	901
SRL-1	46.37	72.47	52.43	57.09	725	813	714	751
SRL-2	70.07	66.63	58.13	64.94	977	919	773	890
SRL-3	51.40	71.87	52.27	58.51	804	827	786	806
Varadhan	88.63	106.33	61.93	85.63	1037	1065	991	1031
Mean	61.72	86.69	58.18	68.87	870.51	942.59	806.77	873.29
CD (0.05)								
Main	3.08				63.05			
Sub	9.64				101.73			
Main x Sub	16.70				176.20			
Sub x Main	16.55				182.11			
CV%								
Main	8.83				14.24			
Sub	15.00				12.47			

T1=Recommended NPK, T2= Recommended NPK + Lime, T3= Recommended N + double PK

Table 5.4.11. Screening of rice genotypes for tolerance to soil acidity (Moncompu- *kharif* 2019)

Available P K and S status (kg/ha) after harvest

Variety	P			K			S		
	T1*	T2	Mean	T1*	T2	Mean	T1*	T2	Mean
RMS 1	7.79	6.28	7.03	460	331	396	24.64	27.20	25.92
RMS 2	11.12	8.47	9.79	383	354	368	22.67	27.55	25.11
RMS 3	8.01	7.04	7.53	524	387	456	22.32	20.42	21.37
RMS 4	15.20	8.65	11.92	436	429	432	26.44	19.31	22.88
RMS 5	7.49	7.26	7.37	504	378	441	31.39	29.21	30.30
RMS 6	6.73	7.94	7.34	461	417	439	19.31	28.45	23.88
RMS 7	6.13	8.32	7.22	570	462	516	22.24	27.86	25.05
RMS 8	10.59	10.59	10.59	446	363	405	27.17	21.43	24.30
GPV 1	5.94	12.78	9.36	343	408	376	30.14	30.57	30.35
GPV 2	13.01	11.57	12.29	439	379	409	21.35	30.73	26.04
GPV 3	9.53	8.17	8.85	504	364	434	22.42	27.37	24.90
PUP 221	6.35	8.40	7.38	345	362	353	21.87	27.44	24.66
KRH 4	9.45	8.85	9.15	436	311	373	25.26	24.78	25.02
MTP 1	7.26	9.39	8.33	387	380	384	17.44	29.35	23.40
VR 181	9.98	5.90	7.94	401	407	404	29.80	31.95	30.88
PS 344	10.06	10.59	10.32	473	380	426	26.65	28.34	27.50
SRL 1	7.18	10.44	8.81	432	439	435	20.59	26.61	23.60
SRL 2	7.94	7.56	7.75	545	330	438	18.55	28.03	23.29
SRL 3	9.30	8.39	8.85	431	454	443	20.97	31.04	26.01
Varadhan	8.17	8.85	8.51	391	354	373	32.63	28.52	30.58
Pratyasa	7.18	7.49	7.34	442	298	370	24.46	29.66	27.06
Uma	7.48	7.56	7.52	400	383	392	28.83	23.01	25.92
Pournami	8.25	11.80	10.02	453	455	454	27.41	27.96	27.69
Mean	8.70	8.79	8.75	444	384	414	24.55	27.25	25.90
CD (0.05)									
Main	NS			NS			NS		
Sub	NS			NS			NS		
Main x Sub	NS			NS			NS		
Sub x Main	NS			NS			NS		
CV%									
Main	96.45			48.51			44.56		
Sub	33.13			21.51			23.24		

T1=Recommended NPK, T2= Recommended NPK + Lime

Table 5.4.12. Screening of rice genotypes for tolerance to soil acidity (Moncompu- *kharif* 2019)

Available Fe, Zn and Boron (mg/kg)

Variety	Fe			Zn			B		
	T1*	T2	Mean	T1*	T2	Mean	T1*	T2	Mean
RMS 1	1171	956	1063	6.50	3.32	4.91	0.83	1.24	1.04
RMS 2	1010	833	921	6.13	4.81	5.47	1.15	1.08	1.12
RMS 3	1079	694	886	11.59	4.23	7.91	1.26	1.28	1.27
RMS 4	953	750	851	5.25	3.56	4.41	1.02	1.35	1.19
RMS 5	972	759	866	4.41	4.21	4.31	1.74	1.42	1.58
RMS 6	1024	683	853	7.00	3.35	5.18	2.04	1.55	1.79
RMS 7	690	821	756	7.41	4.94	6.18	1.28	1.62	1.45
RMS 8	1028	777	903	6.93	4.39	5.66	1.20	1.01	1.10
GPV 1	965	804	884	5.77	3.19	4.48	1.04	0.93	0.98
GPV 2	1103	756	929	5.72	5.11	5.42	1.11	1.60	1.35
GPV 3	1032	607	820	5.16	6.08	5.62	0.84	1.38	1.11
PUP 221	1233	717	975	4.18	3.31	3.75	1.04	1.39	1.21
KRH 4	987	766	876	6.26	3.86	5.06	1.31	1.36	1.33
MTP 1	834	885	859	5.17	3.88	4.53	0.98	1.25	1.11
VR 181	794	613	703	5.36	5.68	5.52	1.04	1.42	1.23
PS 344	738	874	806	5.04	5.39	5.22	0.69	1.49	1.09
SRL 1	932	929	930	6.78	7.89	7.34	0.76	1.11	0.94
SRL 2	1158	819	989	4.52	5.74	5.13	0.98	1.84	1.41
SRL 3	989	748	868	4.64	7.39	6.02	1.03	1.72	1.37
Varadhan	1111	679	895	5.55	5.61	5.58	0.80	1.37	1.08
Pratyasa	1073	805	939	6.62	5.57	6.10	1.53	1.32	1.42
Uma	896	935	915	6.05	4.56	5.30	1.46	1.56	1.51
Pournami	948	571	760	6.28	3.73	5.01	0.78	1.84	1.31
Mean	988	773	880	6.02	4.78	5.40	1.13	1.40	1.26
CD (0.05)									
Main	NS			NS			NS		
Sub	NS			NS			NS		
Main x Sub	NS			NS			NS		
Sub x Main	NS			NS			NS		
CV%									
Main	6.98			152.23			59.24		
Sub	21.14			35.55			36.97		

T1=Recommended NPK, T2= Recommended NPK + Lime

Table 5.5.13. Screening of rice genotypes for tolerance to soil acidity (Moncompu - *kharif* 2019)

Post harvest soil pH and Organic Carbon

Variety	pH			OC%		
	T1*	T2	Mean	T1*	T2	Mean
RMS 1	4.62	4.38	4.50	2.18	2.95	2.57
RMS 2	4.66	4.15	4.41	0.31	3.94	2.13
RMS 3	4.39	4.15	4.27	1.76	1.92	1.84
RMS 4	4.68	4.51	4.59	2.18	1.24	1.71
RMS 5	4.54	4.28	4.41	0.78	0.98	0.88
RMS 6	4.61	3.97	4.29	1.09	1.81	1.45
RMS 7	3.91	4.10	4.01	1.04	1.76	1.40
RMS 8	4.32	4.33	4.32	0.83	1.35	1.09
GPV 1	4.15	4.82	4.49	0.83	2.85	1.84
GPV 2	4.42	4.36	4.39	3.00	2.44	2.72
GPV 3	4.21	4.34	4.27	1.87	1.04	1.45
PUP 221	4.53	3.78	4.16	0.73	2.07	1.40
KRH 4	4.57	4.71	4.64	2.44	2.49	2.46
MTP 1	4.23	4.16	4.19	0.99	0.83	0.91
VR 181	4.16	4.32	4.24	1.04	0.88	0.96
PS 344	4.26	4.44	4.35	0.62	2.33	1.48
SRL 1	4.07	4.90	4.48	0.88	2.38	1.63
SRL 2	4.50	4.71	4.61	1.87	2.12	2.00
SRL 3	4.42	4.52	4.47	1.56	1.40	1.48
Varadhan	4.53	4.22	4.38	1.45	2.59	2.02
Pratyasa	4.38	4.42	4.40	1.66	2.90	2.28
Uma	4.56	4.43	4.50	2.02	3.63	2.82
Mean	4.40	4.37	4.39	1.39	2.13	1.76
CD (0.05)						
Main	NS			NS		
Sub	NS			NS		
Main x Sub	NS			NS		
Sub x Main	NS			NS		
CV%						
Main	28.60			22.14		
Sub	10.07			77.38		

5.5 Yield maximization in farmers' fields using Nutrient Expert software (*Kharif*)

Edaphic stresses constitute a set of factors within a group of abiotic stressors, which need specific address as the conventional blanket fertilizer recommendation causes low fertilizer use efficiency and imbalanced use of fertilizers where both deficit and excess nutrients pose problems. Added to that estimation of field specific fertilizer requirements needs site-specific knowledge of crop nutrient requirements, indigenous nutrient supply, and the efficiency to recover the applied fertilizer. The site-specific nutrient management (SSNM) approach emphasizes 'feeding' plants with nutrients as and when needed and to enable the farmers to optimally fill the deficit between the nutrient needs of a high-yielding crop. For more rapid adoption of SSNM technology by farmers, efforts were made in the consolidation of SSNM research conducted over the last decade across Asia into a simple delivery system by International Plant Nutrition Institute (IPNI) in the form of a software Nutrient Expert (NE). It is an easy to use interactive computer-based decision tool that can rapidly provide nutrient recommendations for farmers in the presence or absence of soil testing data. For validation of this tool, a collaborative (Soil Science & Agronomy) trial was constituted along with IPNI during *Kharif 2019* at different centers namely, Chinsurah (CHN), Faizabad (FZB), Karaikal (KRK), Khudwani (KHD), Maruteru (MTU), Mandya (MND), Pantnagar (PNT), Pudhcherry (PDU) and Purulia (PUR) with three treatments in a randomized block design in three replications at different sites. There was only one site in Mandya, while five sites were tested in Faizabad, Marteru, Pantnagar, Puduchery and Karaikal, six sites in Chinsurah (five different sites along with station) and ten sites in Khudwani centers. The treatments included Farmer's practice (T1), recommended dose of fertilizer (RDF) (T2) and SSNM based on Nutrient expert, which varies with each location (T3). The data were analysed by two factor ANOVA method to understand the impact of treatments, sites and site x treatment interactions to aid in understanding the effect of edaphic factors, which are a part of G x E interactions. The results were presented in tables 5.5.1 to 5.5.7.

Crop growth conditions

The available experimental soil conditions prior to cropping in five centers were presented in Table 5.5.1 along with plant varieties grown. The attempt to describe the soil properties of different sites and centers is to highlight the inherent problems and potentials of crop production. The contents given in the table are self-explanatory in terms of variability in the soil reaction, electrical conductivity, organic matter content and available N, P and K coupled with varieties grown. This information sets the stage to consider the site-specific nutrient management to realize the uniform best.

The details were given considering all sites irrespective of the testing center. The soil pH was ranging from 6.6 to 7.7 while the electrical conductivity widely ranging from 0.18 to 13.6 dS m^{-1} where inter-center variability was more than the intra-center values. Organic carbon content was ranging from as low as 0.3 to 1.2 %. The contents of available nitrogen, phosphorus and potassium were in the range of 154 to 510, 1 to 62 and 80 to 563, respectively. Besides the variability in edaphic factors, varieties were also different where the list include Swarna-sub1, NDR 2065, Pant Dhan 12, BPT 5204, ADT 46, CO-50, IR-64 and MTU7029 (Maruteru) and the details from four centers were not available.

Grain yield

The data in Table 5.5.2 clearly established the significant differences in the effects of sites, treatments and their interactions based on LSD values derived from two factor analysis. For instance, test sites recorded yield differences in Faizabad region with a mean ranging from 3475 to 5089, 4289 to 5929 and 5632 to 6456 kg/ha in T1, T2 and T3, respectively where the supremacy of T3 is clearly established. Supremacy of T3 was seen in three centers while in other centers the effect of treatments was insignificant. Similarly, within each site, the differences among treatments were significant, for instance in Site 2 (Faizabad), the mean rice grain yield was 3673, 4289 and 6258 kg/ha in T1, T2 and T3, respectively. However, in certain cases, the differences in treatments, sites and their interactions were insignificant, like in Karaikal while in others, the significant differences were noticed either among treatments, or sites or their interactions or in combinations. Although, the rice grain yield is a net expression of influence of sites, treatments and their interactions, there could be a way to establish regional differences too. One site in all regions, for example Site 1, registered the mean rice grain yield (across treatments) differently i.e. 4303 (Purulia) < 4741 (Karaikal) < 5061 (Puducherry) < 5161 (Pantnagar) < 5381 (Chinsurah) < 5521 (Marureru), 5825 (Faizabad) < 7029 (Khudwani) < 7485 kg/ha (Mandya) highlighting site specific responses of crop plants.

Straw yield

Like in grain yield, differential responses were noticed in straw yield too to sites, treatments and their interactions (**Table 5.5.3**). In Faizabad center, the straw yield across sites was in the range of 5451 to 6867, 6324 to 7461and 7098 to 8202 kg/ha in T1, T2 and T3, respectively. The means across sites were 6092, 6785 and 7780 kg/ha, respectively for T1, T2 and T3. LSD indicated that the differences in sites, treatments and site x treatment interactions were significant and supremacy of T3.Superiority of T3 was seen in Faizabad and that of T2 in Chinsurah while in other centers, the effect of treatments was insignificant.

Yield components

The data on tillers/m^2 indicated significant difference among sites, for example, in Faizabad, Karaikal and Purulia (Table 5.5.4) while that of treatments was evident only in Faizabad. There were significant differences in site x treatment interactions in Faizabad, Karaikal, Pantnagar and Purulia. There were significant differences in mean straw production among treatments (across sites) in Faizabad center with 273, 296 and 319 tillers/m^2 in T1, T2 and T3, respectively. Likewise, Site 1 (for example) also had differences in mean straw production across treatments; 173 (Pantnagar) < 260 (Puducherry) < 299 (Faizabad) < 360 (Chinsurah) < 414 (Purulia) < 490 (Karaikal) = 490 (Maruteru) highlighting the inter-center differences and site-specific responses of crop plants.

Number of panicles per square meter significantly varied in Faizabad, Karaikal, Khudwani, Maruteru, and Purulia while treatments had significant differences in Faizabad and Purulia centers (Table 5.5.5). Site x treatments caused significant differences in Faizabad, Karaikal, Khudwani, Maruteru and Purulia centers indicating the synergistic effects of both sites and site x treatment interaction. The means of three treatments across sites was 267, 290 and 312 tillers/m^2 in Faizabad center while the means across treatments were 293, 278, 302, 281 and 296 tillers/m^2, respectively for sites 1 to 5. The differences in one test site (for example, Site 1) across treatments in all seven centers followed the order: 127 (Pantnagar) < 293 (Faizabad) < 308 (Karaikal) = 308 (Puducherry < 314 (Purulia) < 317 (Chinsurah) < 357 (Khudwani) indicating the inter-center differences.

With reference to 1000 grain weight (Table 5.5.6), sites, treatments and site x treatment interactions caused significant differences in Faizabad center while sites and site x treatment interaction variations in Karaikal center. Mean treatment differences across sites in Faizabad were 23.55, 24.17 and 24.82 g of 1000 grains while the means of sites across treatments were 24.48, 23.38, 24.53, 24.21 and 24.04, respectively from sites 1 to 5. Similarly, one site (Site 1) in different centers recorded the 1000 grain weight in the order; 18.09 (Karaikal)<20.9 (Pantnagar) < 24.48 (Faizabad) < 30.0 (Khudwani) highlighting inter-center differences due to varietal differences.

Nutrients uptake

Data on uptake by grains were presented in **Table 5.5.6**.Total uptake of rice grain N was mostly influenced by site x treatment interactions in Faizabad, Pantnagar and Puducherry while treatments could bring about significant changes in Puducherry. There were significant differences in P uptake by grains in Karaikal and Maruteru centers, while site x treatment interactions caused significant changes in Faizabad, Karaikal, Maruteru and Puducherry. In case of K uptake by grain, sites in Maruteru and Pantnagar centers brought in significant differences while sites x treatments yielded significant differences in Faizabad, Maruteru, Pantnagar and Puducherry.

Sites in Karaikal and Pantnagar centers caused some significant differences in uptake of N by straw while site x treatment interactions could bring in significant changes in Faizabad, Karaikal, Pantnagar and Puducherry centers (**Table 5.5.7**). With regards to P uptake by straw, sites in Karaikal, site x treatment interactions in Faizabad and Pantnagar yielded significant differences. Significant differences were caused by sites in Maruteru and Pantnagar and site x treatment interactions in Faizabad and Maruteru centers.

The understanding

It is a fact that when the supply potential of the soil in relation to plant requirement is understood, better management is a possibility. In general, soil-based crop management is followed, but when the situation warrants crop-based soil management is required and we ought to know more to do more. It is in this direction; site specific nutrient management is expected to help realization of the uniform best from crop plants. In the present exercise, the site x treatment interaction effects were also added, which in fact contributed better particularly when neither sites nor treatments could describe. However, this data set could not establish the superiority of Nutrient Expert in every center calling for upgradation by including more crop production factors considering the varietal behavior.

Summary

A multi-location trial was conducted in Chinsurah (five sites), Faizabad (five sites), Karaikal (five sites), Khudwani (ten sites), Mandya (one site), Maruteru (five sites), Pantnagar (five sites), Puducherry (five sites)and Purulia (five sites) with three treatments namely, Farmers' practices (T1), Recommended dosage of fertilizers (RDF) (T2) and Nutrient Expert (NE) based fertilizer recommendations (T3) to identify the better performing treatment. Two factor analysis using sites, treatments LSD was derived for all attributes namely grain and straw yields, yield components and total uptake by grain and straw. In three centers (Faizabad, Khudwani and Purulia) only there were significant impacts of treatments on grain yield where T3 was superior. In case of straw yield, treatments could bring in significant changes in Faizabad and Chinsurah. But sites and site x treatment interactions in fact described the variance in better terms, which put together gave a different dimension of understanding fertilizer management. Treatments imposed in Faizabad could bring in differences significantly both in tiller and panicles per m^2 while in Purulia only panicles/m^2 were impacted. With reference to 1000 grain weight, treatments caused significant differences only in Faizabad. Nowhere the influence of treatments was seen on the uptake of N, P and K by grain and straw which would have been controlled by some thing else. In any case the influence of site x treatment interactions was visible in many instances in comparison with both or either of sites and treatments the phenomenon of which needs attention in any method of fertilizer management.

Table 5.5.1: Yield maximization of rice through site specific Nutrient Management *(Kharif 2019)*: Soil and crop characteristics

Centre	Site No.	pH	EC dS/m	OC(%)	Av. N Kg/ha	Av.P Kg/ha	Av. K Kg/ha	Variety
Chinsurah	Site 1	6.9	0.39	1.2	502	43	266	Swarna-sub1
	Site 2	6.9	0.35	1.1	510	49	299	
	Site 3	6.6	0.22	1.1	510	44	304	
	Site 4	6.7	0.43	NA	430	24	224	
	Site 5	7.1	0.27	1.2	498	34	250	
Faizabad	Site 1	7.4	13.6	0.42	210	26	235	NDR 2065
	Site 2	7.6	13.5	0.39	215	26	239	
	Site 3	7.5	13.6	0.45	225	27	235	
	Site 4	7.6	13.4	0.40	210	25	220	
	Site 5	7.5	13.5	0.42	220	25	230	
Pantnagar	Site 1	7.6	0.38	0.51	173	10	189	Pant Dhan-12
	Site 2	7.5	0.37	0.48	177	10	176	
	Site 3	7.6	0.37	0.46	193	11	177	
	Site 4	7.7	0.50	0.30	179	10	182	
	Site 5	7.6	0.40	0.57	177	10	202	
Karaikal	Site 1	6.4	0.23	0.98	229	62	563	BPT 5204
	Site 2	7.7	0.39	0.70	169	37	491	BPT 5204
	Site 3	7.7	1.07	0.93	154	45	327	ADT 46
	Site 4	7.2	0.42	0.90	167	37	270	BPT 5204
	Site 5	6.9	0.18	0.95	166	20	270	CO-50
Mandya	Site 1	7.7	0.37	0.55	306	12	80	IR-64

Table 5.5.2: Yield maximization of rice through site specific Nutrient Management *(kharif 2019)*: Grain yield

		Site 1	Site 2	Site 3	Site 4	Site 5	Mean - T
Faizabad	T1	5,089	3,673	4,661	3,475	4,463	4,272
	T2	5,929	4,289	5,501	4,858	5,425	5,200
	T3	6,456	6,258	6,143	5,632	6,077	6,113
	Mean -S	5,825	4,740	5,435	4,655	5,322	
	LSD	S = 253	T= 196	SxT= 438			
Chinsurah	T1	5,560	5,545	5,376	5,388	5,375	5,449
	T2	5,245	5,468	5,216	5,530	5,529	5,398
	T3	5,338	5,393	5,415	5,367	5,381	5,379
	Mean -S	5,381	5,469	5,336	5,428	5,428	
	LSD	S = NS	T= NS	SxT = 183.8			
Karaikal	T1	5,757	5,390	4,803	6,331	4,813	5,419
	T2	4,308	5,634	4,204	5,361	5,062	4,914
	T3	4,158	5,586	4,542	4,889	5,965	5,028
	Mean -S	4,741	5,537	4,517	5,527	5,280	
	LSD	S = NS	T = NS	SxT = NS			
Maruteru	T1	5,762	5,496	5,506	6,169	6,055	5,797
	T2	5,320	5,982	5,735	5,998	5,793	5,765
	T3	5,481	5,952	5,782	5,534	5,826	5,715
	Mean -S	5,521	5,810	5,674	5,900	5,891	
	LSD	S = 197	T = NS	SxT = 340			
Puducherry	T1	5,287	5,793	4,883	4,240	4,753	4,991
	T2	4,837	3,857	5,227	4,903	5,113	4,787
	T3	5,060	5,107	5,363	4,733	4,293	4,911
	Mean -S	5,061	4,919	5,158	4,626	4,720	
	LSD	S = 377	T = NS	SxT = 654			
Pantnagar	T1	5,133	5,217	5,183	5,147	5,133	5,163
	T2	5,117	5,133	5,233	5,203	5,117	5,161
	T3	5,233	5,143	5,133	5,167	5,143	5,164
	Mean -S	5,161	5,164	5,183	5,172	5,131	
	LSD	S = NS	T = NS	SxT = NS			
Purulia	T1	4,616	3,907	4,344	4,262	4,238	4,273
	T2	4,311	4,266	4,475	4,992	3,857	4,380
	T3	3,980	4,815	4,158	4,255	4,490	4,340
	Mean -S	4,302	4,329	4,326	4,503	4,195	
	LSD	S = 81.2	T = 62.9	SxT =140.6			

Mandya

S.No	GrYld	StrYld	Tillers/m^2	Panicles/m^2
T1	6972	7986	553	492
T2	7385	7850	582	527
T3	8099	8621	612	562
Mean	7485	8152	582	791

Khudwani

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
T1	6,117	6,950	7,017	5,900	7,633	6,950
T2	6,853	6,883	7,233	6,873	6,883	7,050
T3	8,117	6,950	7,367	7,017	6,850	6,567
Mean-S	7,029	6,928	7,206	6,597	7,122	6,856
	Site 7	Site 8	Site 9	Site 10	Mean - T	
T1	7,067	6,883	6,333	6,083	6,693	
T2	6,483	7,067	6,600	6,483	6,841	
T3	6,113	6,850	6,350	6,600	6,878	
Mean S	6,554	6,933	6,428	6,389		
LSD	S = 332	T = 236	SxT = 574			

Table 5.5.3: Yield maximization of rice through site specific Nutrient Management *(Kharif 2019)*: Straw yield

Khudwani

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
T1	9,233	8,467	8,483	8,800	9,233	8,432
T2	8,450	7,917	8,433	9,117	8,617	8,850
T3	9,133	8,583	9,117	8,483	8,483	8,550
Mean-	8,939	8,322	8,678	8,800	8,778	8,611
	Site 7	Site 8	Site 9	Site 10	Mean - T	
T1	9,067	8,517	7,567	8,483	8,628	
T2	8,967	9,250	7,957	8,567	8,612	
T3	8,517	8,917	7,800	8,267	8,585	
Mean	8,850	8,894	7,775	8,439		
LSD	S = 332	T = 236	S T = 574			

		Site 1	Site 2	Site 3	Site 4	Site 5	**Mean - T**
Faizabad	**T1**	6,867	5,830	6,380	5,451	5,929	6,092
	T2	7,461	6,324	7,032	6,390	6,719	6,785
	T3	8,202	8,004	7,707	7,098	7,889	7,780
	Mean -S	7,510	6,720	7,040	6,313	6,846	
	LSD	S = 236	T = 183	SxT = 408			
Chinsurah	**T1**	6,482	6,467	6,287	6,313	5,880	6,286
	T2	6,143	6,387	6,261	6,749	6,745	6,457
	T3	6,183	6,332	6,333	5,946	6,287	6,216
	Mean -S	6,269	6,395	6,294	6,336	6,304	
	LSD	S = NS	T= 176.4	SxT= 394.4			
Karaikal	**T1**	9,075	6,380	9,634	7,058	6,105	7,651
	T2	10,753	8,819	5,830	7,517	6,142	7,812
	T3	5,632	8,433	5,849	9,845	6,994	7,351
	Mean -S	8,487	7,877	7,104	8,140	6,414	
	LSD	S= 926	T= NS	SxT= 1604			
Maruteru	**T1**	7,202	6,870	6,882	7,711	7,568	7,247
	T2	6,650	7,477	7,169	7,497	7,242	7,207
	T3	6,852	7,440	7,227	6,918	7,283	7,144
	Mean -S	6,901	7,262	7,093	7,375	7,364	
	LSD	S = 246	T= NS	SxT= 425			
Puducherry	**T1**	7,873	8,433	7,867	8,140	7,823	8,027
	T2	8,850	7,043	7,443	8,723	8,573	8,127
	T3	8,003	8,423	7,990	8,297	8,130	8,169
	Mean -S	8,242	7,967	7,767	8,387	8,176	
	LSD	S= NS	T= NS	SxT= NS			
Pantnagar	**T1**	6,017	6,317	6,333	6,233	6,633	6,307

	T2	6,333	6,250	6,600	5,933	6,347	6,293
	T3	6,583	6,000	6,317	6,283	6,133	6,263
	Mean -S	6,311	6,189	6,417	6,150	6,371	
	LSD	S= 82.5	T = NS	SxT =142.8			
Purulia	**T1**	5,607	4,744	5,372	5,209	5,241	5,234
	T2	5,200	5,245	5,477	6,014	4,717	5,331
	T3	4,929	5,855	5,028	5,189	5,416	5,283
	Mean -S	5,245	5,281	5,292	5,471	5,125	
	LSD	S = 100.9	T= NS	SxT = 174.9			

Table 5.5.4: Yield maximization of rice through site specific Nutrient Management *(Kharif 2019)*: Tillers/m^2

		Site 1	Site 2	Site 3	Site 4	Site 5	**Mean - T**
Faizabad	**T1**	280	257	296	252	281	273
	T2	300	276	305	299	299	296
	T3	316	321	323	309	325	319
	Mean -S	299	284	308	287	302	
	LSD	S= 7.6	T= 5.9	SxT= 13.1			
Chinsurah	**T1**	365	360	391	377	372	373
	T2	357	389	393	371	368	376
	T3	359	359	359	370	382	366
	Mean -S	360	369	381	373	374	
	LSD	S = NS	T= NS	SxT = NS			
Karaikal	**T1**	635	315	501	590	352	479
	T2	513	664	323	543	314	471
	T3	323	573	310	535	582	464
	Mean -S	490	517	378	556	416	
	LSD	S = 34.5	T= NS	SxT = 59.7			
Maruteru	**T1**	496	499	496	503	503	499
	T2	472	501	501	484	501	492
	T3	503	495	493	494	500	497
	Mean -S	490	498	497	494	501	
	LSD	S= NS	T= NS	SxT= NS			
Puducherry	**T1**	272	249	244	267	242	255
	T2	255	259	252	276	241	256
	T3	252	273	266	260	244	259
	Mean -S	260	260	254	268	242	
	LSD	S = NS	T = NS	SxT = NS			
Pantnagar	**T1**	177	168	172	163	168	170
	T2	177	167	164	182	167	171
	T3	165	182	168	175	162	170
	Mean -S	173	172	168	173	166	
	LSD	S = NS	T = NS	SxT = 10.7			
Purulia	**T1**	441	385	424	410	403	413
	T2	408	406	420	452	366	411
	T3	392	443	395	418	443	418
	Mean -S	414	412	413	427	404	
	LSD	S = 8.3	T = NS	SxT = 14.5			

Table 5.5.5: Yield maximization of rice through site specific Nutrient Management (*Kharif 2019*): Panicles/m^2

		Site 1	Site 2	Site 3	Site 4	Site 5	**Mean - T**
Faizabad	**T1**	274	251	290	247	274	267
	T2	294	270	301	293	295	290
	T3	310	314	315	303	318	312
	Mean -S	293	278	302	281	296	
	LSD	S = 6.8	T = 5.2	SxT = 11.7			
Chinsurah	**T1**	318	316	328	330	321	323
	T2	316	338	329	321	320	325
	T3	319	312	309	321	329	318
	Mean -S	317	322	322	324	323	
	LSD	S = NS	T = NS	S xT = NS			
Karaikal	**T1**	352	287	313	408	291	330
	T2	289	451	289	317	273	324
	T3	283	345	277	297	396	320
	Mean -S	308	361	293	341	320	
	LSD	S = 37.1	T= NS	SxT = 64.3			
Maruteru	**T1**	419	420	384	448	433	421
	T2	367	428	434	433	444	421
	T3	418	425	432	398	461	427
	Mean -S	401	424	417	426	446	
	LSD	S = 22.9	T= NS	SxT = 39.6			
Puducherry	**T1**	307	311	290	317	257	296
	T2	305	306	298	317	298	305
	T3	311	316	320	297	298	308
	Mean -S	308	311	303	310	284	
	LSD	S = NS	T= NS	SxT = NS			
Pantnagar	**T1**	122	132	129	133	135	130
	T2	129	133	133	127	135	131
	T3	128	125	133	133	136	131
	Mean -S	127	130	132	131	135	
	LSD	S = NS	T = NS	SxT = NS			
Purulia	**T1**	338	281	320	313	311	312
	T2	317	313	326	360	276	319
	T3	287	350	303	312	333	317
	Mean -S	314	315	316	328	307	
	LSD	S= 5.7	T= 4.4	SxT= 9.8			

Khudwani

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
T1	339	337	337	347	387	353
T2	351	343	321	365	348	357
T3	381	338	358	363	378	357
Mean-S	357	339	339	358	371	355
	Site 7	Site 8	Site 9	Site 10	Mean - T	
T1	415	299	403	373	359	
T2	388	437	415	362	369	
T3	340	422	397	328	366	
Mean S	381	386	405	354		
LSD	S= 23	T= NS	SxT = 40			

Table 5.5.5: Yield maximization of rice through site specific Nutrient Management *(Kharif 2019)*: 1000 grain weight (g)

Khudwani

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
T1	29.8	30.3	29.9	29.8	29.1	30.5
T2	30.2	29.2	29.4	29.0	29.7	29.6
T3	30.0	30.5	29.8	29.8	29.5	30.0
Mean-S	30.0	30.0	29.7	29.6	29.4	30.1
	Site 7	Site 8	Site 9	Site 10	Mean - T	
T1	30.0	29.9	30.4	30.3	30.0	
T2	30.1	30.2	29.3	29.7	29.6	
T3	29.3	27.3	29.9	30.1	29.6	
Mean S	29.8	29.1	29.8	30.0		
LSD	S = NS	T = NS	SxT = NS			

		Site 1	Site 2	Site 3	Site 4	Site 5	**Mean - T**
Faizabad	**T1**	24.13	22.90	23.90	23.50	23.33	23.55
	T2	24.53	23.60	24.63	24.33	24.27	24.27
	T3	24.77	24.93	25.07	24.80	24.53	24.82
	Mean - S	24.48	23.81	24.53	24.21	24.04	
	LSD	S = 0.15	T = 0.12	SxT = 0.26			
Karaikal	**T1**	17.0	26.0	15.8	16.5	23.3	19.7
	T2	15.9	16.8	23.2	16.7	25.2	19.6
	T3	23.9	16.4	25.2	15.5	16.2	19.4
	Mean - S	18.9	19.7	21.4	16.2	21.5	
	LSD	S = 0.74	T = NS	SxT = 1.23			
Pantnagar	**T1**	21.7	21.8	21.1	21.1	20.5	21.3
	T2	20.4	20.5	20.9	21.6	22.3	21.2
	T3	20.5	21.6	22.2	20.8	21.3	21.3
	Mean - S	20.9	21.3	21.4	21.2	21.4	
	LSD	S = NS	T = NS	SxT = NS			

Table 5.5.6: Yield maximization of rice through site specific Nutrient Management *(Kharif 2019)*: Uptake- Grain (kg/ha)

Grain N																				
	Faizabad				Karaikal				Maruteru				Pantnagar				Puducherry			
	T1	T2	T3	Mean-T	T1	T2	T3	Mean-T	T1	T2	T3	Mean-T	T1	T2	T3	Mean-T	T1	T2	T3	Mean-T
Site 1	66.8	53.8	64.0	61.5	57.2	30.4	39.2	42.2	51.1	53.4	55.9	53.5	48.0	52.4	47.9	49.4	69.1	62.9	64.6	65.5
Site 2	52.2	63.8	67.1	61.0	54.6	48.8	52.1	51.8	51.6	52.6	58.4	54.2	50.2	46.6	50.1	49.0	70.8	39.1	60.4	56.8
Site 3	54.7	61.4	54.3	56.8	38.6	39.5	46.2	41.4	54.8	63.3	57.6	58.6	50.1	50.3	49.5	50.0	59.6	71.0	65.2	65.3
Site 4	59.8	69.6	51.7	60.4	58.6	50.3	42.2	50.4	54.8	59.5	54.3	56.2	47.4	51.2	50.5	49.7	44.4	57.6	61.0	54.3
Site 5	60.2	50.2	59.2	56.6	46.7	49.6	56.0	50.8	63.1	53.6	51.3	56.0	51.0	50.4	48.1	49.8	59.0	62.2	43.7	54.9
Mean-S	58.8	59.8	59.3		51.1	43.7	47.1		55.1	56.5	55.5		49.4	50.2	49.2		60.6	58.6	59.0	
LSD	S=NS	T = NS	SxT = 9.9		S= NS	T = NS	SxT = NS		S = NS	T = NS	SxT = NS		S = NS	T = NS	SxT = 2.9		S = 5.3	T = NS	SxT = 9.2	
Grain P																				
Site 1	27.6	20.0	23.9	23.8	37.1	32.9	37.4	35.8	13.5	13.1	12.3	13.0	6.0	5.3	6.1	5.8	13.8	13.9	12.1	13.2
Site 2	20.9	24.4	28.1	24.5	47.8	56.7	41.8	48.7	16.0	16.8	14.4	15.7	6.1	5.8	5.9	5.9	20.4	9.6	14.1	14.7
Site 3	20.2	22.9	21.1	21.4	36.0	37.7	40.7	38.1	13.6	16.0	16.9	15.5	6.0	6.5	6.2	6.2	12.4	15.4	22.7	16.8
Site 4	22.1	29.5	19.0	23.5	60.2	39.3	33.3	44.3	18.3	14.5	14.4	15.7	6.1	19.7	6.2	10.7	11.6	13.8	14.5	13.3
Site 5	22.4	18.8	22.1	21.1	45.4	43.6	55.5	48.2	14.4	17.5	16.9	16.3	6.3	5.8	6.0	6.1	14.8	15.7	10.2	13.6
Mean-S	22.7	23.1	22.8		45.3	42.0	41.7		15.2	15.6	15.0		6.1	8.6	6.1		14.6	13.7	14.7	
LSD	S NS	T=NS	SxT = 5.3		S= 8.4	T = NS	SxT = 14.5		S = 1.54	T = NS	SxT = 2.67		S = NS	T = NS	SxT = NS		S = NS	T = NS	SxT = 5.5	
Grain K																				
Site 1	31.2	24.8	30.9	29.0	33.8	28.1	25.3	29.1	17.2	15.0	20.8	17.7	20.6	20.3	22.7	21.2	21.2	17.7	25.7	21.5
Site 2	25.9	31.7	31.8	29.8	33.2	37.6	32.0	34.3	19.1	21.3	18.3	19.6	22.5	24.9	21.0	22.8	26.9	15.7	22.4	21.7
Site 3	24.9	29.3	26.5	26.9	29.9	24.1	27.5	27.2	16.9	22.4	20.5	20.0	20.0	26.8	23.1	23.3	19.0	21.4	25.2	21.9
Site 4	28.9	32.9	23.5	28.4	39.9	32.7	29.6	34.1	23.0	17.1	15.8	18.6	25.8	21.5	20.7	22.7	17.7	18.5	18.5	18.2
Site 5	28.2	24.2	29.0	27.1	27.7	30.9	39.9	32.8	22.9	21.8	21.1	21.9	24.8	25.0	26.7	25.5	16.6	18.9	16.4	17.3
Mean-S	27.8	28.6	28.3		32.9	30.7	30.9		19.8	19.5	19.3		22.8	23.7	22.8		20.3	18.4	21.6	
LSD	S = NS	T = NS	SxT = 6.4		S = NS	T = NS	SxT = NS		S = 2.1	T = NS	SxT = 3.6		S = 2.6	T = NS	SxT = 5.4		S = NS	T = NS	SxT = 5.5	

Table 5.5.7: Yield maximization of rice through site specific Nutrient Management *(Kharif 2019)*: Uptake- Straw (kg/ha)

	Faizabad				Karaikal				Maruteru				Pantnagar				Puducherry			
Straw N																				
	T1	T2	T3	Mean-T	T1	T2	T3	Mean-T	T1	T2	T3	Mean-T	T1	T2	T3	Mean-T	T1	T2	T3	Mean-T
Site 1	80.6	72.5	76.7	76.6	68.4	67.6	32.1	56.0	45.6	42.5	43.1	43.7	33.2	32.8	32.8	32.9	32.1	48.2	36.5	38.9
Site 2	66.7	74.9	81.3	74.3	28.1	57.0	61.5	48.9	44.4	43.8	49.8	46.0	41.9	40.3	33.4	38.5	40.4	27.9	33.9	34.1
Site 3	70.7	75.3	67.9	71.3	58.9	35.5	25.3	39.9	44.7	1646.3	48.6	579.9	34.7	35.5	39.8	36.6	38.9	32.8	40.1	37.3
Site 4	72.8	83.3	68.0	74.7	43.7	53.0	60.5	52.4	50.1	45.4	44.5	46.7	37.2	34.5	38.8	36.8	34.8	36.2	36.8	35.9
Site 5	74.2	63.9	73.2	70.4	33.1	28.9	42.8	34.9	49.0	48.7	45.8	47.8	38.1	40.2	41.3	39.8	33.0	33.4	30.5	32.3
Mean-S	73.0	74.0	73.4		46.5	48.4	44.4		46.7	365.3	46.4		37.0	36.6	37.2		35.8	35.7	35.6	
LSD	S=NS	T=NS	SxT=8.9		S=8.1	T=NS	SxT = 14.0		S = NS	T = NS	SxT = NS		S = 3.3	T = NS	SxT = 5.7		S = NS	T = NS	SxT = 1.5	
Straw P																				
Site 1	29.6	23.2	25.8	26.2	49.0	58.5	26.1	44.5	9.2	8.4	8.9	8.8	7.9	8.7	8.6	8.4	12.6	17.9	11.7	14.1
Site 2	23.2	24.5	30.0	25.9	30.4	56.0	51.3	45.9	7.8	9.8	9.7	9.1	10.1	10.9	7.6	9.5	15.9	12.0	16.2	14.7
Site 3	23.5	24.6	22.9	23.7	59.5	24.9	33.4	39.3	9.3	9.6	9.6	9.5	9.3	8.2	11.6	9.7	14.1	11.8	15.2	13.7
Site 4	22.8	30.8	21.9	25.2	45.3	43.0	50.5	46.3	10.5	8.8	8.5	9.3	10.6	7.9	9.4	9.3	16.7	15.8	16.8	16.4
Site 5	24.6	20.7	23.1	22.8	25.5	33.3	41.6	33.4	9.6	9.3	10.0	9.6	8.2	10.2	9.8	9.4	13.8	15.5	12.3	13.9
Mean-S	24.7	24.8	24.7		41.9	43.2	40.6		9.3	9.2	9.3		9.2	9.2	9.4		14.6	14.6	14.4	
LSD	S = NS	T = NS	SxT = 5.9		S = 7.5	T = NS	SxT = 12.9		S = NS	T = NS	SxT = NS		S = NS	T = NS	SxT = 1.8		S = NS	T = NS	SxT = NS	
Straw K																				
Site 1	52.5	45.3	48.8	48.9	167.1	238.5	101.7	169.1	97.7	97.6	96.8	97.4	42.1	43.4	47.3	44.3	81.7	98.7	78.1	86.1
Site 2	44.5	51.0	53.2	49.5	119.8	165.9	157.7	147.8	105.7	117.8	105.8	109.8	46.6	45.5	42.1	44.7	84.2	71.7	96.0	84.0
Site 3	44.4	47.0	44.3	45.2	219.0	108.0	117.5	148.2	100.5	105.3	112.9	106.2	47.5	47.4	48.5	47.8	55.1	78.0	83.5	72.2
Site 4	48.7	54.1	42.2	48.3	138.5	144.0	220.2	167.6	119.6	103.4	101.0	108.0	45.4	39.6	45.8	43.6	80.2	103.5	79.4	87.7
Site 5	46.3	41.2	49.0	45.5	110.4	116.5	135.8	120.9	110.7	113.2	113.4	112.4	48.7	48.7	47.2	48.2	68.3	86.1	80.3	78.3
Mean-S	47.3	47.7	47.5		151.0	154.6	146.6		106.8	107.5	106.0		46.1	44.9	46.2		73.9	87.6	83.5	
LSD	S = NS	T = NS	SxT = 6.6		S = NS	T = NS	SxT = 64.1		S = 7.5	T = NS	SxT = 13.1		LSD	S = 3.4	T = NS	SxT = NS	S = NS	T = NS	SxT = NS	

5.6 Bio - Intensive Pest Management (BIPM) in rice under Organic Farming

This trial was initiated during *kharif* 2015 in collaboration with Entomologists to study the influence of organic farming on productivity, grain quality, soil health and pest dynamics in rice and also to develop a package of bio-intensive pest management (BIPM) practices in organic farming. There are two treatments here viz., BIPM block and Farmers Practice (FP) block. In BIPM block, all organic farming practices involving from seed treatment, nursery application, nutrient and pest management using organic sources only were practiced as per the technical programme. Whereas, in FP block, general POP with RDF and need based application of insecticides were practiced. Each main block was divided into 6 smaller blocks and observations on pest incidence, yield parameters and grain yield were recorded. Plant nutrient (NPK) uptake was calculated using nutrient concentration and dry matter yield. Soil samples were collected before conducting experiment and after harvest and were analysed for important soil properties. The trial was conducted at three locations viz., [IIRR, Chinsurah (CHN) and Titabar (TTB)] during *kharif* 2019 and *Boro* at CHN. The results are presented in Tables 5.6.1 to 5.6.5.

Grain and straw yields

During *kharif* 2019, Among the three locations, grain yield (Table 5.8.2) was significantly superior in BIPM block compared to FP at CHN and TTB locations by recording 29-76% higher grain yield in BIPM over FP, respectively. While at IIRR, farmer's practice of nursery and main field (with insecticide schedule) was significantly superior to all other treatments (Table 5.8.3).At CHN, during *boro* season also, BIPM recorded significantly higher values of yield parameters over FP and it reflected in significantly higher grain yield by 13% (Table 5.8.4). Straw yield followed the similar trend as that of grain yield at all locations. Observations on pest incidence are given in Entomology report.

Soil Properties after harvest

The important soil properties after harvest at CHN locations are presented in Table 5.8.5. Almost all soil properties were superior in BIPM compared to FP treatment, in both *Kharif* and *boro* season, an improvement in soil available N,P and K was noticed in BIPM compared to FP.

Summary

From the fourth year of study on “Bio-intensive pest management”, it can be summarized that out of three locations (CHN, IIRR and TTB), BIPM was significantly superior to FP at CHN and TTB, while at IIRR, farmer's practice of nursery and main field with insecticide schedule was significantly superior to all other treatments. Similar to previous years, in this fourth year also, most of the soil properties improved with organics in BIPM compared to FP.

Table 5.6.1 Bio-intensive Pest Management (BIPM) in Rice under Organic farming Soil, Crop and weather data - *Kharif* 2019

Parameter	Chinsurah	Titabar
Cropping system	Rice-Rice	Rice-Rice
Variety	Swarna-Sub1	
RDF (kg NPK/ha)	60-30-30	
Crop growth	Satisfactory	Good
% clay	-	-
% silt	-	-
% sand	-	-
Soil Texture	Clay loam	Silty Clay
pH (1:1)	7.43	5.6
Org.carbon (%)	0.97	1.15
EC (dS/m)	0.19	-
Avail.N (kg/ha)	518	395
Avail. P_2O_5 (kg/ha)	132	28.5
Avail. K_2O (kg/ha)	347	165
Max. Temp (ºC)	-	-
Min. Temp (ºC)	-	-
Total Rainfall(mm)	-	-
RH(%)	-	-

Table 5.8.2: Bio-intensive Pest Management (BIPM) in Rice under Organic farming Grain yield (kg/ha) at different locations - *kharif* 2019

Treatments	Grain yield (kg/ha)		Straw Yield (kg/ha)
	Chinsurah	Titabar	Chinsurah
BIPM	5081	5321	6199
FP	3933	3020	4829
t – test	**	**	**

Table 5.8.3: Bio-intensive Pest Management (BIPM) in Rice under Organic farming Grain yield (kg/ha) at IIRR - *kharif* 2019

Treatments	Grain yield (kg/ha)
Farmer's practice of Nursery and Main field (with Insecticide Schedule)	6144
Treated Nursery with Treated seed (Trichoderma)	4342
Treated Nursery with Treated seed (Pseudomonas)	4444
Treated Nursery with Untreated seed	3917
Normal practice of Nursery and Planting (Un treated control)	3899
t – test	**

Table 5.8.4: Bio-intensive pest management (BIPM) in Rice under Organic farming Boro rice (Location: Chinsurah)

Treatments	Grain yield (kg/ha)	Panicle/m^2	1000 grain weight(g)	Tillers/m^2	Straw Yield (kg/ha)
BIPM	5650	290	3.2	336	6611
FP	5018	263	3.0	308	5793
t-test	**	**	**	**	**

Table 5.8.5: Bio-intensive pest management (BIPM) in Rice under Organic farming Soil properties after harvest atdifferent locations– K*harif and boro* 2019

Treat ments	pH	EC	Org. C. (%)	Available Nitrogen (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Chinsurah (K*harif*)						
BIPM	7.0	0.19	1.14	524	151	360
FP	7.01	0.23	1.2	485	103	296
Chinsurah (*boro*)						
BIPM	7.02	0.25	1.09	520	152	333
FP	6.87	0.21	0.87	422	90	274

5. 7 Residue management in rice based cropping systems

In India, about 371 million tons (mt) crop residues are produced annually of which wheat and paddy residues constitute 27–36% and 51–57% respectively. The disposal of such huge quantity of paddy residues has become a big problem, particularly in North-West Indian states, mainly due to the use of combine harvester and narrow time gap (one to three weeks) between paddy harvesting and planting of wheat in NW India, resulting in farmers preferring to burn the residues in-situ. Burning biomass not only pollutes environment by depleting air quality, emitting green house gases (GHGs), but also causes smog in the environment, results in loss of appreciable amount of plant essential nutrients besides being deleterious to soil microbes. The incineration of crop residues contributes to emissions of harmful air pollutants, which can cause severe impacts on human health too. Thus, proper residue management is of utmost important as it contains plant nutrients and improves the soil-plant-atmospheric continuum. As an alternative strategy, these crop residues can be used for mulching, compost making and in-situ incorporation for improving soil fertility.

Keeping this in view, the present trial was initiated, in *kharif* 2018, to study the influence of rice/wheat residue on rice crop productivity, soil health, pest dynamics and grain quality in rice based cropping systems (RBCS). In the current year, the trial was conducted at ten centres *viz*., Ghaghraghat (GHG), Kanpur (KNP), Karaikal (KRK), Khudwani (KHD), Maruteru (MTU), Pantnagar (PNT), Puducherry (PDU), Pusa (PSA), Raipur (RPR) and IIRR

The treatments (8) consisted of application of crop residues in combination with either chemical fertilizers, green manure (GM)/green leaf manure (GLM), vermicompost (VC), efficient microbial culture (MC) or *Trichoderma* culture (TC) to supply the N requirement on equal basis (50%:50%) in addition to Control and recommended dose of N. The data from ten locations are presented in Tables 5.7.1 to 5.7.7. The test varieties were NDGR-201 at GHG, NDR-2064 at KNP, ADT 46 at KRK, SR-4 at KHD, MTU-1061 & MTU 1153 at MTU, Pant Dhan-12 at PNT, ADT 53 at PDU, Rajendra Bhagwati at PSA, TCDM-1 at RPR and MTU 1153 at IIRR. The details of crop, soil and weather parameters of the experimental sites (Table 5.7.1) show variation in soil characteristics with reference to pH, organic carbon content, soil texture and available nutrient status.

Rice productivity

Data presented in Tables 5.7.2 & 5.7.3 shows that the rice productivity significantly varied with the source of nitrogen application. In *Kharif* 2019, supplementation of 100% N through RDF resulted in significantly highest grain yield at KHD (6.53 t/ha), PNT and PSA (8.61 t/ha) while Control maintained the lowest grain yield values. However, combined application of residues (50% N) with RDF (50% N) + $ZnSO_4$ + Borax gave highest yield at KNP (5.70 t/ha) while it yielded (5.21 t/ha) on par with RDF (100% N) (5.12 t/ha) and Crop residue (50% N) + RDF (50% N) (4.94 t/ha) at PDU. At MTU, PSA and RPR, the treatments consisting of various combinations of crop residues with either RDF, GM, VC, MC or *Trichoderma* were on par not only with each other and but also with RDF (100% N) in terms of grain yield. The results prove that the crop residues can be deployed to substitute half of the recommended nitrogen without yield penalty. Similar trend was also observed for straw yield as well. At GHG and IIRR, the effect of crop residues was not significant.

In *rabi* too, the highest grain yield was obtained under RDF (100% N) which was on par with combinations of crop residues with either GM/GLM, VC or MC/BM.

Nutrient uptake and use efficiency

Data presented in Table 5.7.4 show significant effect of source of N application on nutrient uptake. RDF recorded the highest N (72-133 kg/ha), P (13-42 kg/ha) and K (43-170 kg/ha) uptake while control maintained the lowest values. The crop residue treatments were at par and didn't vary much.

Data presented in Table 5.7.6 show lower nutrient use efficiencies in RDF as compared to crop residue treatments which were mostly at par with each other.

Post harvest soil nutrient status:

The available nutrient status (N, P and K) of soils at are presented in Table 5.7.7 & 5.7.8. The data reveals that the soil nitrogen, phosphorus and potassium contents after harvest of the crop were not influenced much by various residue treatments and were at par with each other.

Summary

Supplementing half of the recommended N through residues (50% N) in addition to either RDF (50% N) or GM, VC/ MC or *Trichoderma* yielded at par not only with each other and but also with RDF (100% N) in terms of grain yield. The results show that the crop residues can be deployed to substitute half of the recommended nitrogen without yield penalty. RDF recorded the highest N (72-133 kg/ha), P (13-42 kg/ha) and K (43-170 kg/ha) uptake while control maintained the lowest values. The crop residue treatments were at par and didn't vary much in terms of nutrient uptake and maintained higher nutrient use efficiencies over RDF. Post-harvest soil nutrient status was not influenced much by various residue treatments which were at par with each other.

Table: 5.7.1 Residue management in RBCS
Crop and soil characteristics

Parameter	**GHG [1]**	**KNP [2]**	**KRK [3]**	**KHD [4]**	**MTU [5]**	**PNT [6]**	**PDU [7]**	**PSA [8]**	**RPR [9]**	**IIRR [10]**
Cropping system	Rice-Wheat	Rice-Wheat	Rice-Rice	Rice-Wheat	Rice-Rice	Rice-Wheat	Rice-Rice	Rice-Wheat	Rice-Wheat	Rice-Rice
Variety										
Kharif	NDGR-201	NDR-2064	-	SR-4	MTU-1061	Pant Dhan-	ADT 53	Bhagwati	TCDM-1	MTU1153
Rabi	PBW15	PBW-	ADT 46	-	MTU-	-			-	-
RFD (Kg NPK/ha)										
Kharif	80:60:4	120:60:	-	-	90:60:6	120:60:	120:40:	120:60:	100:60:	120:60:
Rabi	120:60:	120:60:	150:50:	-	180:90:	-	-	-	-	-
Crop growth										
Kharif	Good	Good	-	Good	Good	Good	Good	Good	Good	Good
Rabi	Good	Good	Good	-	Good	-	-		-	-
Soil data										
% clay	27	21	17	41	38	26	-	18	45	-
% silt	31	22	2	37	28	61	-	31	35	-
% sand	42	57	81	22	34	13	-	51	20	-
Soil Texture	Sandy Loam	Sandy Loam	Sandy loam	Silty clay	Clay loam	Silty clay	Clay loam	Sandy loam	Clay	Clay
pH (1:1)	8.2	7.9	6.91	6.93	5.96	7.6	7.16	8.49	7.3	8.1
Org. carbon	0.4	0.42	0.51	0.85	1.34	0.65	0.29	0.65	0.49	-
CEC [c mol	-	23.9	8.2	-	48.6	23.5	-	-	-	-
EC (ds/m)	-		0.07	-	0.69	0.39	0.24	0.14	0.42	-
Avail.N	210	206	251	212	179	150	134	198	144	119
Avail. P_2O_5	10	18	35	12.8	50	9.6	22	38	13	85
Avail. K_2O	242	194	161	225	350	190	142	212	472	615

Table: 5.7.2 Residue management in RBCS
Grain and straw yields (*Kharif* 2019)

Treatment	Grain yield (t/ha)									Straw yield (t/ha)								
	GHG	KNP	KHD	MTU	PNT	PDU	PSA	RPR	IIRR	GHG	KNP	KHD	MTU	PNT	PDU	PSA	RPR	IIRR
Control	3.60	2.20	4.26	4.55	1.96	3.23	2.91	3.31	3.76	4.42	2.58	5.90	5.68	1.93	5.09	2.66	3.14	3.50
RDF (100%)	5.03	5.45	6.53	7.86	8.61	5.12	4.19	5.15	4.50	6.37	6.70	8.98	9.82	5.83	7.77	4.32	6.38	4.14
Crop residue (50% N) + RDF (50% N)	4.17	5.10	5.29	6.86	7.02	4.94	3.90	4.78	5.06	5.49	6.22	7.85	8.57	4.93	8.34	3.99	4.61	5.19
Crop residue (50% N) + GM (50% N)	4.44	4.70	4.56	7.13	6.15	4.47	3.81	3.80	4.92	5.73	5.64	6.65	8.92	4.16	7.50	3.50	4.23	4.80
Crop residue (50% N) + VC (50% N)	4.63	4.85	4.76	6.92	6.34	4.62	3.69	4.83	4.55	6.10	5.87	6.98	8.65	4.31	7.24	3.41	5.70	4.05
Crop residue (50% N) + RDF (50% N) + $ZnSO_4$ + Borax	4.61	5.70	5.54	6.38	7.20	5.21	3.98	4.00	3.29	5.84	7.03	8.32	7.97	5.17	7.51	3.49	4.30	2.96
Crop residue (100% N) + MC	4.93	4.20	4.42	6.87	4.32	4.19	3.59	4.64	-	6.12	5.00	6.43	8.59	3.15	6.25	3.09	4.91	-
Crop residue (100% N) + TC	4.88	3.90	4.99	7.26	4.39	4.07	3.44	5.08	-	6.15	4.60	7.58	9.07	3.28	5.92	2.73	3.93	-
Expt. Mean	**4.54**	**4.51**	**5.04**	**6.72**	**5.75**	**4.48**	**3.69**	**4.45**	**4.35**	**5.78**	**5.46**	**7.34**	**8.40**	**4.10**	**6.95**	**3.40**	**4.65**	**4.11**
CD (0.05)	**NS**	**0.13**	**0.69**	**1.28**	**0.10**	**0.41**	**0.60**	**0.67**	**NS**	**NS**	**0.15**	**0.95**	**1.60**	**0.04**	**1.25**	**0.49**	**0.72**	**NS**
CV (%)	**11.5**	**1.62**	**7.79**	**10.83**	**1.03**	**5.26**	**9.22**	**8.61**	**35.93**	**12.11**	**1.60**	**7.36**	**10.84**	**0.54**	**10.27**	**8.29**	**8.83**	**31.42**

Table: 5.7.3 Residue management in RBCS
Grain and straw yields (*Rabi* 2018-19 and 2019-20)

Treatment	Grain yield (t/ha)				Straw yield (t/ha)			
	GHG	KNP	KRK (2019-20)	MTU	GHG	KNP	KRK (2019-20)	MTU
Control	2.83	0.98	5.22	3.75	11.56	1.14	8.83	4.69
RDF (100%)	4.72	2.13	6.17	6.31	19.75	2.55	9.56	7.88
Crop residue (100%N)	3.43	1.19	5.72	4.16	13.55	1.40	9.06	5.20
Crop residue (150%N)	3.58	1.28	5.83	3.90	14.15	1.51	9.00	4.87
Crop residue (50% N) + GM/GLM (50% N)	4.22	1.45	6.17	4.23	17.32	1.72	10.78	5.29
Crop residue (75% N) + GM/GLM (75% N)	3.83	1.62	5.44	3.99	15.65	1.92	9.78	5.00
Crop residue (50% N) + VC (50% N)	4.28	1.57	5.55	4.82	17.65	1.86	11.50	6.02
Crop residue (75% N) + VC (75% N)	4.27	1.72	-	4.93	17.20	2.05	-	6.16
Crop residue (100% N) + MC/BM	-	1.26	-	-	-	1.49	-	-
Crop residue (150% N) + MC/BM	-	1.42	-	-	-	1.69	-	-
Expt. Mean	**3.90**	**1.46**	**5.73**	**4.51**	**15.85**	**1.73**	**9.79**	**5.64**
CD (0.05)	**0.82**	**0.09**	**0.43**	**0.47**	**1.01**	**0.11**	**1.27**	**0.58**
CV (%)	**12.08**	**3.68**	**4.18**	**5.94**	**3.65**	**3.63**	**7.32**	**5.9**

Table: 5.7.4 Residue management in RBCS
Nutrient uptake (kg/ha) in total dry matter (*Kharif* 2019)

Treatment	GHG			KNP			MTU			PNT			PDU			PSA			RPR			IIRR		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Control	58	22	20	50	10	47	63	15	69	25	5	28	61	15	66	37	14	44	45	7	78	66	6	73
RDF (100%)	106	42	43	133	33	133	102	27	170	126	25	101	117	32	122	72	28	88	83	13	160	84	8	86
Crop residue (50% N) + RDF (50% N)	71	29	30	123	30	122	94	23	136	85	18	80	112	29	125	60	23	77	73	11	124	107	9	114
Crop residue (50% N) + GM (50% N)	77	34	31	111	27	109	97	19	140	75	14	66	95	27	98	64	22	70	57	9	115	87	8	98
Crop residue (50% N) + VC (50% N)	86	32	36	116	29	114	89	21	126	84	21	73	95	28	104	62	23	69	96	13	161	92	7	89
Crop residue (50% N) + RDF (50% N) + $ZnSO_4$ + Borax	81	37	35	140	35	141	79	21	117	99	20	86	126	30	123	65	22	69	71	11	112	63	5	41
Crop residue (100% N) + MC	99	37	37	98	24	95	100	23	139	62	12	53	86	23	92	51	19	59	81	11	130	-	-	-
Crop residue (100% N) + TC	93	31	38	90	22	87	101	21	135	67	14	61	80	21	79	50	17	51	83	11	106	-	-	-
Expt. Mean	**83.8**	**33.1**	**33.8**	**108**	**26.3**	**106**	**90.5**	**21.2**	**129**	**77.9**	**16.2**	**68.5**	**96.5**	**25.8**	**101**	**57.7**	**20.9**	**66.0**	**73.8**	**10.7**	**123**	**83.1**	**7.22**	**83.5**
CD (0.05)	**16.8**	**6.5**	**6.8**	**3.4**	**0.63**	**3.2**	**21.1**	**6.6**	**44.2**	**4.1**	**2.9**	**7.7**	**14.8**	**4.6**	**21.4**	**6.74**	**2.59**	**11.9**	**13.3**	**2.8**	**28.4**	**NS**	**NS**	**NS**
CV (%)	**11.9**	**11.3**	**11.5**	**1.8**	**1.4**	**1.7**	**13.3**	**17.8**	**19.6**	**3.0**	**10.4**	**6.4**	**8.7**	**10.1**	**12.1**	**6.67**	**7.04**	**10.3**	**10.3**	**14.7**	**13.2**	**27.2**	**30.9**	**32.9**

Table: 5.7.5 Residue management in RBCS
Nutrient uptake (kg/ha) in total dry matter (*Rabi* 2018-19 and 2019-20)

Treatment	**KRK (*Rabi* 2019-20)**			**MTU (*Rabi* 2018-19)**		
	N	**P**	**K**	**N**	**P**	**K**
Control	305	80	150	74	15	49
RDF (100%)	389	102	239	134	26	80
Crop residue (100%N)	283	86	199	74	18	60
Crop residue (150%N)	333	84	246	78	17	55
Crop residue (50% N) + GM/GLM (50% N)	340	107	286	66	19	61
Crop residue (75% N) + GM/GLM (75% N)	312	97	283	68	19	56
Crop residue (50% N) + VC (50% N)	388	121	253	87	23	74
Crop residue (75% N) + VC (75% N)	-	-	-	93	22	69
Expt. Mean	**335.6**	**96.6**	**236.5**	**84.3**	**19.9**	**63.06**
CD (0.05)	**102**	**9.2**	**58.2**	**14.3**	**4.0**	**10.5**
CV (%)	**17.1**	**5.3**	**13.8**	**9.7**	**11.6**	**9.5**

Table: 5.7.6 Residue management in RBCS
Nutrient use efficiency (kg grain/kg uptake) (*Kharif* 2019)

Treatment	GHG			KNP			MTU			PNT			PDU			PSA			RPR			IIRR		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Control	62	161	179	44	221	47	72	315	66	77	368	71	53	213	50	78	206	67	73	453	43	57	643	52
RDF (100%)	47	119	116	41	165	41	77	304	47	68	343	86	44	164	43	58	150	48	62	399	32	54	602	55
Crop residue (50% N) + RDF	59	143	137	41	168	42	73	305	50	82	400	88	44	169	40	65	171	51	65	446	39	47	560	44
Crop residue (50% N) + GM (50% N)	58	132	144	42	172	43	75	369	52	83	442	93	47	169	47	59	177	55	66	413	33	55	590	52
Crop residue (50% N) + VC (50% N)	54	145	127	42	170	42	79	331	56	75	309	87	49	167	45	60	161	54	51	382	30	49	616	54
Crop residue (50% N) + RDF (50% N) + $ZnSO_4$ + Borax	57	124	134	41	164	40	82	301	56	73	353	83	42	176	42	61	182	57	56	377	36	52	609	91
Crop residue (100% N) + MC	50	134	134	43	174	44	69	293	50	69	374	81	49	186	46	70	185	61	57	428	36	-	-	-
Crop residue (100% N) + TC	53	156	129	43	176	45	75	351	54	66	306	72	51	197	52	70	199	67	61	475	48	-	-	-
Expt. Mean	**55.0**	**139**	**137**	**42.3**	**176**	**43.1**	**73.2**	**321**	**53.9**	**7.2**	**362**	**82.8**	**47.3**	**180**	**45.5**	**65.2**	**179**	**57.4**	**61.4**	**421**	**37.1**	**52.3**	**603**	**57.9**
CD (0.05)	**1.1**	**2.6**	**3.5**	**0.18**	**1.68**	**0.34**	**NS**	**NS**	**NS**	**3.13**	**74.6**	**9.66**	**NS**	**27.5**	**NS**	**6.76**	**28.1**	**11.0**	**3.4**	**NS**	**5.23**	**NS**	**NS**	**NS**
CV (%)	**1.2**	**1.1**	**1.4**	**0.24**	**0.54**	**0.45**	**8.79**	**9.41**	**11.1**	**2.42**	**11.8**	**6.67**	**8.58**	**8.82**	**12.1**	**5.93**	**8.95**	**11.0**	**3.17**	**9.10**	**8.15**	**8.11**	**12.1**	**38.5**

Table: 5.7.6 Residue management in RBCS
Nutrient use efficiency (kg grain/kg uptake) (*Rabi* 2018-19 and 2019-20)

Treatment	KRK (*Rabi* 2019-20)			MTU (*Rabi* 2018-19)		
	N	P	K	N	P	K
Control	17	66	35	50	254	77
RDF (100%)	16	61	26	47	240	79
Crop residue (100%N)	20	68	29	56	233	69
Crop residue (150%N)	18	69	24	50	228	71
Crop residue (50% N) + GM/GLM (50% N)	20	58	22	65	225	69
Crop residue (75% N) + GM/GLM (75% N)	17	57	20	59	214	72
Crop residue (50% N) + VC (50% N)	14	46	22	55	212	65
Crop residue (75% N) + VC (75% N)	-	-	-	53	222	72
Expt. Mean	**17.6**	**60.6**	**25.4**	**54.5**	**228**	**71.8**
CD (0.05)	**NS**	**8.81**	**4.99**	**8.25**	**NS**	**6.54**
CV (%)	**18.76**	**8.18**	**11.05**	**8.65**	**8.57**	**5.20**

Table: 5.7.7 Residue management in RBCS
Available nutrient status of soils (kg/ha) (*Kharif* 2019)

Treatment	KNP			KHD			MTU			PNT			PDU			PSA		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Control	205	18	192	194	13	225	201	48	274	147	10	195	164	16	131	148	21	165
RDF (100%)	208	19	198	230	17	285	267	63	384	146	10	196	190	16	146	212	32	229
Crop residue (50% N) + RDF (50% N)	212	22	204	212	16	279	204	68	290	145	10	195	213	19	144	203	25	203
Crop residue (50% N) + GM (50% N)	216	24	206	200	15	269	262	68	347	146	10	196	198	21	134	197	26	205
Crop residue (50% N) + VC (50% N)	213	22	206	201	15	272	244	77	305	143	10	195	216	28	136	208	31	213
Crop residue (50% N) + RDF (50% N) + $ZnSO_4$ + Borax	218	26	209	216	17	282	279	69	329	144	10	197	194	21	131	214	31	222
Crop residue (100% N) + MC	210	20	201	197	14	231	254	62	331	146	10	195	217	25	154	188	23	200
Crop residue (100% N) + TC	210	21	202	207	16	277	274	58	295	145	10	197	201	25	152	187	24	198
Expt. Mean	**211**	**21.4**	**202**	**207**	**15.3**	**265**	**248**	**64.1**	**319**	**145**	**10.1**	**196**	**199**	**21.4**	**141**	**195**	**26.6**	**204**
CD (0.05)	**1.53**	**1.23**	**1.55**	**11.9**	**0.54**	**15.2**	**44.3**	**13.8**	**46.0**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**11.1**	5.9	18.2
CV (%)	**0.41**	**3.28**	**0.44**	**3.28**	**2.03**	**3.27**	**10.2**	**12.3**	**8.23**	**1.61**	**2.69**	**1.21**	**16.8**	**24.1**	**7.04**	**3.25**	**12.7**	**5.1**

Table: 5.7.8 Residue management in RBCS
Available nutrient status of soils (kg/ha) (*Rabi* 2018-19 and 2019-20)

Treatment	**KRK (*Rabi* 2019-20)**			**MTU (*Rabi* 2018-19)**		
	N	**P**	**K**	**N**	**P**	**K**
Control	102	38	164	170	50	370
RDF (100%)	83	34	169	156	66	351
Crop residue (100%N)	69	34	186	142	69	418
Crop residue (150%N)	97	28	201	165	67	409
Crop residue (50% N) +	79	31	169	190	75	422
Crop residue (75% N) +	90	30	168	194	72	397
Crop residue (50% N) + VC	73	21	182	206	65	447
Crop residue (75% N) + VC	-	-	-	181	60	433
Expt. Mean	**85**	**31**	**177**	**176**	**66**	**406**
CD (0.05)	**18.0**	**8.63**	**NS**	**28.6**	**12.1**	**26.0**
CV (%)	**11.96**	**15.75**	**11.19**	**9.29**	**10.53**	**3.66**

5.8 Screening of rice germplasm for Nitrogen use efficiency (NUE)

Among the essential nutrients, nitrogen (N) is the major element which is required in large quantities by rice. The most limiting nutrient in irrigated rice is nitrogen and N recovery efficiency is only about 25-40% of applied N in most farmers' fields and N is mostly lost by leaching, gaseous loss through volatilization and surface run off. Now a day's consumption of N fertilizer is in the increasing trend, but its use efficiency is low in most of the production systems. Nitrogen use efficiency depends not only on the efficient fertilizer management, but also on the cultivar that is used. Genetic variation in nitrogen use efficiency in rice was reported by several workers. Keeping this in view, the present trial was formulated to evaluate the nitrogen use efficiency (NUE) of a few popular rice varieties in addition to the varieties developed for high NUE. Here, 10 entries were tested across 9 locations viz., Kanpur (KNP), Karaikal (KRK), Maruteru (MTU), Mandya (MND), Pantnagar (PNT), Purulia (PUR), Pusa (PSA), Raipur (RPR) and Titabar (TTB) at three nitrogen levels (N0, N1 and N2 where 0, 50 and 100% of recommended dose of N, respectively). The results are presented in Tables 5.8.1 to 5.8.5 and discussed below.

Yield and yield parameters

At Titabar (TTB), grain yield at N1 and N2 did not differ and N3 recorded significantly higher yields over N1 and N2 by 37 and 36%, respectively. Among the varieties, at all 3 N levels, MTU1010 and ARRH7576 recorded higher yields with overall mean maximum yield by ARRH7576. Whereas, CNN5 at N1 and N2 and CNN1 at N3 were on par to MTU 1010 and ARRH7576.

At Mandya (MND), significantly higher yield was recorded at N3 by 56 and 16% over N1 and N2, respectively. Among the varieties, CNN1 was significantly superior to other varieties while ARRH7576 was at par to CNN1, CNN4 and Varadhan. ARRH7576 recorded maximum yield (5.84 t/ha) at N1 and CNN5, Varadhan and CNN1 were at par and recorded higher yields at N3 (7.63-7.81 t/ha).

At Kanpur (KNP), N3 recorded significantly higher yield than N1 and N2 by 24 and 19%, respectively. Among the varieties, CNN1, CNN4 and CNN5 recorded higher yields (4.00-4.06 t/ha0 and the yield difference among other varieties was marginal by about 0.17-0.38 t/ha.

At Purulia (PUR) also, N3 recorded significantly higher yield than N1 and N2 by 22 and 7%, respectively. Among the varieties, ARRH7576 recorded maximum yield (5.21 t/ha) that was significantly superior to all varieties except Varadhan which was on par with 4.81 t/ha.

The grain yield at Raipur (RPR) was significantly high at N3 compared to N2 and N1 for all varieties. N3 recorded higher yield by 80 and 12%, over N1 and N2, respectively. Among the varieties, ARRH7576 recorded significantly higher yield at all N levels (4.3-6.3 t/ha) than all other varieties (2.1-5.9 t/ha) and next in the order are, Varadhan, CNN5, CNN1 and MTU 1010.

At Karaikal (KRK), the yield difference between N levels was not significant though there was an incremental increase of about 0.6 t/ha at N2 and N3 levels. Among the varieties, ARRH7576 recorded mean maximum yield (5.98 t/ha) followed by Varadhan (5.80 t/ha) and CNN4 (5.36 t/ha) which were at par and these were superior without external N application.

In case of Maruteru (MTU), though N3 recorded significantly higher yield than N1 (by 21%) and N2 (by 5%), the difference between N2 and N3 is only marginal. Among the varieties, CNN4(6.42 t/ha) and CNN5 (6.05 t/ha) were at par and significantly superior to all other varieties. Next in the order was CNN2 with 5.42 t/ha.

At Pantnagar (PNT), there was gradual response up to N3 in case of all varieties that responded significantly at N3 (5.8 t/ha) over N2 (4.8 t/ha) and N1 (2.76 t/ha). Among the varieties, at N1, Varadhan, CNN5 and TI93 were superior. At N2, Varadhan, ARRH7576 and CNN5 and at N3, CNN3, CNN4 and Rasi were superior. Here, at each N level, the differences among the varieties was only marginal (0.2-0.45 t/ha).

At Pusa, grain yields in general were low compared to other centres ranging from 2.06 t/ha at N1 level to 2.76 t/ha at N3 level. Among the varieties, ARRH7576 and CNN2 (2.64 and 2.72 t/ha, respectively) at N1 level; Varadhan, ARRH7576 and CNN2 (2.72-3.06 t/ha) at N2; and CNN3, Varadhan and CNN1 (3.61-3.77 t/ha) at N3 level recorded higher yields.

Averaged over nine locations, pooled over varieties, the mean yield data at different N levels indicated an increase at N3 (4.92 t/ha) over N2 (4.26 t/ha) and N1 (3.24 t/ha) to an extent of 31 and 51%, respectively. Among the varieties, pooled over three N levels, mean maximum yield across nine locations was recorded by ARRH7576 (4.72 t/ha) that recorded a minimum of 7.0% increase over CNN4 (4.41 t/ha) and Varadhan (4.41 t/ha) and maximum of 41% increase over Rasi (3.34 t/ha).

Straw yields followed almost similar trend as that of grain yields al all locations. Tiller and panicle number (Table 5.8.3) in general followed the grain yield trend in most of the locations with maximum number in N3 followed by N2 and N1. Among the varieties, ARRH7576, CNN1, CNN5, Varadhan and MTU 1010 recorded maximum number in most of the locations.

Nutrients uptake

Total nutrients (NPK) uptake data was presented in Table 5.8.4. N uptake was maximum at N3 level at all locations ranging from 47-115 kg/ha and 31-80 kg/ha at N1 level. Pusa centre with low yields recorded lowest N uptake than other centres. Among the varieties, ARRH7576, CNN5, Varadhan and MTU 1010 recorded maximum uptake values at most of the locations.

Soil Properties

From the Table 5.8.5, the soil properties pH and EC were not influenced by N levels as well as varieties. In case of available N, N levels did not influence at PNT and PSA while at MTU, KRK and MND, N values were significantly less at N1 compared to N2 and N3.

Among the varieties, there was no significant difference at PNT, MND and PSA and no specific trend was noticed at KNP, MTU and KRK.

Summary

In the first year of study on "Screening of rice germplasm for NUE, ten genotypes were evaluated at three nitrogen levels (0, 50 and 100% of recommended N) at nine locations. At all locations, grain yield was significantly higher at 100% RDN and the increase was in the range of 5-36% over 50% RDN and 21-110% over no N application. Among the varieties, out of nine locations, ARRH7576, CNN5, CNN4 and Varadhan recorded higher yields of around 5.0 t/ha. Yield parameters and nutrients uptake almost followed similar trend as that of grain yield trend and no spectacular differences were noticed in soil properties after harvest.

Table 5.8.1: Screening of rice germplasm for Nitrogen use efficiency (NUE), *Kharif* 2019 Soil and crop characteristics

Parameter	TTB [1]	MND [2]	KNP [3]	PUR [4]	RPR [5]	KRK [6]	MTU [7]	PNT [8]	PSA [9]
Cropping system	Rice-Rice	Rice-Rice	Rice-Rice	Rice-Rice	Rice-Rice	Rice-Rice	Rice-Rice	Rice-Wheat	Rice-Wheat
RFD (Kg NPK/ha)	60:20:40	125:50:50:40	120:60:60:25	70:35:35	100:60:40	150:50:50	90:60:60:50	120:60:30	120:60:40:25
Crop growth	Good	Very	-	Good	Good	Good	Good	Good	Good
Soil data									
% clay	42-48	48.32	20.5		45	17.4	38	25.9	17.5
% silt	20-35	30.45	23.7		35	2.0	28	61.4	31
% sand	25-30	21.23	55.8		20	82.76	34	13.0	51.5
Soil Texture	Clay	Clay	Sandy loam	Sandy loam loam	Clay	Sandy loam	Clay loam	Silty clay loam	Sandy loam
pH (1:1)	5.3 -5.8	8.97	7.93	6.5	7.3	6.91	6.10	7.5	8.49
Org. carbon	0.65-	0.38	0.45	0.85	0.49	0.51	1.24	0.68	0.65
CEC [c mol	15-18		25.5	-		8.2	48.6	23.7	-
EC (ds/m)	-	0.53	0.47	0.13	0.42	0.07	0.64	0.42	0.14
Avail.N	215-	269	225	360	144	250	234	165	197
Avail. P_2O_5	20-34	25.7	18.7	26	13.2	35.1	61.2	9.08	38
Avail. K_2O	125-	186	174	309	472	161	294	210	211
DTPA –Zn	0.65-0.9	-	0.43	-	1.01	-	-	0.68	0.48
DTPA –Fe	18.5-	-	38.7	-	6.0	-	-	128	-
DTPA –Mn	12-15.5	-	22.6	-	8.42	-	-	22.7	-
DTPA –Cu	0.65-0.9	-	0.15	-	3.08	-	-	6.4	-

Table 5.8.2: Screening of rice germplasm for Nitrogen use efficiency (NUE), *Kharif* 2019 , Grain and Straw yields of rice

Variety / N levels	Titabar								Mandya								Kanpur							
	Grain yield (t/ha)				Straw Yield (t/ha)				Grain yield (t/ha)				Straw Yield (t/ha))				Grain yield (t/ha)				Straw Yield (t/ha)			
	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean
CNN -1	2.15	2.60	4.43	3.06	3.85	4.65	7.93	5.48	5.49	6.69	7.63	6.61	5.66	6.01	8.51	6.73	3.04	4.25	4.88	4.06	3.22	5.07	5.86	4.71
CNN -2	2.77	2.85	3.47	3.03	4.80	4.88	6.20	5.29	3.61	6.09	6.66	5.46	4.31	6.38	8.63	6.44	2.82	4.04	4.80	3.89	3.34	4.88	5.87	4.70
CNN -3	2.77	3.08	3.80	3.22	5.05	6.00	6.80	5.95	4.58	5.47	5.88	5.31	6.62	6.95	7.84	7.14	2.62	3.82	4.59	3.68	3.15	4.72	5.69	4.52
CNN -4	2.53	3.02	3.83	3.13	4.53	5.40	6.90	5.61	4.29	6.70	7.31	6.10	5.90	8.02	9.01	7.64	2.94	4.18	4.95	4.02	3.47	5.04	5.97	4.82
CNN -5	2.80	3.13	3.72	3.22	5.05	5.63	6.68	5.79	3.95	6.06	7.81	5.94	4.76	7.18	8.74	6.89	2.93	4.17	4.90	4.00	3.42	4.94	5.87	4.74
ARRH7576	2.93	4.28	4.73	3.98	5.40	7.27	8.61	7.09	5.84	6.13	6.69	6.22	7.57	8.26	9.13	8.32	2.50	3.65	4.38	3.51	2.93	4.35	5.37	4.21
Rasi	2.25	2.63	2.70	2.53	4.03	4.72	4.91	4.55	3.01	3.88	4.48	3.79	4.02	5.04	6.80	5.29	2.71	3.93	4.71	3.78	3.16	4.69	5.73	4.53
Varadhan	2.53	2.73	2.93	2.73	4.57	4.93	5.34	4.95	4.20	6.30	7.77	6.09	5.09	6.64	7.98	6.57	2.76	3.81	4.80	3.79	3.22	4.54	5.79	4.52
MTU- 1010	3.03	3.43	4.50	3.66	5.70	6.17	8.19	6.69	2.70	3.20	4.13	3.35	4.63	5.70	6.64	5.66	2.89	4.04	4.66	3.86	3.37	4.79	5.55	4.57
TI-93	2.47	2.50	4.48	3.15	4.00	4.38	8.16	5.51	2.48	4.11	5.12	3.90	4.70	6.66	7.95	6.43	2.77	3.69	4.66	3.71	3.24	4.40	5.64	4.42
Mean	**2.62**	**3.02**	**3.86**	**3.17**	**4.69**	**5.40**	**6.97**	**5.69**	**4.01**	**5.46**	**6.35**	**5.27**	**5.33**	**6.68**	**8.12**	**6.71**	**2.80**	**3.96**	**4.73**	**3.83**	**3.25**	**4.74**	**5.73**	**4.58**
CD M	0.09				0.13				0.26				0.33				0.03				0.07			
CD S	0.27				0.53				0.40				0.41				0.21				0.24			
M X S	0.47				0.93				0.69				0.72				NS				NS			
S XM	0.45				0.88				0.68				0.71				NS				NS			
CV (%) M	5.86				4.83				10.76				10.67				1.6				3.5			
CV (%) S	9.02				9.96				8.05				6.55				5.7				5.5			

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.2: Screening of rice germplasm for Nitrogen use efficiency (NUE), *Kharif* 2019 , Grain and Straw yields of rice

Variety / N levels	Purulia								Raipur								Karaikal							
	Grain yield (t/ha)				Straw Yield (t/ha)				Grain yield (t/ha)				Straw Yield (t/ha))				Grain yield (t/ha)				Straw Yield (t/ha)			
	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean
CNN -1	3.59	3.99	4.21	3.93	4.31	4.80	5.16	4.72	3.20	4.86	5.61	4.55	4.06	5.82	6.11	5.33	3.70	4.44	5.19	4.44	10.3	11.8	14.1	12.0
CNN -2	4.06	4.14	4.30	4.16	4.78	4.89	4.96	5.01	2.72	4.81	5.48	4.34	3.98	5.65	6.11	5.25	4.26	4.96	5.37	4.86	11.0	11.7	14.1	12.3
CNN -3	2.89	3.68	4.00	3.52	3.51	4.44	4.49	4.26	2.12	4.41	5.22	3.92	3.44	5.29	5.75	4.83	4.48	5.00	5.19	4.89	13.9	11.1	11.8	12.2
CNN -4	3.58	3.61	3.68	3.62	4.32	4.35	5.20	4.37	2.85	4.81	5.15	4.27	3.64	5.59	5.68	4.97	5.19	5.39	5.49	5.36	10.9	12.3	15.1	12.8
CNN -5	3.66	3.86	4.31	3.94	4.40	4.65	6.08	4.75	3.05	4.97	5.52	4.51	4.01	5.78	6.14	5.31	4.48	4.81	5.19	4.88	10.4	12.4	14.5	12.4
ARRH7576	4.93	5.12	5.59	5.21	4.32	5.91	6.23	6.07	4.27	5.84	6.26	5.46	5.52	7.25	7.26	6.68	5.48	5.93	6.52	5.98	12.9	14.8	15.7	14.5
Rasi	3.18	3.29	3.61	3.36	3.81	3.96	6.17	4.03	2.38	4.08	4.86	3.77	3.22	4.91	5.34	4.49	3.33	3.70	4.81	3.95	6.0	6.6	7.8	6.8
Varadhan	4.05	5.12	5.25	4.81	4.92	6.13	6.51	5.74	3.53	5.56	5.96	5.02	4.37	6.52	6.72	5.87	4.44	5.93	7.04	5.80	9.7	11.0	11.0	10.6
MTU- 1010	3.22	4.89	5.49	4.53	3.83	5.91	6.00	5.41	3.38	4.85	5.82	4.68	4.25	5.81	6.41	5.49	3.40	3.70	4.26	3.89	9.1	9.6	9.9	9.5
TI-93	3.96	4.58	4.99	4.51	4.79	5.16	5.47	5.42	2.49	3.94	4.19	3.54	3.84	4.78	5.82	4.81	3.26	3.52	4.44	3.74	6.2	9.8	10.3	8.8
Mean	**3.71**	**4.23**	**4.54**	**4.16**	**4.29**	**5.02**	**5.62**	**4.98**	**3.00**	**4.81**	**5.41**	**4.41**	**4.03**	**5.74**	**6.13**	**5.30**	**4.20**	**4.73**	**5.35**	**4.81**	**10.0**	**11.1**	**12.4**	**11.2**
CD (0.05)-M	0.08				0.11				0.08				0.04				NS				NS			
CD(0.05)-S	0.39				0.47				0.13				0.07				1.01				2.3			
M X S	NS				NS				0.23				0.13				NS				NS			
S XM	NS				NS				0.22				0.13				NS				NS			
CV (%) M	4.38				4.9				3.8				1.62				15.2				48.8			
CV (%) S	9.9				9.92				3.2				1.5				20.4				21.7			

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.2: Screening of rice germplasm for Nitrogen use efficiency (NUE), *Kharif* 2019 , Grain and Straw yields of rice

Variety / N levels	Maruteru								Pantnagar								Pusa							
	Grain yield (t/ha)				Straw Yield (t/ha)				Grain yield (t/ha)				Straw Yield (t/ha))				Grain yield (t/ha)				Straw Yield (t/ha)			
	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean
CNN -1	3.68	4.10	3.78	3.85	4.30	4.72	4.83	4.62	2.50	4.55	5.60	4.21	2.81	5.20	5.95	4.65	2.05	2.20	3.61	2.62	2.59	2.62	4.51	3.24
CNN -2	5.22	5.42	5.62	5.42	4.90	6.49	7.03	6.14	2.70	4.68	5.81	4.40	2.99	5.22	5.92	4.71	2.72	2.87	3.48	3.02	3.13	3.44	4.19	3.59
CNN -3	3.97	4.49	4.60	4.35	4.79	5.05	5.76	5.20	2.71	4.73	5.96	4.47	3.18	5.28	5.88	4.78	1.51	2.09	3.77	2.46	2.48	2.80	3.93	3.07
CNN -4	5.82	6.62	6.81	6.42	6.07	6.89	8.51	7.16	2.75	4.82	5.95	4.51	2.92	5.28	6.16	4.79	1.81	2.49	2.50	2.27	3.11	3.29	3.44	3.28
CNN -5	5.17	6.46	6.52	6.05	5.56	6.62	8.16	6.78	2.91	4.95	5.81	4.56	2.77	5.28	5.88	4.64	1.79	2.04	2.45	2.09	2.31	2.94	3.13	2.80
ARRH7576	4.17	5.01	5.23	4.80	5.47	6.02	7.20	6.23	2.79	4.97	5.83	4.53	2.99	5.27	6.02	4.76	2.64	2.72	2.98	2.78	2.90	3.23	3.53	3.22
Rasi	2.24	2.38	3.33	2.65	3.39	3.83	4.47	3.90	2.54	4.62	5.92	4.36	3.12	5.35	6.01	4.83	1.17	2.13	2.23	1.84	1.71	2.70	3.19	2.54
Varadhan	3.09	4.06	4.22	3.79	3.86	4.86	6.35	5.02	2.99	5.00	5.85	4.61	2.98	5.27	6.01	4.76	2.26	3.06	3.73	3.02	3.65	3.70	4.18	3.84
MTU- 1010	4.60	5.39	5.72	5.24	5.31	6.58	7.41	6.43	2.81	4.86	5.73	4.47	2.95	5.27	6.08	4.77	1.31	1.97	2.74	2.00	1.70	2.58	3.36	2.54
TI-93	3.97	5.37	5.54	4.96	4.51	6.37	6.38	5.75	2.90	4.84	5.54	4.43	2.86	5.23	5.93	4.68	1.93	1.98	2.79	2.23	2.57	2.63	3.21	2.80
Mean	**4.19**	**4.93**	**5.14**	**4.75**	**4.82**	**5.74**	**6.61**	**5.72**	**2.76**	**4.80**	**5.80**	**4.45**	**2.96**	**5.26**	**5.99**	**4.74**	**1.90**	**2.36**	**3.03**	**2.43**	**2.62**	**2.99**	**3.67**	**3.09**
CD (0.05)-M	0.11				0.44				0.03				0.16				NS				NS			
CD (0.05)-S	0.65				0.66				0.1				NS				0.50				0.52			
M X S	NS				1.14				0.17				NS				0.87				0.91			
S XM	NS				1.12				0.16				NS				1.06				1.15			
CV (%) M	4.9				16.6				1.43				7.38				87				79			
CV (%) S	14.5				12.2				2.35				3.15				21.9				17.9			

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.3: Screening of rice germplasm for nitrogen use efficiency (NUE) , *Kharif* 2019 yield parameters of rice

Variety / N levels	Titabar								RAIPUR								Purulia							
	Tillers/m^2				Panicles/m^2				Tillers/m^2				Panicles/m^2				Tillers/m^2				Panicles/m^2			
	N1	**N2**	**N3**	**Mean**	**N1**	**N2**	**N3**	**Mean**	**N1**	**N2**	**N3**	**Mean**	**N1**	**N2**	**N3**	**Mean**	**N1**	**N2**	**N3**	**Mean**	**N1**	**N2**	**N3**	**Mean**
CNN -1	300	283	208	264	223	258	192	225	345	385	388	373	235	260	282	259	372	413	438	408	288	327	350	322
CNN -2	225	267	325	272	181	216	226	208	345	398	426	389	248	255	270	258	421	429	447	432	329	333	362	341
CNN -3	208	283	317	269	156	240	263	220	344	372	381	366	240	250	269	253	313	381	415	370	240	290	334	288
CNN -4	292	308	325	308	254	261	252	256	365	378	389	377	250	260	258	256	370	390	381	380	289	301	299	296
CNN -5	308	375	308	331	200	258	215	224	369	412	391	390	200	280	305	262	379	399	449	409	299	309	365	324
ARRH7576	292	367	250	303	219	250	229	233	394	405	410	403	250	290	325	288	497	518	535	517	401	386	395	394
Rasi	275	283	300	286	212	233	231	225	379	413	401	398	235	248	270	251	328	339	373	347	245	247	300	264
Varadhan	200	283	308	264	153	230	227	203	380	400	415	398	260	275	310	282	421	518	513	484	335	360	388	361
MTU- 1010	267	342	358	322	242	277	233	251	370	403	397	390	245	266	298	270	332	494	527	451	259	379	399	345
TI-93	367	367	300	344	282	267	236	261	365	392	400	385	210	200	236	216	410	477	520	469	326	360	394	360
Mean	**273**	**316**	**300**	**296**	**212**	**249**	**230**	**231**	**366**	**396**	**400**	**387**	**237**	**258**	**282**	**259**	**384**	**436**	**460**	**427**	**301**	**329**	**359**	**330**
CD (0.05)- M	NS				NS				2.31				1.26				8.22				11.3			
CD(0.05)- S	NS				36				6.59				2.55				36.2				32.8			
M X S	NS				NS				11.4				4.41				NS				NS			
S XM	NS				NS				10.9				4.26				NS				NS			
CV (%) M	25				31				1.3				1.06				4.2				7.5			
CV (%) S	23				17				1.81				1.04				9.01				11.6			

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.3: Screening of rice germplasm for nitrogen use efficiency (NUE) , *Kharif* 2019 yield parameters of rice

Variety / N levels	Karaikal								Kanpur								Maruteru							
	Tillers/m^2				Panicles/m^2				Tillers/m^2				Panicles/m^2				Tillers/m^2				Panicles/m^2			
	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean
CNN -1	364	369	287	340	321	337	271	310	333	424	447	401	329	420	444	398	294	377	316	329	175	203	183	187
CNN -2	349	385	308	348	325	347	283	318	326	410	443	393	320	406	440	388	309	363	343	338	173	226	214	204
CNN -3	335	400	324	353	316	372	303	330	313	397	435	381	305	393	430	376	301	329	311	314	178	215	209	201
CNN -4	387	364	319	356	359	324	293	325	335	436	465	412	329	431	461	407	290	329	327	315	167	197	193	186
CNN -5	371	451	265	362	351	420	242	338	329	446	462	412	322	441	459	407	295	349	331	325	183	217	228	209
ARRH7576	301	291	245	279	275	256	223	251	300	378	403	360	294	372	398	355	301	328	315	315	192	202	194	196
Rasi	337	411	317	355	320	389	292	334	326	422	409	385	318	416	406	380	311	316	294	307	213	193	178	195
Varadhan	259	360	375	331	233	323	351	302	322	437	462	407	315	431	458	401	260	319	311	297	163	188	199	183
MTU- 1010	371	365	364	367	343	335	349	342	317	401	417	378	311	395	415	373	294	322	330	315	179	207	200	195
TI-93	293	349	279	307	277	325	258	287	315	402	422	380	306	395	419	374	297	364	320	327	185	237	180	201
Mean	**337**	**375**	**308**	**340**	**312**	**343**	**286**	**314**	**322**	**415**	**436**	**391**	**315**	**410**	**433**	**386**	**295**	**340**	**320**	**318**	**181**	**209**	**198**	**196**
CD(0.05)-M	NS				NS				4.39				4.43				17.6				NS			
CD(0.05)-S	NS				NS				18.2				18.7				22.1				NS			
M X S	NS				NS				NS				NS				NS				NS			
S XM	NS				NS				NS				NS				NS				NS			
CV (%) M	61				58				2.45				2.50				12.0				26			
CV (%) S	20				21				4.96				5.13				7.4				10			

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.3: Screening of rice germplasm for nitrogen use efficiency (NUE) , *Kharif* 2019 yield parameters of rice

Variety / N levels	Pantnagar								Kanpur								Mandya			
	Tillers/m^2				Panicles/m^2				Tillers/m^2				Panicles/m^2				Panicles/m^2			
	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean
CNN -1	175	162	167	168	127	118	132	126	333	424	447	401	329	420	444	398	338	427	476	414
CNN -2	180	165	162	169	137	118	123	126	326	410	443	393	320	406	440	388	246	349	446	347
CNN -3	180	160	158	166	127	127	128	127	313	397	435	381	305	393	430	376	297	413	486	399
CNN -4	173	177	150	167	130	115	120	122	335	436	465	412	329	431	461	407	304	395	479	393
CNN -5	173	163	135	157	135	120	123	126	329	446	462	412	322	441	459	407	253	421	452	375
ARRH7576	163	170	142	158	127	118	125	123	300	378	403	360	294	372	398	355	335	436	474	415
Rasi	170	160	130	153	133	115	118	122	326	422	409	385	318	416	406	380	249	344	456	350
Varadhan	170	152	137	153	133	133	118	128	322	437	462	407	315	431	458	401	197	362	409	323
MTU-1010	160	160	155	158	125	128	125	126	317	401	417	378	311	395	415	373	237	379	419	345
TI-93	163	147	157	156	133	130	142	135	315	402	422	380	306	395	419	374	289	408	452	383
Mean	**171**	**162**	**149**	**160**	**131**	**122**	**126**	**126**	**322**	**415**	**436**	**391**	**315**	**410**	**433**	**386**	**275**	**393**	**455**	**374**
CD(0.05)-M	NS				NS				4.39				4.43				20.2			
CD (0.05)-S	11				NS				18.2				18.7				13.4			
M X S	NS				NS				NS				NS				23.3			
S XM	NS				NS				NS				NS				25.8			
CV (%) M	17				14				2.45				2.50				11.7			
CV (%) S	7				11				4.96				5.13				3.82			

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.4: Screening of rice germplasm for Nitrogen use efficiency (NUE) , *Kharif* 2019 Total nutrient uptake (kg/ha)

Variety / N levels	Kanpur												Maruteru											
	Nitrogen				Phosphorus				Potassium				Nitrogen				Phosphorus				Potassium			
	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean
CNN -1	64	103	121	96	15.7	24.8	30.5	23.7	61	101	119	94	50	66	78	65	14.1	17.4	16.5	16.0	66	81	83	76
CNN -2	62	98	118	93	14.9	23.6	29.9	22.8	62	96	119	92	89	100	106	98	19.1	24.5	27.7	23.8	74	126	129	110
CNN -3	58	93	110	87	14.3	22.4	28.7	21.8	58	93	114	88	79	84	96	86	17.4	18.4	22.0	19.3	73	93	98	88
CNN -4	65	101	121	96	15.8	24.5	31.1	23.8	64	100	122	95	109	118	127	118	23.7	28.9	32.2	28.3	101	120	148	123
CNN -5	64	100	121	95	15.6	24.5	30.6	23.6	63	98	120	94	105	112	131	116	20.7	24.9	28.3	24.6	100	133	157	130
ARRH7576	54	87	104	82	13.0	21.0	27.0	20.3	54	86	108	82	80	100	111	97	19.0	26.8	23.9	23.2	91	125	107	107
Rasi	59	95	114	89	14.3	22.9	29.4	22.2	58	93	116	89	51	56	70	59	9.8	11.9	14.8	12.1	60	71	67	66
Varadhan	60	92	114	89	14.6	22.3	30.0	22.3	59	90	118	89	66	83	86	79	12.4	20.6	18.6	17.2	69	116	84	90
MTU- 1010	63	97	115	92	15.2	23.5	28.8	22.5	62	95	113	90	90	96	114	100	19.9	25.6	22.6	22.7	96	135	127	119
TI-93	60	88	113	87	14.5	21.4	28.9	21.6	60	87	114	87	79	105	110	100	18.2	24.2	26.3	22.9	91	123	101	105
Mean	**61**	**95**	**115**	**90**	**14.8**	**23.1**	**29.5**	**22.5**	**60**	**94**	**116**	**90**	**80**	**92**	**103**	**92**	**17.4**	**22.3**	**23.3**	**21.0**	**82**	**112**	**110**	**101**
CD(0.05)-M	0.99				0.27				1.24				4.8				0.69				7.5			
CD(0.05)-S	5.30				1.26				4.81				12.6				3.1				12.3			
M X S	NS				NS				NS				NS				NS				21.3			
S XM	NS				NS				NS				NS				NS				20.7			
CV (%) M	2.38				2.65				3.01				11.4				7.18				16.2			
CV (%) S	6.21				5.97				5.67				14.5				15.5				12.9			

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.4: Screening of rice germplasm for Nitrogen use efficiency (NUE) , *Kharif* 2019 Total nutrient uptake (kg/ha)

Variety / N levels	Raipur												Karaikal											
	Nitrogen				Phosphorus				Potassium				Nitrogen				Phosphorus				Potassium			
	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean
CNN -1	78	98	110	96	6.77	12.3	13.6	10.9	107	147	156	137	199	234	267	233	87	123	100	233	213	323	320	286
CNN -2	75	103	116	98	6.08	10.8	13.1	10.0	106	148	159	138	189	210	268	222	85	93	111	215	254	271	346	290
CNN -3	40	88	119	82	5.67	9.1	13.5	9.4	90	140	151	127	181	186	292	220	100	93	104	220	292	291	420	335
CNN -4	49	97	105	84	7.22	13.1	13.5	11.3	98	151	155	134	171	238	244	218	93	103	127	218	328	367	545	413
CNN -5	59	101	113	91	8.78	12.0	14.7	11.8	106	156	163	142	203	229	233	222	88	102	112	222	267	353	468	363
ARRH7576	73	125	137	112	13.50	12.7	16.4	14.2	145	185	194	175	237	241	247	242	121	107	123	242	284	361	340	328
Rasi	36	80	93	70	6.44	12.1	13.1	10.5	85	133	140	119	139	143	149	144	62	60	65	143	186	162	215	188
Varadhan	72	115	134	107	9.86	13.2	13.9	12.3	117	176	174	156	180	199	229	203	85	109	107	203	227	350	320	299
MTU- 1010	61	110	119	96	9.78	9.8	15.4	11.7	111	149	168	142	170	181	328	226	85	78	87	226	238	315	289	281
TI-93	47	100	103	83	6.98	9.9	9.8	8.9	102	127	151	126	106	156	182	148	54	84	88	148	148	262	274	228
Mean	**59**	**102**	**115**	**92**	**8.11**	**11.5**	**13.6**	**11.1**	**107**	**151**	**161**	**140**	**178**	**202**	**244**	**208**	**86**	**95**	**102**	**95**	**244**	**306**	**354**	**301**
CD(0.05)-M	1.46				0.32				0.88				NS				NS				NS			
CD(0.05)-S	2.48				0.81				2.14				38				18				61			
M X S	4.30				1.41				3.70				67				NS				NS			
S XM	4.18				1.35				3.55				69				NS				NS			
CV (%) M	3.46				6.20				1.37				45				39				47			
CV (%) S	2.87				7.76				1.62				20				20				22			

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.4: Screening of rice germplasm for Nitrogen use efficiency (NUE) , *Kharif* 2019 Total nutrient uptake (kg/ha)

Variety / N levels	Pantnagar												Mandya											
	Nitrogen				Phosphorus				Potassium				Nitrogen				Phosphorus				Potassium			
	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean
CNN -1	40	70	100	70	10.4	18.1	22.4	16.9	36	69	100	68	102	123	157	128	16.3	20.4	27.0	21.2	117	130	181	143
CNN -2	44	73	90	69	12.1	19.6	27.8	19.8	40	71	99	70	70	120	147	112	11.9	20.0	25.1	19.0	88	133	179	133
CNN -3	42	75	93	70	10.9	19.8	25.8	18.8	40	67	90	66	99	116	131	115	15.7	19.1	22.8	19.2	132	143	164	146
CNN -4	44	80	103	76	12.3	20.6	25.9	19.6	39	69	90	66	88	137	157	127	14.7	23.8	27.7	22.1	119	167	189	158
CNN -5	44	83	96	74	11.8	19.7	25.1	18.9	35	64	93	64	79	124	161	121	12.3	20.4	27.1	19.9	96	149	185	144
ARRH7576	43	79	96	75	12.1	34.8	25.9	24.3	39	81	98	73	120	133	152	135	19.3	22.3	26.1	22.5	153	169	189	170
Rasi	41	77	102	73	11.1	19.4	26.2	18.9	43	72	93	69	62	83	106	84	10.1	14.1	18.3	14.1	81	103	138	107
Varadhan	46	81	100	73	12.6	21.3	27.2	20.4	38	71	96	68	82	124	156	120	13.4	20.5	27.8	20.5	103	139	171	138
MTU- 1010	43	74	101	76	12.7	20.3	24.0	19.0	39	63	102	68	63	79	100	81	9.6	12.3	16.7	12.9	91	114	135	113
TI-93	45	82	99	73	11.8	20.5	24.4	18.9	34	71	94	66	61	97	123	93	9.7	16.5	22.1	16.1	91	133	161	129
Mean	**43**	**77**	**98**	**73**	**11.8**	**21.4**	**25.5**	**19.5**	**38**	**70**	**96**	**68**	**82**	**114**	**139**	**112**	**13.3**	**18.9**	**24.1**	**18.8**	**107**	**138**	**169**	**138**
CD(0.05)-M	2.66				5.4				2.27				5.08				0.33				6.5			
CD (0.05)-S	3.30				NS				NS				5.15				1.22				7.18			
M X S	5.72				NS				NS				8.92				2.12				12.4			
S XM	5.67				NS				NS				9.05				2.02				12.5			
CV (%) M	7.98				60.8				7.28				9.91				3.84				10.3			
CV (%) S	4.81				24.2				11				4.89				6.92				5.51			

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.4: Screening of rice germplasm for Nitrogen use efficiency (NUE) , *Kharif* 2019 Total nutrient uptake (kg/ha)

Variety / N levels	Purulia				Titabar				Pusa			
	Nitrogen				Nitrogen				Nitrogen			
	N1	N2	N3	Mean	N1	N2	N3	Mean	N1	N2	N3	Mean
CNN -1	53	57	73	61	32	46	80	53	18	31	34	28
CNN -2	61	62	67	63	44	49	67	53	23	42	64	43
CNN -3	40	50	69	53	44	49	75	56	31	34	37	34
CNN -4	59	65	68	64	42	54	80	59	33	39	62	45
CNN -5	67	71	75	71	44	53	74	57	18	35	39	31
ARRH7576	79	86	89	85	55	80	94	76	30	43	58	44
Rasi	54	56	67	59	37	50	56	47	29	44	48	40
Varadhan	72	90	98	87	45	48	61	51	39	42	43	41
MTU- 1010	53	87	107	82	58	55	95	70	33	35	45	38
TI-93	74	87	96	86	40	42	80	58	38	45	64	49
Mean	**61**	**71**	**81**	**71**	**44**	**52**	**77**	**57**	**29**	**39**	**49**	**39**
CD (0.05)-M	0.91				1.12				NS			
CD (0.05)-S	7.03				5.17				7.6			
M X S	12				8.95				13.2			
S XM	12				8.52				17.4			
CV (%) M	2.79				4.26				99.5			
CV (%) S	10.5				9.57				20.8			

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.5: Screening of rice germplasm for Nitrogen use efficiency (NUE) , *Kharif* 2019 Soil fertility status at harvest

Variety / N levels	Kanpur						Maruteru						Karaikal						
	pH	EC (ds/m)	OC (%)	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	pH	EC (ds/m)	OC (%)	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	pH	EC (ds/m)	OC (%)	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	S (Kg/ha)
N levels																			
N1	7.91	0.48	0.49	136	23.1	181	6.65	0.42	0.88	248	39.6	359	5.57	0.11	0.29	99	16.8	97	84
N2	7.90	0.53	0.54	173	20.6	177	6.52	0.48	0.93	299	59.1	348	5.62	0.06	0.26	89	22.4	80	89
N3	7.88	0.55	0.61	207	18.7	172	6.65	0.57	0.91	302	54.4	347	5.6	0.04	0.36	121	37.5	80	154
CD(0.05)	0.00	0.00	0.01	0.21	0.09	0.27	ns	0.01	ns	5.61	0.8	ns	ns	0.02	0.03	1.49	5.18	7.4	9.47
CV(%)	0.06	1.85	2.59	0.27	0.98	0.34	3.62	2.8	7.33	4.33	3.5	6.31	3.52	63.0	22.9	3.15	44.2	18.8	19.0
Variety																			
CNN -1	7.89	0.52	0.54	170	17.9	177	6.53	0.45	0.89	292	52.3	352	5.62	0.09	0.32	87	15.1	111	70
CNN -2	7.89	0.52	0.54	172	20.9	177	6.68	0.49	0.87	284	52.5	367	5.73	0.08	0.31	97	19.6	96	91
CNN -3	7.89	0.52	0.55	173	22.7	176	6.65	0.46	0.94	283	48.6	361	5.49	0.06	0.26	101	16.5	77	103
CNN -4	7.89	0.52	0.56	171	18.7	175	6.86	0.47	0.95	271	48.3	350	5.52	0.12	0.25	97	20.8	69	93
CNN -5	7.90	0.52	0.56	171	18.9	175	6.69	0.41	0.84	287	54.8	345	5.65	0.05	0.29	103	23.2	75	110
ARRH7576	7.90	0.52	0.55	174	24.6	178	6.48	0.52	0.87	296	50.1	356	5.6	0.06	0.35	106	32.2	88	76
Rasi	7.90	0.53	0.56	172	21.2	176	6.7	0.5	0.93	276	51.6	339	5.51	0.06	0.24	91	29.1	86	124
Varadhan	7.90	0.52	0.56	172	20.7	175	6.61	0.49	0.98	280	47.5	354	5.67	0.06	0.3	125	45.0	82	161
MTU- 1010	7.89	0.52	0.53	171	20.0	178	6.5	0.56	0.9	279	52.5	354	5.51	0.06	0.35	91	29.1	86	124
TI-93	7.90	0.53	0.54	173	22.2	178	6.38	0.57	0.9	278	52.0	335	5.59	0.07	0.34	114	29.9	90	133
CD(0.05)	ns	ns	0.02	1.69	1.79	1.36	0.27	0.04	0.06	12.6	3.89	19.2	0.12	0.03	0.05	8.52	5.00	11.0	36.9
CV(%)	0.12	2.97	3.02	1.04	9.13	0.82	4.32	9.54	7.5	4.7	8.08	5.8	2.35	53.0	18.91	8.76	20.8	13.7	36.0
Interaction																			
MXT	0.02	ns	Ns	ns	ns	2.36	0.47	0.08	0.11	21.9	6.7	ns	0.22	0.06	ns	14.8	8.66	19.1	64
TXM	0.01	ns	Ns	ns	ns	2.25	0.45	0.07	0.11	21.0	6.4	ns	0.21	0.06	ns	14.0	8.85	18.7	61
Mean	**7.89**	**0.52**	**0.55**	**172**	**20.7**	**177**	**6.61**	**0.49**	**0.91**	**283**	**51.0**	**351**	**5.6**	**0.07**	**0.3**	**103**	**25.6**	**86**	**109**

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705

Table 5.8.5: Screening of rice germplasm for Nitrogen use efficiency (NUE) , *Kharif* 2019 Soil fertility status at harvest

Variety / N levels	Pantnagar						MANDYA	Pusa
	pH	EC (ds/m)	OC (%)	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	Available N (Kg/ha)	Available N (Kg/ha)
N levels								
N1	7.35	0.36	0.54	177	10.6	193	217	192
N2	7.32	0.36	0.56	192	9.5	204	295	198
N3	7.41	0.4	0.60	255	13.4	206	324	202
CD(0.05)	ns	ns	ns	ns	0.9	ns	4.05	ns
CV(%)	2.08	44.3	25.2	76.8	17.1	16	3.17	5.45
Variety								
CNN -1	7.24	0.4	0.58	180	11.4	206	276	199
CNN -2	7.33	0.36	0.56	187	11.7	201	278	198
CNN -3	7.38	0.38	0.59	186	11.4	197	277	198
CNN -4	7.3	0.43	0.58	194	11.2	203	280	197
CNN -5	7.46	0.39	0.58	189	10.9	202	280	198
ARRH7576	7.4	0.4	0.56	193	10.9	201	276	197
Rasi	7.49	0.33	0.55	383	11.1	200	277	198
Varadhan	7.51	0.36	0.55	191	10.7	196	280	195
MTU- 1010	7.22	0.34	0.54	193	11.1	200	283	197
TI-93	7.27	0.34	0.57	187	11.3	203	279	197
CD(0.05)	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	3.19	23.3	14.5	86.9	7.0	5.69	3.68	1.61
Interaction								
MXT	ns	ns	ns	ns	ns	ns	ns	ns
TXM	ns	ns	ns	ns	ns	ns	ns	ns
Mean	**7.36**	**0.37**	**0.57**	**208**	**11.2**	**201**	**279**	**197**

CNN1- RP6252-BV/RIL/1689; CNN2- RP6252-BV/RIL/1690; CNN3- RP6252-BV/RIL/1692; CNN4- RP6252-BV/RIL/1700; CNN5- RP6252-BV/RIL/1705