# वार्षिक प्रतिवेदन
# Annual Report

## 2020

भाकृअनुप-भारतीय चावल अनुसंधान संस्थान

**ICAR-Indian Institute of Rice Research**

(An ISO 9001:2008 Certified Institute)

Rajendranagar, Hyderabad - 500 030

# वार्षिक प्रतिवेदन
# Annual Report

## 2020

भाकृअनुप-भारतीय चावल अनुसंधान संस्थान

ICAR-Indian Institute of Rice Research

(An ISO 9001:2008 Certified Institute)

Rajendranagar, Hyderabad - 500 030

**ISSN No. 2347-8985**

**Correct Citation:**
Annual Report 2020
ICAR-Indian Institute of Rice Research
Rajendranagar, Hyderabad - 500 030,
Telangana, India

**Compiled and Edited by:**
Dr. Chitra Shanker, Chief Editor and Chairperson
Dr. P. Raghuveer Rao, Dr. Y. Sridhar, Dr. K.B. Kemparaju, Dr. D. Ladha Lakshmi, Dr. S. Arun Kumar, Dr. Divya Balakrishnan, Dr. Kalyani M. Barbadikar, Dr. S. Bandeppa, Dr. Soumya Saha and U Chaitanya

**Published by:**
**Dr. R M Sundaram**
Director
ICAR-Indian Institute of Rice Research
Rajendranagar, Hyderabad - 500 030, India
Tel : +91-40-2459 1216, 2459 1258
Tel fax : +91-40-2459 1217
email : director.iirr@icar.gov.in
Website : www.icar-iirr.org

Printed at:
**Balaji Scan Pvt. Ltd.,**
11-2-1145, Beside Matas Temple, Opp: Subhan Bakery,
Nampally, Hyderabad, Telangana – 500001, INDIA.
Tel: 23303424/25, 9848032644 Press: 9248007736/37

Contents

# Contents

# Preface

I am privileged to place before you the annual report of the ICAR-Indian Institute of Rice Research, for the year 2020.

We are responsible for coordinating the world's largest network on Rice research with 44 funded centres and around 98 voluntary centres, involving more than 300 rice scientists, in addition to pursuing lead research related to irrigated rice ecosystem. In spite of the pandemic conditions prevailing in the past year, we could produce a record 118.87 million tonnes of rice during 2019-20. A total of 2040 trials covering all the major disciplines were conducted during 2019-2020, representing all the rice growing situations/ecosystems and states. During 2020, 54 varieties including 10 Hybrids for different ecologies have been released by both central and state varietal release committees. Breeder seed production of rice varieties and parental lines of rice hybrids was organized at 48 centres across the country for a target of 4398 quintals at the national level with a record production of 11,963 Quintals.

On the research front, in addition to institute funded projects, the Consortia Research Platforms (CRP) on Bio fortification, Hybrid technology, Agro-biodiversity, Molecular breeding and Incentivizing research and 47 other externally funded projects are presently in operation in the Institute including 13 new projects with a total outlay of Rs. 509 lakhs. In view of the ongoing pandemic, the institute utilized the virtual mode for its outreach activities, advisories and extension services.

The institute brought several accolades during the reporting period including patent and copyright applications and commercialization of technology. Two scientists were deputed abroad for advanced training and as consultant. I congratulate and appreciate all the staff members who have been bestowed with awards and recognitions in various research and development platforms. On a personal note, I take this opportunity to express my sincere gratitude to Dr. T. Mohapatra, Secretary DARE and DG (ICAR); Dr. T.R. Sharma, DDG (Crop Science), Dr. D.K. Yadava, ADG (Seeds), Dr. Y.P. Singh, ADG (F&FC), Dr. A.K. Tyagi, Chairman RAC and members of RAC for providing valuable guidance and suggestions towards implementation of various research programmes. I appreciate the support and cooperation from SAUs, AICRIP centres and sister ICAR institutes for their tremendous support during the pandemic for showcasing consistent progress in rice improvement.

Dr R. M. Sundaram
(Director)

# Executive Summary

# All India Coordinated Rice Improvement Project (AICRIP)

During the year 2020, a total of 54 varieties were released by Central Sub Committee on Crop Standards, Notification and Release of Varieties (CSCCSN & RV) and State Varietal release Committee (SVRC). Among these CVRC released 16 varieties and the State Varietal Release Committees released 38 varieties.

## Crop Improvement

- ✓ Forty-two varietal trials and four hybrid rice trials were conducted in 820 experiments at 118 locations (45 funded and 73 voluntary centres) in 28 states and 2 union Territories across seven zones of the country during 2019.
- ✓ In the 46 trials constituted with 1319 entries including 182 checks, twenty-two promising elite lines were identified for release.
- ✓ The Variety Identification Committee identified 10 varieties and 7 hybrids for release in different states during 2020.
- ✓ Breeder seed production of rice varieties and parental lines of rice hybrids as per the DAC indents was organized at 48 centres across the country, involving 282 varieties and parental lines of 5 rice hybrids for a target of 4398 quintals at national level. A record production of 11,963 Quintals was produced.
- ✓ At IIRR centre, 21 varieties were included in breeder seed production and produced 124 quintals covering 1.58 m ha of rice area.

## Crop Production

### Agronomy

- ✓ A total of 236 agronomy experiments were conducted at 49 locations during *Rabi* 2018-19 and *kharif* 2019 across the county.
- ✓ Eleven promising entries were identified of which IET 28812 and IET28813 were identified herbicide tolerant cultures to Imazethapyr.
- ✓ Mechanical transplanting of 15 days seedlings and mechanized line sowing was found promising.
- ✓ Alternate wetting and drying resulted in the highest grain yield.
- ✓ Mechanical transplanting with chemical weed control and/or mechanical weeding using weeder was superior in reducing weeds.
- ✓ Systemic post-emergence herbicide thiobencarb @ 5 L/ha applied at 20 days after sowing was found superior over other herbicide treatments.
- ✓ Two to five times lower weed population and biomass under IPM plots resulted in significantly higher grain yields compared to farmers' practice.
- ✓ The Rice Equivalent Yield (REY) of system productivity was higher at three locations due to rice- residue incorporation.
- ✓ The cultivars identified with better yields for late planting were AD 17037, ADT 53 at Aduthurai; Indiraero-1, MTU 1010, Co-51, IR 64, GNV-1089 at Gangavathi and KMP 175, Samleshwari, CR Dhan 201, Co-51 and CTH-3 at Mandya.

### Soil Science

- ✓ A total of 8 trials were conducted during *rabi* 2018-19 and *kharif* 2019 in 18 locations representing typical soil and crop systems and important rice growing regions.
- ✓ In the 31st year of study on long term soil fertility management in RBCS at three locations, the treatments RDF+FYM and RDF were at par and significantly superior to other treatments.
- ✓ The soil quality index showed variations in the quality and health of the soil across different farmers' categories. Application of gypsum in sodic soils in conjunction with

NPK produced the highest grain yields. The genotypes responsive to liming were RMS-1, GPV-1, RMS-5, Varadhan, RMS-1-4, Varadhan, RMS-8, GPV-3 and MTP-1.

- ✓ Nutrient Expert®'(NE) software derived fertiliser management recorded high grain and straw yields.
- ✓ Soil properties in bio-intensive pest management was significantly superior to farmer's practice.
- ✓ Crop residues can be deployed to substitute a part of the recommended nitrogen.
- ✓ The grain yield was significantly higher at 100% RDN.

### Plant Physiology

- ✓ Physiological studies under AICRIP were constituted in six trials at eight funded centers, two ICAR institutions and six voluntary centers.
- ✓ JKRH-3333 followed by IIRRH-122 responded well to Silicon application. Sahabhagidhan and IIRRH-131 showed maximum mitigation for Silicon application on water stressed plants.
- ✓ Based on drought indices IET 28252, IET 28256, IET 28245, Sahabhagidhan and US-314 were found relatively drought tolerant.
- ✓ Based on heat tolerance indices considered IET28387, IET28390, IET28393, IET28397, IET28403, Gontra bidhan-3 and IET28432 performed better.
- ✓ Screening for multiple abiotic stress tolerance IET 27762 show tolerance to salinity and water stress, IET 27768 and Mahulata performed well under salinity, water stress and anaerobic stress, IET 27356 show relative tolerance to water stress and anaerobic stress.
- ✓ Screening for submergence tolerance in rice, AC42088, Sabita followed by AC38575, AC42088 and Madhulata, AC42088, Sabita, Swarna Sub-1 and IC516009 show better survival percentage. A significant positive association was observed between the leaf starch content and % survival.
- ✓ IET27595, IET275995 and IET27596 showed tolerance to low light stress.

## Crop Protection

### Entomology

- ✓ Seven major trials involving 234 experiments encompassing various aspects of rice entomology were conducted at 41 locations in 22 states and one Union territory.
- ✓ Of seven screening trials involving 1652 entries evaluated at 42 locations against 11 insect pests, 64 entries (3.87%) were identified as promising.
- ✓ Against brown planthopper, 7 breeding lines *viz*., KNM 7629, MTU 1305, MTU 1306, MTU 1308, RMS-ISM-Bph33-1, RP 221-3-5-2, RP 179-3-9-1 were found promising. Four germplasm accessions *viz*., IC 216735, IC 76013, IC 75975 and IC 76057 performed consistently. Two germplasm accessions *viz*., CRCPT 7, and CRCPT 8 from NRRI performed better.
- ✓ One culture from Sakoli, SKL-07-8-720-63-147-182-276 was identified as promising to gall midge. One germplasm line IIRR-ENT-2019-17 and 14 pyramided lines (MTU1010 with gm3+Gm4 +Gm8) along with Aganni were identified as promising for gall midge.
- ✓ Three mutant cultures of PTB *viz*., Cul M8, Cul M9, Cul M6-2 and Kalluruli, a selection from landrace were found promising to leaf folder.
- ✓ Identified 12 entries promising to stem borer.
- ✓ Three entries and one culture *viz*., Sinnasivappu, JS5 (selection from Jaya) and SKL -07-11-177-50-65-60- and Cul7 were found promising against three pests.

- ✓ Gall midge biotype monitoring studies revealed that *Gm8* and *Gm1* hold promise across the locations.
- ✓ All insecticides module was found to be superior in reducing stem borer, plant and leaf hoppers, and leaf folder.
- ✓ Incidence of stem borer, gall midge, leaf folder, whorl maggot, hispa, case worm, and planthopper damage was more in late planting.
- ✓ Iron seed coating revealed low stem borer, gall midge, and brown planthopper incidence across the locations.
- ✓ In dry direct seeding stem borer, leaf folder and whorl maggot damage were relatively high.
- ✓ Multispecies pheromone blend attracted both rice leaf folder and yellow stem borer.
- ✓ Ecological engineering for pest management was found to suppress brown planthopper and stem borer damage while encouraging natural enemies with higher benefit cost ratio.
- ✓ The stem borer incidence was lower in bio intensive pest management as compared to farmers practice along with higher natural enemy population.
- ✓ Integrated pest management module was found effective against stem borer, gall midge, leaf folder, hispa and planthoppers as compared to farmers' practices.
- ✓ Light trap data indicated that yellow stem borer, leaf folder, and hoppers continued to be the most important pests. Gall midge continues to be an endemic pest. However, case worm, white stem borer, pink stem borer, black bug, gundhi bug and zigzag leaf hopper showed an increase.

## Plant Pathology

- ✓ A total of 13 trials were conducted at 49 locations on host plant resistance, field monitoring of virulence of major pathogens and disease management methods.
- ✓ Twenty-one promising cultures were identified across the screening nurseries and locations.
- ✓ Field monitoring of virulence of *Pyricularia grisea* revealed a shift in pathogen profile structure at many locations.
- ✓ Most of the differentials possessing single bacterial blight resistance were susceptible at most of the locations. The differential, IRBB 55 possessing two BB resistance genes *xa13* and *Xa21* showed susceptibility at 10 hot spot locations.
- ✓ Leaf blast and sheath rot was more severe in the late sown crop whereas neck blast and sheath blight were more severe in the early sown crop. BLB was high in normal sown crop. Rainfall had a greater impact on diseases like sheath rot and sheath blight.
- ✓ New fungicidal molecules *viz.*, prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/L) was found effective in reducing leaf blast and neck blast.
- ✓ The combination fungicide azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (1.0 ml/L) was effective against sheath blight and sheath rot. Hexaconazole 5% EC (2.0 ml/L) was effective against brown spot.
- ✓ Integrated disease management consisting of bio agent as seed treatment alone + propiconazole; bio agent as seed treatment + field application + propiconazole were found effective against leaf and neck blast.
- ✓ Neem oil and Clove oil @ 2 ml/L performed better in reducing the leaf blast severity, whereas Neem oil @ 2 ml/L alone was effective in reducing both leaf and neck blast disease severity.

## Production Oriented Survey

- ✓ During 2019, the survey was conducted in 16 states of India.
- ✓ Hybrid rice varieties occupied a significant area in states like Uttar Pradesh, Haryana, Chhattisgarh, Gujarat and Bihar.
- ✓ The major problems faced by the farmers were shortage of agricultural labour, high wages and irrigation water, timely availability of seeds, inputs, farm mechanization, market facility and farm loan.
- ✓ Diseases like blast, neck blast, sheath blight, brown spot, sheath rot, false smut, grain discoloration and bacterial blight were widespread almost throughout India. High incidence of bacterial blight and bacterial leaf streak were observed in some areas of Karnataka. Severe blast was reported from many districts of Telangana during *Rabi* season, 2020. The insect pests like stem borer, leaf folder and BPH were widespread throughout India. High incidence of BPH was recorded in parts of Kerala.

# Lead Research

## Crop Improvement

### Plant Breeding

- ✓ During 85th CVRC conducted on 9th November 2020, DRR Dhan 54 (IET No. 25653) an aerobic variety was identified and recommended for notification for cultivation in Telangana, Odisha, Jharkhand, Bihar, Haryana and Gujarat. DRR Dhan 56 a GSR variety for early transplanted conditions was also recommended for notification during 2020 for Punjab and Haryana.
- ✓ Novel QTL *qDS3.1* for resistance to BPH using RILs of Swarna/Sinnasivappu was identified and further narrowed down to 0.16 Mb from 1.12 Mb within SNP marker interval (C3-7457660 to C3-6520851).
- ✓ Elite advanced breeding lines and introgression lines developed in the background of elite cultivars *viz*., Swarna, WGL14, Krishna Hamsa, MTU1010 and NDR 359 are under testing in various AICRIP trials and also in station trials.
- ✓ Introgression lines ($BC_2F_5$) in the background of WGL14 and Krishna Hamsa have been identified with resistance to BB and tolerance to sheath blight. The ILs were developed using multiple donors.
- ✓ Multiple biotic stress (Bacterial leaf blight, Blast, BPH) resistant introgression lines were developed in the genetic background of Swarna, NDR 359, Improved Samba Mahsuri and MTU 1010.
- ✓ Two high grain protein lines with >10% GPC have been identified. Moderate to high Zn (15.2 to 23.54ppm) was observed in 156 six germplasm lines evaluated for zinc content.
- ✓ New sources of bacterial blight resistant sources were identified in wild species of rice (*Oryza minuta, O. australiensis, O. punctata* and *O. rufipogon*) which are resistant to multiple isolates. Further, BB resistance was identified in *O. glaberrima* introgressed into IR64. The stable $BC_2F_5$ BB resistant introgression lines were developed.

### Hybrid Rice

- ✓ A total of 106 *indica* tropical *japonica* derived lines were screened for fertility restoration genes *and* wide compatibility gene using reported markers. Out of 106 lines, 2 lines were identified with three gene combinations (*Rf3*/*Rf4*/*S5*n).
- ✓ Twelve promising abiotic stress restorers (PSV7272, VTCP25, VTCP38, NRR 11, NPVR27, NPVR 52, PSV 7505, PSV 736, PSV 433, PSV3636, PSV702 and PSV783) were identified as promising for yield contributing traits.
- ✓ Based on station trial evaluation, the new hybrid combinations (IR68897A/PSV1818, IR68897A/ NPVR32, IR68897A/NPVR48, and APMS6A/PSV729) were identified as promising hybrids.
- ✓ Restorer lines with multiple stress (BLB, blast, sheath blight, BPH, GM & drought, salinity, low P) resistance/tolerance were developed utilizing IR 36 GMS restorer population.
- ✓ $BC_1F_1$ population was generated between IR 58025B and YPK lines for genetic improvement of maintainers lines.
- ✓ A total of 134 genotypes was subjected to molecular characterization. 33 SSR markers were found to be highly polymorphic and grouped into 5 clusters.

### Biotechnology

- ✓ Two candidate genes associated with filling of grains viz., a sugar transporter (STP) (LOC_Os11g42430) and sucrose phosphate synthase (SPS) (LOC_Os02g09170) have been identified.

- ✓ Twelve major effect QTLs were identified in double haploid mapping populations (KRH2 (IR58025A/KMR3R)).
- ✓ Five major effect QTLs were identified using iso-cytoplasmic recombinant inbred lines (RILs) developed from the rice hybrid KRH2 (IR58025A/KMR3R).
- ✓ A very accurate, cost-effective and rapid assay has been developed to test the purity of bulked parental line (A-line) seed using a co-dominant mitochondrial marker in a genetic analyser.
- ✓ Two unique genomic regions on chromosome 4 and chromosome 12 for complete panicle exertion (CPE) were identified. Four candidate genes viz. F-Box domain containing protein, DUF domain contain protein, Zinc finger and a protein kinase are present in the region identified.
- ✓ Whole-genome expression differences in six different rice genotypes (TN1, BPT 5204, Tetep, Pankaj, Vandana and N22) during sheath blight disease were profiled using RNA-sequencing.
- ✓ The in-silico analysis of the marker-trait associations on 118 highly diverse rice lines for root traits identified abiotic stress related genes viz. NAM, LEA, brassinosteroid insensitive 1, spanning the nearby regions of the markers implying high co-relation of the marker with the root and yield traits contributing to aerobic adaptation.

## Crop Production

### Agronomy

- ✓ Application of water through AWD – automation saved 15% of water in all methods of crop establishment methods. Eco Agra – a water saving product found promising.
- ✓ In Andhra Pradesh potential area for aerobic rice cultivation was worked out to 48,77,400 ha and in Telangana State it was 311700 ha.
- ✓ Both mechanical weeding and chemical weed control were comparable.
- ✓ Penoxsulam 30 and 60 g a.i./ha and bispyricbac sodium were on par in reducing weed population.
- ✓ Highest system productivity of 13.2 t/ha was recorded in *Kharif* rice transplanted on 1st July followed by conventional tilled maize in *rabi*. Higher bacteria (193 x $10^6$) and actinomycetes (105 × $10^4$) population were observed under transplanted plots compared to those under direct wet seeded plots.
- ✓ About 2 to 12% reduction in grain yield in different varieties/cultures was observed when sowing was done on August 8 compared to July 25.
- ✓ Integrated nutrient management with organics and inorganics resulted in higher crop growth and yield attributes such as increased grain yield and straw yield.

### Soil Science

- ✓ The genotypes, PSV 190, PSV 469, PSV 344, PUP 221, Varadhan and land races IC463254, Kola Joha-3 and IDSA77 performed well without external N application. Coating with Allicin 2000ppm coating and NBPT1000 ppm increased NUE and yields.
- ✓ The methane emissions decreased by more than 40 per cent in SRI and by 49 and 54 per cent in AWD. Nitrous oxide emissions were higher by 31 per cent in SRI and 42 - 44 per cent in AWD. The water productivity ranged from the lowest of 4.49 kg ha $mm^{-1}$ in TPR to 5.98, 6.27 and 6.41 kg ha $mm^{-1}$ in SRI and AWD at 5 and 10 cm depletion respectively.
- ✓ A significant positive relation between NDVI and rice productivity was observed while NDVI was negatively influenced by increased pH.
- ✓ A large variation up to the tune of > 70% was noticed for soil organic carbon percentage

and stocks among the four different rice ecologies. The mean surface soils carbon content of irrigated areas was 0.39% and it ranged from 0.13% to 0.78%.

- ✓ Inoculation of rice seeds with endophytic actinobacterial isolates improved germination percentage and mean germination rate of rice. PKS-I genes were detected in 13.3% of the isolates, while 66.6% of the isolates were found to harbour PKS-II genes and NRPS genes were detected in 26.66% of the isolates. The predicted products of the genes were surfactin, yanuthone, granaticin, monensin and gramicidin possessing antimicrobial and antiprotozoal activity.
- ✓ A total of 432 nitrogen fixing bacteria were isolated, among which eleven isolates were promising with high ARA activity. Nine potential phosphorus solubilising microbes isolated were identified through 16S rRNA gene. Four isolates were able to solubilize K and Zn.
- ✓ The stability of the ZnO nanoparticle suspension was improved to 45 min by the addition of sulfate dodecyl acetate (SDS) surfactant agent. Two sprays of nano ZnO @ 150 mg $L^{-1}$ increased the Zn content in straw, brown rice and husk by 76, 41 and 47 per cent.
- ✓ FYM + 75% RDF+ hydrogel @ 5 kg/ha recorded 24% higher grain yield and 20% higher straw yield compared to control (100% NPK). Hydrogel applied plots recorded 9 to 30% increase in soil moisture content compared to untreated plots.

### Plant Physiology and Biochemistry

- ✓ Significant variation was observed for leaf photosynthetic efficiency and its associated factors among 30 advanced breeding lines of rice (IVT-E-TP).
- ✓ Application of 0.6% silicon in two genotypes Chandra and KRH-4, increased yield and yield attributes
- ✓ Gene expression studies indicate that variation in the availability of branching enzymes is responsible for the variation in cooking quality. In ageing experiments, protein content decreases, gel consistency becomes hard and preliminary analysis indicates variation in c18 group fatty acids.
- ✓ Silica content in different parts of the rice plants was analysed from 65 different varieties and the highest silica content was found in husk followed by straw.
- ✓ A simple low-cost process for silicic acid formulation for foliar spray without stabilizer was developed. The silicon content was 2.5 times higher than that of the commercial formulation.
- ✓ Slow releasing urea (SRU) gave better performance for increasing yield and yield parameters.

## Crop Protection

### Entomology

- ✓ Eight Haplo NILs (IRGC 135572-NEANG AN, IRGC 128108 -MAUNG NYO, IRGC 128164 -SIDJERO GUNDIL, IRGC 127818-SLOBOK, IRGC 128075-KAZALSAIL, IRGC 132021-OB CHUEY, IRGC 127793-SEMENDANG and IRGC 125966-IA CUBA 17) were found resistant to brown planthopper.
- ✓ Eight entries (IET 29308, IET 28993, IET 29002, IET 28991, IET 28988 and IET 29308) were found resistant brown planthopper.
- ✓ Lines of RP5587 and RP5588 showed non-preference while some lines of KMR3 showed tolerance mechanism of resistance to stem borer.
- ✓ One line of RP6506 was found promising at Jagdalpur (biotype1) and Warangal (Biotype4M).
- ✓ 20 BILs (Swarna X *Oryza nivara*) were found resistant to leaf folder. Inclusive Composite

Interval Mapping revealed 7 QTLs for damage area on chromosomes 1,2,3,10 and 11 and 1 QTL for damage score on chromosome 5. qDS5.

- ✓ Slow-release pheromone blends and multi species pheromone blends for rice leaf folder and yellow stem borer were found superior.
- ✓ A new molecule, BASF 560 00 I @30 g a.i./ ha was found superior in management of brown planthopper in rice without any adverse effects on the natural enemies.
- ✓ The stem borer and leaf folder incidence were lower in the BIPM module with *Trichoderma* treatment. Whereas, yield was highest in BIPM with *Pseudomonas* and *Bacillus* treatments. Benefit cost ratio in BIPM modules was higher.
- ✓ Six genotypes (KPM, LD24, Dhanrasi, Vandana, Swarnadhan and Aganni) were resistant and two genotypes (DRR Dhan 41 and DRR Dhan 55) were moderately resistant to root-knot nematode, *Meloidogyne graminicola* in pot culture experiments.
- ✓ Two insecticides *viz*., Cartap hydrochloride (4G) and Carbofuran (3G) were found effective against rice root nematode *Hirschmanniella* spp. under field conditions and rice root-knot nematode *M. graminicola* under pot culture conditions.

## Plant Pathology

- ✓ DRR Dhan 53, a MAS derived, durable bacterial blight resistant high-yielding, fine-grain type rice variety having the major bacterial blight resistance genes, *Xa21+xa13+xa5+Xa38* with seed-to-seed maturity of 130-135 days and average yield of 5.5-6 t/ ha was developed.
- ✓ 1721 lines were found resistant to blast disease.
- ✓ Thirty-eight accessions of NSN-1 & 2 (2019) were reconfirmed for their bacterial blight resistance against *Xoo* strain IX-020.
- ✓ Identified 36 entries (which were multiple donors for bacterial blight blast, gall midge, BPH, yield and drought stress) with very high level of resistance.
- ✓ Five accessions *viz*., CG-61 (*O. officinalis*), CG-125 (*O. rufipogon*), CG-146 (*O. punctata*), CG-154 (*O. minuta*) and CG-164 (*O. australiensis*) were found with moderate to high level of resistance against 5-6 virulent strains of *Xoo*. Twenty-eight accessions of *Oryza glaberrima* were identified with high level of resistance against bacterial blight.
- ✓ Eighty-one isolates of *R. solani and Rhizoctonia* spp. were collected from major rice growing areas of Tamil Nadu and Chhattisgarh state and characterized.
- ✓ Whole genome sequencing (WGS) of 32 *R. solani* isolates from all different rice ecosystems in India were grouped based on the cultural, morphological, microscopic and WGS.
- ✓ Patho-phenotyping of RILs identified six highly tolerant RILs *viz*., RP-5976-243-15-8-81, RP-5976-210-5-12-20, RP-5976-45-30-12-16, RP-5976-5-28-2-11, RP-5976-78-2-4-19 and RP-5976-78-26-6-2. Out of 6000 germplasm entries, identified slow blighting entries *viz*., IET # 22272, 23642, 24518, 23542, 25157, CB-11-107, CB-05-022, DRR-BL--155-2, 25196, 26326, 25341, 26652 and 25912.
- ✓ 23 lines expressed tolerant reaction against false smut of which the germplasm lines IC334233, IC335422 and IC282421 were found moderately resistant against false smut disease.
- ✓ 43 resistant entries with the score 3 were identified to rice tungro. 12 high level of resistant lines with a disease score of 1-3 were identified.
- ✓ Culturing of *U. virens* in rice leaf extract broth

for about 5 to 6 days resulted in high amount of conidia. Incubation of cultured *U. virens* conidia in potato sucrose broth for 12 hours induce the germination and increased the percentage of disease infection.

- ✓ *In vitro* assay using detached leaf technique found that spray inoculation with spore suspension of *B. oryzae* (@$10^5$ conidia/ml) was more effective in inducing brown spot.
- ✓ Injection method of inoculation was best for producing sheath rot. Typha leaf bit method was found suitable for large scale screening purpose of stem rot.
- ✓ Two oils *viz*., cinnamon bark oil and cinnamon leaf oil showed high level of inhibitory activity against *Xoo in vitro*.
- ✓ Essential oils *viz*., Thyme, Cedar wood, Organo oils were effective against sheath blight disease in both greenhouse and field. GC-MS results showed limonene followed by cymene, himachalene and atlantone in cedar wood oil, and limonene in case of oregano oil as main compounds.
- ✓ Cinnamon bark and Cinnamon leaf oil completely inhibited the mycelial growth of *U. virens* at all the five concentrations *in vitro*. Lemon grass oil and Clove oil inhibited the mycelial growth at 0.2% and 0.3% concentrations onwards, respectively. Citronella oil and Cedarwood oil were effective at 0.5% concentration.
- ✓ *Rb8* followed by *Rb12* from 25 isolates of rhizosphere bacteria was found most effective against *B. oryzae in-vitro*.
- ✓ Soapnut followed by garlic, *Datura* and *Ocimum* sp. were the most effective botanicals against *B. oryzae*.
- ✓ *In-vitro* evaluation indicated the chemicals Mancozeb 63% + carbendizm 12% WP, azoxystrobin 11.5% + mancozeb 30%WP and tebuconazole 250EC, organic amendments vermicompost, karanja cake and neem cake; eucalyptus, cedarwood and lemon grass oils were found promising in the control of *Sclerotium oryzae*.
- ✓ The sequence of the purified DNA samples was generated, analyzed and submitted to NCBI of *Trichoderma asperellum* IIRRCK1 (TAIK1) and Bacillus subtilis IIRRCK3 (BIK3) isolated from native soils of rice fields. TAIK 1 was submitted to NBAIM for registration. A purified compound, 6-pentyl-2H-pyran-2-one was identified from secondary metabolites of TAIK1.

## Training and Transfer of Technology

- ✓ An exploratory study on climate change and rice farming conducted with 200 rice farmers covering 10 villages documented the farmer's perception and adaptation strategies in Koraput district of Odisha.
- ✓ Training of trainers' approach was used as an adaptation to the COVID induced disruptions for dissemination of technologies in selected villages along with demonstration of Seed smart, Technology smart, Water-smart, Nutrient-smart practices.
- ✓ Mapping of potential stakeholders involved in transfer of rice knowledge for the proposed digital extension ecosystem, selected start-up projects were analyzed to capture their role in the framework.
- ✓ Based on the relevance and effectiveness of the sequential rice messages to the farmers, farmer producer organizations based EAS scheduling system and a learning module for FPO extension professionals is being developed.
- ✓ The number of rice varieties increased by 1.8 times and number of hybrids notified by 5.8 times respectively compared to the period of 1991-2000. PVP and GI are complementing each other in promoting varietal development and biodiversity.

- ✓ Economic, Energy and Sensitivity Analysis comparing conventional and the system of rice intensification methods of rice cultivation recommended the adoption of environmentally friendly SRI method of crop establishment in the Telangana region in terms of higher productivity, net returns, energy efficiency and sustainable rice production.
- ✓ On-Farm Adoption of IPM Technologies and impact analysis studies trained farmers on locally adoptable IPM components and it resulted in the increased adoption of important IPM practices leading to higher yield and better returns.
- ✓ The developed models in the statistical modelling and soft computing approaches for genomic selection in rice outperformed the classical ANN and SVR. The artificial neural network intervention models were developed to assess the impact of policies or intervention in time series data.
- ✓ About 14 farmers training programs were organized and about 805 farmers were trained on improved rice production technologies and other identified interventions to enhance yield and profitability.
- ✓ Overall 2430 tribal farm families in eight states were benefitted with cafeteria of rice related technologies. The targeted farm household were given improved rice varieties, and other critical inputs capable to breaking the yield barriers. By imparting the subject matter training about the technical know-how and do-how of rice cultivation, the extension gaps were minimized along with technological gaps.
- ✓ Under the ICAR-IIRR-SCSP, critical inputs like paddy seed (2,630), drying sheets (650), sprayers (290), fertilizers (120), pheromone traps and lures (58), herbicide (58), insecticide (58) and fungicide (58) were distributed to the SC beneficiaries. Training programmes on IPM, Good agricultural practices, INM were organized.

Introduction

# Introduction

**Genesis**

**Mandate**

**Organization**

**Infrastructure**

**Linkages**

**Staff & Budget**

# Introduction

## Genesis

The All India Coordinated Rice Improvement Project (AICRIP) was established in 1965 at Hyderabad, with the responsibility to organize multi-disciplinary, multi-location testing and develop suitable varietal and production technologies. AICRIP capitalized upon the available research infrastructure in different states of India and successfully introduced a national perspective in technology development and testing. AICRIP was later elevated to the status of Directorate of Rice Research (DRR) from April 1983 with the added mandate of pursuing research on irrigated rice.

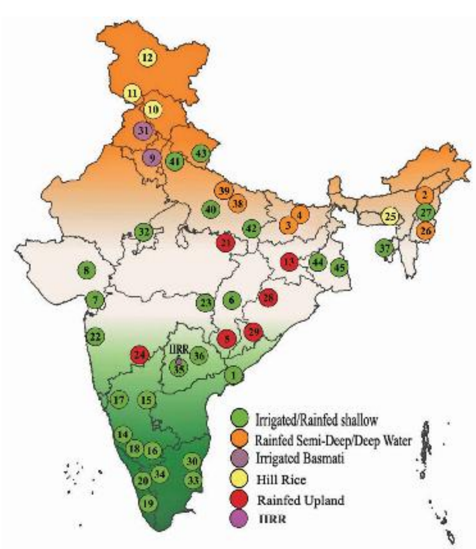
In 1965, AICRIP was started with 22 centers (19 main and 3 testing centers) with 7 zonal centers and 12 regional centers. During the fifth five-year plan (1974-79) the main and sub centers were classified as single cropped (24) and double cropped (21) centers. Excepting Pondicherry and Varanasi which were fully funded by the ICAR, the rest of the centers were financed in the ratio of 75:25 with State Agricultural Universities (SAUs-25%) or 50:50 per cent basis with State Departments of Agriculture (SDAs – 50%). During VI plan period (1980-85), 8 more sub centers were sanctioned raising the total to 53. There was a total of 61 centers including 8 subject related special centers. In the VII plan period (1985-89) the number of centers was reduced to 50 (18 main and 32 sub centers. During the eighth plan (1992-97) there were 51 approved centers of which six centers were withdrawn and Karnal centers was merged with Kaul in the IX plan period (1997-2002). The total number of centers during X plan (2002-2007) increased to 46 with the approval of Kanpur and Nagina centers and to 47 during XI plan (2007-2012) with the addition of Navsari in southern Gujarat in western India. Two centers were dropped in XII plan due to poor performance. The Institute (AICRIP) has evolved into an efficient and successful program of partnership in rice research bringing together more than 300 rice researchers from 45 funded and over 100 voluntary research centers.

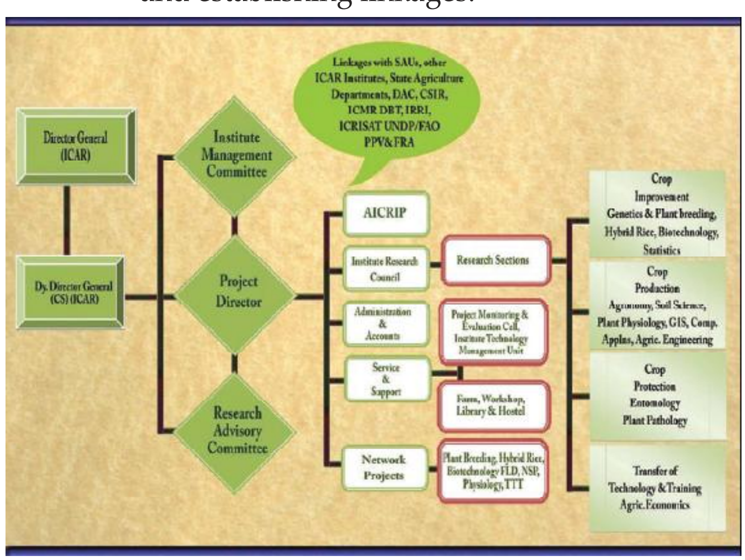
## The Mandate

Basic and strategic research for enhancing rice productivity under irrigated ecosystem.

Coordination of multi-location testing to develop location specific varieties and technologies for various ecosystems.

Dissemination of technologies, capacity building and establishing linkages.



## The Organisation

IIRR is an important constituent institute of ICAR under direct supervision of the Deputy Director General for Crop Sciences. The detailed organizational setup of the Institute is provided in the organogram. For fulfilling its mandate effectively, IIRR is organized into four sections and ten units along with centralized service wings and administration. AICRIP activities are integrated into the mandate with senior most scientists of each discipline acting as the PIs of the programme. There are 45 funded and more than 100 voluntary centers involved in rice research activities. Research and institutional activities are planned and guided by Research Advisory Committee and Institute Management Committee while the progress is critically evaluated once in five years by the Quinquennial Review Committee (QRT).

| S. No. | Center | S. No. | Center | S. No. | Center | S. No. | Center |
|---|---|---|---|---|---|---|---|
| 1 | Aduthurai | 13 | Jeypore | 25 | Mugad | 37 | Ranchi |
| 2 | Agarthala | 14 | Kanpur | 26 | Nagina | 38 | Rewa |
| 3 | Bankura | 15 | Karjat | 27 | Navasari | 39 | Sakoli |
| 4 | Brahmavar | 16 | Kaul | 28 | Nawagam | 40 | Titabar |
| 5 | Chatha | 17 | Khudwani | 29 | Pantnagar | 41 | Tuljapur |
| 6 | Chinsurah | 18 | Kohima | 30 | Patna | 42 | Upper shillong |
| 7 | Chiplima | 19 | Kota | 31 | Pattambi | 43 | Varanasi |
| 8 | Coimbatore | 20 | Ludhiana | 32 | Pondicherry | 44 | Wangbal |
| 9 | Faizabad | 21 | Malan | 33 | Ponnampet | 45 | Warangal |
| 10 | Gangavati | 22 | Mandya | 34 | Pusa | | |
| 11 | Ghaghraghat | 23 | Maruteru | 35 | Raipur | | |
| 12 | Jagdalpur | 24 | Moncompu | 36 | Rajendranagar | | |

## Infrastructure

The Institute is equipped with state-of-the-art facilities with fully equipped laboratories for all the sections, centrally air-cooled greenhouses for screening germplasms for resistance against pests and diseases, net-houses, growth chambers, screening nursery beds, containment transgenic poly-houses and heat tunnels. Field facilities include well laid out experimental farms at Rajendranagar (20 ha) and Ramachandrapuram (40 ha) with a wild rice garden and pollination chambers along with adequate farm machinery, warehouses and limited cold storage facilities. A centrally air-conditioned auditorium with a seating capacity of 350, seminar halls, guest house, hostel facilities and a canteen, have been established for imparting training and to disseminate information using the latest multi-media and ICT tools. The Central library of the institute is fully digitized with over 4,654 books, 6,500 bound volumes and subscribes to 55 Indian and 13 foreign journals. The significant achievements of the Institute are exhibited in the form of posters, graphs and other visuals for the benefit of visitors through a state-of-the-art museum.

## Linkages & Collaborations

ICAR-IIRR has a strong and wide network of linkages and collaborations with research organizations both in India and abroad. Under AICRIP, it has 45 funded centers affiliated to State Agricultural Universities and Departments of Agriculture of 27 states and 2 Union territories, besides five ICAR institutes. About 90-100 voluntary centers are also providing support in the evaluation and testing work.

***Research Linkages:*** ICAR-IIRR has a strong collaboration with CGIAR institutes such as International Rice Research Institute (IRRI), Philippines and International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad and many National institutes like CRIDA, Hyderabad, NBAIR (Bengaluru), NBPGR, New Delhi (ICAR); PPV&FRA, New Delhi, IICT (CSIR), NIN (ICMR), Hyderabad, IICPT, Delhi University, Centre for Cellular and Molecular Biology (CCMB), Hyderabad and Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad.

***Academic linkages:*** ICAR-IIRR has accreditation from several universities such as ANGRAU, PJTSAU, IGKV, Osmania University, University of Hyderabad, Jawaharlal Nehru Technological University, Yogi Vemana University, Kakatiya University, University of Agricultural Sciences, Bangalore, Acharya Nagarjuna University etc.,

ICAR-IIRR also has a strong **Public Private Partnership** (PPP) mode of operational linkage with the private sector, especially relating to hybrid rice technology and its commercialization. This partnership started two decades back has turned out to be one of the best examples of PPP in the country.

## The Staff

*As on 31st March, 2020*

| S. No. | Category | Sanc-tioned | Filled | Vacant |
|---|---|---|---|---|
| 1 | Scientists | 71 | 68 | 3 |
| 2 | Administration | 32 | 23 | 09 |
| 3 | Technical | 43 | **34** | 09 |
| 4 | Supporting Grade | 09 | 07 | 02 |
| | **Total** | **155** | **132** | **23** |

## The Budget (2020)

*(Rupees in lakhs) As on 31st March, 2021*

| Item | 2020-21 | |
|---|---|---|
| | Outlay | Expenditure |
| IIRR, Hyderabad | 4387.81 | 4249.44 |
| AICRP Rice, Hyderabad | 3515.78 | 3515.78 |

# Research Achievements

## Coordinated Research

### Crop Improvement

New Varieties and Hybrids released

### Crop Production

Agronomy

Soil Science

Plant Physiology

### Crop Protection

Entomology

Pathology

### Transfer of Technology

# All India Coordinated Rice Improvement Project (AICRIP)

## Crop Improvement

### New Varieties and Hybrids released

During the year 2020, a total of fifty-four varieties were released by the Central Sub Committee on Crop Standards, Notification and Release of Varieties (CSCCSN & RV) and State Varietal release Committee (SVRC). Among these CVRC released 9 varieties and 7 hybrids the State Varietal Release Committees released 35 varieties and 3 hybrids. The Variety Identification Committee identified 10 varieties and 7 hybrids for release in different states during 10$^{th}$ June 2020 of 55$^{th}$ ARGM.

**Table 1: List of Varieties and hybrids released by Central and State Varietal Release Committee during 2020**

**CVRC Release Varieties 2020**

| Sl. No | Variety | IET No | Designation | Cross combination | FD | GT | Ecosystem | Yield t/ha | Reaction | Recommended state |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CR Dhan 308 | 25523 | CR 3505-7-1-1-1-2-1 | IR 36/Vijetha | 130-135 | MS | Rainfed | 5.03 | R- FS, GD, RTD, MR-BS, BB, NB | CH, MH |
| 2 | CR Dhan 312 | 25997 | | | 106 | MS | IRM | 6.3 | MR-BL | MH, CH |
| 3 | CR Dhan 313 | 25489 | CR 3511-3-2-2-5-1-1 | IR 36/Surendra | 101 | MS | Rainfed | 4.7 | R – FS, MR-BL, NB, LB | MH, CH |
| 4 | CR Dhan 602 | 25692 | IR 82489-7-2-2-2-CR 3724-1 | IR 72967-12-2-3/PR 31090 – 33-2-1 | 129-138 | LS | BORO | 5.7 | MR – LB, SB, SR, | AS, TR |
| 5 | MP 3030 | 25764 | | 100727A/ 100874 | 94 | LS | IRME | 6.5 | | HR, UK, MH, GU |
| 6 | MRP 5222 | 25269 | MEPH 126 | PMS 305/ PR590 | 112-117 | MS | IRL | 5.2 | MR- LB, NB, BLB | WB, BI, OD, MH |
| 7 | PAC 8744+ | 25785 | ADV 1603 | | 100-105 | LB | IRM | 6.5 | MR- BLB, NB, LB | HA, JK, UT |
| 8 | Pusa Basmati 1692 | 26995 | Pusa 1692-10-20-1-1-1 | Pusa Basmati 1509/Pusa 1601 | 82 | LS | Basmati | 5.2 | MR- Blast | DE, HA, UP |
| 9 | Sandhya | 25508 | | | 105 | MS | IRME | 5.4 | MR-BL & T-BS | CH, TS |
| 10 | SAVA 134 | 24797 | | F 819/Y 1015 | 90 | LS | IRE | 6.8 | MR-BL, BS & GM | HR, PU, AS, UT |
| 11 | Swarna Shakti Dhan | 25640 | | IR78877-208-B-1-1/IRRI 132 | 84 | SB | ARB | 4.9 | T-BL, BLB, BS & SB, R-ShBl | HR, OD, BI, JH, CH, GU, MH |
| 12 | Telangana Vari 1 | 25330 | | RP 4516-3-6/ Kavya | 102 | LB | IRM | 6 | MR-BL | OD, WB, TN |
| 13 | US 303 | 25804 | | 5030A/6384-4R | 102 | MS | IRME | 5.3 | R-BL, ShBl& BS, MR-BLB & GM | CH, MH, MP |
| 14 | US 380 | 25728 | | 5014A/1066R | 94 | MS | IRE | 5.6 | MR-BLB & BS | CH, MP |
| 15 | Uttar Lakshmi | 24173 | | MTU 7029/ Annada | 135 | SB | BORO | 5.7 | T-SB | WB, OD, TR |
| 16 | KPH 471 | 25746 | KPH 471 | | 120-124 | LS | IRT | 7.6 | MR- LB | HA, PU, UT, TS, KE, KA |

SVRC Release Varieties 2020

| Sl. No | Variety | IET No | Designation | Cross combination | FD | GT | Ecosys-tem | Yield (t/ha) | Reaction | Recom-mended state |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ADT 54 | 24249 | AD 09493 | I.W. Ponni/ Banskathi | 100-105 | MS | | 6.3 | R- LF, MR-SP, Blast | TN |
| 2 | Bastar Dhan 1 | 26624 | | Rastic BR 240/ Chander | 75-80 | LS | | 4.8 | T- LB, NB | CH |
| 3 | Bhavathi | 27124 | BPT 2782 | NLR 145/MTU 2077 | 110-115 | MS | | 5.6 | R- LB, | AP |
| 4 | Chhattisgarh Rice Hybrid 2 | 24956 | IRH-103 | IR 79156A/R-710-32 | 95 | LS | IME | 6.0 | | CH |
| 5 | CO 53 | 24057 | CB 06803 | PMK (R) 3/ Norungan | | SB | | | MR- LB, NB, SR, BS, RTD | TN |
| 6 | CR Dhan 102 | 25121 | CR 3951-3-2-2-1-1 | IR64/PSB RC 52 | 80-85 | SB | | 3.3 | MR- LB, RTV | OD |
| 7 | CR Dhan 210 | 23449 | CR 3630-1-2 | IR 7002-247-1-1-2/ IR 77080-B-34-1-1 | 86 | LS | Aerob | 3.7 | MR-LB, NB, BS, SR | OD |
| 8 | CR Dhan 410 | 24471 | CR 2683-45-1-2-2-1 | CRLC899/Ac.38700 | 130 | LS | RSL | 4.3 | MR- NB, BB, SR, BS | OD |
| 9 | Eenotphou | 22469 | | Moirangphou/ Leimaphou | 110 | LB | IRL | 4.5 | MT-BL, BS, SB & GM | MN |
| 10 | GR 17 | | NVSR 2117 | | 83-86 | LB | | 5.5 | | GU |
| 11 | Him Palam Dhan 1 | 22294 | | RP 2421/VL Dhan 221 | 78 | SB | HRUR | 2.1 | R-BL & T-LF | HP |
| 12 | Him Palam Dhan 2 | 24209 | | HPU 2216/Tetep | 87 | MS | HRIR | 5.5 | R-BL & LF | HP |
| 13 | IR 64 Sub 1 | 21247 | IR 64 Sub 1 | IR 64*3/IR 49830-7-1-2-3 | 103 | LS | IRM | 3.2 | T- BLB, SB, LB, NB, RTD | UP |
| 14 | Jagtiala Rice 1 | 25310 | JGL 24423 | (MTU 1010/NLR 34449)/ MTU 1010 | 120-125 | LB | | 6.9 | T- Blast, BS | TS |
| 15 | Kunaram Rice 1 | 27405 | KNM 733 | MTU 1010/JGL 11470 | 85-90 | SS | | 6.5 | R- LB, MR- NB | TS |
| 16 | Mangalphou | 22833 | | RCM 7/V20 B | 70 | LS | IRE | 4.5 | T-BL & BS | MN |
| 17 | Maruteru Mahsuri | 27151 | MTU RM 67-14-1-1-1 (MTU 1262) | (BPT 5204/NLR 3449)/ MTU 1075 | 125 | MS | | 5.9 | MR-BLB | AP |
| 18 | Maruteru Samba | 26225 | MTU RM 71-42-1-1-1 (MTU 1224) | (JGL 3884/NLR 3449)/ BPT 5204 | 100-105 | MS | | 5.5 | R- LB | AP |
| 19 | Maruteru Sujatha | 25305 | MTU 2274-3-2-2 (MTU 1210) | MTU 1001/KMP 150 | 105 | MS | | 6.6 | R- LB | AP |
| 20 | MRP 5433 | 25793 | MEPH-129 | PMS 315/PR 563 | 110 | MS | IRM | 5.5 | | MH |
| 21 | MRP 5626 | 26198 | MEPH-134 | PMS 85/PR 620 | 84 | LS | ARB | 5.07 | R- LB, NB | BI |
| 22 | Nellore Dhanyarasi | 26226 | NLR 3354 | NLR 34242/NLR 34303 | 95-100 | MS | | 4.9 | T- Blast | AP |
| 23 | Nellore Siri | 25273 | NLR 4001 | NLR 145/ MTU 5249 | 110-115 | MS | | 4.7 | T- NB | AP |
| 24 | Nellore Sugandha | 23194 | NLR 40054 | MTU 7029/RNR 19994 | 100-105 | MS | | 6.4 | T- LB, SR | AP |
| 25 | Numali | 27405 | Numali | APMS 6B/Piolee | 106 | LS | | 5.2 | Blast, BLB, LB, SB, NB, SR, RTD | AS |
| 26 | Pant Dhan 22 | 20533 | | Pant Dhan 12/UPR 1600-31-1-1 | 94 | MB | IRME | 6.1 | MR-SB | UK |
| 27 | Pant Dhan 28 | 23227 | | IR 72981-92-1-1-2-2/UPRI 99-1 | 86 | LS | IRM | 4.1 | MR-BS | UT |
| 28 | PR 127 | 23691 | | | 110 | LS | IRM | 7.5 | | PU |

| Sl. No | Variety | IET No | Designation | Cross combination | FD | GT | Ecosys-tem | Yield (t/ha) | Reaction | Recom-mended state |
|---|---|---|---|---|---|---|---|---|---|---|
| 29 | Protezin | 25470 | R-RHZ-R-56 | | 98 | LS | Biofort | 4.5 | T- BLB, SR, RTD | CH |
| 30 | Rajendra Saraswati | 23423 | RAU 1397-18-3-7-9-4-7 | IR 36/ Type-3 | 80-85 | LS | | 5.0 | T- BLB, SR, LB, SB, RTV | BI |
| 31 | RH 9000 Plus | 24931 | | | 95 | LS | IRM | 6.9 | MR-BL, BLB | MH |
| 32 | Sabour Harshit Dhan | 25342 | BRR 0043-IR83383-B-B-B-141-2 | IR 72022-46-2-3-3-2/IR 57514-PMI 5-B-1-2 | 90-95 | LS | IRM | 5.7 | MR-BLB, LB, BS | BI |
| 33 | Sasya | 23081 | BPT 2411 | Samba Mahsuri/ Surya | 110 | MS | | 5.2 | T-Blast, BS, SR, BLB | AP |
| 34 | Sukumar | 21261 | CN 1646-6-11-9 | Pusa Basmati/IR 64 | 90-100 | LS | | 3.9 | MT – SR, Blast, LB, NB | WB |
| 35 | Teja | 25486 | BPT 2595 | Mutant of BPT 2270 | 130-135 | MS | | 4.1 | R - BPH | AP |
| 36 | Tomthinphou | 23540 | | Cauvery/V20 B | 95 | SB | HRUR | 4.2 | T-BL, BS, SB & GM | MN |
| 37 | TrombayKarjat Kolam | 27100 | | PB1 Mutant/PB 1 | 100-105 | SS | | | MR – BLB, Blast | MH |
| 38 | Warangal Rice 1 | 25284 | WGL-915 | SN22R/IRBBN39 | 105-107 | LB | IM | 5.1 | MR-LB, NB, BLB, RTD | TS |

## Coordinated varietal testing

Coordinated Research ICAR-Indian Institute of Rice Research (IIRR) conducts and coordinates multidisciplinary and multi-location evaluation of elite cultures, crop management and crop protection technologies in different agro-climatic zones of the country under All India Coordinated Rice Improvement Project (AICRIP) to enhance rice production. A total of 46 trials (42 varietal trials and 4 hybrid rice trials) were conducted in 820 experiments (671 varietal and 149 hybrid rice) at 118 locations (45 funded, 73 voluntary centers) in 28 states and 2 union Territories across seven zones of the country during 2019. Hybrid rice experiments were conducted by 10 private seed companies. The 46 trials were constituted with 1319 entries (1225 varietal and 94 hybrid rice) including 182 checks. The overall data receipt was 78.66% of which 89.69% and 65.37% data was received from funded and voluntary centers respectively. Altogether, 19 promising lines were identified in varietal trials (Appendix 1).

## Hybrid Rice

The total area planned to hybrid rice has reached three million ha during the year 2019 and more than 80% of the total hybrid rice area is in the states of Uttar Pradesh, Jharkhand, Bihar, Chhattisgarh, Madhya Pradesh, Odisha and Haryana. So far, 121 hybrids have been released in the country for commercial cultivation. During the period under report, 11 hybrids (central releases-10; state release-1) were released (Table 1) and notified by CSCCSN&RV for commercial cultivation in different states of the country.

## Initial Hybrid Rice Trials

During *Kharif* 2019, totally 77 hybrids were evaluated in four hybrid rice trials *viz.,* IHRT-E, IHRT-ME, IHRT-M, IHRT-MS, in different locations representing North, East, Northeast, Central, West and South zones of the country. Details of the top three ranking hybrids in each of the trials are given in Appendix 2.

## Monitoring of AICRIP trials:

The visit of monitoring teams from IIRR to different AICRIP centers during *kharif* 2020 was greatly restricted due to pandemic COVID-19 situation. However, the scientists at the respective AICRIP centers have supported the assessment of entries of trials by nominating self-monitoring teams from their organizations. A series of zone wise virtual field monitoring has also been conducted from ICAR-IIRR and ICAR-NRRI and interacted with scientists about the conduct of the trial, performance of entries, information about the mixtures and segregating lines and shifts based on flowering. The online virtual platform, helped participation of most of the centers including voluntary centers in the AICRIP field trial monitoring meetings. In addition, monitoring of field trials were carried out at RARS, Maruteru, ANGRAU, Andhra Pradesh and ARI, Rajendranagar, PJTSAU, Telangana by scientists of IIRR.

**National seed project and Breeder seed production:**

Breeder seed production of rice varieties and parental lines of rice hybrids as per the DAC indents was organized at 48 centers across the country, involving 282 varieties and parental lines of 5 rice hybrids for a target of 4398 quintals at national level, a record production of 11,963 Quintals was produced. (Appendix 3). At IIRR centre, 21 varieties were included in breeder seed production and produced 124 quintals which covers 1.58 m ha of rice area.

## Crop Production

### Agronomy

A total 236 experiments were conducted at 49 locations during *kharif* 2019 and *rabi* 2018-19 across the country. These trials consisted of evaluation of promising cultivars (94 cultures) belonging to 16 groups for their response to integrated nutrient management at 50, 100 and 150% of recommended dose of fertilizer (RDF). Also, six trials on cultural management, five trials on weed management, four trials on rice-based cropping systems (RBCS) and climate-resilient agriculture and five collaborative trials with Soil Science, Entomology, and Plant Breeding were conducted to develop cost-effective technologies in rice and RBCS in different locations. The findings are as follows.

#### Nutrient Management Trial (NMT)

Promising cultivars were identified in different groups based on agronomic performance in different locations. In AVT-2 EH (Irrigated) the culture IET 26565 at Almora; AVT-2 MH (Irrigated) IET 25838 and IET 26579; AVT - Early

(Transplanted) - IET 25713 (5.13 t/ha) followed by IET 26477 (5.05 t/ha); AVT -2 IM (Transplanted)- IET 27263 and IET 26420; AVT Late- IET 26974, IET 26948 and IET 25948; AVT-2 MS - IET 25802, IET 25798 and IET 26549; AVT-2 AL and ISTVT- IET 27077; AVT-2 RSL- IET 26692;AVT-2 BT- IET 26999 and IET 26995; AVT-2 Biofortified- IET 27179 ; NMT NIL (Bl & BLB)-IET 27280 (5.88 t/ha), IET 27285 (4.97 t/ha) were found promising. In herbicide tolerant AVT-2 trial, identified herbicide tolerant cultures were: IET 28812 and IET28813 with no or low phytotoxicity to Imazethapyr. Popular varieties and advanced entries which performed better under low soil nitrogen conditions were IET 28080, IET 28088, IET 28087, IET 28827, IET 28826, IET 27730, IET 27730 and IET 28831 are the high yielding and high nitrogen use efficient. Similarly, cultures under low soil phosphorus conditions were IET 28061, IET 28816, IET 28066, IET 28076, IET 28066, IET 28076, IET 28071, IET 28059, IET 28061, IET 28076, IET 28066, IET 28075, 28824, IET 28070 and IET 28818 are the high yielding and high phosphorus use efficient.

### Cultural Management Trials

Six trials on cultural management were conducted across various locations. Mechanical transplanting of 15 days seedlings at normal sowing time resulted in the highest grain yield at five out of seven locations. Mechanized line sowing found to be the best among all establishment methods. Local practices such as dibbling SRI at Chatha, semi-dry rice at Ragolu and Rice intercropped with Sesbania at Ranchi showed better results in DSR. The highest rice-rice system productivity was recorded under LCC based N management in mechanical transplanting followed by Nutrient Expert ® based N management. Alternate wetting and drying resulted in the highest grain yield while higher cost of cultivation was recorded under flooding throughout crop growth at Mandya (Rs. 56717) and Varanasi (Rs. 32943). Input water saved due to adoption of alternate wetting and drying was 49.0 cm at Varanasi and 66.9 cm at Mandya.

### Weed Management Trials

Five trials on weed management were conducted. Among the test genotypes IET 28812, IET 28813 and IET28814 were superior and comparable under the Imazethapyr application. Mechanical transplanting with chemical weed control and/or mechanical weeding using weeder showed superiority in reducing weed problems in the long-term trial on weed dynamics in mono or double-cropped rice system under different establishment methods. In clay loam and clay soils, chemical weed control using pre- and post-emergence herbicides was found superior and in sandy loam soils, mechanical weeding using weeder showed superior performance. For the second consecutive season, systemic post-emergence herbicide thiobencarb @ 5 L/ha applied at 20 days after sowing was found superior to standard post-emergence herbicide bispyribac sodium @ 300 ml/ha and comparable to hand weeding twice. Two to five times lower weed population and biomass recorded under IPM implemented plots compared to farmers' practice, resulted in significantly higher grain yields.

### Resource Conservation Technologies (RCTs) in RBCS

A total of three trials were conducted. Among the crop establishment methods, the transplanting method gave better yields at Rajendranagar (5.62 t/ha) and Karjat (8.68 t/ha) due to reduced weed competition. The REY of system productivity in Vadagaon, Rajendranagar and Karjat due to rice- residue incorporation. In rice – pulse system, higher average system productivity (10.65 t/ha) was recorded under the rice-cowpea system as compared to the rice-rice system (7.65 t/ha). Rice fallow pulse increased grain yield significantly over the rice-rice system for the past two years of study. There was yield reduction to the tune of 16 and

53% due to 15- and 30-days delay in planting at Mandya. The cultivars AD 17037, ADT 53 at Aduthurai, Indiraero-1, MTU 1010, Co-51, IR 64, GNV-1089 at Gangavathi and KMP 175, Samleshwari, CR Dhan 201, Co-51 and CTH-3 at Mandya was found promising for late planting with better yields.

## Soil Science

In the 31st year of study on long term soil fertility management in RBCS at three locations, the treatments RDF+ FYM and RDF were on par and significantly superior to other treatments in both seasons at MTU and in *kharif* at TTB. 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 in INM and organics and 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 population as well as enzymatic activity. Additional dose of FYM @5t/ha along with RDF improved the productivity growth rate substantially at all three locations.

A survey was conducted in farmers' fields at Chinsurah, Titabar, Karaikal and Pantnagar representing Indo-Gangetic plains and the plateau region 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 data representing the irrigated and shallow lowland rice ecosystems revealed wide variations. Soil nutrient uptake varied between the sites corresponding with the grain yields. Variations in grain yields between low yielders and high yielders was 2.39 t /ha to 5.0 t /ha at Chinsurah; 3.59 t /ha to 4.67 t /ha at Karaikal; 2.63 t /ha to 4.87 t /ha at Titabar; 5.7 t/ha among high yielders at Pantnagar. The soil quality index generated from various soil parameters showed variations in the quality and health of the soil across different farmers' categories.

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 (2.62 -2.81 kg/ ha) in the genotypes SRL-3, SRL-2, RMS-1, SRL-1 and MTP-1. In unamended native sodic soils of Faizabad, the genotypes that produced the highest yields were 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 -3.92 t/ha.

The genotypes that performed better with yields ranging from 2-2.43 t/ha in unlimed acid soils of Hazaribagh 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 comparatively higher yields (7.62 – 9.48 t/ha) in unlimed treatment. The highest grain yields (6.23 - 6.99 t/ha) at Ranchi in the treatment without liming were observed in RMS-4, RMS-5, RMS-1, GPV-2 and GPV-1. 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). An increase in yield of 12.48% and 19.11% was observed at Ranchi and Titabar due to liming. The genotypes responsive to liming at Ranchi were RMS-1, 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-1 due to liming in Titabar.

A multi-locational trial was conducted to study the effect of sites, treatments and their interactions through two factor analysis at Chinsurah, Faizabad, Karaikal, Khudwani, Mandya, Maruteru, Pantnagar, Puducherry and Purulia with varied number of test sites. The impact of treatments was significant only in three locations *viz*., Faizabad, Purulia and Khudwani, in which the recommendations of Nutrient Expert software was superior with reference to grain yield. While straw yield was also higher in the recommendations of Nutrient Expert software at Faizabad, RFD proved better in Chinsurah. Significant effects of site x treatment interactions in majority attributes were observed which highlight the role of Site-Specific Nutrient Management.

From the fourth year of study on "Bio-intensive pest management", it can be summarized that out of three locations, 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.

A trial to manage paddy residues initiated in 2018 was conducted this year at ten centres. The results show that the crop residues can be deployed to substitute a part of the recommended nitrogen without yield penalty. Nutrient uptake was highest under RDF. The crop residue treatments were at par 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.

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 nutrient uptake followed a similar trend as that of grain yield and no significant differences were noticed in soil properties after harvest.

### Plant Physiology

A trial was conducted on silica nutrition at different AICRIP locations spread across the country. The results revealed that application of silicon in the form of 0.8% silixol resulted in >11% increase in mean grain yield across all varieties and locations. The increase in grain yield was maximum at REWA (>17% increase over control). Similarly, imposition of water stress resulted in >10% reduction in mean grain yield across locations. The mean grain yield varied between 566 g/m$^2$ (IRRH-132) to 480 g/m$^2$ (Sahabhagidhan). Application of Silicon showed maximum effect in JKRH-3333 followed by IIRRH-122. Imposition of water stress show maximum effect on HRI-174 followed by IRRH-132 and KRH-4. Application Silicon on water stressed plants resulted in maximum mitigation of yield reduction caused by water stress in Sahabhagidhan followed by IIRRH-131.

A screening trial for drought tolerance was conducted with 30 rice genotypes from IVT-E-DS trial and 5 released varieties during *Kharif*-2019 at 5 locations and during *Rabi*-2018-19 season at TTB where in 22 AVT entries and 8 released varieties were tested for drought tolerance. Based on the reduction in grain yield under rainfed condition IET 28250, IET 28262, IET 28262, IET 28660 and US 314 could be identified as relatively drought tolerant and these entries are suitable for rainfed cultivation. Based on drought indices computed, IET 28252, IET 28256, IET 28245, Sahabhagidhan and US-314 have high Mean Rank with low SEm and they may be considered as relatively drought tolerant and are suitable for rain fed cultivation. Stability analysis indicated IET 28243, Sahabhagidhan, IET 28246, IET 28247, IET 28249, IET 282 51, IET 280 52, IET 28254, Tulsi, IET 28255, 28256, US314, IET 28260 and IET 28262 can be selected as stable genotypes which performed well across the locations. In *rabi*, based IET 27519, Vandana and Govind were identified as drought tolerant varieties. Based on various drought tolerance indices the genotypes IET 27514, IET27522, Govind, IET 27520, 27525, 27519 and Sammaleswari were identified as relatively drought tolerant and suitable for rainfed conditions.

Covering the field grown crop with polythene supported by metal frame immediately after PI stage resulted in an increase in temperature inside the tunnel. The increase in temperature was <4.0 C at most of the centres, with an exception of IIRR, PTB and PNR where the temperature difference was >8.0 C. Only IET26780 with 19.5% reduction and IET28403 (>25% reduction over control) showed moderate tolerance to high temperature. Based on temperature tolerance indices, IET28387, IET28390, IET28393, IET28397, IET28403, Gontra bidhan-3 and IET28432 performed better than the tolerant check N-22. These entries may be considered as relatively heat tolerant. Based on stability variance and stability rating IET 28386, 28387,28390, 27668, 28393, 28397, 28400, 28403, Gontra bidhan-3, IET28408, 28409, 28511, 28422, 28425, 27908 and IET25713 performed well and are selected as genotypes with high yield.

Screening for multiple abiotic stress tolerance was conducted at 11 AICRIP centres for salinity, water stress (1% and 2%) and anaerobic stress. Based on their performance under salinity stress, IET 27762, IET 26861, Mahulata, IET 27768, Rashpanjor and IET 27768 may be considered as relatively tolerant genotypes. The entries IET 27750, IET 27762, Parijat, IET 27768, IET 26861 and IET 27356 performed well under moderate water stress (1% mannitol) whereas under 2% mannitol induced stress, Mahulata, IET 27768, BVD 109, IET 27762 IET 27750, Brahman-Nakhi), IET 27758 and IET 27757 were identified as relatively tolerant. Under anaerobic stress, all the tested entries suffered reduction in important physiological traits. However, IET 27768, Rashpanjor, Mahulata, and IET 27356 were identified as relatively suitable for anaerobic conditions. IET 27762 showed tolerance to salinity and water stress, IET 27768 and Mahulata performed well under salinity, water stress and anaerobic stress while IET 27356 showed relative tolerance to water stress and anaerobic stress. These entries could be identified as possessing tolerance to multiple abiotic stresses.

Seventeen different rice genotypes were evaluated for submergence tolerance by survival percentage of the seedlings subjected to complete submergence at four AICRIP centres (NRRI, PTB, FZ B and TTB). The survival percentage was relatively higher in AC42088, Sabita followed by AC38575, AC42088 and Madhulata. These show better survival percentage than the Swarna sub1 at TTB centre. Similarly, at NRRI, AC42088 showed maximum survival percentage (98%) followed by Sabita (61%) Swarna Sub-1 (61%) and IC516009 (<58%). A significant positive association was observed between the leaf starch content and% survival indicating its importance in seedling survival during submergence.

18 genotypes at 7 AICRIP centres were evaluated for low light stress. Low light treatments were imposed immediately after transplanting by enclosing the plots in shade-net (50% transmittance). Low-light stress did not significantly influence the days to flowering and days to maturity. Significant increase in leaf chlorophyll content was observed in all genotypes under low-light. Low-light treatment significantly influenced many yield contributing

traits and reduced grain yield substantially. The reduction in grain yield was highest in IET27590 followed by IET27597 and IET27592. IET27595, IET275995 and IET27596 recorded a grain yield reduction of <40% and may be considered as relatively tolerant to low-light in comparison with tolerant check Swarnaprabha.

## Crop Protection

### Entomology

Seven major trials encompassing various aspects of rice entomology involving 234 experiments were conducted at 41 locations (32 funded and 9 voluntary) in 22 states and one Union territory. Host plant resistance studies comprised of seven screening trials involving 1652 entries evaluated at 42 locations against 11 insect pests. 64 entries (3.87%) were identified as promising. Against brown planthopper, 7 breeding lines *viz.,* KNM 7629, MTU 1305, MTU 1306, MTU 1308, RMS-ISM-Bph33-1, RP 221-3-5-2, RP 179-3-9-1 were found as promising. Four germplasm accessions *viz*., IC 216735, IC 76013, IC 75975 and IC 76057 from IIRR performed consistently in the second year of retesting. Two germplasm accessions *viz*., CRCPT 7, and CRCPT 8 from NRRI performed better. Three breeding lines *viz*., MTU 1305, MTU 1306 and MTU 1308 performed better in the second year of retesting. One culture from Sakoli, SKL-07-8-720-63-147-182-276 was identified as promising to gall midge. Sixteen lines, IIRR-ENT-2019-17 and 14 pyramided lines (MTU1010 with gm3+Gm4 +Gm8) along with Aganni were identified as promising for gall midge. Three mutant cultures of PTB *viz*., Cul M8, Cul M9, Cul M6-2 and Kalluruli, a selection from landrace were found promising to leaf folder Identified 12 entries as promising to stem borer. Sinnasivappu, JS5 (selection from Jaya), SKL -07-11-177-50-65-60- and Cul7 were promising against 3 pests. Gall midge biotype monitoring studies revealed that *Gm8* and *Gm1* hold promise across the locations.

All insecticide modules were found to be superior in reducing stem borer, plant and leaf hoppers, and leaf folder. Gall midge damage was lower in neem formulations + triflumezopyrim module on par with all insecticide treatments. All insecticide modules recorded highest yield of 4781.2 kg/ha with 32.3 per cent increase over control (IOC) followed by neemazal + neem oil + triflumezopyrim module with an yield of 4393.0 kg/ha (21.6 per cent IOC).

Incidence of stem borer, gall midge, leaf folder, whorl maggot, hispa, case worm, and plant hopper damage was more in late planting as compared to early and normal planting. Effect of iron seed coating revealed, low stem borer, gall midge, and brown planthopper incidence across the locations. In dry direct seeding stem borer, leaf folder and whorl maggot damage were relatively high as compared to wet direct seeding and mechanised transplanting methods. Multispecies pheromone blend attracted both rice leaf folder and yellow stem borer.

Ecological engineering for pest management with a combination of interventions such as organic manuring, alleyways, spacing management, water management and growing of flowering plants on the bunds found to suppress brown planthopper and stem borer damage and to encourage natural enemies with higher benefit cost ratio. The stem borer incidence was lower in bio intensive pest management as compared to farmers practice with higher natural enemy population. Integrated pest management module was found effective against stem borer, gall midge, leaf folder, hispa, and plant hoppers as compared to farmers' practices.

Light trap data indicated that yellow stem borer, leaf folder, and hoppers continued to be the most important pests in terms of numbers as well as spread across the locations. Gall midge continues to be an endemic pest. However, case worm, white stem borer, pink stem borer, black bug, gundhi bug, and zigzag leaf hopper showed an increase in the spread and intensity of incidence.

## Plant Pathology

A total of 13 trials were conducted at 49 locations on host plant resistance, field monitoring of virulence of major pathogens and disease management methods. In various screening nurseries, many of the test entries were showing resistance against more than two major diseases. The identified promising cultures were IET No. 27438, 25212, 27077, 26118 in NSN-1; 28306, 28521, 28732, 28301, 28304 in NSN-2; 26594 and 27466 in NSN-H; 28148, 28130, 28115, 28117, 28129, 28154, 28160, 28152, 28134 in NHSN and CR 4209-2 and Phoghak in DSN.

Field monitoring of virulence of *Pyricularia grisea* across the 24 hot spot locations revealed a shift in pathogen profile structure at many locations. The reaction pattern of genotypes at all the locations was grouped into six major clusters at 60 per cent similarity coefficient.

Field monitoring of virulence of Bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*) was conducted at 26 locations across India. Most of the differentials possessing single bacterial blight resistance genes like *Xa1, Xa3, Xa4, xa5, Xa7, xa8, Xa10, Xa11* and *Xa14* were susceptible at most of the locations. BB resistance gene *xa13* was susceptible in 14 locations while *Xa21* was susceptible in 21 locations. The differential, IRBB 55 possessing two BB resistance genes *xa13* and *Xa21* showed susceptibility at 10 hot spot locations. Based on their virulence, the isolates were grouped into high, moderate and low virulence groups. The isolate from Maruteru showed exceptional virulence and all the differentials showed susceptible reaction to this isolate.

The disease observation nursery trial was conducted at 9 locations and it was observed in general that the disease incidence varied according to the sowing dates. Incidence of leaf blast was more severe in the late sown crop whereas neck blast was more severe in the early sown crop. The severity of sheath blight was higher in early sown crop whereas, BLB severity was high in the normal sown crop. The severity of the sheath rot disease was found to be high in the late sown crop at Chinsurah and Nawagam. It was observed that in general, rainfall had a greater impact on the impact of diseases like sheath rot and sheath blight in the spread among the populations. However, in the case of disease like leaf blast and brown spot the humidity played a major role and is directly correlated with the increase in the spread of the disease among the populations. Further it is possible that heavy rainfall might have washed away the pathogen inoculum from the leaves. In contrast, the AUDPC of another disease primarily infecting the leaf, the BLB, was found to increase directly with the total rainfall. This might be due to the ability of the bacterial pathogen to survive in water and spread among the plants.

Under disease management trials, new fungicidal molecules prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) was found effective in reducing the leaf blast and neck blast and increasing the yield. In case of neck blast, tricyclazole 75% WP (0.6g) found effective in reducing the severity. The combination fungicide azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (1.0ml/L) was found effective in minimizing the disease severity and incidence of sheath blight and sheath rot. Hexaconazole 5%EC (2.0 ml/l) was found effective in managing the brown spot of rice compared to other treatments.

The integrated disease management trial was conducted in 14 locations. The results indicated that in all the cases, the treatment with fungicide alone gave maximum percentage of reduction in disease severity over other treatments. In the case of leaf and neck blast, the treatments with bioagent as seed treatment alone followed by propiconazole in main field and bioagent as seed treatment and field application + propiconazole were on par with each other. In the case of sheath blight management, it was observed that the treatment with bioagent + propiconazole was more effective in managing the disease when compared to standard check. In the case of sheath rot disease, the percentage increase in grain yield was directly proportional to the decrease in the disease severity and the bioagents were able to improve the yield of the crop.

A special trial on essential oils to test their performance against leaf blast, neck blast, sheath blight, bacterial blight, false smut, brown spot was conducted at 15 locations. Two sprays of Neem oil and Clove oil @ 2 ml/l respectively, performed better in reducing the leaf blast severity; Neem oil @ 2 ml/l alone was effective in reducing both leaf and neck blast disease severity. In case of sheath blight, spraying of Neem oil, Citronella oil, Clove oil, Cedar wood oil, Lemon grass oil @ 2.0 ml/l respectively, were effective. Application of Citronella @ 2.0 ml/l, reduced development of brown spot. Citronella @ 2.0 ml/l and Neem oil @ 2.0 ml/l were effective against false smut.

### Production Oriented Survey (POS)

During 2019, Production oriented survey was conducted in 16 states of India *viz*., Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Maharashtra, Odisha, Punjab, Tamil Nadu, Telangana, Uttar Pradesh, and West Bengal by 17 AICRIP centres. Scientific staffs from the different cooperating centres and officials from state department of agriculture surveyed 116 districts in 16 states.

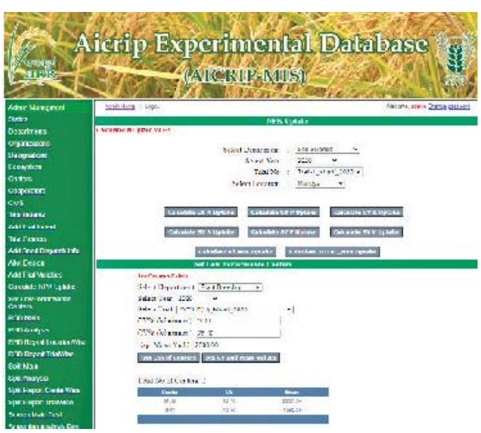
The seasonal (June-September) rainfall across the country as a whole, was 110% of its long period average (LPA). Seasonal rainfall over northwest India, central India, south Peninsula and northeast (NE) India were 98%, 129%, 116% and 88% of respective LPA. Hybrid rice varieties occupied a significant area in the states like Uttar Pradesh, Haryana, Chhattisgarh, Gujarat and Bihar and its area is increasing in states like Himachal Pradesh, Karnataka, Maharashtra and West Bengal.

The major problems faced by the farmers were shortage of agricultural labour and their high wages and irrigation water. Many farmers from different states also expressed problem of timely availability of seeds of different hybrids and HYVs, availability of different inputs in time, farm mechanization (on hire basis/custom hiring), market facility and farm loan.

Diseases like blast, neck blast, sheath blight, brown spot, sheath rot, false smut, grain discoloration and bacterial blight were widespread almost throughout India. High incidence of bacterial blight and bacterial leaf streak were observed in some areas of Karnataka. Severe blast was reported from many districts of Telangana during *Rabi*, 2020. The insect pests like stem borer, leaf folder and BPH were widespread throughout India. High incidence of BPH was recorded in parts of Kerala.

### AICRIP Intranet

AICRIP-Intranet was utilized by many centres for uploaded data. Soil Science and Hybrid Rice Trials of 2020 were successfully analysed with PI





User interfaces for marking low performance centers, NPK uptake computation and dashboards of AICRIP intranet privileges. The RBD Analysis module of AICRIP Intranet was used to generate location wise treatment means with CD, CV, ranks over checks. New features like dashboards on receipt of data from centres, excel data interface, marking of low performance centres, NPK uptake computation, state/zone/elevation wise yield reports along with ranks and performance over checks were added in the AICRIP Intranet.

# Research Achievements

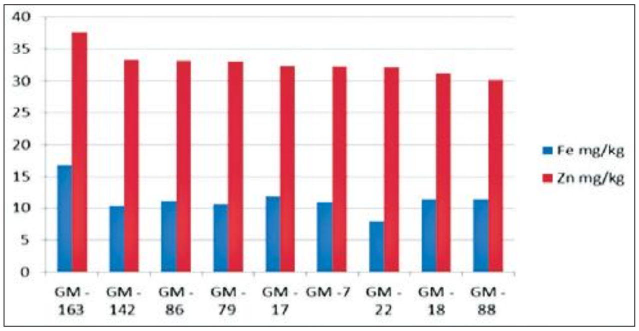
## Lead Research

| | | |
|---|---|---|
| GEQ | - | Genetic enhancement of quality for domestic and export purpose |
| GEY | - | Genetic enhancement of yield and stress tolerance |
| ABR | - | Application of biotechnology tools for rice improvement |
| RUE | - | Enhancing resource and input use efficiency |
| SSP | - | Sustaining rice system productivity |
| CCR | - | Assessing and managing crop response to climate change |
| HRI | - | Host-plant resistance against insect pests and its management |
| HRP | - | Host-plant resistance against pathogens and its management |
| IPM | – | Integrated pest management |
| TTI | – | Training, transfer of technology and impact analysis |

# GEQ - Genetic enhancement of quality for domestic and export purpose

### GEQ/CI/BR/8: Enhancing nutritional quality of rice through bio-fortification

One hundred and fifty-six germplasm lines were evaluated for zinc content, screened for plant hoppers tolerance and various agronomic traits. Results indicated presence of moderate to high Zn (15.2 to 23.54 ppm) content. 32 *Oryza glabarima* accessions were assessed for Zinc content and three best populations were developed with Samba Mahsuri. Parental polymorphism among a promising donor Edavankudi Pokkali with Zinc in polished rice 26 ppm and five recipient parents (MTU1010, IR64, BPT5204, Swarna and CRDhan310 with ZPR< 20 ppm) was surveyed using 204 SSR markers. 21 markers were polymorphic across all the six parents. Three sets of recombination inbred lines were analysed for their zinc content and six promising RILs ($F_8$-$F_{10}$) were selected. A set of 13 crosses were made involving high Zn donors.




Genotypes with high Zn and Fe which are highly resistant to resistant to BPH tolerance (0-5 score)

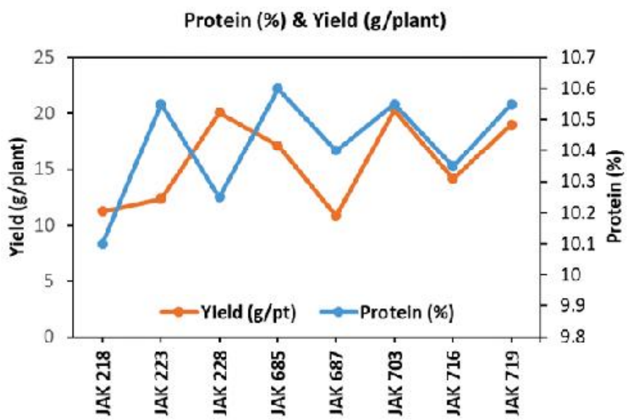
Field view of screening for BPH resistance at ARI, Maruteru

**Sets of recombination inbred lines and their zinc content**

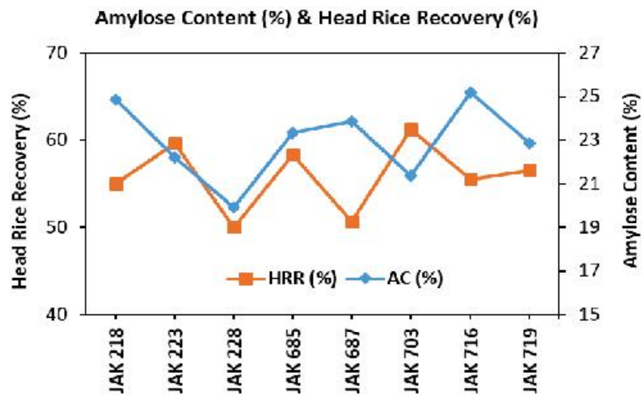
| Sl. No. | Cross combination | No. RILs | Range | Mean | ≥35 ppm ZBR* | Desirable Plant Type** |
|---|---|---|---|---|---|---|
| 1 | PR 116 /Chittimutyalu | 237 | 11.5-31.8 | 22.4 | 4 | 2 |
| 2 | Rp Bio-226 /Jalpriya | 241 | 9.9 – 36.5 | 36.3 | 6 | 2 |
| 3 | MTU1010 / BR 2655 | 192 | 16.6-32 | 28.2 | 8 | 2 |

### GEQ/CI/ BR/9: Development of Rice Cultivars with High Grain Protein Content and Quality Traits

Two varieties Improved Samba Mashuri and RNR 15048 were chosen for the crossing program to incorporate high GPC in the elite background of popular varieties. Multiple crosses were performed with JAK 685, JAK 686, JAK 688, JAK 221, JAK 223, JAK 224, JAK 228 and JAK 231 (GPC >10.0%). The quality traits were estimated in the 8 high grain protein content (GPC >10.0%) lines along with morphological and yield related traits. Two high GPC genotypes (JAK 703 and JAK 719) were identified to have high grain yield (~20.0 g/plant) with desirable quality parameters. GPC, amylose content (AC) and head rice recovery exhibited moderately high (~71.0) heritability values. The eight lines had intermediate amylose content (20-25) with the highest being JAK 716 (25.2). Amino acid analysis of JAK 719 exhibited relatively high levels of lysine content of 4.29%.




Protein and Yield (g/ plant) in the 8 high protein content lines



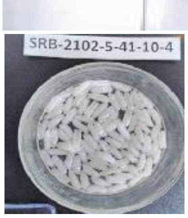

Amylase content and head rice recovery in the 8 high protein content lines

## GEQ/CI/ BR/10: Genetic improvement of elite aromatic short and medium grain rices

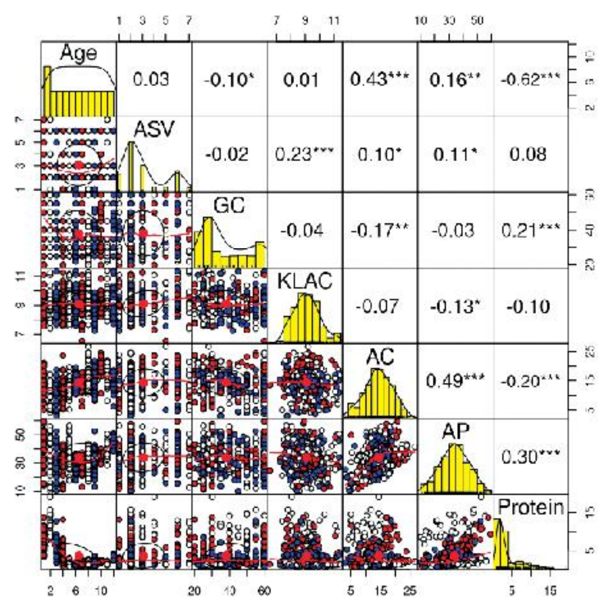
Populations were derived from crossing programme using Shobini, Gontrabidhan -3, Narendra lalmati, Muhulakuchi, Neelabati, Kalikati, Kalanamak, Dubraj Bandi, Joha Bora, Joha, Loungchoosi B, Champaran Basmati 4, Ganjeikalli, Thakurabhog, Muhulakuchi, Champaran Basmati 1, WGL 14 and Sugandha samba as parental material. Selections were made in field and lab for yield and aroma. At $F_4$ generation out of 680 genotypes, SRB-2002-4-14 and SRB-2002-4-29 lines were selected for good aroma.

## GEQ/CI/BR/26/Investigation into the role of major metabolites on rice grain quality:

Photosynthetic rate decreases with DAF and the extent of decrease is more in low yielding varieties. Grain filling will be initiated in multiple branches of the panicle simultaneously. The rate of increase in grain dry weight was high during 0-15 days period in comparison with 16-30 days. Gene expression studies indicate that variation in the availability of branching enzymes is responsible for the variation in cooking quality. In ageing experiments, protein content decreases, gel consistency becomes hard and preliminary analysis indicates variation in c18 group fatty acids were observed. As 6 to 12 months aged rice is preferred by majority of the consumers and variation in cooking quality was observed with ageing, appropriate changes may be introduced in varietal testing and release.


Husked, dehusked paddy and cooked rice of aromatic short grain (ASG) rice SRB-2102-5-41-10-4




Correlation between grain quality parameters and shelf-life

# GEY-Genetic enhancement of yield and stress tolerance

## GEY/CI/BR/16: Traditional and molecular approaches for breeding improved rice varieties with resistance to plant hoppers

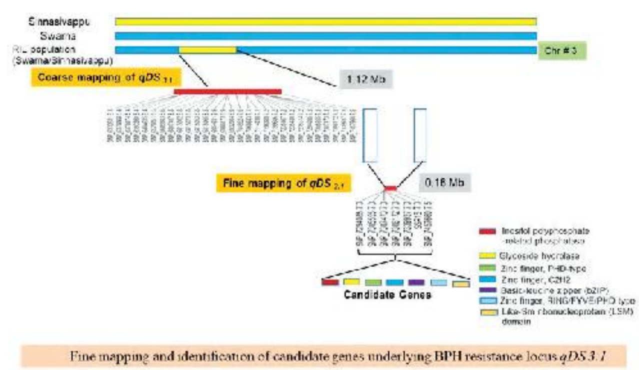
A total of 50 superior breeding lines ($F_7$) for yield trait were selected in the genetic background of Swarna, Gontrabidhan 3, RP bio 226 and Sona mahsuri.

Twenty-five advanced lines ($F_8$) derived from crosses involving the donors Vajram, KAUM 166-2, IET 21510, CR15MR1523 and CR 2711-76; and susceptible popular varieties such as Sona mahsuri, NDR 359, RP bio-226, IR 64, Rasi, Swarna were screened at Maruteru under hopper-burn. Three lines were found moderately resistant with damage scores of 3.5 to 4.2 and one line as resistant with a damage score 3.

Identified two promising breeding lines designated as RP 221-3-5-2 and RP 179-3-9-1 derived from the cross MTU 1121/Vijetha possessing resistance to planthoppers upon testing in PHS trials during 2020 at 12 locations in 15 screening tests. Based on their stable and durable resistance exhibited over 2 years (2019 & 2020), they could be exploited as new sources of resistance to planthoppers. Genotyping with linked as well as gene specific markers led to the identification of 4 reported BPH resistance genes (*bph4, Bph 9, Bph 17* and *Bph 32*) and 2 WBPH resistance genes (*wbph 10* & *wbph 9)* in the donor RP 5690-20-6-3-2-1 while *Bph 32* gene in RP 179-3-9-1.

Field screening under hopper-burn at Maruteru

The region harbouring BPH resistance QTL *i.e.,* $qDS_{3.1}$ was fine mapped to 0.16 Mb from 1.12 Mb on Chr #3 contributing to 12.1% of phenotypic variance in a RIL population of a cross between Swarna/Sinnasivappu. A total of seven annotated genes with biological function were identified within the fine mapped region playing a key role in regulating plant's defense against biotic stresses.



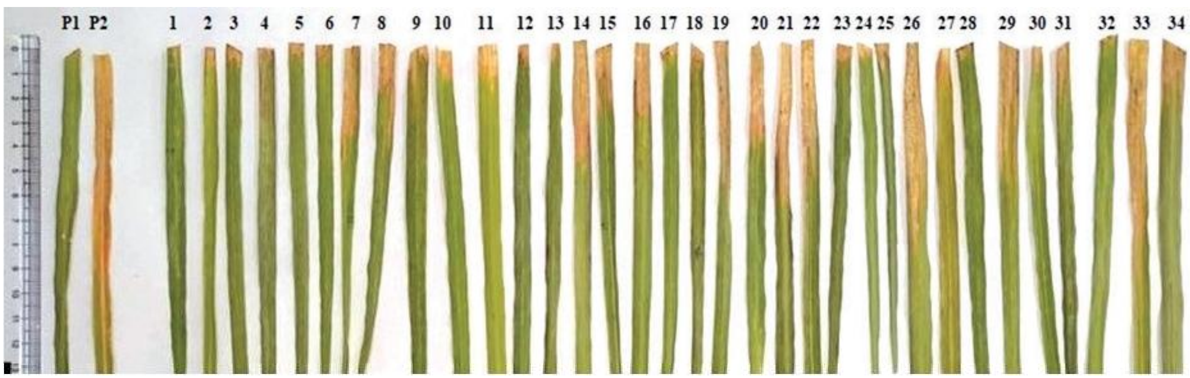

Fine mapping and identification of candidate genes underlying BPH resistance locus $qDS_{3.1}$

## GEY/CI/BR/22: Identification and introgression of agronomically important traits from wild species of rice

QTLs associated with weed competitive traits were identified in $BC_1F_{2:3}$ population derived from weed competitive accession of *O. glaberrima* (IRGC105187) and IR64. 144 lines were phenotyped for 33 weed competitive associated traits under direct seeded condition. Genetic analysis showed significant variation for the weed competitive traits and predominance of additive gene action. Linkage map covering 1423 cM was constructed by genotyping with 81 SSR markers. CIM analysis identified 72 QTLs linked to 33 weed competitive traits across 11 chromosomes. Among 72 QTLs, 59 were found to be major QTLs (> 10% PVE) and of them, 38 had favourable allele contributed from the *O. glaberrima*. We also observed nine QTL hotspots for weed competitive traits (qWCA2a, qWCA2b, qWCA2c, qWCA3, qWCA5, qWCA7, qWCA8, qWCA9, and qWCA10) wherein several QTLs co-localised.

31 accessions of *O. glaberrima* were screened for bacterial blight (BB) resistance and 28 accessions consistently exhibited high level of resistance for four seasons with a mean lesion length of < 3cm. Molecular characterization using gene specific markers revealed absence of major resistance genes *viz.*, *xa5, xa13, Xa21, Xa38, xa41*(t) and *xa45* in these accessions, indicating the possibility of presence of novel gene(s). Analysis of $BC_2F_2$ population for yield attributing traits showed transgressive segregation for plant height, productive tillers, panicle length which indicates that *O. glaberrima* also harbor beneficial alleles for yield related traits.

Molecular characterization of 26 blast resistant lines from *O. rufipogon* Griff. in the background of Samba Mahsuri, identified presence of multiple blast resistance genes in IL-136 [*Pib, Pi9 (t), Pi54, Pi38, Pitp and Pi20(t)], IL-3 [Pib, Pi54, Pi38, Pitp and Pi20*(t)], and IL-140 [*Pib, Pi9(t), Pi54, Pi38, and Pitp*]. Based on the performance of yield-enhancing traits and blast resistance, seven lines (IL-27, IL-28, IL-29, IL-72, IL-139, IL-158 and IL-171) showed merit. Estimation of the recovery of the recurrent parental genome by using 117 polymorphic SSR markers revealed that recurrent parental genome recovery varied from 54.0 (IL-158) to 92.3% (IL-27).

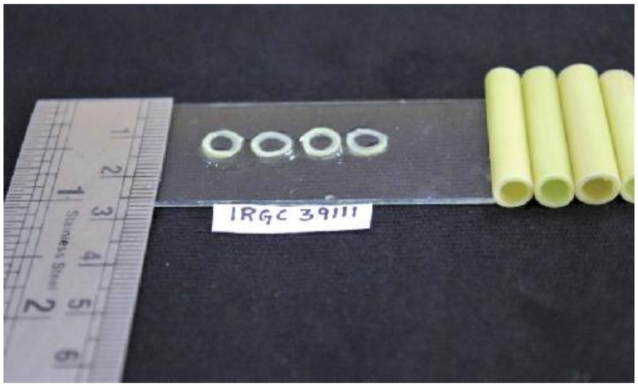



**Reaction of IR 64, *Oryza glaberrima* and backcross derived introgression lines against bacterial blight (isolate *IXo20*). P1- *Oryza glaberrima* (EC861812); P2- IR 64; 1-34 – $BC_2F_4$ introgression lines derived from IR64*2/ *Oryza glaberrima* (EC861812)**

### GEY/CI/ BR/25: Broadening the genetic base of indica rice and modify plant type by introgressing traits from Tropical japonica

Indica/tropical *japonica* derived introgression lines has been generated from 7 crosses (ISM/JBB1325; BPT5204/JBB1325; BPT5204/JBB631-1; Swarna/JBB1325; MTU1010/KJ54//Swarna/KJ55; Swarna/JBB 631-1; MTU1010/JBB631-1) and advanced to $F_2$. Out of 11 $F_1$ crosses involving elite *indica* cultivars, advanced breeding lines with high photosynthetic efficiency (JBB 631-1), strong culm (JBB 1325) and low shattering trait (JBB 661-1) and tropical japonica accessions *viz.*, KJ54 and KJ55 with strong culm and high grain number were identified. $F_3$ mapping population of Swarna/IRGC39111 (2470 plants) and ISM/Thongmoi (740 plants) was raised with the objective of mapping novel QTLs for strong culm of which 15 superior plant types were selected. $F_2$ seed was generated from three-way crosses of Samba Mahsuri/Phougak//Wazuhophek, Samba Mahsuri/Gumdhan//Wazuhophek and Samba Mahsuri/Phougak//Ngonolasha that included previously identified novel sources for sheath blight tolerance.

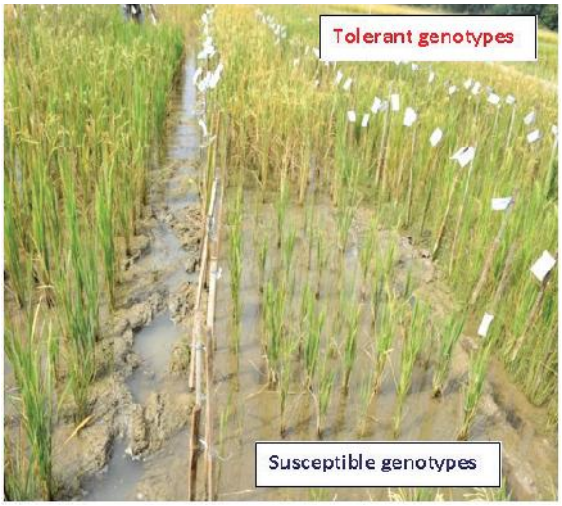
Indica/tropical *japonica* derived introgression lines (JBB689-1, JBB674-1 in IVT-IME, JBB631 in IVT-LNT and JBB680-1, JBB680-2, JBB622-3, JBB687-2, JBB687-3 and JBB683-1 in IVT-Biofortification, JBB631-1 in IVT-Aerobic trials) with high yield potential of >6 t/ha were nominated in AICRIP 2021 testing in various ecologies. IET 25653 with desirable grain quality, 115-120 days maturity and an average yield of 5.5 t/ha under aerobic cultivation was identified and recommended for notification during 85th CVRC conducted on 9th November 2020, for cultivation in Telangana, Odisha, Jharkhand, Bihar, Haryana and Gujarat. IET 29287 (Swarna*2/IRGC4105) with 28% yield advantage in more than two states in IVT-IM in southern zone during 2020 was promoted to AVT-IM.

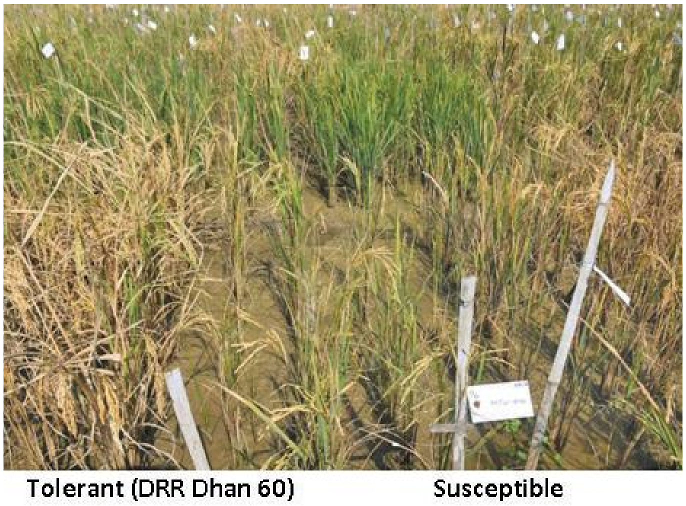



**Novel source of Strong culm: TJP-IRGC39111 (strong culm [bending moment at breaking stress -2243 g.f]) and high grain number (396)**

### GEY/CI/ BR/24: Breeding high yielding Rice cultivars tolerant to low phosphorus and nitrogen

Advanced breeding lines (700) involving donors for low Phosphorus tolerance and agronomically superior varieties were evaluated under low soil phosphorus field. Promising entries were identified with low P tolerance and seed multiplication was taken up. A total of 15 major QTLs were identified in RILs of Rasi/ISM for days to 50% flowering, plant height, panicle length, root volume, dry shoot weight, dry root weight, straw weight, plant yield and test seed weight. Identified 16 QTLs (seven major and nine minor QTLs), in 330 RILs of ISM/Wazuhophek associated with low soil P tolerance related traits. QTL hotspot region harbouring 10 out of 16 QTLs




**Promising Low P tolerant genotypes along with susceptible checks at Low P conditions at IIRR farm**

was identified on the short arm of chromosome 8 (flanked by the makers RM22554 and RM80005). Five major QTLs explaining phenotypic variance to an extent of 15.28%, 17.25%, 21.84%, 20.23%, and 18.50%, associated with the traits, plant height, shoot length, the number of productive tillers, panicle length and yield, respectively, were located in this region. Two major QTLs located on chromosome 1, associated with the traits, total biomass and root to shoot ratio, explaining 15.44% phenotypic variance were also identified. Complex epistatic interactions were observed among the traits, grain yield per plant, days to 50% flowering, dry shoot weight, and P content of the seed. *In-silico* analysis of genomic regions flanking the major QTLs revealed the presence of key putative candidate genes, possibly associated with tolerance. A MAS derived product IET28061 developed in the genetic background of improved Samba Mahsuri by using Swarna as donor for Pup 1 QTL which is high-yielding, low soil phosphorous tolerant, bacterial blight resistant and fine-grain type has been identified by VIC during 56$^{th}$ARGM.

## GEY/CI/ BR/26: Breeding for high yielding water use efficient short duration rice hybrids & varieties

Crosses were made between 10 selected parents using half diallel. 36 F1s were assessed for yield and other characters. F2 Populations will be raised in ensuing season and selections will be made for high yield and short duration.

Field view of screening high yield water use efficient rice hybrids

## GEY/CI/ BR/27: Novel Genetic approaches for development of Climate Smart Rice Varieties

Development of Multi-parent Advance Generation Inter-cross (MAGIC) populations was undertaken with parents including elite lines with desirable traits such as heat tolerance, seedling and reproductive salinity tolerance, nutrient use efficiency, flood tolerance and yield enhancing genes Gn1, SCM2 and OsSPL14. First cycle of crossing with 8 founder lines was completed during *Kharif*, 2020. Generation of $F_1$s: A total of 75 crosses were generated involving diverse parents for yield, quality, heat tolerance, cold tolerance, salinity tolerance, anaerobic germination, strong culm, nutrient use efficiency, yield and quality.

About 2101 entries of breeding material in $F_7$ and $F_8$ generation were evaluated in two pedigree material and 585 promising SPS and 27 bulks were selected for generation advance and evaluation in preliminary yield trials. Twenty-nine promising elite lines were evaluated and 6 entries were found promising for yield.

Promising climate smart elite lines with high yield at irrigated field condition

## GEY/CI/ BR/28: Genetic Enhancement of Specialty Rices of India

Total of 64 coloured rice germplasm were collected from various sources. These coloured rice germplasms were characterized for agro-morphological and yield related traits in the field. A total of 15 crosses were made during *Kharif* 2020 using selected speciality rices with different donors having favourable genes/ QTLs and fifteen $F_1$ hybrids were planted and evaluated. A total of 22 introgression lines homozygous for bacterial leaf blight, blast resistance and yield enhancing genes in the genetic background of Swarna and 14 introgression lines similar to recurrent parent (NDR359) and homozygous for yield enhancing genes were evaluated. A total of 52 crosses were made, 124 advanced populations were generated and 15 station trial entries were evaluated during *Kharif* 2020 and fifteen fresh $F_1$'s crosses and 52 $F_2$'s were evaluated during *rabi* 2020-21. 900 germplasm consisting of lines collected from different states of India, IRRI Philippines, green super rice lines, INGER lines were evaluated and maintained. Total of 404 donor lines identified in AICRIP screening were also maintained.

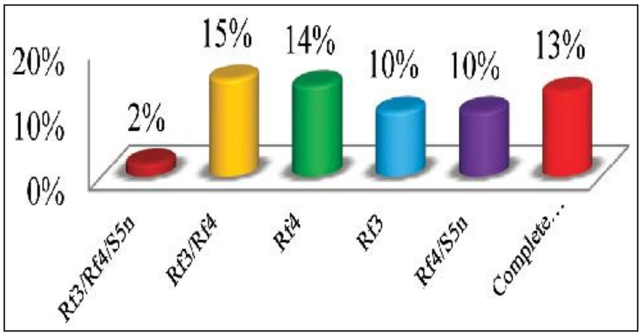
**Field view of coloured grain rice at IIRR Farm, Hyderabad**

**Variability in the panicles for coloured rice grain**

## GEY/CI/HY/13: Development and evaluation of three-line hybrids with better grain quality and resistance to major pests and diseases

A total of 106 *indica* tropical *japonica* derived lines were screened for fertility restoration genes (*Rf3* and *Rf4) and* wide compatibility (*S5n*) gene using reported markers of which 2% were identified with three gene combinations (*Rf3*/ *Rf4*/ *S5*n), 15% of genotypes were identified with both *Rf3* and *Rf4*, 14% of genotypes possessed only *Rf4*, 10% of genotypes carried *Rf4* and *S5n* gene combination and 13% of genotypes were observed to be completely devoid of any of the genes tested through marker analysis.

Further, based on test cross nursery performance, 13 genotypes test crossed with four CMS lines (IR68897A, IR79156A, APMS6A and PUSA5A) in LXT fashion. The 52 derived hybrids along with their parents and checks evaluated for yield and its attributing traits.




**Percentage of indica tropical japonica genotypes identified with different gene combinations of fertility restorer genes (Rf4 and Rf3) and wide compatibility gene (S5n)**

Among 13 novel restorers, the 5 best general combiners are: IJD28 for single plant yield, and biomass; IJD38 for productive tillers, the total number of tillers, panicle exsertion ratio, pollen fertility and spikelet fertility per cent; IJD13 for panicle length, panicle exsertion ratio and thousand grain weight; IJD4 for thousand grain weight; IJD30 for pollen fertility, spikelet fertility and biomass.

Based on mean performance, the hybrids between IR68897A X IJD38 (Pollen fertility %), PUSA 5A X IJD32 (Spikelet fertility %), PUSA5A X IJD13 (Single plant yield and biomass), IR79156A X IJD68 (Thousand grain weight) and APMS 6A X IJD28 (Harvest index) were identified as best combinations.

Panicle type of few hybrid combinations derived from newly bred restorers

## GEY/CI/HY/15: Genetic enhancement of parental lines suitable for aerobic and tolerance to salinity conditions through conventional and molecular approaches

IET 26194, an aerobic variety developed from parental lines of MTU-1010 / IR79915-B-83-4-3 cross combination and was evaluated in AICRIP aerobic trials during wet seasons of 2016-2019. It has been identified by Varietal Identification Committee (VIC) during 55$^{th}$ARGM held during 2020 for cultivation in aerobic ecosystems of Bihar (Zone III) and Chhattisgarh (Zone V) states with a mean grain yield 4974 Kg/ha. It showed moderate resistance to leaf blast and neck blast; resistance to gall midge and rice thrips; and moderate resistance to plant hoppers. It possesses LB grain and desirable grain and cooking quality parameters.

The aerobic hybrid IIRRH-124 (IET 27937) was promoted to AVT 2 aerobic trial. The hybrid IIRRH-115 (IET 27847) was promoted in AVT1-CSTVT trial and will be evaluated in AVT 2 of CSTVT trial. The hybrid IIRRH-147 (IET 29364) was found promising in AL&ISTVT- trial and will be further tested for its performance in AVT1 trial.

IET 26194, Representation of paddy, brown and polished rice

Twelve promising abiotic stress restorers (PSV7272, VTCP25, VTCP38, NRR 11, NPVR27, NPVR 52, PSV 7505, PSV 736, PSV 433, PSV3636, PSV702 and PSV783) were identified as promising and utilized in seed production of station trial hybrids during dry season 2021. Based on station trial evaluation, the new hybrid combinations (IR68897A/PSV1818, IR 68897A/NPVR32, IR 68897A/NPVR48, and APMS6A/PSV 729) were identified as promising hybrids and nominated in AICRIP 2021 for IVT-Aerobic/AL&ISTVT trails.

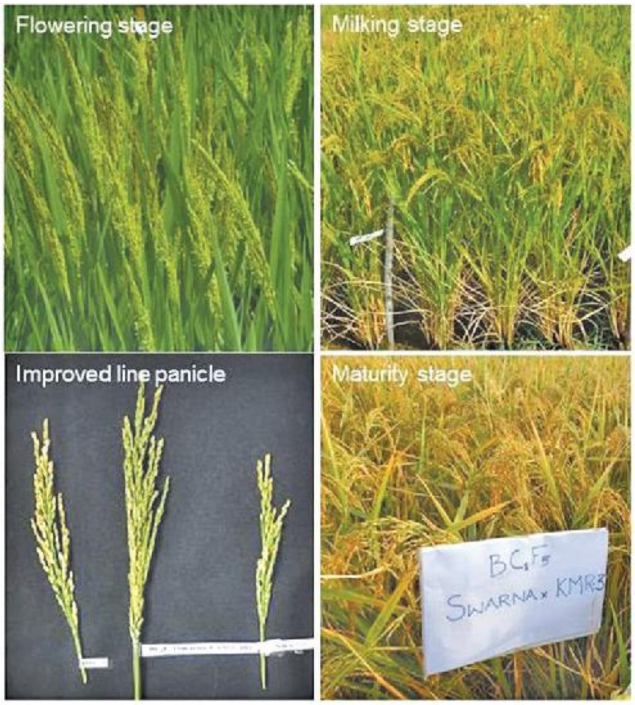
AR9-18, aerobic restorer line of promising hybrid, IIRRH 124 was selected for improvement of yield enhancing genes (*Gn1a* and *OsPL14*) and blast resistance through marker assisted pedigree breeding. The segregating population was screened for gene-based markers, and 25 positive lines for yield genes were forwarded for further selection and CMS crossing.

Genetic improvement of KMR3 for salinity (Saltol), submergence (SUB1), Heat (qHTS1.1 & 4.1), drought (qDTY12.1) and APMS6B for BB and PuP1 through MABB approach and 37 promising improved restorers were identified. For heat tolerance, the three BILs, RP6338-9, RP6338-24 and RP 6338-155 performed well under high temperature stress, the entry RP6338-9 with *Rf3*, *Rf4* and qHTSF4.1 showed yield superiority over parents under ambient and high temperature conditions.

For improvement of reproductive drought tolerance in KMR3R, out of 34 BILs identified, the two BILs, RP 6340-NPVR-32 & RP 63340-NPVR 1 possessing drought tolerant QTLs (*qDTY12.1, qDTY2.3, qDTY1.1* and *qDTY6.1*) and *Rf3* and *Rf4* genes performed well under drought conditions. Similarly in case of seedling stage salinity and submergence tolerance improvement in KMR3R, the ILs RP 6341-VTCP 56, RP 6341-VTCP45 possessing Saltol and *Rf3* and *Rf4* genes, RP 6342-MB44 and RP 6342-TCP2 possessing SUB1 and *Rf3* and *Rf4* genes performed well under respective stress over the recurrent parent. The IL RP 6343-BP10-5 possessing *Xa21, Xa38* + *Pup1* in the background of APMS6B found promising for low P tolerance. These improved parental lines can be registered as abiotic stress tolerant genetic stock and exploited further in heterosis breeding.

### GEY/CI/HY/12: Development of superior restorers and identification of new restorer (Rf) genes for WA-CMS system in rice by conventional and molecular approaches

The majority of the popular, mega varieties released in India like Swarna, Samba Mahsuri and MTU1010 were found to be partial or incomplete restorers and hence cannot be utilized as such to produce experimental hybrids. One of the major constraints, which limit the spread of hybrid rice area in shallow low lands and coastal areas, is non availability of long duration hybrids, which can mature in 145-150 days or more. To address above mentioned issues, an attempt was made to convert partial restorers to complete restorers by transferring *Rf* genes through marker-assisted backcross breeding. We could successfully demonstrate the concept of conversion of partial restorers to complete restorers by developing restorers with characteristic features of popular mega Indian rice varieties of Swarna, Samba Mahsuri and Improved Samba Mahsuri for utilization in hybrid rice breeding, especially for development of late maturity hybrids.




**Converted restorers with improved plant height, panicle length with Swarna's specific traits of stay greenness, golden hull colour**

The entry RP 5964-82 derived from the cross KMR 3R/Swarna*1 was evaluated in AICRIP IVT-low phosphorus trial during *Kharif* 2019 and based on superior performance this entry got promoted to AVT-1 LPT for evaluation during *Kharif* 2021.

Restorer lines with multiple stress (BLB, blast, sheath blight, BPH, GM & drought, salinity, low P) resistance/tolerance were developed utilizing IR 36 GMS restorer population through population improvement program. The phenotypic characterization and genotyping studies are under way for deriving multiple biotic stress resistance restorers and highly heterotic multiple stress resistance rice hybrids.

One hundred test cross hybrids were evaluated for pollen and spikelet fertility and grain yield heterosis during *Kharif 2020* and identified complete restorers, maintainers and partial sterile/fertile lines.

By utilizing hidden genes from wild species *viz*., *O. rufipogon* and *O. nivara* development of pre-breeding lines for improving hybrid rice parental lines for genetic diversity and out crossing, biotic and abiotic stress tolerances is under progress.

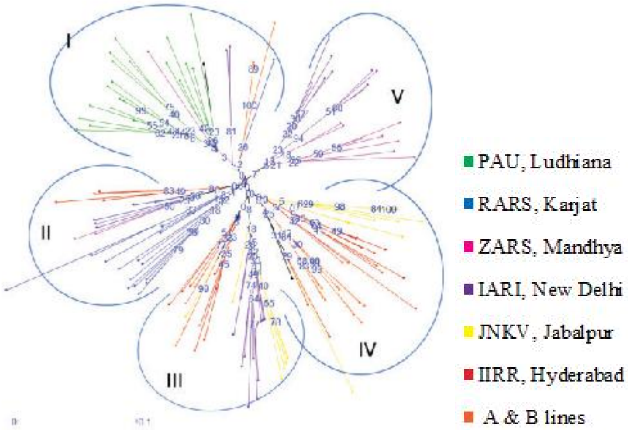
### GEY/CI/HY/16: Genetic improvement of maintainer for yield and attributing traits with introgression of yield enhancing genes

$BC_1F_1$ population was generated between IR 58025B and YPK lines (introgressed improved lines for yield and yield attributing traits) to genetic improvement of maintainers lines for yield and yield attributing traits. $BC_1F_1$ population was validated with molecular markers *viz.,* Gn1,Spl 14, SCM2, Ghd7, GS5 and TGW6for presence of gene of interest (yield and yield attributing traits *viz.,*grain numbers, number of filled grain number per panicle, grain size, panicle architecture and plant architecture). $BC_1F_1$ population was morphologically evaluated for Grain numbers, number of filled grain number per panicle, grain size, panicle architecture and plant architecture.


Improved plant type over native IR 58025B

### GEY/CI/HY/14: Establishment and validation of heterotic gene pools in hybrid rice

A total of 134 genotypes received from 6 hybrid rice centers (PAU, Ludhiana; RARS, Karjat; ZARS, Mandya; IARI, New Delhi; JNKVV, Jabalpur; IIRR, Hyderabad) was subjected to molecular characterization using 45 GCP SSR markers. Out of 45 SSR markers, 33 were found to be highly polymorphic. The genotypic data of 33 highly polymorphic markers were used for cluster analysis using DARwin software ver 6.0.021 (Perrier and Jacquemoud Collet 2006). The DARwin grouped 136 lines into 5 clusters The cluster-I consisted of 28 lines with 20 lines from Ludhiana. These lines were grouped along with KMR3R and few lines from IARI, New Delhi and 2A lines and their corresponding B lines (DRR-9A&B and DRR-10A&B). The cluster-II consisted of 25 lines including 16 lines from RARS, Karjat, 3 lines from ZARS, Mandya, 4 lines from IIRR, Hyderabad and 2 lines from IARI, New Delhi. The cluster-III consisted of 30 lines, including 8 lines from IIRR, Hyderabad, 7 lines from JNKV, Jabalpur, 11 lines from IARI, New Delhi and 2A lines and their corresponding B lines (PUSA6A&B and DRR6A&B). The cluster-IV was consisting of 35lines, including 11 lines JNKV, Jabalpur and 13 lines from IIRR, Hyderabad and 5 A and their corresponding B lines (KCMS53A&B, KCMS54A&B, KCMS55A&B, APMS6A&B and IR79156A&B). The cluster-V was consisting of 18 lines including the 10 lines from IARI, New Delhi and 8 lines from ZARS, Mandya. Two clusters (Cluster II & V) completely grouped for restorers and three clusters (I, III & IV) grouped for both R and B lines. The 136 genotypes include 116 restorers and 9 A lines and their corresponding B lines and two control checks (KMR3R and APMS6B). The tree distance varied from 0.00007 to 0.41 with a mean tree distance of 0.24. This indicates the genetic similarity between the materials bred from different centres of particular group. The lines received from different centres represented by different colours.




**Radial representation of molecular clustering pattern of 136 genotypes (116 Restorers+9B lines+9A lines+ two control checks)**

### GEY/CP/PP/12/Physiological studies for improving ideotype breeding in rice

A field experiment was conducted in randomized block design with three replications to investigate the performance of 20 promising breeding lines in the genetic background of Samba Mahsuri, Swarna and MTU 1010 possessing yield related genes for grain yield associated traits which includes morphological, physiological, yield attributing and leaf gas exchange traits to identify the superior donors with good morpho-physiological traits for ideotype breeding. Under morphological characters, average tiller number was 12 and LAI and days to maturity varied from 3.3 to 7.4 and 111 to 133 days respectively. Among yield and yield attributes, average grain yield (GY) was 849 g/m$^{-2}$. Highest GY was noted for YPR-39 with 960 g/m$^{-2}$ yield potential, 55 Harvest Index and 17.5 T/ha biomass. The leaf gas exchange traits revealed that the mean photosynthetic rate was 25 µmol ($CO_2$) m$^{-2}$s$^{-1}$ which indicates high photosynthetic rate in most of the lines. Transpiration rate varied from 7.5 to 13 mol (H2O) m$^{-2}$s$^{-1}$ and YPR-39 noted close to the highest value (12). The above results indicate that 13 of the 20 lines as good physiological donors (YPR-33, 1107, 1077, 53, 1074, 1103, 1105, 30, 11, 1108, 1073, 48 and 39) with a yield potential of >8.5 T/ha and good ideotype characteristics.

## ABR - Application of biotechnology tools for rice improvement

### ABR/CI/BT/9: Improvement of rice against biotic and abiotic stresses through transgenic approach inside

Activation tagged lines of BPT5204 were developed through *Ac-Ds* system by using pSQ5 construct. After molecular characterization, 31 homozygous lines of Ac-Ds, 3 lines of Ac and 1 line of Ds system were identified. The physiological parameters related to WUE of the *Ds-1* stable line was studied in both un-stressed and stressed conditions. The results indicated that Ds-1 line showed better WUE compared to control plants of BPT 5204. Also developed transgenic lines using En-Bar construct and after molecular characterization, identified several homozygous lines. A few lines, particularly the mutant line En-62 on evaluation under water stress conditions, showed increased water use efficiency. In the process, a few candidate genes were identified and their expression analysis was carried out. Expression studies confirmed that mutants with both gain-of function and loss-of-function could be obtained. The loss of function mutant with LOC_Os06g24540 gene was responsible for increased water use efficiency. 1020 out of total 1200 lines are from AC-Ds, AC and Ds systems and 1180 lines of En-Bar lines are in homozygous state either in T-5 or T-6 generations.

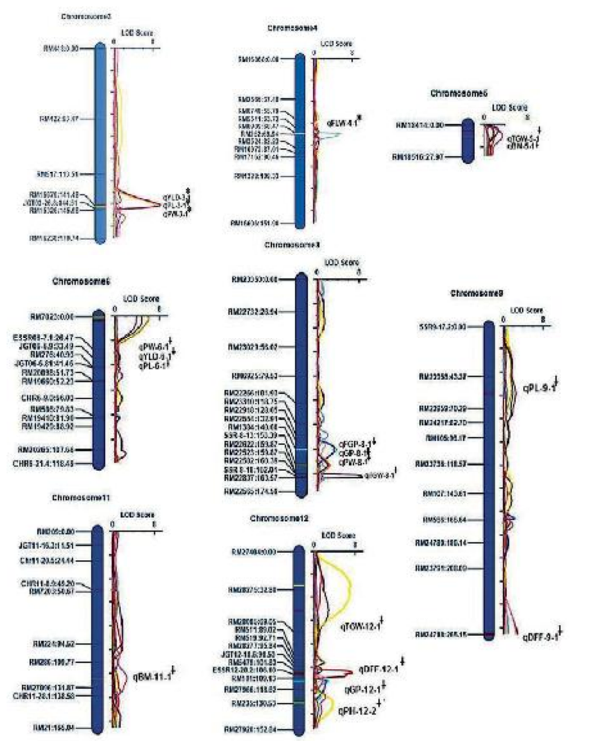
### ABR/CI/BT/6: Identification of genes for grain filling in rice (*Oryza sativa* L.)

Based on candidate gene mapping, two candidate genes have been identified *viz.*, a sugar transporter (STP) (LOC_Os11g42430) associated with filling of grains on primary and secondary branches of lower portions of the panicle and sucrose phosphate synthase (SPS) (LOC_Os02g09170) associated with filling of grains on primary branches of upper half of the panicle. Complete sequence analyses of two genes from contrasting parents showed very few SNPs in the genic region and several SNPs and Indels in the promoter region. Sequence analysis of the complete STP and SPS genes has shown highly conserved genic region and several Indels and SNPs in the upstream region. Haplotype analysis of these two genes in 3K panel (~250 genotypes) using SNPSeek also confirmed limited SNPs/Indels in the genic region. Expression analyses of STP and SPS in 1st node, flag leaf and developing panicle (10 DFF) in four efficient genotypes for grain filling (over IR64) have shown enhanced expression specifically in panicle tissues. Cloning of these two candidate genes is in progress.


**Expression analyses of STP and SPS in 1st node, flag leaf and grain filling panicle (10 DFF)**

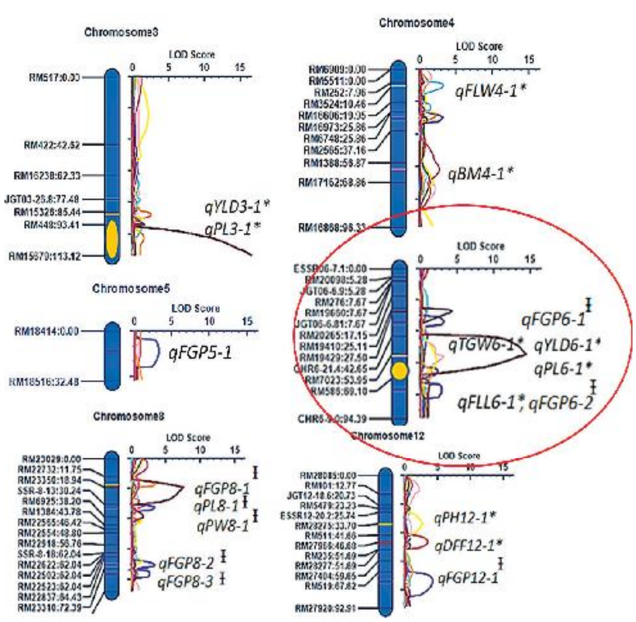
## ABR/CI/BT10: Genomic studies on grain yield heterosis and WA-CMS trait in rice

A total of 125 stable, doubled haploid lines (DHLs) were produced from the rice hybrid KRH2 (IR58025A/KMR3R). Quantitative trait loci (QTL) mapping was undertaken using the DH population along with 126 SSRs in order to identify novel genomic regions associated with yield and related traits. Twelve major effect QTLs were identified for the days to fifty per cent flowering (qDFF12-1), total grain yield/ plant (qYLD3-1 and qYLD6-1), test (1,000) grain weight (qTGW6-1 and qTGW7-1), panicle weight (qPW9-1), plant height (qPH12-1), flag leaf length (qFLL6-1), flag leaf width (qFLW4-1), panicle length (qPL3-1 and qPL6-1) and biomass (qBM4-1), explaining 29.95-56.75% of the phenotypic variability with LOD scores range of 2.72-16.51. Three DHLs showed yield levels higher than KRH2 hybrid by 13.8%.



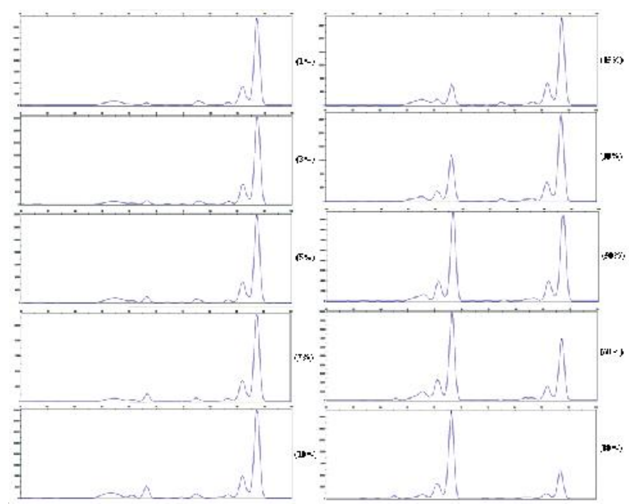
**SSR marker based Identification of QTLs and QTL hotspots associated with yield heterosis and yield related traits in an isocytoplasmic RIL mapping population derived from the elite rice hybrid, KRH2**

A set of 105 iso-cytoplasmic recombinant inbred lines (RILs) developed earlier from the rice hybrid KRH2 (IR58025A/KMR3R) were utilized for mapping yield and yield associated traits and also loci associated with heterosis using SSR and SNP markers. Five major effect QTLs were identified for the traits, total grain yield/plant (*qYLD3*-1), panicle weight (*qPW3*-1), plant height (*qPH12*-1), flag leaf width (*qFLW4*-1), panicle length (*qPL3*-1), explaining 20.23-22.76% of the phenotypic variability with LOD scores range, 6.5-10.59. Few genomic regions controlling several traits (i.e. QTL hotspot) were identified on chromosome 3 for total grain yield/plant (*qYLD3-1*) and panicle length (*qPL3-1*). Most of the high-yielding RILs possessing the major yield related QTLs were identified to be complete restorers. Few loci putatively associated with grain yield heterosis have been identified and two crosses, *viz.*, IR58025A/RIL-24 and CRMS32A/RIL-24 were observed to be the most promising cross combinations showing standard heterosis of > 50% for YLD trait (as compared with KRH-2) with higher prevalence of GCA and SCA, respectively. Heterotic yield advantage of IR58025A/RIL-24 and CRMS32A/RIL-24 was 77.05% and 54.74%, respectively over KRH-2 and these RILs can be utilized for developing commercial hybrids.




**QTL mapping with KRH-2 derived DH (Doubled Haploid) line population using 126 hyper-variable SSRs**

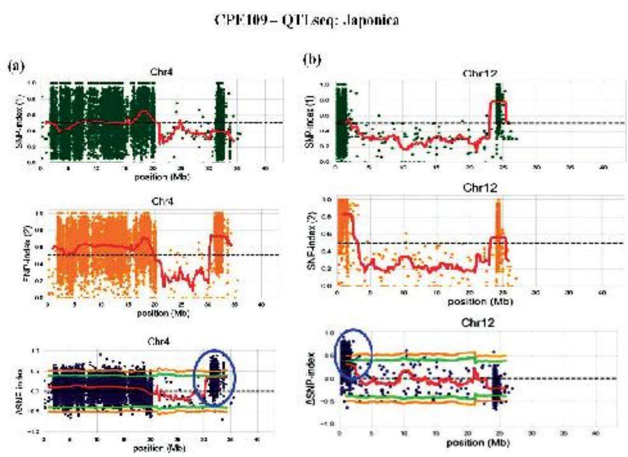
Genetically pure cytoplasmic male sterile line (A-line) is essential to generate pure hybrid seeds in order to harness the yield heterosis in rice. An assay based on bulked-seed and molecular markers will be an ideal system and keeping these points in view, the collaborative team of scientists from ICAR-IIRR, Hyderabad and DBT-CDFD, Hyderabad has utilized a co-dominant mitochondrial marker, developed earlier by ICAR-IIRR to test the purity of bulked parental line (A-line) seed utilizing capillary electrophoresis system in a genetic analyzer. The results obtained using coded samples indicate that this method is very simple, accurate, and can be used to test purity of large number of samples rapidly in a cost-effective way compared to grow-out test and conventional molecular marker analysis.



**Capillary electrophoresis to determine adulteration in the standard samples of IR68897A generated by admixing progressive amounts (1, 3, 5, 7, 10, 15, 30, 50, 60 and 80%) of IR68897B line using RMS-DRR-4 marker. Each electropherogram consists of peaks at 97 bp and 89 bp positions corresponding to fragments from A-line and B-line respectively and the areas of both the peaks depend on the amount of B-line admixture in A-line.**

## ABR/CI/BT/16: Exploring the mutant resources for rice improvement

Complete panicle exertion (CPE) is an important trait contributing to yield in rice as incomplete panicle exsertion results in an average of 10-20% yield loss as the panicles covered with flag leaf fail to emerge completely. One Samba Mahsuri EMS mutant (TI-109) showing complete panicle emergence was identified. An integrated approach combining linkage mapping, QTL seq, and RNA-seq was employed to identify the genomic regions and there by candidate genes governing this trait. Two unique genomic regions on chromosome 4 (31.21 – 33.69 Mb) and chromosome 12 (0.12-3.15 Mb) were identified through QTL seq that matched and correlated with conventional QTL analysis and RNA- seq data. The region was narrowed down to four candidate genes which includes F-Box domain containing protein, DUF domain contain protein, Zinc finger and a protein kinase. The validation of SNP's in the candidate genes is under progress.

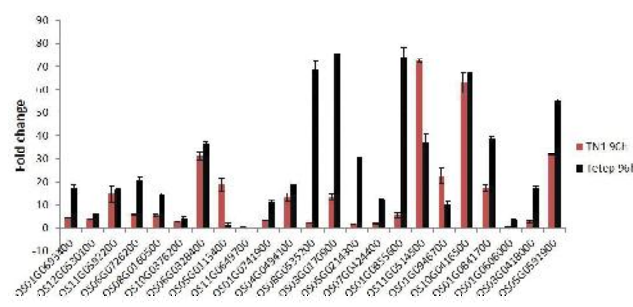



**Single nucleotide polymorphism (SNP)-index plots of WT-bulk (top; green dots) and MT-bulk (middle; orange dots) and plots of the Δ (SNP index) (blue dots) of the two bulks (bottom) (WT-bulk and MT- bulk) on (a) chromosome 4 & (b) chromosome 12. Sliding window plots of the average SNP index, with a 500-kb window size and 10-kb steps presented as red lines. The pairs of orange and green lines in the Δ (SNP index) plots represent the 95% and 99% confidence intervals, respectively. The blue colour circles highlight the detected QTL region**

## ABR/CI/BT/14: Exploring RNAi Technology for Management of Rice Diseases

A comprehensive approach was followed to analyse the whole-genome expression differences in six different rice genotypes (moderately tolerant and susceptible) during sheath blight disease caused by *Rhizoctonia solani*. The RNA-seq was done from control and *R. solani* infected rice genotypes TN1, BPT 5204, Tetep, Pankaj, Vandana and N22. Twenty-three genes were shortlisted based on their expression value and putative functions. Most of these genes are associated with either susceptibility or resistance response. These genes are annotated as chitinases- *OS06G0726200*, *OS04G0494100*, *OS10G0416500* and *OS03G0418000*; resistant genes or pathogenesis related-*OS11G0592200, OS05G0113400, OS08G0535200, OS05G0214300, OS01G0855600, OS01G0946700, OS01G0606000* and *OS05G0591900*; susceptible genes- *OS03G0418000* and *OS01G0606000*. The quantitative Real-Time qRT-PCR analysis of these genes was done in susceptible TN1 and tolerant Tetep genotypes. Expression analysis showed that *OS08G0535200, OS03G0170900, OS05G0214300* and *OS01G0855600* were more up-regulated in Tetep than in TN1 while *OS10G0416500* showed significant increase in expression in both the genotypes after fungal infection.

The interaction between rice tungro virus and *Rhizoctonia solani* was studied. The plants were-co-inoculated with both the pathogens. qRT-PCR was done to quantify the RTBV and RTSV population. Population of both the viruses (RTBV and RTSV) was reduced due to presence of *R. solani* pathogen. These results were supported by symptomatology and disease score.

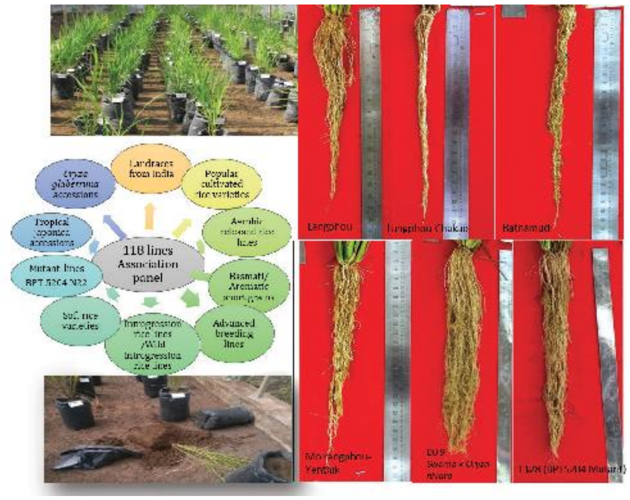



**qRT-PCR expression analysis of 23 shortlisted genes at 96h after *R. solani* inoculation in TN1 and Tetep. Data is presented after internal reference genes *OsActin1* normalization. The error bars represent the standard error of three biological replicates. X-axis: genes, Y-axis: Fold change expression in fungal infected sample in comparison to control**

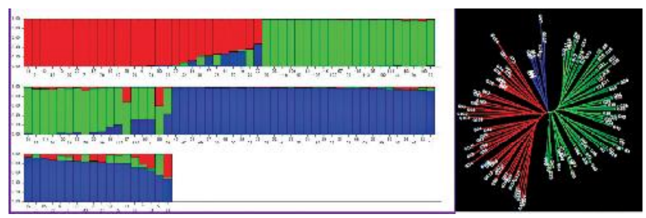
## ABR/CI/BT/15: Molecular and functional characterization of useful root traits in rice

A panel of highly diverse lines constituting germplasm, landraces, mutant lines, popular varieties, rice wild accessions, introgression lines etc. were evaluated stage wise and year wise under aerobic condition. A genome wide association (GWAS) study was conducted on 118 highly diverse rice lines using 97 polymorphic SSR markers (root traits linked and hypervariable) distributed across rice chromosomes. The STRCUTURE grouping of the lines based on K value was 3 and hence was sub-divided in three sub-populations. Using the TASSEL 4, (GLM and MLM), 27 highly significant marker-trait associations were recorded (MTA). The markers associated with more than two traits (RM 410, RM1385, RM18472, RM18939, RM22961, RM25310, RM28157, RM3188, etc.) were selected for *in silico* analysis.

The *in-silico* analysis identified abiotic stress related genes viz. NAM, LEA, brassinosteroid insensitive 1, spanning the nearby regions of the markers implying high co-relation of the marker with the root and yield traits contributing to aerobic adaptation. The three genes NAM, LEA, brassinesteroid insensitive 1 genes were expressed under aerobic conditions in aerobic adapted cultivars through RNA-seq and hence can be taken up as strong candidates genes for further functional studies for aerobic condition. The maximum number of significant MTAs (p value less than 0.05 and $r^2$ value more than 0.1) were found on chromosome 2, 3, 12 and the significantly associated regions can be further explored for fine mapping. The identified lines (WB-30, TI-128, TI-112, NPK-45, JBB631-1, WB-16, WB-24, Ratnachudi, CG 243) having high seedling vigor, high yield, root length, root volume can be further employed in aerobic breeding programmes.




Root phenotyping in rice association panel

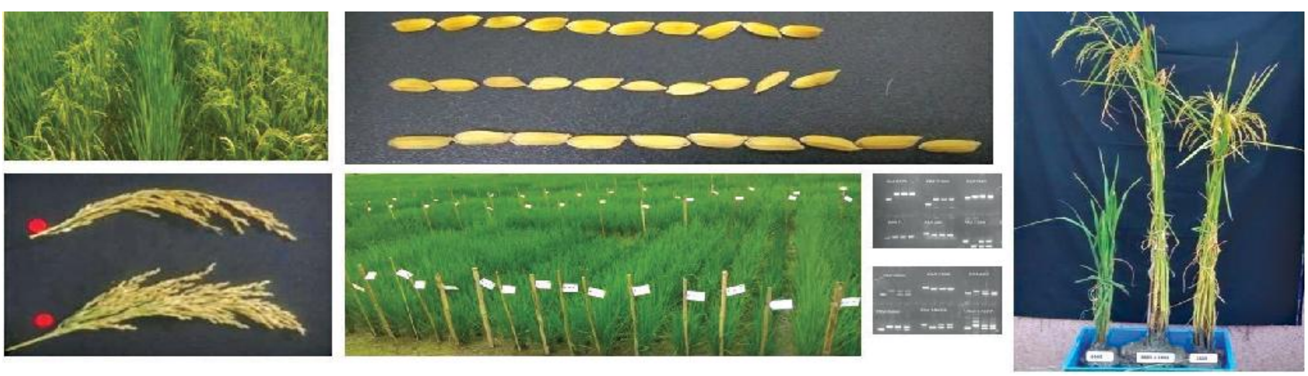


Population structure of association mapping in panel of 118 diverse rice lines (K=3) P1-Populaion 1, P2-Population 2, P3- Population 3. Bar plot represents the sub-populations, where in each bar indicate the single genotype and each colour represents the ancestry or recombination. Single bar with single colour indicates same ancestry; single bar with more than one colour indicates admixture/two population. Unrooted neighbour-joining trees of 118 genotypes in TASSEL

## ABR/CI/BR/28: Exploring Wild Introgression Lines and Mutants to identify novel Genes/ QTLs for Yield Contributing Traits

About 3600 segregating lines from 8 mapping populations derived from wild introgression lines and mutants in popular cultivar background at $F_2$-$F_6$ generations (148s/ 166s, Swarna/166s, 166s/14s, SM669/ Krishnahamsa, MTU1010/ SM363, Rasi/PY101 DRRDhan44/Rasi, MTU1010/Tulasi) and 1 CSSL population from MTU1010/ *O. rufipogon* ($BC_4F_5$) IC309814 (cross RP6166) were evaluated for yield related traits. 22 new crosses were made using wild introgression lines of *O. nivara* and *O. rufipogon* and also N22 mutants and secondary mapping populations from CSSLs were made. 8 high yielding lines were submitted for AICRIP trials under various ecologies and two entries IET27641 andIET29534 were found promising and are promoted in low Phosphorus and medium slender trials. High yielding wild introgression and mutant derived lines were screened for various biotic and abiotic stress *viz.*, Blast, BLB, false smut, sheath blight, leaf folder, planthoppers, low P tolerance, heat tolerance, aerobic condition and hybrid rice development and resistant/ tolerant donor lines were identified. 151 RILs of Swarna/166s, were studied for the stability and adaptability using AMMI and GGE biplot models for yield related traits. Pooled analysis over three season's data revealed that genotype G14 recorded the highest single plant yield (SPY) and the highest 1000-grain weight was shown by G76. The genotype G65 was identified as the stable and adaptable across all three seasons for SPY and G148, G116 and G76 for thousand grain weight.

Mapping population generated from two stable backcross alien introgression lines 166s and 14s derived from Swarna x *O. nivara* was characterized for yield traits and QTL mapping was conducted. $C_2$12, $C_2$124, $C_2$128 and $C_2$143 were identified with significantly higher SPY; $C_2$103, $C_2$116 and $C_2$117 had higher thousand grain weight values than both the parents and Swarna consistently across the generations. A total of 21, 30 and 17 quantitative trait loci (QTLs) were identified in $F_2$, $F_{2:3}$ and $F_{2:4}$ respectively for yield traits using ICIM v4.1. QTLs *qSPY4.1* and *qSPY6.1* were detected for grain yield in $F_2$ and $F_{2:3}$ with phenotypic variance (PV) of 8.5% and 6.7% respectively. The trait enhancing alleles of QTLs *qSPY4.1*, *qSPY6.1*, *qPH1.1*, *qTGW6.1*, *qTGW8.1*, *qGN4.1* and *qTDM5.1* were from *O. nivara*. *qTGW8.1* was identified in a 2.6Mb region between RM3480 and RM3452 in all three generations with PV 6.1 to 9.8%.

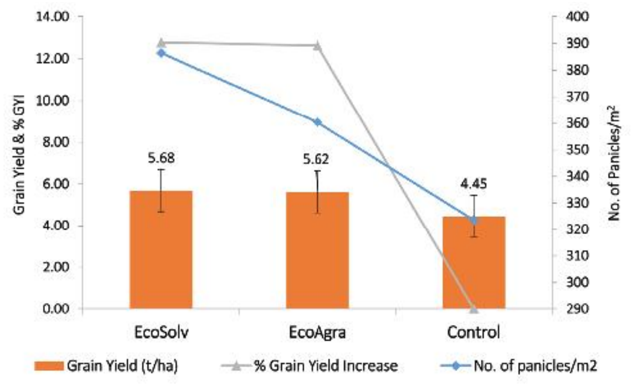


**Variation of segregating mapping populations for yield and grain traits**

# RUE - Enhancing resource and input use efficiency

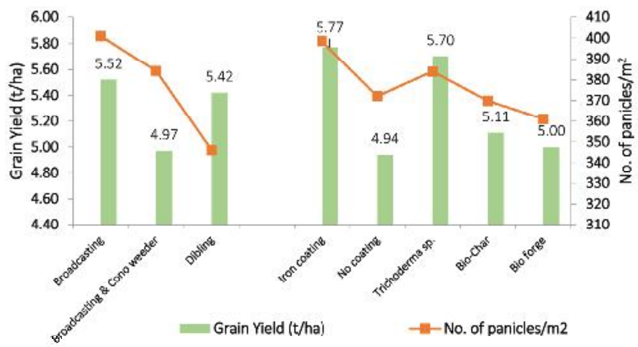
### RUE/CP/AG/11: Strategic research on enhancing water use efficiency and productivity in irrigated rice system

Hydroponic nursery raised in trays was used for mechanised transplanting to test for its suitability for mechanized transplanting in SRI. The yields were on par (6.12 t/ha and 6.07 t/ha) in both mat and hydroponic nursery. EcoSolv irrigating device and EcoAgra were evaluated Yield enhancement in DSR dibbling method were evaluated and EcoSolv irrigating device and ecoAgra growth promotor and surfactant performed significantly better than control but were on par in terms of grain yield, number of panicles/$m^2$ and other yield attributes. Pest incidence was lesser in ecoSolv and ecoAgra plots and there were no algae found in the plot equipped with ecoSolv irrigation device.




Grain yield, grain yield increase (%) and number of panicles/m² as influenced by EcoSolv and EcoAgra

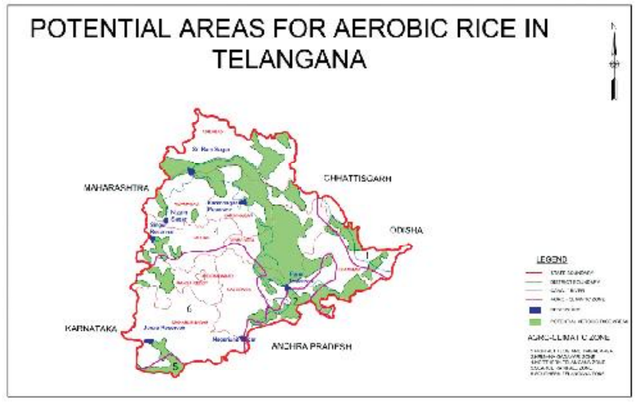
Iron coated seed and seed treatment with *Trichoderma* species was found significantly better over untreated in terms of yield attributes in three methods of cultivation.

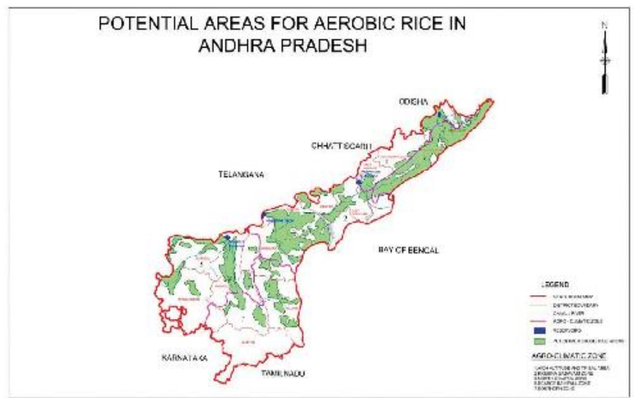



Grain yield and number of panicles/m² as influenced by different establishment methods and seed treatments

## RUE/CP/AG/13: Innovative agro-techniques for improving the productivity of aerobic rice and aerobic rice based cropping systems

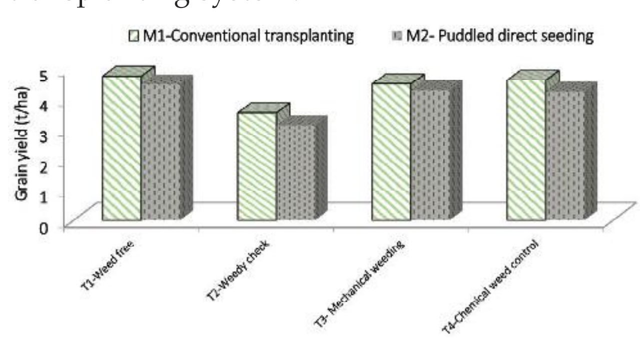
The multicriteria evaluation for potential areas for aerobic system was generated based on the information and maps available from NARP(ICAR) for Agro-climatic zones, water sources etc., of Andhra Pradesh and Telangana States, Time series Satellite data (AWiFS) images, SOI topographic map (1: 10,00,000).The extent of the potential areas of aerobic rice were calculated based on suitability polygons. In Andhra Pradesh potential area for aerobic rice cultivation was 48,77,400 ha and in Telangana State it was 311700 ha.



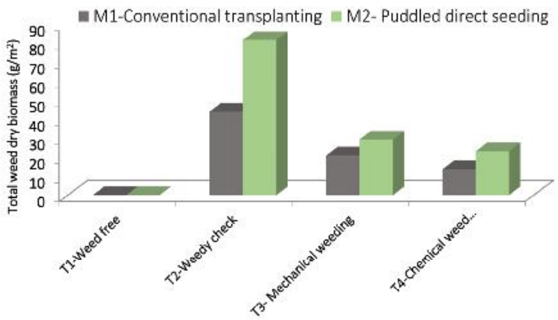

## RUE/CP/AG/18: Development of climate smart and economic weed management technologies for changing rice establishment systems

Irrespective of the system of establishment methods, both mechanical weeding and chemical weed control were comparable for reducing weed population, weed biomass, and increasing grain and straw yields. Species wise weed population showed group wise dominance of grasses>sedges>broad leaf weeds. The puddled direct sown rice system has higher broadleaf weed population than transplanting system.




Grain yield of rice in different establishment methods and weed management treatments

Lead Research




Total weed dry biomass at active tillering stage under different establishment methods and weed management treatments

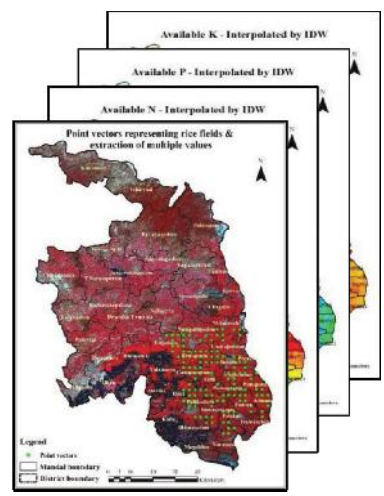
### RUE/CP/AG/17: Comparative study of organic and conservation agriculture for enhanced resource use efficiency, yield and quality of rice

Comparative study of organic and conservation agriculture in rice-rice system was conducted in *kharif* 2020 in randomized block design with six treatments *viz*., T1-100% RDF through inorganic sources + Residue incorporation (RI), T2- Integrated nutrient management+ RI, T3- Need based nutrient application+ RI, T4-100% RDF through inorganic sources+No residue retention, T5-Integrated nutrient management + No RI, T6- Need based nutrient application + No RI. T2- Integrated nutrient management+ RI recorded highest number of tillers/m$^2$, dry matter accumulation, leaf area index and SPAD values. The yield attributes, grain yield and straw yield was also highest under T2 treatment. The nutrient contents in grain and straw did not exhibit considerable differences due to the different nutrient management practices. The N and P contents in grain as well as their uptake was much higher than that of straw; whereas, K content in straw was higher than that of grain.

### RUE/CP/SS/16: Study of rice vegetation in terms of crop stress to model the yield using NDVI

A ground truth survey was conducted in the study areas with recording of yield and sampling of leaf material. A data matrix of 136-point vectors, representing different rice fields in West Godavari district with extracted values of 12 different soil themes developed from interpolated soil maps using about 13000 soil health cards, was created. Similarly, NDVI at maximum growth stage obtained from Sentinel-2 satellite data (10 m resolution), rice productivity obtained from crop cutting experiments organized by Department of Agriculture, Government of AP were extracted to these 136 points. This data matrix was subjected to statistical analysis and inferences were drawn.

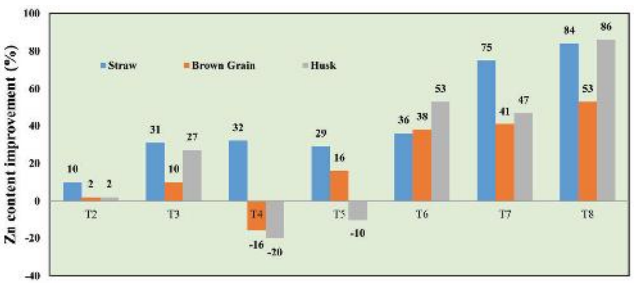
There was a significant positive relation between NDVI and rice productivity while NDVI was negatively influenced by increased pH. It was inferred that interpolation techniques could be applied to soil attributes derived from SHCs, though the soils were not sampled at equally spaced grids. It was also evident that these digital soil maps along with satellite data products can be used in geospatial analysis of crop performance coupled with crop production.




Combined use of RS data and interpolated maps to assess crop productivity

### RUE/CP/SS/19: Evaluation of ZnO nano Particles in performance of rice

The field level testing on nano ZnO was initiated during the year 2020, and the trial was formulated with two sprays of ZnO nanoparticles at 50, 100, and 150 mg L$^{-1}$ with bulk ZnO at 500, 1000, and 1500 mg L$^{-1}$ and 0.5% $ZnSO_4$ along with control (T1) were tested. Before spraying, nanoparticles were made into suspension with the help of a medium with dispersing agents. Of the two dispersing agents *viz.,* sodium dodecyl sulfate (SDS) and polyethylene glycol (PEG) used. SDS improved the stability of the nanoparticle suspension by 45 min over PEG. This result indicated that the selection of surfactant agents is more important to stabilize the nanoparticle in the medium for a maximum period. Two sprays of ZnO @ 150 mg $L^{-1}$ increased the Zn content in straw by 76 per cent over the control, which was at par with the 0.5% $ZnSO_4$ (84%). The zinc content in brown rice and husk was increased to the tune of 41 and 47%, respectively over control by nano ZnO (150 mg $L_{-1}$), but the improvement was lower than the $ZnSO_4$ application. Application of nano ZnO in different doses did not impact plant height and chlorophyll content. Straw Zn Content significantly improved by nano ZnO addition over control but lowers than $ZnSO_4$ in straw and husk. The movement of ZnO to husk is low due to less penetration in the seed coat.




**Per cent improvement of Zn content in different parts of rice over control**

T2=Bulk ZnO 500 mg $L^{-1}$ T3=Bulk ZnO 1000 mg $L^{-1}$ T4=Bulk ZnO 1500 mg $L^{-1}$ T5=Nano ZnO 50 mg $L^{-1}$ T6=Nano ZnO 100 mg $L^{-1}$ T7=Nano ZnO 150 mg $L^{-1}$ T8=ZnSO4 mg $L^{-1}$

## RUE/CP/SS/19: Efficacy of hydrogel on yield and soil properties of rice

Field experiments were conducted in two seasons to study the effect of graded doses of hydrogel in combination with FYM and different levels of recommended doses of fertilizers (100% RDF and 75% RDF) in a randomized block design with DRR Dhan 44. During *Rabi* 19 -20, the yield parameters revealed that application of FYM (10 t/ha) + 75% RDF+ Hydrogel @ 5 kg/ha resulted in highest number of tillers/ $m^2$ (291), panicles/ $m^2$ (254), grain yield (3917 kg/ha) and straw yield (4360 kg/ha) which was on par with FYM + 75% RDF+ hydrogel @ 10 kg/ha and 100% RDF in combination with 5 and 10 kg /ha hydrogel. During *Kharif* 2020, results revealed that, FYM + 75% RDF+ hydrogel @ 5 kg/ha recorded 24% higher grain yield and 20% higher straw yield compared to control (NPK alone). Hydrogel applied plots recorded 9 to 30% increase in soil moisture content compared to untreated plots.

**Field view of hydrogel experimental plot at Rajendranagar farm**

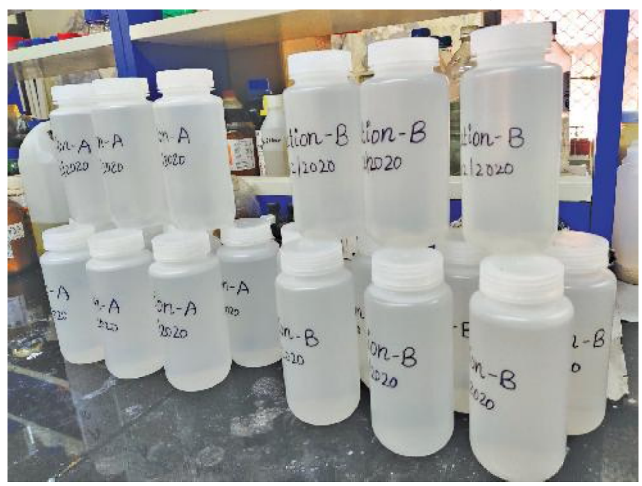
## RUE/CP/ENG/6: Selective mechanization in rice cultivation

A custom soil puddling machine using 0.5 hp electrical motor and stand was fabricated. Another specially designed tool for puddling in pots has been fabricated. In addition, a small auger was also designed and evaluated for refinements. Riding type drum-seeder was tested during *Kharif* 2018. Performance is encouraging. There is no yield difference between riding type drum seeder and manual drum seeder. Riding type 8 row Chinese transplanter was successfully used to transplant 18-20 days seedlings. In view of uniform depth of planting the yield was 5-8% more as compared to transplanting. Drum type biochar unit has been fabricated. Testing will be taken up to optimize parameters.

Custom soil puddling machine using 0.5 hp electrical motor

### RUE/CP/AC/1: Post Harvest Treatment of Rice and Rice By-Products for Health Benefits and on-farm application

Silica content in different parts of the rice plants was analysed from 65 different varieties and the highest silica content was found in husk followed by straw. We simplified and standardized the process of silicic acid formulation for foliar spray and compared with the commercially available product. The commercially available silicic acid formulation for foliar spray is composed of 0.8% Si with 47.5% PEG-400 as stabilizer. A simple low-cost process for silicic acid formulation for foliar spray without stabilizer was developed by eliminating polyethylene glycol-400 from the formulation, the production cost of the non-colloidal silicic acid formulation will drastically reduce. The silicon content was 2.5 times higher than that of the commercial formulation. Among the silica-based products evaluated *viz.*, Slow-release urea SRU-65, SRU-75 and SRU-85, silicic acid and K-Silicate, slow releasing urea (SRU) gave better performance. The number of grains / pots ranged from 302 to 537 in SRU treatment (applied with 50 kg N/ha) was higher than the number of grains in Nitrogen coated urea treatment (NCU) (211 -247, grains/pot). Total grain weight in SRU treated pots (4.8-7.51 g/pot in 50 kg N/ha; 6.71-8.74 g/pot in 100 kg N/ha) was higher than that of NCU treated pots (3.42 g/pot in 50 kg N/ha; 3.83 g/pot in 100 kg N/ha) and control (1.24 g/pot). All concentrations (Si- 20, 40, and 80 ppm) of silicic acid foliar spray produced higher yield than that of the control and silicic acid spray 20 ppm Si with RDF, produced highest rice grain yield (5.99 t/h) as compared to 4.93 t/h obtained from the control treated with RDF only.

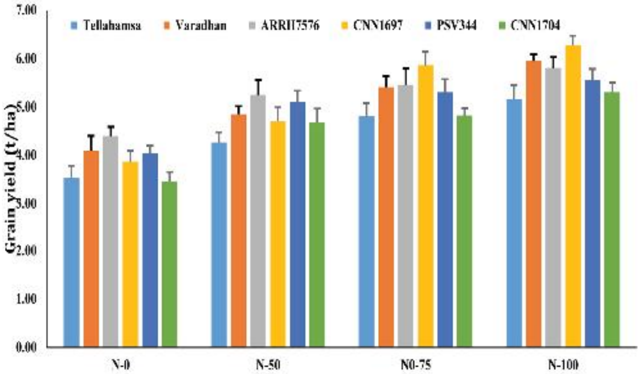


Formulating silicic acid for foliar spray

## SSP – Sustaining rice system productivity

### *SSP/CP/SS/11*: Assessment of genotypic variability and improving nitrogen use efficiency (NUE) in irrigated rice

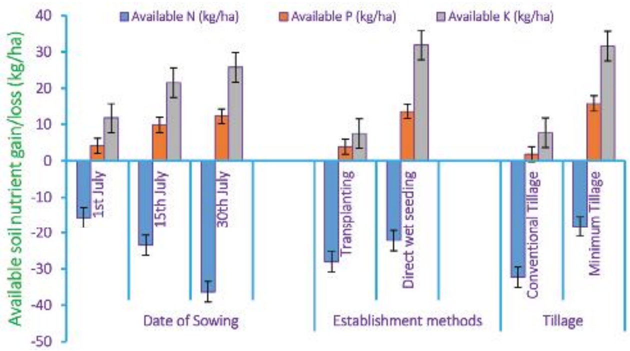
To evaluate the N use efficiency of existing popular rice varieties and to identify efficient rice genotypes for their responsiveness and utilisation of soil and applied N, a field experiment was conducted under N-0 and N-100 kg/ha as main treatments and 20-21 popularly grown high yielding varieties and hybrids as sub treatments in a split plot design with 3 replications during *kharif* and *rabi* seasons of 2020. In addition, 28 entries of land races were also evaluated under N0 and N100 levels during both seasons. In another experiment, six promising varieties including one hybrid, identified for high NUE from the initial screening were subjected to graded levels of N (0, 50, 75 and 100 kg N/ha) during *kharif* 2020. To improve N use efficiency, slow-release N materials (SRU and NCU) and urease inhibitors along with silicic acid were tested under field experiment with three varieties (DRR Dhan 42, DRR Dhan 44 and DRR Dhan 46) during *kharif* 2020. In both the seasons, mean yield was significantly higher at N100 compared to N0 and the response to N was high in *rabi*. Among the 20 varieties tested, PSV 190, PSV 469, ARRH 7576 and Varadhan during *rabi*; PSV 344, PUP 221, PUP 223, Varadhan and PSV 56 during *kharif* recorded higher yields without external N application and were found promising. The varieties identified as promising for their responsiveness to applied N and its utilisation were: PSV 181, KRH 4, PUP 221 and PSV 469 during *rabi* and PSV 344, Varadhan, PUP 221 and PSV 56 during *kharif*. Out of 28 land races tested, IC463254, Pooja, Kola Joha-3, IDSA77, and KMR-3 without external N application and Kola Joha-3, KMR-3, IR88634:3-B-1 along with Anjali and Dehradun basmati with recommended N performed well with higher grain yield. At graded levels of N, grain yield was maximum at N100 followed by N75 and N50 and these 3 levels were significantly superior to N0. Four varieties, (ARRH 7576, CNN1697, Varadhan and PSV 344) were on par and recorded significantly higher yields than the other two varieties (Tellahamsa and CNN 1704). The hybrid, ARRH 7576 at lower N (N0 and N 50) and CNN 1697 at higher N (N75 and N 100) recorded maximum grain yield than other varieties. The first season results on improving NUE indicated significantly higher yield (5.15 t/ha) with allicin 2000ppm coating which was on par to NBPT1000 ppm coating (4.73 t/ha) followed by SRU 85@100kgN/ha (4.43 t/ha) and allicin 1000ppm (4.41 t/ha). All these improved N sources recorded yield increase over NCU by 6-23%.



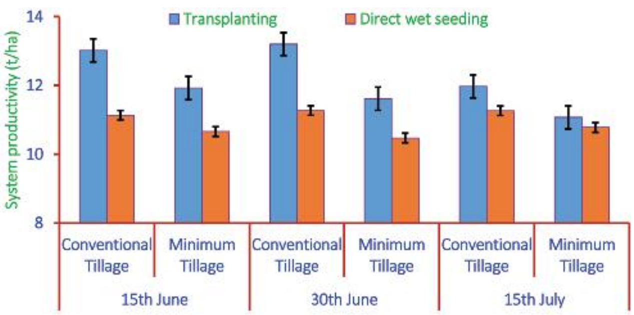

Grain yield (t/ha) of varieties at graded levels of nitrogen

### SSP/CP/AG/15: Sustainable intensification of conservation agriculture practices in rice-maize system to enhance system productivity in Southern India

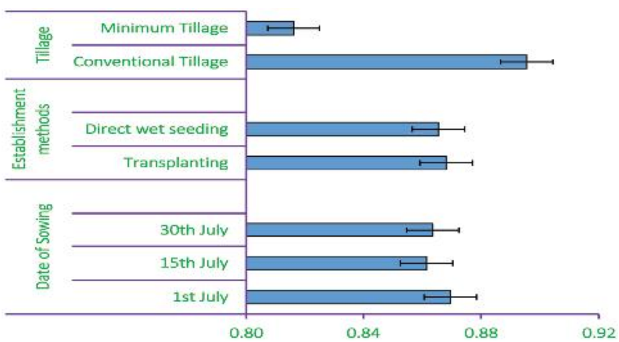
The effect of different rice establishment methods, mulching stubbles and tillage on system productivity of rice-maize system is in the fourth year of study. Pooled analysis of 4-year data revealed that available soil nitrogen was getting depleted in all the plots. Sowing on 30th July recorded the highest nitrogen mining (36.3 kg/ha) as compared to sowing on 1st July (-15.6 kg/ha). Similarly, transplanted rice mined more nitrogen (28.1 kg/ha) compared to wet direct seeding (22.2 kg/ha). Minimum tilled plots mined less nitrogen (18.2 kg/ha) than conventional tilled plots (32.3 kg/ha). The highest system productivity was recorded in transplanted rice sown on 15th July followed by conventional tilled maize system (14.8 t/ha). Higher sustainable yield index (0.90) was also found in the same treatment combination.




Available soil nutrient gain\loss over initial soil status after 4 years of rice-maize crop rotation



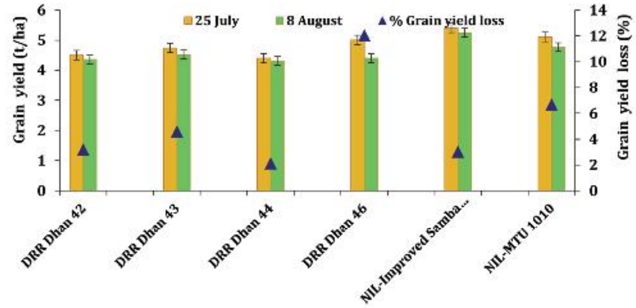

Rice-maize system productivity after 4 years (2016-2020) of continuous cultivation




Sustainable yield index (SYI) of rice-maize system after 4 years of continuous cultivation

## SSP/CP/AG/16: Development of sustainable agro-techniques for direct seeded rice

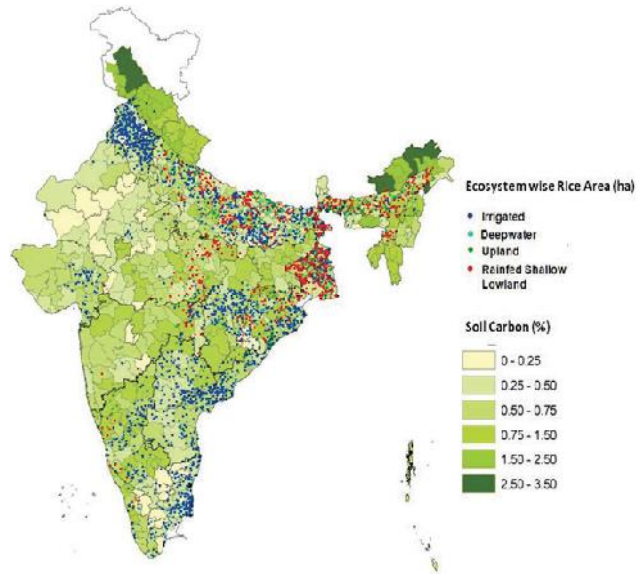
Four promising rice varieties DRR Dhan 42, DRR Dhan 43, DRR Dhan 44, DRR Dhan 46 and two NILs of Improved Samba Mahsuri and MTU 1010 were evaluated under timely and late sown wet-DSR. The mean grain yield was significantly higher with sowing on 25 July (4.86 t/ha) compared to 8 August (4.60 t/ha). On an average 2 to 12% reduction in grain yield in different varieties (including NILs) was observed when sowing was done on August 8 compared to July 25.



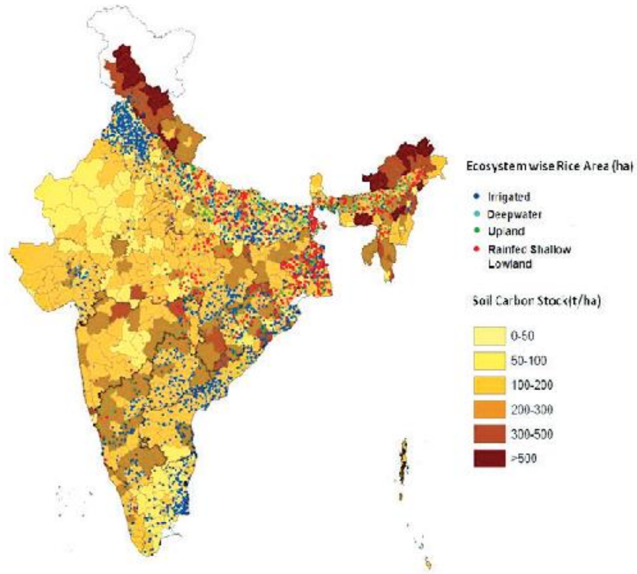

Grain yield and grain yield loss (%) of rice varieties under different date of sowing

## *SSP/CP/SS/18:* Studies on Soil Organic Carbon Status. Mapping and stocks in Rice Soils of India

10000 Soil samples were collected from various places across different rice ecologies and analysed. The data for soil organic carbon is being collated and integrated into series of soil organic carbon maps. This is a first attempt to characterize the rice ecologies for its soil organic carbon and their stocks. A large variation up to the tune of >70% was noticed for soil organic carbon percentage and stocks among the four different rice ecologies. This study indicated that decline in surface soil organic carbon in the rice ecologies of India reduced two times faster than that of the soil carbon storage in the upland/ hilly rice ecologies. In the irrigated rice ecologies especially in the Indo-Gangetic Plains, the decline in soil organic carbon was to the extent of 69.6% in comparison to the upland/hilly rice ecologies. This was closely followed by rainfed shallow lands where decline in soil organic carbon due to cultivation was to the tune of 67.0%. Invariably, cultivation leads to decline in soil organic carbon in the range of 19-70% from the initial value. It is particularly to be noticed that the agricultural soils of northwest India exclusive of the Himalayas have lost about one half to two thirds of their original organic carbon content. In the different ecology wise studies, the mean surface soils carbon content of irrigated areas was 0.39% and it ranged from 0.13% to 0.78%.




**Soil Carbon status in 0-20 cm depth in all the rice ecologies of India**




**Soil Organic Carbon stock in 0-20 cm depth in all the rice ecologies of India**

## SSP/CP/SS/19: Prospecting endophytic actinobacteria of rice for sustainable rice production

The ability of endophytic actinobacteria to improve rice seedling growth under in vitro conditions was assessed by seed biopriming. Actinobacteria treatment improved germination response measured as germination percentage and mean germination rate compared to untreated control. Inoculation with actinobacteria resulted in root and shoot growth that differed significantly from uninoculated control. Forty-six per cent of the isolates increased shoot growth, while 87% of the isolates were observed to improve root growth. Differences were also observed in lateral root formation due to inoculation. The isolates were tested for the presence of polyketide synthase type I (PKS-I), polyketide synthase type II (PKS-II), and non-ribosomal peptide synthase genes (NRPS), which play a fundamental role in the biosynthesis of secondary metabolites. PKS-I genes were detected in 13.3% of the isolates, while 66.6% of the isolates were found to harbour PKS-II genes and NRPS genes were detected in 26.66% of the isolates. After sequencing of the amplified PKS-I, PKS-II, and NRPS genes, gene sequences were translated to amino acid sequences and BLASTP and Do BISCUIT (Database of BIo Synthesis clusters CUrated and InTegrated) database were used to predict metabolite products for the genes. The predicted products of PKS-I gene sequences were surfactin and yanuthone (antifungal activity) while the prediction for the PKS-II sequences were for aromatic polyketides such as granaticin and monensin classified under the benzoisochromanequinone and polyether group of compounds with antimicrobial and antiprotozoal activity. The prediction of the NRPS gene sequences were for gramicidin which is also an antibacterial compound. The isolates were identified by using 16S rDNA sequence analysis and were found to predominantly belong to genus *Streptomyces* while some were novel like *Amycolotopsis*.

**Predicted secondary metabolites and their activity based on PKS-I, PKS-II and NRPS genes in actinobacterial isolates**

| Isolates | Similarity (%) | Predicted pathway product | Product classification | Activity reported |
|---|---|---|---|---|
| **PKI** | | | | |
| *Amycolatopsis lurida* | 99.8 | Linear gramicidin synthase subunit C | Gramicidin | Antibacterial |
| Streptomyces sp. QLS77 | 93.7 | Non-reducing polyketide synthase yanA | Yanuthone biosynthesis | Antifungal |
| **PK II** | | | | |
| *Amycolatopsis lurida* | 93.4 | Granaticin polyketide putative beta-ketoacyl | Granaticin | Antibacterial |
| *Streptomyces* sp. 6R004, *Amycolatopsis orientalis* strain B-37, Streptomyces sp. 3030, *Marinateneraspora sediminis* strain TPS81, *Streptomyces* sp. QLS77, sp 3030, sp SM716, sp MAG 45, sp UBA10994 | 95.1 | Putative polyketide beta-ketoacyl synthase 1 | Monensin | Antiprotozoal |
| **NPRS** | | | | |
| *Amycolatopsis lurida* | 100 | Linear gramicidin synthase subunit C | Gramicidin | Antibacterial |
| *Amycolatopsis sp*. BCA-696 | 90.3 | Linear gramicidin synthase subunit D | Gramicidin | Antibacterial |
| *Amycolatopsis orientalis* strain B-37 | | | | |
| *Streptomyces* sp. 3030 | | | | |

## SSP/CP/SS/15: Microbial population dynamics in different rice establishment methods in relation to nutritional availability and acquisition

Soil samples were collected from farmer field and IIRR research farm from different rice establishment methods to isolate potential nitrogen fixing and phosphorus solubilising microbes. A total of 432 nitrogen fixing bacteria were isolated on N- free media and 245 unique morphotypes were purified and evaluated for nitrogenase activity through Acetylene Reducing Assay (ARA) of which eleven isolates possessing high ARA activity were selected for further studies. Among twenty potential phosphorus solubilising isolates, nine viz. P6, P7, P7-1, P7-2, P8, P8-1, P9, P14 and P14-1 were identified through 16S rRNA gene sequencing. Interestingly four isolates namely *Bacillus flexus* strain VL2, *Bacillus pumilus* strain AB1, *Bacillus pumilus* strain KSU_12 and *Bacillus pumilus* strain AB12 were able to solublize the potassium (K) and Zink in addition to phosphorus(P).

**List of identified Phosphorus solubilizing bacterial isolates**

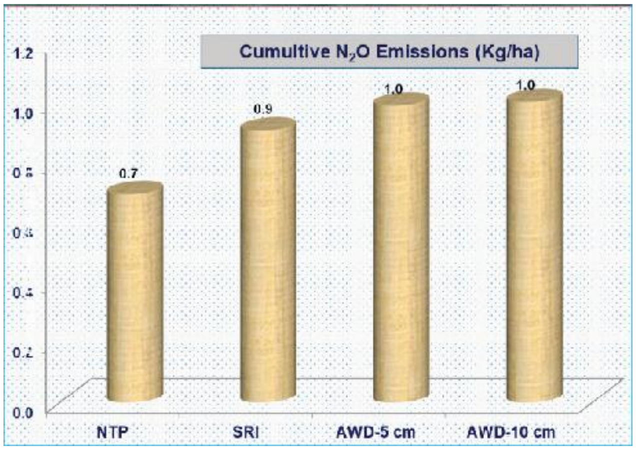
| SL. No. | Isolates | Identified P-solubilizing bacteria |
|---|---|---|
| 1 | P6 | *Citrobacter sp.* |
| 2 | P7 | *Bacillus flexus* strain VL2 |
| 3 | P7-1 | *Citrobacte ramalonaticus* strain Rashtia |
| 4 | P7-2 | *Bacillus pumilus* strain AB1 |
| 5 | P8 | *Bacillus marisflavi* strain KR3M-25, |
| 6 | P8-1 | *Bacillus pumilus* |
| 7 | P9 | *Bacillus altitudinis* strain 14b |
| 8 | P14 | *Bacillus pumilus* strain KSU_12 |
| 9 | P14-1 | *Bacillus pumilus* strain AB12 |

# CCR – Assessing and managing crop response to climate change

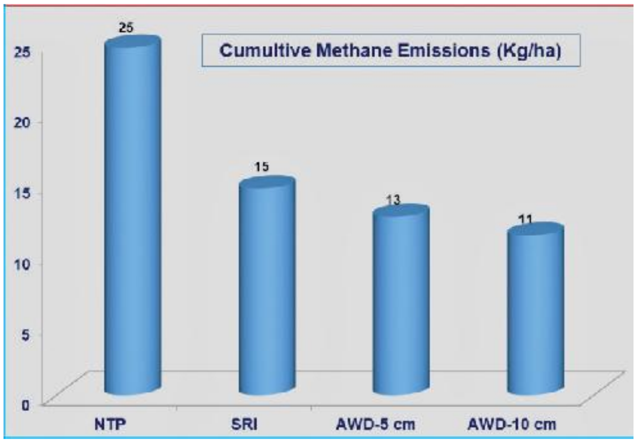
## CCR/CP/SS/17: Studies on emission of greenhouse gases (GHGs) from rice soils and their mitigation

Field experiments to study the impact of different water management/crop establishment methods (puddled transplanted, SRI and puddled AWD) on GHG emissions (methane and nitrous oxide) as well as water use efficiency were conducted during 2020-21. The impact of different water management methods on Carbon Equivalent Emissions (CEE) and Carbon Efficiency Ratio (CER) too were studied.

The different establishment/planting methods significantly impacted both the greenhouse gas (GHG) i.e., methane and nitrous oxide emissions throughout the crop growth period. The seasonal integrated flux (SIF) for methane was the highest in normal/conventional transplanted (TPR) method (24.59 kg ha$^{-1}$) followed by SRI (14.64 kg ha$^{-1}$) and AWD methods resulted in lower flux values of 12.65 and 11.32 kg ha$^{-1}$ with irrigation at 5 cm and 10 cm depletion of ponded water, respectively. Methane emissions decreased by more than 40 per cent in SRI and by 49 and 54 per cent in AWD at 5 and 10 cm, respectively as compared to TPR. The higher methane emissions under conventional TPR method were due to the depletion of oxygen under submerged condition leading to conducive anaerobic or reduced atmosphere throughout the crop growth season. The seasonal integrated fluxes of $N_2O$-N were the least in TPR (0.69 kg ha$^{-1}$) as compared to SRI (0.91 kg ha$^{-1}$) and AWD methods (0.99 and 1.00 kg ha$^{-1}$). $N_2O$-N emissions were higher by 31 per cent in SRI and 42 and 44 per cent in AWD at 5 and 10 cm, respectively over TPR.




Carbon Equivalent Emissions (CEE) significantly varied with different establishment techniques. The CEE was the highest under TPR (224 kg C ha$^{-1}$) followed by SRI (174 kg C ha$^{-1}$).




The lowest CEE values were observed under AWD methods at 5 and 10 cm (167 & 159 kg C ha$^{-1}$). The highest CEE in TPR was due to higher methane emissions during the entire crop growth period.

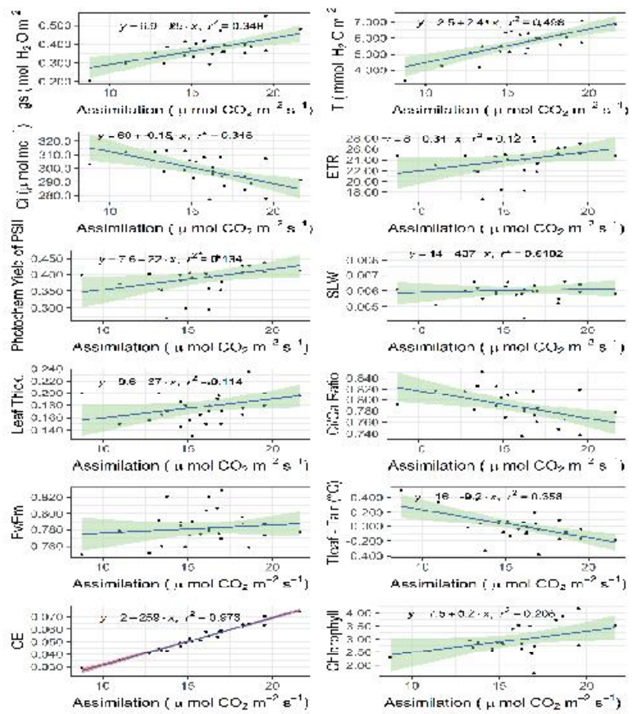
The Carbon Efficiency Ratio (CER), an index of efficiency of a treatment which is a ratio of carbon (C), fixed in grain per unit of C emitted from soil. CER was the lowest in TPR method (11) and highest in (15) SRI. A low CER in TPR shows that more C is emitted and less C fixed where as in case of SRI the C emitted was significantly reduced as compared to the carbon fixed. The

CER of conventional method was 27 per cent lower than SRI method, which shows that the latter is more efficient as it causes less emission in comparison to TPR.

The irrigation water applied was maximum (1197 mm $ha^{-1}$) in TPR followed by 20 per cent saving (956 mm $ha^{-1}$) in SRI. The water usage further reduced by 37 and 49 per cent in AWD at 5 and 10 cm respectively. However, there is a yield penalty in AWD methods as compared to TPR and SRI. The water productivity ranged from the lowest of 4.49 kg ha $mm^{-1}$ in TPR to 5.98, 6.27 and 6.41 kg ha $mm^{-1}$ in SRI and AWD at 5 and 10 cm depletion respectively.

### CCR/CP/PP/11: Evaluation of genotypic variability in leaf photosynthetic efficiency and its associated factors in rice

During *Kharif* 2020 season, leaf gas exchange traits were measured on 3 fully-expanded flag leaves 3 days after anthesis from each replication, using a portable open gas-exchange system (*LI6400XT*, *LI-COR*, Lincoln, NE, USA). In this trial 30 advanced breeding lines of rice (IVT-E-TP) were assessed for leaf photosynthetic traits, fluorescence characteristics and some important leaf attributes. Photosynthetic efficiency ($P_N$) was measured on flag leaf and varied between 8.75 (RP-63389-9) to a maximum of 21.69 (IET-29162) with a mean of 16.3 µmol ($CO_2$) $m^{-2}$ $s^{-1}$. Similarly, significant variation was observed amongst the tested entries for stomatal conductance (*gs*). Significant variation (p<0.01) was observed between the tested entries for intrinsic water use efficiency (iWUE). The iWUE was highest in IET 29150 (55.07) and lowest in KMR-3R (28.71) with a mean of 48.7. The carboxylation efficiency (CE) showed significant variation among the tested entries. The CE varied between a maximum of 0.0742 (IET 29162) and minimum CE of 0.031 was recorded in RP 63389-9. For apparent electron transport rate (ETR) differences amongst other entries are not significant. The maximum photochemical efficiency Fv/Fm also did not differ significantly amongst the tested entries. The YS(II) (effective photochemical yield) measured in different entries show marginal but statistically significant differences. The coefficient of photochemical quenching shows significant differences amongst the tested entries. The qP varied between 0.693 (IET29154) to 0.402 (KMR-3R) with a mean of 0.599. The coefficient non-photochemical quenching (qN) shows significant differences amongst tested entries. Multiple correlation analysis was performed to understand the relationship between the leaf gas change and fluorescence traits and leaf characteristics and some important yield parameters). Highly significant positive association was observed between the leaf photosynthetic efficiency ($P_N$), stomatal conductance (gs) and $P_N/C_i$ (carboxylation efficiency), ETR, and YII. The intercellular $CO_2$ (Ci), Ci/Ca (ratio of intercellular and ambient CO2 concentration) ΔTc show a negative association with $P_{N.}$ The association between $P_N$ and grain yield was non-significant. However, the TDM show a positive association with $P_N$. PN show significant association with SPAD value (chlorophyll).

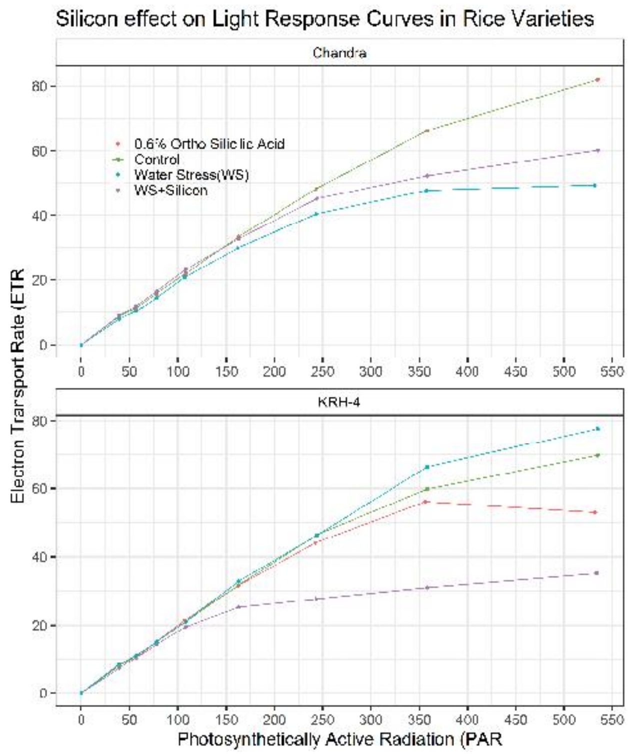


Relationship between leaf photosynthetic efficiency and important gas-exchange and leaf characteristics

Lead Research

### CCR/CP/PP/12: Role of Silicon in inducing water stress tolerance in rice genotypes:

Two rice genotypes Chandra (high yielding) and KRH-4 (hybrid) were evaluated using 0.6% silicon applied in the form of Orthosilicic acid in a split plot design with four treatments (Control, 0.6% Silicon, Silicon+WS and WS) and three replications. The results revealed that on application of 0.6% silicon, there was increase in yield and yield attributes in the treated plot. There was significant increase in biomass, leaf area index and grain number per panicle along with increase in yield, however the increase in growth and yield was more in hybrid (KRH-4). Similarly, on imposing water stress and application of silicon, there was significant increase in relative water content in the treatment of silicon applied along with water stress as compared with water stress plots. This suggests that on application of silicon at the rate of 0.6% alleviates water stress effects and improves relative water content (RWC) of rice plants. Studies on florescence data for Fv/Fm suggest that the quantum yield (QII), electron transport rate (ETR) and Fv/Fm values did not show any significant variation. When we tried to plot light response curves in rice varieties with and without application of silicon, it was found that ETR increased with increasing PAR and it was more in silicon applied plots and clearly showed that ETR was much better in water stress plots with the application of silicon and increased activities of photosystem I and II by improving ETR and reducing power ($NADPH_2$ and ATP).




**Influence of Silicon on *Electron Transport Rate (ETR)* measured at different light intensities in selected rice varieties**

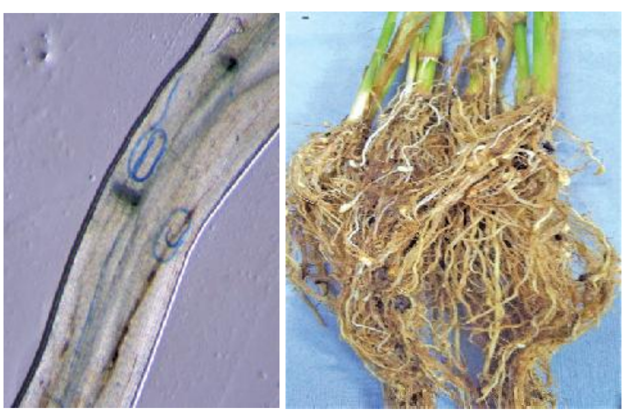
## IPM – Integrated pest management

### IPM/CPT/ENT/21: Botanicals for sustainable management of major pests of rice

Trial was carried out during *kharif*, 2020 at IIRR to evaluate performance of various treatments having combinations of commercially available botanicals along with recommended insecticides against major insect pests of rice and consequent impact on natural enemies and grain yield. Based on the results from various locations, 'all insecticides module' was found to be superior in reducing stem borer, leaf folder, plant hoppers compared to other insecticide-botanical modules and untreated control. Among combinations, lowest silver shoot damage was recorded in all botanical treatments. Combination of *Neemazal,* neem oil and *triflumezopyrim* treatment was found to be effective against BPH. Floral diversity in irrigated rice ecosystems was documented in Rajendranagar area. Medicinal plant species observed were *Eclipta alba, Cleome viscosa, Euphorbia hirta, Sida cordifolia, Tridax procumbens, Tribulus terrestris, Bacopa monneri*; food plants observed were *Alternanthera sessaslis, Amaranthus viridis, Celosia argentia;* aromatic plants were *Ageratum conozoides* and *Blumea lacera.*

### IPM/CPT/ENT/22: Investigations on Nematodes of Importance to Rice Cultivation

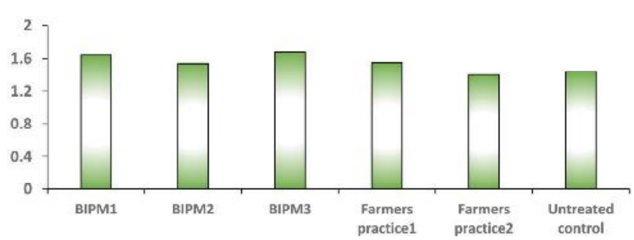
Screening of rice genotypes for resistance to rice root-knot nematode *Meloidogyne graminicola* in pot culture experiments revealed that six genotypes (KPM, LD24, Dhanrasi, Vandana, Swarnadhan and Aganni) were resistant and two genotypes (DRR Dhan 41 and DRR Dhan 55) were moderately resistant. Among the five granular insecticides *viz.*, Chlorantrinipole (0.4G), Cartap hydrochloride (4G), Phorate (10G), Fipronil (0.3G) and Carbofuran (3G) that were evaluated against rice root nematode *Hirschmanniella* species under field conditions. Two insecticides *viz.*, Cartap hydrochloride and Carbofuran were found effective in reducing root (23.9 and 30.32% respectively) and soil (29.34 and 41.22% respectively) population of the nematode. Similar results were observed against rice root-knot nematode *M. graminicola* in pot culture experiments. Pure cultures of entomopathogenic nematode isolates and cultures of their insect hosts (*Galleria mellonella* and *Corcyra cephalonica*) are being maintained in the laboratory and cultures of plant parasitic nematode *M. graminicola* are being maintained in the glasshouse. Observations on rice root-knot nematode *M. graminicola* population in sick plot showed that the incidence of root galls was 55.55% and number of root galls/plant ranged from 0-17 galls/plant. Nematode population density in soil was 38 J2/100 cc soil.



**Roots infected with root knot nematode**

## IPM/CPT/ENT/26: Bio-intensive pest management with emphasis on biological control of rice pests

Three modules of Bio-intensive Pest Management (BIPM) were tested at the research farm (BPT 5204) and at a farmer's field in Nalgonda district, Telangana (KNM 118). The BIPM modules differed in seed treatment with either of three microbials *viz.*, *Psuedomonas fluorescens* (BIPM1), *Trichoderma asperellum* IIRRCK1strain (BIPM 2), and a new strain of *Bacillus subtilis* (BIPM 3) along with application of phosphorous solubilising bacteria, alleyways, organic manuring in addition to synthetic fertilizers (dose adjusted), monitoring with traps, owl perches for rodent management and marigold and pulse crops grown on bunds to provide floral diversity for conservation of natural enemies. The stem borer incidence ranged from 8 to 26.2% among various treatments, the least being in the BIPM module with *Trichoderma* treatment and maximum in untreated control at Rajendranagar. The leaf folder incidence was lowest in the BIPM module with *Trichoderma* seed treatment (9.61%) while the highest incidence was observed in untreated control (23.15%). Due to heavy rainfall natural zoonosis of leaf folder larvae was observed, with highest number of diseased larvae in untreated control (15.25/ 5 hills) and plots with *Pseudomonas* treatment (15.47%). The yield was highest in *Pseudomonas* and *Bacillus* treatments (8275 and 8475 kg/ha respectively) indicating the economic feasibility of these modules. The economics of crop production of various treatments indicated a maximum benefit cost ratio (B:C) in BIPM-3 (1.68), followed by BIPM-1 (1.64) and the lowest BC ratio was observed for Farmers' practice- with 1.40.




**Benefit cost ratio of BIPM modules in farmers field, Nalgonda, Telangana. The BIPM modules showed greater B:C ratio**

Bund cropping with marigold and straw bundle as bird perch for rodent management at Nalgonda, Telangana

### IPM/CPT/ENT/28: Bio-efficacy and toxicological studies of insecticides against insect pests of rice

A new molecule, BASF 560 00 I was evaluated under field conditions against brown planthopper and BASF 560 00I@30 g *a.i.*/ha was found superior in management of brown planthopper with highest per cent reduction in population over control (44.5%), without any adverse effects on the natural enemies *viz*., green mirid bug and spiders and phytotoxicity. Yield in plots treated with the test insecticides was significantly higher than untreated control (6357.5 Kg/ha) and significantly higher yield was recorded in the treatment BASF 560 00 I @35 g *a.i.* /ha (7192 Kg/ha).

Field view of the evaluation of new molecule, BASF 560 00 I

## HRI – Host-plant resistance against insect pests and its management

### HRI/CPT/ENT/11: Host plant resistance against insect pests and their management

Three hundred and forty Haplo NILs were screened for brown planthopper resistance in the glass house by Standard Seed Box Screening Test and scored by SES methodology. Eight NILS (IRGC 135572-NEANG AN, IRGC 128108 -MAUNG NYO, IRGC 128164 -SIDJERO GUNDIL, IRGC 127818-SLOBOK, IRGC 128075-KAZALSAIL, IRGC 132021-OB CHUEY, IRGC 127793-SEMENDANG and IRGC 125966-IA CUBA 17) were resistant to brown planthopper with a damage score of 1.6-3.0. Fifteen NILs (IRGC 128148-RAYDHAN 1, IRGC 127883-VARIRANGAHY, IRGC 128109-MILAGROSA, IRGC 125901-SIPULUT HITAM PENDEK, IRGC 132415-SAWK GAM MAH, IRGC 128123-PADAN, IRGC 128057-INDO NO 13030, IRGC 125747-GAM PAI 30-12-15, IRGC 132035-PRADOO DAENG, IRGC 126984-LEUANG LAI MAE PRAJAN, IRGC 132363- PARE MAROMBA, IRGC 128535-LATA MONA, IRGC 128193- TP MIL 53, IRGC 127386-GI TAH, and IRGC 132300-SRAU KHGNAERNG) were moderately resistant with a damage score of 3.1-5.0.

Out of 1500 entries consisting of advanced breeding lines, germplasm accessions screened for brown planthopper resistance, eight entries (IET 29308, IET 28993, IET 29002, IET 28991, IET 28988 and IET 29308) were resistant and 54 entries (HWR-15-IR 75870-5-8-5-B-5-B, Cul 7, IBT-BPH 1, WGL-1523, HWR-1-IR83784-5-28-B, KNM 10067, KNM 7660, WGL-1608, KNM 7629, HWR-8-IR 54751-1-2-44-15-2-3-B, IET 28818, IET 28493, IET 27826, IET 27332, IET 27892, IR 64, IET 27387, IET Nos 28342, 28626, 28467, 29297, 29341, 28374, 29503, 28357, 29557, 28621, 29438, 28506, 29268, 29439, 28380, 29451, 29390, 28331, 29274, PA 6444, 29343, 29444, 29445, 29285, 29286, 29432, 29434, 29440, IR64, IET 28206, IET 28047, IET 28193, IET 28983, IET 28982, HR 12, IET 28966 and HRI-174) were moderately resistant.

The gene differentials *viz*., PTB33 (*Bph2, bph3* and *Bphh32* genes), RP Bio4918-230S, RP2068-18-3-5 were found resistant to brown planthopper populations collected from different parts of Telangana state.


**Standard seed box screening of lines for BPH resistance**

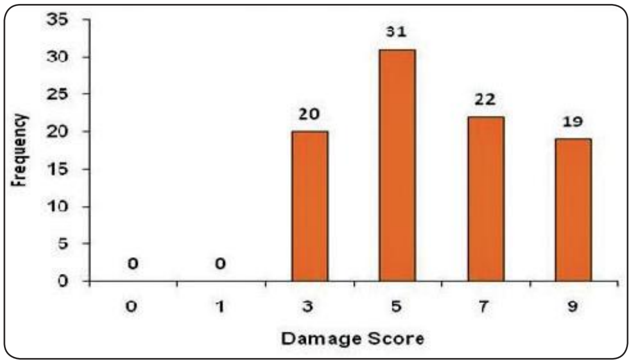
## HRI/CPT/ENT/23: Insect-plant interactions with special reference to rice pests – yellow stem borer and gall midge

Breeding lines derived from RP5587, RP5588 and KMR 3 were evaluated under field conditions at vegetative and reproductive phases of crop growth for yellow stem borer damage to study the components of resistance with PB1 as susceptible check. Screening was done by pinning of the egg mass. Few lines of RP5587 and RP5588 exhibited non preference mechanism for both dead heart and white head damage; damage was significantly higher ($P \leq 0.05$) in infested plants (0-50%) as compared to natural infestation (0-10%). Some lines of KMR3 exhibited tolerance mechanism without loss in grain yield (>25g/plant when the damage varied from 0-21% WE) in spite of damage. Neonate larval mortality varied from 20-60% in cut stem assays. Natural incidence of stem borer at reproductive phase was recorded in the field in the mapping population of HWR17X ISM (80 plants). The per cent white ear damage varied from 3.3 to 64.5 in the mapping population. Susceptible and resistant bulks were collected for further analysis.

Mapping populations of RP6503, RP6504, RP6505 and RP6506 that were developed to study the mechanism of resistance to rice gall midge were advanced to F5 generation. Of the many promising lines of RP6506 with nil damage against biotype 1 in IIRR greenhouse reaction, one line of RP6506 was evaluated at multiple locations and was found to have nil damage at Jagdalpur (biotype1) and low damage (27.9% DP) at Warangal (biotype4M).

## HRI/CPT/ENT/19: Assessment of host plant resistance to leaf folder and Semio-chemical approaches for the management of insect pests of rice

In the second year, 92 backcross inbred lines (BILs) with Swarna as recurrent parent and *Oryza nivara* (Acc No. 81832) as donor parent were phenotyped using rapid field screening method. Damage scoring (0 – 9) was done based on the damaged area. Data revealed 20 BILs as resistant to leaf folder with damage score of 3.0 and 31 as moderately resistant with damage score of 5.0. Leaf length ranged between 24.3 and 53.8 cm while leaf width varied from 0.53 to 1.40 cm. A significant negative correlation was observed between damage area and leaf length (-0.4661) while it was positive with leaf width (0.6571). Genotyping of these BILs was done using 140 polymorphic SSR markers with genome wide distribution. Inclusive Composite Interval Mapping (ICIM) revealed 7 QTLs for damage area on chromosomes 1,2,3,10 and 11 and 1 QTL for damage score on chromosome 5. qDS5.1 was considered as major QTL with a LOD value of 3.09 and phenotypic variance of 14.86.

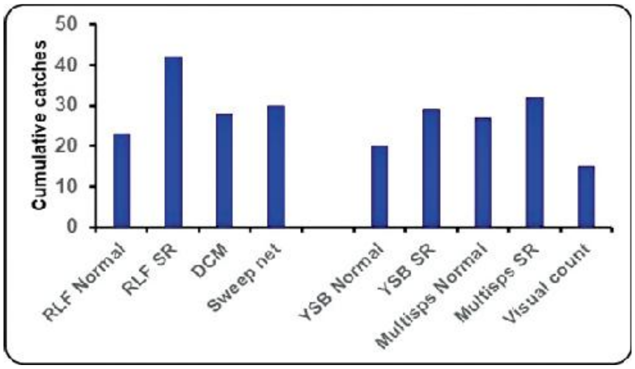



**Frequency distribution of damage score in BILs phenotyping for leaf folder resistance**

**Inclusive Composite Interval Mapping of BILs for leaf folder resistance**

| Trait Name | Chromosome | Position | Left Marker | Right Marker | LOD | PVE (%) | Add | LeftCI | RightCI |
|---|---|---|---|---|---|---|---|---|---|
| DA | 1 | 6 | RM283 | RM1220 | 3.7047 | 2.8666 | -1023.17 | 5.5 | 6.5 |
| DA | 2 | 15 | RM290 | RM341 | 5.5917 | 3.2558 | -1012.14 | 12.5 | 16.5 |
| DA | 2 | 30 | RM53 | RM250 | 4.1509 | 2.423 | -1039.88 | 29.5 | 30.5 |
| DA | 3 | 4.4 | RM231 | RM517 | 2.7285 | 1.8229 | -752.367 | 3.9 | 6.9 |
| DA | 3 | 30.4 | RM55 | RM1352 | 2.6598 | 1.5895 | -599.173 | 27.9 | 31.9 |
| DA | 10 | 17.7 | RM271 | RM6100 | 2.6808 | 1.5553 | -1092.08 | 17.2 | 18.2 |
| DA | 11 | 22.8 | RM206 | RM224 | 2.5034 | 2.9834 | -982.897 | 22.3 | 24.3 |
| ADAR | 1 | 6 | RM283 | RM1220 | 3.6616 | 3.4197 | -56.8256 | 5.5 | 6.5 |
| ADAR | 2 | 15 | RM290 | RM341 | 5.5327 | 3.8708 | -56.2482 | 12.5 | 16.5 |
| ADAR | 2 | 30 | RM53 | RM250 | 4.1221 | 2.8945 | -57.8094 | 29.5 | 30.5 |
| ADAR | 3 | 4.4 | RM231 | RM517 | 2.6701 | 2.1647 | -41.7281 | 3.9 | 6.9 |
| ADAR | 3 | 30.4 | RM55 | RM1352 | 2.5788 | 1.8738 | -33.0986 | 27.9 | 31.9 |
| ADAR | 10 | 17.7 | RM271 | RM6100 | 2.6707 | 1.8637 | -60.9699 | 17.2 | 18.2 |
| DS | 5 | 14.071 | RM5140 | RM146 | 3.0947 | 14.8566 | 1.2242 | 13.571 | 15.571 |

Normal and slow-release pheromone blends of rice leaf folder (RLF), yellow stem borer (YSB) and multispecies blends of both leaf folder and yellow stem borer were formulated and evaluated in the IIRR farm. Maximum catches were obtained in slow-release blends of RLF (42), YSB (29) and multispecies (32) as compared to normal blends.

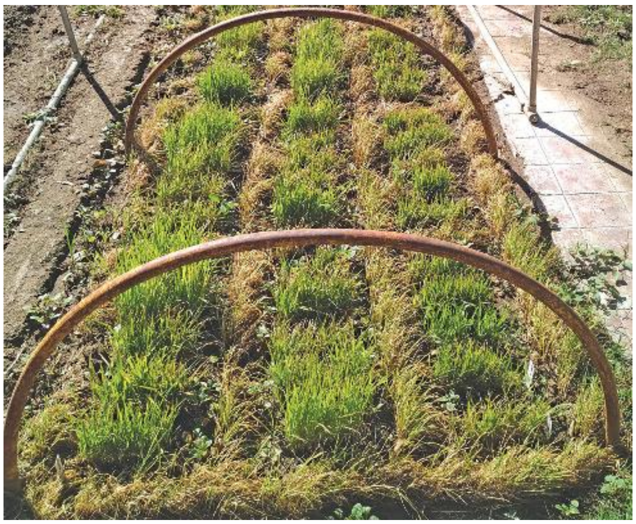



**Field catches in traps baited with normal and slow release (SR) pheromone blends of yellow stem borer (YSB) and rice leaffolder (RLF)**

# HRP - Host-plant resistance against pathogens and its management

## HRP/CPT/PATH /15: Assessment of host plant resistance for rice blast disease and its management

Advanced breeding lines, near isogenic lines (NILs), RILs and germplasm were evaluated against rice blast disease in Uniform Blast Nursery under artificial inoculation with the virulent blast isolate. The data was recorded when the score on the susceptible line reached to 9 on SES scale. A total of 3336 lines were evaluated in 2020 *kharif* season, out of that 1721 lines were found resistant. The virulence of the blast pathogen was monitored across the locations in the country and observed that there is no major shift of the virulence of the pathogen.



**A. Artificial screening of entries against blast under Uniform Blast Nursery**

**B. Identified resistant entries against rice blast during K- 2020**

## HRP/CPT/PATH/13: Assessment of resistant sources and monitoring of pathogen virulence in bacterial leaf blight of rice

Bacterial blight resistant rice variety, DRR Dhan 53 was released. It is a MAS derived, durable bacterial blight resistant high-yielding, fine-grain type rice variety having the major bacterial blight resistance genes, *Xa21+xa13+xa5+Xa38* with seed to seed maturity of 130-135 days and average yield of 5.5-6 t/ ha.


**A. Susceptible variety (BPT-5204) infected with BLB; B. Bacterial blight resistant rice variety, DRR Dhan 53 incorporated with BLB resistant genes viz., *Xa21+xa13+xa5+Xa38* completely free from disease**

Forty-two promising entries from NSN 1-2019 and NSN 2-2019 were re-evaluated during *Kharif* 2020 under glasshouse condition using *Xoo* strain IX-020 and 38 entries showed high level of resistance. One hundred and fifty-six lines having multiple donors for different biotic stresses were evaluated under glasshouse conditions using the *Xoo* strain IX-020. Thirty-six entries showed very high level of resistance with a disease score of one. Many entries in this category showed typical browning at the point of inoculation indicating highly resistant/immune reaction. Ten entries showed high level of resistance with a disease score of 1-3 with a lesion length of 2-3 cm. Another 14 entries showed a moderate level of resistance with a disease score of 3-5.

Six promising wild rice accessions *viz.,* CG-61 (*O. officinalis*), CG-125 (*O. rufipogon*), CG-135 (*O. rhizomatis*), CG-146 (*O. punctata*), CG-154 (*O. minuta*) and CG-164 (*O. australiansis*) were evaluated for broad spectrum resistance against 7 different and highly virulent *Xoo* strains. All the accessions showed moderate to high level of resistance to 5-6 strains of *Xoo* except CG-135 which showed susceptibility to 5 out of 7 *Xoo* strains tested.

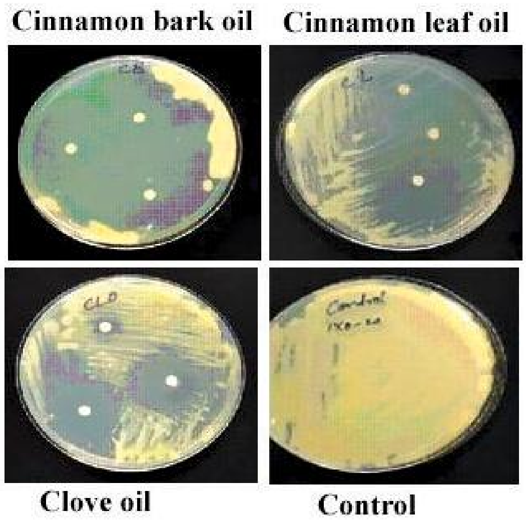
**Resistant line (E. No. 19248) showing very high level BLB resistance with typical browning near the point of inoculation**

**Mean lesion length of selected wild rice accessions to multiple isolates of *Xanthomonas oryzae* pv. *oryzae***

| Wild rice accessions | Mean lesion length (cm) ± SE to different *Xoo* strains | | | | | | |
|---|---|---|---|---|---|---|---|
| | CHN/J | IX-020 | Kaul-10-5-1 | Lud-09-1-1 | FZB-09-2-1 | PNT-09-1-1 | RPR-09-1 |
| CG-61 | 1.46 ±0.15 | 1.64±0.37 | 1.46±0.22 | 11±1.65 | 10.3±0.63 | 9.2±0.75 | 8.4±1.23 |
| CG-125 | 1.08±0.36 | 0.92±0.17 | 0.12±0.02 | 0.16±0.04 | 0.12±0.02 | 10±1.24 | 0.14±0.02 |
| CG-135 | 11.32±1.78 | 4.56±0.74 | 15.4±2.29 | 17.4±2.29 | 2.46±0.40 | 16.6±0.66 | 9±1.59 |
| CG-146 | 9.06±1.17 | 3.2±0.37 | 0.12±0.02 | 6.4±1.34 | 5.9±0.49 | 9.7±1.05 | 7.25±0.65 |
| CG-154 | 1.4±0.28 | 16.9±2.07 | 0.95±0.21 | 0.38±0.06 | 0.26±0.06 | 0.24±0.06 | 1.16±0.32 |
| CG-164 | 6.74±1.17 | 1.04±0.12 | 1.74±0.29 | 1.7±0.59 | 0.6±0.29 | 2.7±0.38 | 7.2±0.91 |
| $TN_1$ | 13.44±0.19 | 15.6±0.93 | 16.2±0.66 | 16.7±1.36 | 11.2±0.60 | 12.6±0.42 | 16.2±1.14 |
| ISM | 0.36 ±0.11 | 0.5± - | 0.37±0.13 | 0.14±0.02 | 0.12±0.02 | 0.14±0.02 | 0.14±0.02 |

In the initial screening, 28 accessions of *Oryza glaberrima* (out of 31) showed high level of resistance to bacterial blight. Among them, accession EC861812 showed a high level of resistance (1-3 cm) to three isolates, moderately resistant (3-6 cm) to five isolates and susceptible (>9 cm) to one isolate, while resistant check Improved Samba Mahsuri showed resistance to all the 10 isolates.

Ten essential oils were screened for their inhibitory activity against *Xanthomonas oryzae* pv. *oryzae* under in vitro condition. Out of ten essential oils tested, 2 oils *Viz.,* cinnamon bark oil and cinnamon leaf oils showed high level of inhibitory activity against *Xoo* under in vitro condition. Clove oil also showed a moderate level of inhibitory effect against *Xoo.*




***In-vitro* inhibitory activity of cinnamon bark oil, clove oil and cinnamon leaf oil against *Xoo***

### HRP/CPT/PATH/14: Assessment of host plant resistance and development of diagnostic tools for rice tungro virus disease

Screening of 1613 lines / breeding materials/ land races was done artificially by forced feeding insect transmission method against rice tungro virus disease and 43 entries showed resistant reaction with a score of 3. Out of 100 lines of 3K Indica rice panel tested against RTD, 12 highly resistant lines were identified with a disease score of 1-3.

**Artificial Screening of entries against Rice Tungro disease under glasshouse conditions- *Kharif* 2020**

Six insecticides were evaluated on the highly susceptible genotype TN1 and resistant cultivar, Vikramarya under glasshouse conditions. Among the insecticides, buprofezin (@1.6 g/L) and imidacloprid (@ 0.25 ml/L) controlled the insect vector population fully without any RTD infection after one and five days of treatment. These were significantly superior over the rest of the treatments. The spray of difenthiuron and dinotefuron @ 0.2% concentration were found effective significantly in controlling the insect vector population (94%) and decreasing the RTD infection by 75%. In rice cultivar, Vikramarya, buprofezin (@1.6 g/L), imidacloprid (@ 0.25 ml/L), dinotefuran (@ 2 g/L), difenthiuron (@1.2 ml/L) gave complete control of vector with no RTD infection at one and five days after treatment.

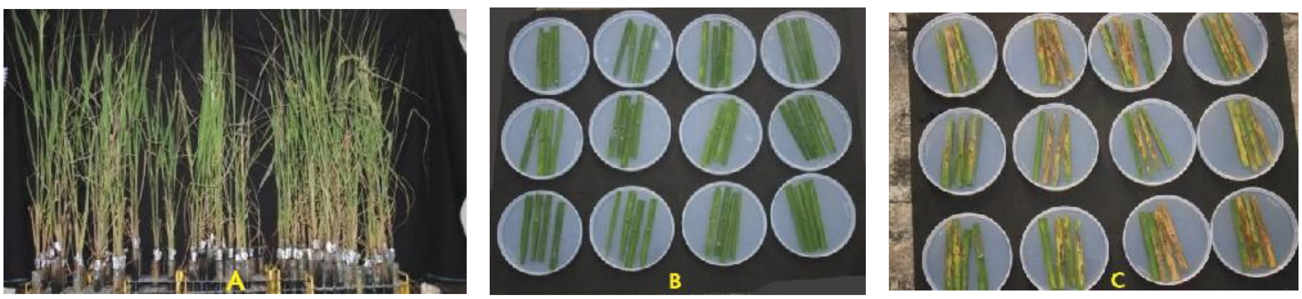
### HRP/CPT/PATH/22: Population dynamics of *Rhizoctonia solani* and sustainable management of rice sheath blight disease

Forty isolates of *R. Solani; Rhizoctonia* spp. and 41 isolates of *R. solani* were collected from major rice growing areas of Tamil Nadu, Chhattisgarh and characterized. Based on the RAPD and ISSR grouping of 41 isolates of Chhattisgarh, 20 isolates ITS region were sequenced and submitted to GenBank. It revealed that all the 20 isolates had 93.4 to 100% identity with each other. Whole genome sequencing (WGS) of 32 *R. solani* isolates was done from all different rice ecosystem in India. These 32 isolates grouped based on the cultural, morphological, microscopic and WGS.

Selected 100 RILs derived from Wazuhophek/ Improved Samba Mahsuri population (330) and revalidated their sheath blight tolerance during *R*-2020 and *K*-2020 under glass house conditions, detached tiller method and cut leaf method of screening. Highly tolerant entries were identified *Viz*., (KR/VPR) VPR-5, VPR-25, VPR-39, VPR-44, VPR-45, VPR,-78, VPR-88, VPR-109, VPR-122, VPR-124, VPR-128, VPR-130, VPR-134, VPR-135, VPR-150, VPR-157, VPR-158, VPR-186, VPR-210, VPR-243, VPR-262, VPR-289, VPR-295, VPR-297, VPR-299, VPR-302 and VPR-311.

Sheath blight promising entries were selected from NSN1, NSN2, NSNH and DSN based on the multi-location testing of different entries during K-2013, K-2014 and K-2015. Out of 150 entries revalidated under field condition through artificial inoculation, eight entries were selected as tolerant from six monsoon season (K-2015, K-2016,K-2017, K-2018, K-2019 andK-2020) screening and the identified lines *Viz*., IET # 22272, 23642, 24518, 23542, 25157, CB-11-107, CB-05-022 and DRR-BL-155-2.


**1. Highly tolerant RILs identified against sheath blight (KR-150, KR-12, KR-45, ISM and Wazuhophek) through artificial screening under glasshouse conditions; 2. Highly tolerant RILs identified (A-KR-12, B-KR-78, C-KR-88, D-KR-157) through artificial screening under field conditions *Kharif* -2020**




**A. Identification of Sheath blight tolerant lines through detached tiller method; B. Through cut-leaf method - tolerant RILs; C - Susceptible RILs**


**Identified sheath blight slow blighting entries through artificial Screening in *Kharif* 2020; (A) Susceptible genotype TN1 and IET23642 (B) CB-05-022 along with susceptible genotype TN1**

Antifungal activity of 14 EO was tested *in vitro* against mycelial growth of *Rhizoctonia solani.* Green house and field experiments showed that Thyme (*Thymus vulgaris* L.), Cedar wood (*Cedrusa tiantica*), Organo (*Oreganum vulgare*) oils recorded significantly low levels of per cent disease index (PDI). GC-MS results showed presence of limonene, cymene, himachalene and atlantone in cedar wood oil, where as in case of oregano oil, limonene was found to be the main compound.

Fungicidal management of sheath blight: Among the new molecules tested against sheath blight severity and grain discoloration, spray of BAS 750 02 F 400 g/l SC (Mefentriconazole) @ 175 and 225 ml/ha performed on par with Hexaconazole 5% SC 1000 ml/ha and Propiconazole 25% EC 500 ml/ha in two seasons. Fungicidal molecules *Viz.,* difenoconazole 25% EC, isoprothiolane 40% EC, kasugamycin 3% SL, kitazin 48% EC, propineb 70% WP, tebuconazole 25.9% EC and thifluzamide 24% SC were tested in field and found difenoconazole 25% EC (0.5 ml/l) as a best molecule to manage Sheath blight.

### HRP/CPT/ PATH/23: Variability in *Ustialginoidea virens* and management of false smut disease

Around 113 field resistant lines from AICRIP and other sources were grown under field conditions. A minimum of 5 panicles were artificially inoculated in all the lines at booting stage. 23 lines expressed tolerant reaction against false smut, which needs to be re-evaluated. Germplasam lines *viz*., IC334233, IC335422 and IC282421 were identified as moderately resistant to false smut disease.

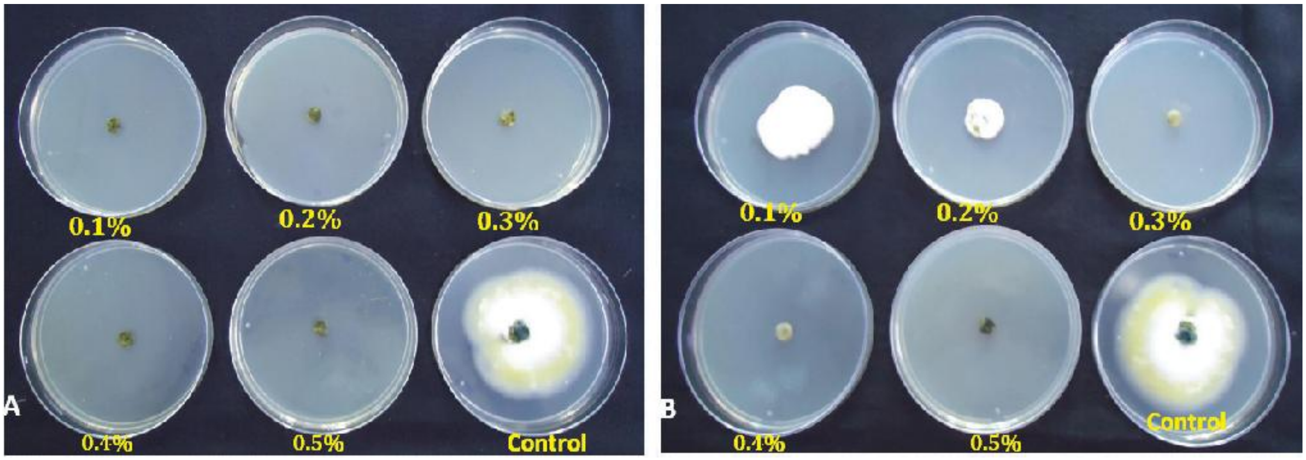


**A- Field view of artificial screening against false smut – *Kharif* 2020; B - Artificially inoculated plants expressed false smut symptom under field condition**

Conidia were harvested from an artificial culture of *U. virens* inoculated in rice leaf extract broth (RLEB) and potato sucrose broth (PSB). For artificial inoculation the concentration was adjusted to $2.0\times10^5$ conidia/ml with sterile distilled water. Rice leaf extract broth (6g/100ml) induced significantly more number of conidia production ($31.83 \times 10^6$ conidia/ml) compared to PSB. Microscopic observation revealed that conidia produced in RLEB were of smaller size compared to PSB induced conidia. However, incubation of these conidia in PSB, resulted in increase of the size of the conidia and enhanced the initiation of germination. Results of artificial inoculation revealed that plants inoculated with germinated conidia grown on RLEB +incubated in PSB expressed number of smut balls compared to conidia grown only in PSB.

***Ustilaginoidea virens* conidia cultured in RLEB and incubated in PSB broth for germination, produced more number of smut balls and increased the percentage of disease infection**

Nine essential oils (Neem oil, Citronella oil, Cedarwood oil, Clove oil, Lemon grass oil, Nirgundi oil, Eucalyptus oil, Cinnamon bark oil, Cinnamon leaf oil) and emulsifier were tested under *in vitro* at different concentrations (0.1%, 0.2%, 0.3%, 0.4% and 0.5%) against false smut pathogen. Among the oils tested, Cinnamon bark and Cinnamon leaf oil completely inhibited the mycelial growth of *U. virens* at all the five concentrations. Lemon grass oil and Clove oil inhibited the mycelial growth of *U. virens* at 0.2% and 0.3% concentrations onwards, respectively. Citronella oil and Cedarwood oil were effective at 0.5% concentration.

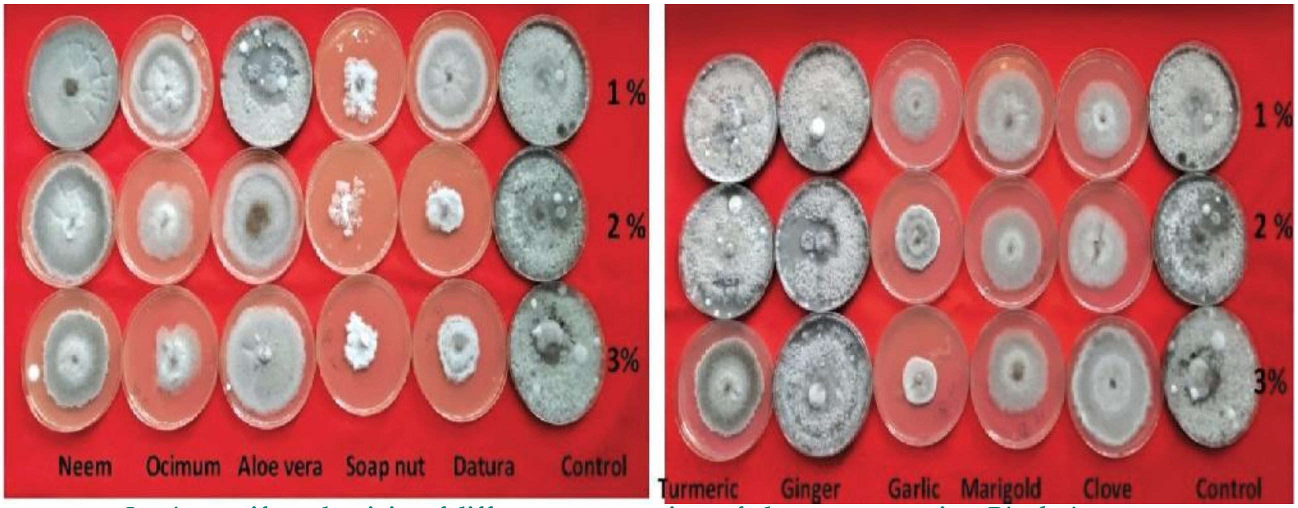



**Effect of different concentrations of A. Cinnamon Bark and B. Clove oil against *U. virens***

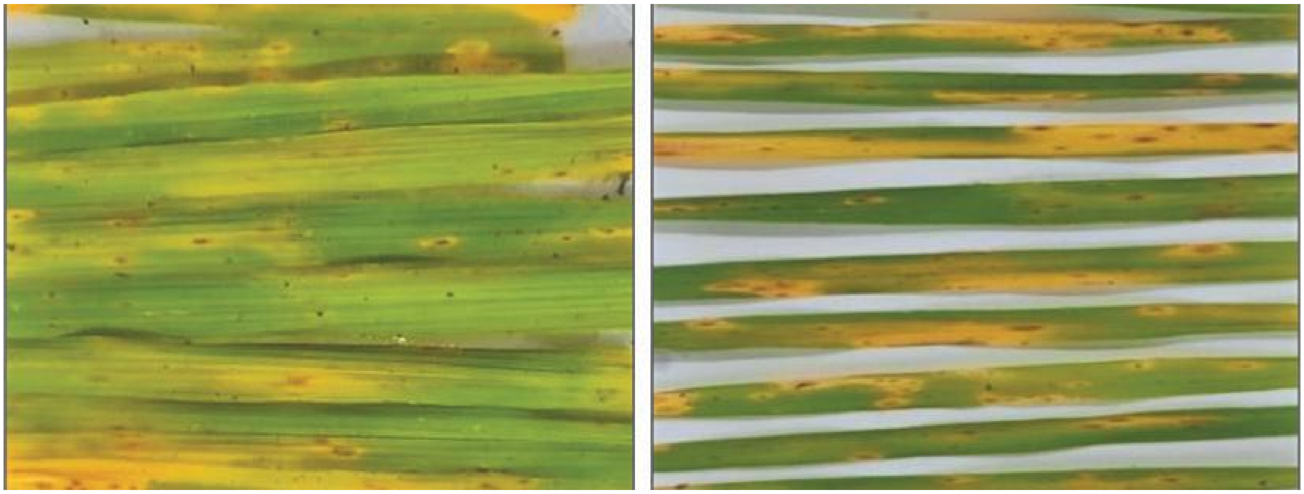
### HRP/CPT/ PATH/24: Survey, host plant resistance to brown spot disease of rice and its management

Around 25 isolates of rhizosphere bacteria was isolated from the root zone of rice plants. The isolated bacterium was morphologically characterized and has been named from *Rb1* to *Rb25* and tested for their ability to inhibit the mycelial growth of *B. oryzae under in-vitro* by following the dual culture technique. It was found that, *Rb8* was most effective in controlling the mycelial growth *in vitro* followed by *Rb12*. The isolates such as *Rb25* and *Rb2* were also showed significant antagonistic activity against *B. oryzae*.

*In-vitro* experiments were conducted to test the antifungal activity of 15 plant extracts. They were tested for their efficacy in inhibiting the mycelial growth of *B. oryzae in vitro* following poison food technique. Aqueous extracts of all the botanicals




***In-vitro* antifungal activity of different concentrations of plant extracts against *Bipolaris oryzae***



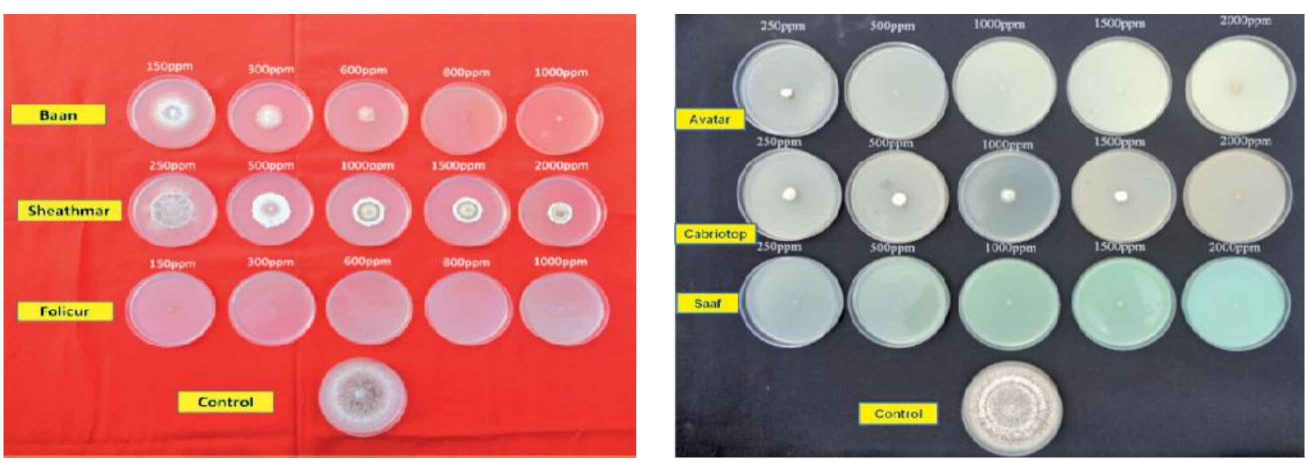
**Use of detached leaf technique for the development of symptom on spraying of *B. oryzae* spore suspension (@10[5] conidia/ml) on rice leaves**

were prepared, mixed with liquid potato dextrose agar (PDA) medium at 1, 2 and 3% concentration. Among the tested plant extracts, soapnut followed by garlic, *Datura* and *Ocimum* sp. were the most effective botanicals against *B. oryzae* in inhibiting the growth of mycelium at all the three tested concentration. Soapnut was found to inhibit the 61, 70 and 86% mycelial growth of fungus at 1, 2 and 3% concentrations respectively. At higher concentration (3%), marigold, lemongrass and clove had considerable antifungal activity.

*In vitro* assay using detached leaf technique to enable rapid screening of genotypes was evaluated for brown spot disease. The leaf segments were inoculated by two methods - spray with spore suspension (@10[5] conidia/ml) of *B. oryzae* and Mycelial disc inoculation on leaves. The petriplates were kept closed for creating humidity for two days. It was observed that, only spray inoculation could develop brown spot symptoms but not in disc inoculation. Spray inoculation *in vitro* under detached leaf assay may be helpful in identifying the resistance source more precisely.

## HRP/CPT/ PATH/25: Host plant resistance and Characterization of pathogens of Sheath rot and Stem rot diseases of Rice

Five different methods of inoculations were tested during *Rabi* 2020 to select the best screening method for sheath rot disease *viz.*, injection, spraying inoculum, placing of infected seed between panicle and upper leaf sheath, seed inoculation and soil inoculation. Among the




***In-vitro* effects of different fungicide molecules on the radial growth of stem rot pathogen *Sclerotium oryzae***

methods tried, injection method produced the disease. Three different methods of inoculations were tested for stem rot of rice in *Kharif* 2020 *viz.,* Typha leaf bit method, placing of sclerotia at base of hill and placing of fungal bit at base of hill at tillering stage of the crop. Typha leaf bit method found suitable for large scale screening purpose.

Fifteen different fungicide molecules, each one at five different concentrations were evaluated against *Sclerotium oryzae* under controlled conditions. Out of these, mancozeb 63% + carbendizm 12% WP, azoxystrobin 11.5%+ mancozeb 30% WP and tebuconazole 250EC showed the maximum inhibition of the fungal growth under *in-vitro* conditions.

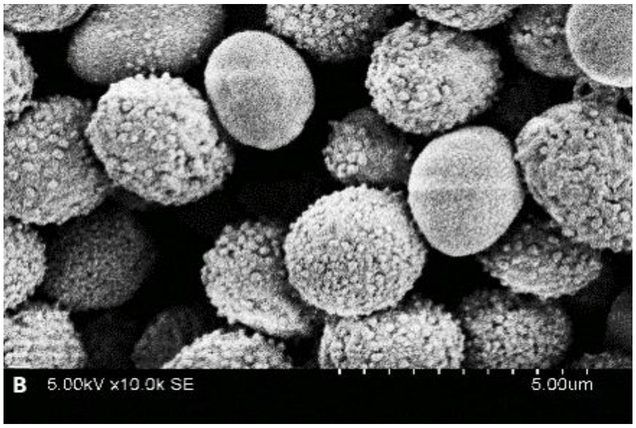
Six organic amendments at three different concentrations were tested for their efficacy in controlling the growth of the stem rot fungus, out of which vermicompost, karanja cake and neem cake showed better performance under *in-vitro* conditions (Table). Six essential oils were tested at 5 different concentrations *in-vitro* and eucalyptus oil, cedarwood oil and lemon grass oil were found promising in the control of radial growth of the *Sclerotium oryzae*.

**Table : *In-vitro* effect of different organic amendments on radial growth of *Sclerotium oryzae***

| Per cent inhibition of Radial growth of mycelium Concentration (%) | | | | |
|---|---|---|---|---|
| | **Organic amendment** | **1%** | **3%** | **5%** |
| 1 | Neem cake | 49.63 (44.79) | 64.07 (53.17) | 68.89 (56.10) |
| 2 | Karanja cake | 46.30 (42.88) | 75.93 (60.62) | 100.00 (90.00) |
| 3 | FYM | 15.56 (23.23) | 21.48 (27.61) | 35.19 (36.38) |
| 4 | Vermicompost | 67.78 (55.41) | 71.11 (57.49) | 76.67 (61.12) |
| 5 | Castor cake | 39.26 (38.80) | 54.81 (47.76) | 61.85 (51.86) |
| | | Factor A | Factor B | Factor A×B |
| CD | | 1.59 | 1.24 | 2.76 |
| SE(d) | | 0.78 | 0.60 | 1.35 |
| SE(m) | | 0.55 | 0.43 | 0.95 |
| A= Organic amendment, B= concentrations, () =all values in parenthesis are transformed values | | | | |

## HRP/CPT/ PATH/20: A consortia approach to the biological management of diseases in rice Biological control

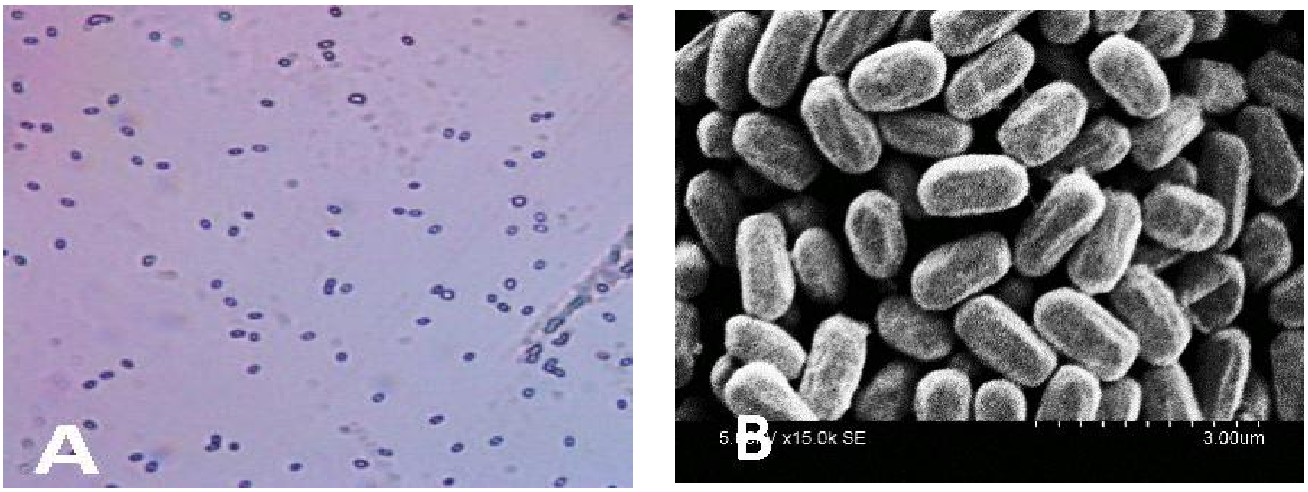
The whole genome sequencing of three *Trichoderma* isolates was done using Illumina HiSeq 2500 platform. The sequences were


***Trichoderma*** **conidia viewed through (A) Compound Microscope (40X) B. Scanning Electron Microscope**

submitted in the NCBI repository and the accession numbers of the isolates obtained as *Viz., T. asperellum* IIRRCK1 (TAIK1, NCBI Accession number- MH825714), *T. asperellum* IIRRCK4 (TAIK4, NCBI Accession number- MH825717) and *T. viride* IIRRCKTV1 (TVIK1, NCBI Accession number- MT802436). The three strains were compared with most closely related representative species from the Uniprot database using BLASTX program and were identified as *Trichoderma asperellum* (E-value <=1e-3 and Similarity score >=40%).

Similarly, three isolates of *Bacillus viz.,* IIRRCK2, IIRRCK3 and IIRRCK4 were isolated from the soil samples. The comparative analysis (E-value <=1e-3 and Similarity score >=40%) with Uniprot and top BLASTX hits indicated the species as *Bacillus velezensis*, *Bacillus subtilis* and *Bacillus paralicheniformis*.

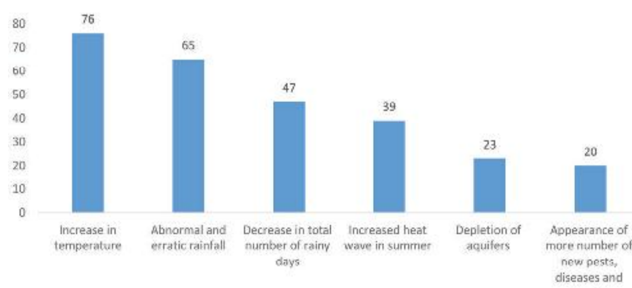



***Bacillus subtilis*** **endospore viewed through (A) Compound Microscope Image; B. Scanning Electron Microscope**

## TTI – Training, transfer of technology and impact analysis

### TTT/EXT/15 : Climate change and Rice Farming: Farmers Perception and Adaptation Strategies

An exploratory study on climate change and rice farming was designed to elicit the farmer's perception and adaptation strategies in Koraput district of Odisha. Information collected through questionnaire from 200 rice farmers covering 10 service villages of MSSRF wherein the climate change challenges were severe. The upland rice farmers perceived the climate change through the prism of increase in temperature (76%) abnormal and at times erratic rainfall (65%), decrease in total number of rainy days (47%) increased heat wave in summer (39%), depletion of aquifers (23%) and appearance of a greater number of new pests, diseases and weeds (20%). The major adaptation measures followed by the rice farmers to overcome climate change were documented as follows: Change of rice variety (62%), planting early maturing variety (50%), planting drought resistant rice (33%), irrigation management (30%), use of water harvesting schemes (18%), reducing the number of livestock (15%), intercropping of rice with pigeon pea (11%) and working on MGNRGEA scheme (13%).




**Perception of the respondents on climate change (in percentage)**

### TTT/EXT/16: Smart village strategy for accelerated rice technology transfer

The training of trainers approach was used as an adaptation to the COVID induced disruptions for dissemination of technologies. Training of contact farmers was organized at the institute and the trainer farmers were provided technical and physical inputs for demonstration of Seed smart, Technology smart, Water-smart, Nutrient-smart practices in selected villages of Ranga Reddy and Yadadri-Bhongir districts of Telangana.

Nutrient smart interventions such as Sodic soil management (soils with high pH of around 8.6-9.1) was taken up on farmers' fields covering an area of 10 hectares. Zinc deficiency is very common in sodic soils and they respond well to organics. Therefore, vermicompost, critical fertilizer inputs such as DAP, Urea, Murate of potash and chelated zinc were distributed to farmers. Vermicompost @ 600 kg/ha was applied two times; half as basal and another half as top dressing at tillering stage. The yield was estimated and the yield advantage of the intervention with straw, chelated zinc and vermicompost improved rice yields to an extent of 30.7 to 46.1% over check plots.

Agricultural waste management through vermicompost preparation for nutrient management was promoted and HDPE vermibeds were distributed. First cycle of production from vermicompost preparation resulted in an average income of Rs.2300/- which has triggered increased use of vermicompost and scaling it up as an income earning enterprise.

Water smart interventions included aerobic rice cultivation demonstrations in farmers' fields. Paddy variety DRR Dhan46 was grown and the aerobic method saved 57% irrigation water when compared to traditional irrigated system of same duration variety with a grain yield of 3.5 tons/ha. On-farm demonstrations on use of Bowman's pipes for water management were organized and saving in irrigation water was recorded as 14.4% over traditional flooding method.

Knowledge smart interventions included demonstrations on popularization of IIRR variety Improved Samba Mahsuri in farmers' fields in Chandepally village of Yadadri-Bhongir, and a yield of 3.5t/ha was recorded. The farmers were educated about the important quality of this variety i.e. Low-GI (50.9), the consumption of which will especially benefit the diabetic population.

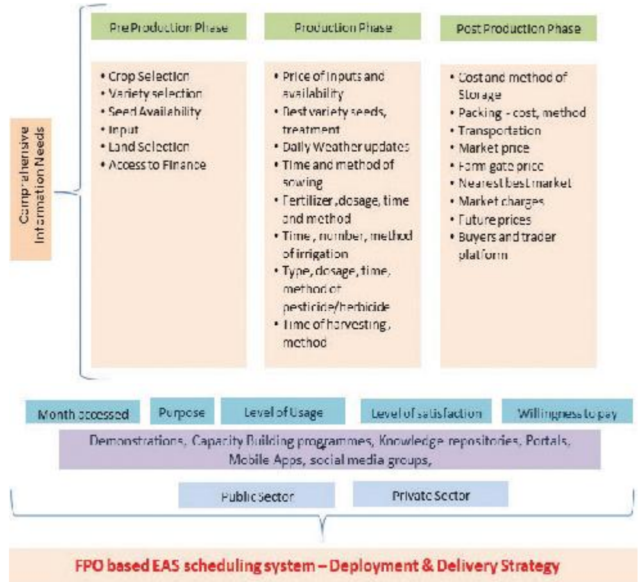

### TTI/ TTT/ EXT/ 18: Impact Acceleration with Digital Extension Ecosystem for Rice Farmers

The potential stakeholders of proposed digital extension ecosystem for rice sector namely the public, private, civil society extension agencies involved in transfer of rice knowledge and technologies are being mapped. About 52 start-up projects were analyzed to capture their role and were classified as pre-production, production and post production groups.

In the pre-production category, majority of the start-ups were engaged in input supply (46%) followed by weather information (40%), precision agriculture (40%) and market information (40%). Other activities were renting machinery (25%) credit linkage (25%). In case of production group, majority of the start-ups are providing services such as capturing data of farm (36%), prediction services (36%), crop management advisories (34%), linking farmers with experts for crop management advisories (23%), training and skill development for farmers (23%). Other activities undertaken were cooperative land preparation, individual farmer specific mobile application provision, cold storages, transportation, quality seed production, harvest management and contract farming. In the post-production group, activities undertaken by start-ups are procuring produce from the farmers (28%), operations like linkage of buyers and sellers (25%), linking of consumers and farmers (25%), better payment (25%). Based on the insights developed by the synthesis, a framework for Digital Extension Ecosystem for Rice farmers will be formulated.

### TTI/TTT/EXT/14: Innovations in group-based extension approaches: Accelerating rice technology transfer through farmer-based organizations

Based on the various case studies and success stories, the Farmer Producer Organisations (FPOs) have been identified as one of the significant approaches to accelerate the rice technology transfer. A customised intervention matrix was specifically designed and being undertaken in the selected FPOs. Sequential rice messages to the farmers during the cropping season and the level of relevance was analysed from the 120 farmer members. The identified information parameters like new varietal technologies (70%), seed availability (93%), latest management practices (88%), land management (53%), pest and disease (96%), nutrient management (86.6%) were considered more relevant.




In order to develop an exclusive rice EAS scheduling system, the farmers' response on parameters like month accessed, method used, purpose, level of usage, level of satisfaction and willingness to pay for better services were recorded. About 83% of extension specialists of FPOs strongly agree that digital tools help in improving the effectiveness of various FPO activities and 73% of them were willing to collaborate with agri-start-ups. Based on the finding that 63% of FPOs felt exclusive extension professional/team is essential to cater the extension and advisory services for the needy farmers, learning module is being designed. A database on Farmer Producer Organisations is being maintained and updated.

### TTI/TTT/ECON/3: IPR-Competition interaction in Indian rice seed sector- emerging scenario- implications for enhancing quality seed use

Impact of two types of IPRs *viz*., PVP rights under PPV&FRA and geographical indications under GI Act on rice varietal development and rice biodiversity was analyzed. During 2011-2020, number of typical rice varieties notified increased by 1.8 times and number of hybrids notified increased by 5.8 times compared to the period of 1991-2000. About 44 per cent of varieties and

64 per cent of hybrids notified in the last three decades (1991-2020) was concentrated in the last decade (2011-2020). The share of private hybrids in total notified rice hybrids increased over the three decades from 8 to 88 per cent. Further 83 per cent of private hybrids were notified during 2011-2020. PVP and GI are complementing each other in promoting varietal development and biodiversity. Issues in the current IPR regime like handling overlapping IPRs, Evaluation of EDV's conformity with initial variety in terms of traits and test statistics and use of DNA markers in DUS test system for reducing cost and time, consequences of implementation of PPV&FRA notice regarding pricing and trait value fixation of protected varieties on competition in seed sector are under discussion and debate.

| Progress of rice varieties/ hybrids notified and their spread | 1991-2000 | | 2001-2010 | | 2011-2020 | |
|---|---|---|---|---|---|---|
| | Number | Spread (%) | Number | Spread (%) | Number | Spread (%) |
| Typical | 191 | 23 | 272 | 33 | 352 | 44 |
| Hybrids | 13 | 11 | 29 | 25 | 75 | 64 |
| All | 204 | 22 | 301 | 32 | 427 | 46 |

Progress of rice varieties/hybrids notified and their spread in the last three decades

## TTI/TTT/ECON/4: Economic, Energy and Sensitivity Analysis of selected Rice Production Technologies

A comparison was made between conventional and the system of rice intensification (SRI) methods of rice cultivation. The field data at 25 locations across India under the All India Coordinated Rice Improvement Project for a period of five years was compared with the survey data collected from 262 randomly selected SRI farmers using a personal interview method in the Telangana state of India. Survey data revealed that total costs of rice production reduced by 22.71% under SRI. Adoption of SRI saved total energy inputs by 4350 MJ/ ha. The energy productivities were 0.16 kg/MJ and 0.21 kg/MJ for conventional and SRI methods, respectively. Also, SRI resulted in the lowest greenhouse gas emissions of 0.280 kg $CO_2$ e/ kg rice grain. Therefore, for ensuring higher productivity, net returns, energy efficiency and sustainable rice production, it is recommended to adopt an environmentally friendly SRI method of crop establishment in the Telangana region of India.

## TTI/TTT/EXT/17: On-Farm Adoption of IPM Technologies and impact analysis

In 2020, on-farm IPM study was implemented in around 58 acres of Venkatampalle village of Ghanpur Mandal, Wanaparthy district. Farmers of the study were trained on locally adoptable IPM components and there was increased adoption of following important IPM practices:

Proper use of pesticides

Use of pheromone traps

Identification of pests

Training of farmers in rice IPM strategies

- Leaving alleyways after every 10 rows,
- Clipping off leaf tips during transplanting,
- Installation of pheromone traps for yellow stem borer,
- Spraying of effective chemicals, such as cartap hydrochloride for stem borer, Nativo for fungal diseases and pretilachlor for weed management.

The study revealed that IPM farmers (58 acres) obtained an yield of 4.2 to 7.9 t/ha (average of 5.9 t/ha) compared to other farmers (15 acres) yield of 3.5 to 7.0 t/ha (average of 5.7 t/ha). IPM farmers obtained cost: benefit ratio of 1: 2.73 compared to that of 1 : 2.13 obtained by non IPM farmers.


**Actual V/s predicted GEBV's by different models under 3 environments *viz.*, N Recommended, N50 and N Low in 44k SNP RDP data sets**

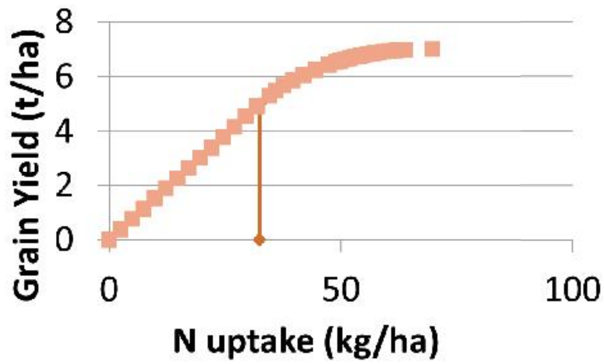
## TTI/TTT/STAT 4: Statistical modelling and soft computing approaches for genomic selection in Rice

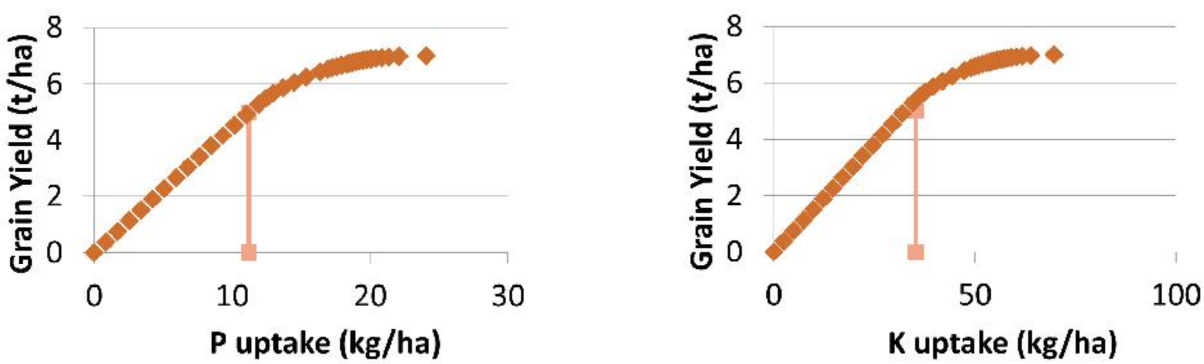
Project was envisaged to develop models for genomic selection in rice data using statistical and machine learning based models. The machine learning based models involves optimization of hyper parameters which in turn leads to accuracy of genomic selection. The genetic algorithm was used to optimize the weights of feed forward neural network in backpropagation algorithm and also to optimize the hyper parameters of support vector machines. The developed models outperformed the classical ANN and SVR. The proposed models were implemented in simulated data sets. The standardized algorithm was used to develop GS models in 44k SNP RDP data sets. The hybrid spatio-temporal time series models with the combination of space-time autoregressive moving average models and time delay neural network models were developed using k-nearest neighbour based correlated spatio-temporal weight matrix for modelling and forecasting rice yield. The weather-based integer valued generalized autoregressive heteroscedastic and artificial intelligence models were developed to model and forecast the rice gall midge population using AICRIP light trap data sets. Statistical issues like consideration of F values, CD values and lattice designs were suggested in AICRIP breeding trials. The artificial neural network intervention models were developed to assess the impact of policies or intervention in time series data.

### TTI/CP/CA/4: Wireless Sensor Networks integrating with Rice DSS model for real time advisories.

In continuation to fabricating weather sensors and optimum sowing date estimation, during this year, long term soil fertility experimental data of AICRIP, Mandya was analysed with Quantitative evaluation of the fertility of tropical soils (QUEFTS) model.

Experimental data of Mandya from 2011-19 was used for the validation. The data set contained many different nutrient management treatments including single-nutrient omission plots such as +PK (N omitted), +NK (P omitted) and +NP (K omitted) as well as treatments with optimal fertilizer management and treatments with excessive NPK rates. Internal efficiencies (IE) of N,P and K were derived from N,P and K uptake values and accumulated (a) and diluted (d) coefficients were computed as percentile values of internal efficiencies. With the new a and d coefficients derived from our data, QUEFTS model was used to simulate nutrient uptake requirements at potential yield target of 7 t/ha. This model will be further simulated and can be integrated with Rice DSS for estimating nutrient requirement of rice crop.




N, P and K uptake requirement simulated using QUEFTS model at potential yield target 7 t/ha.

# Institutional Activities

Technologies Assessed and Transferred

Human Resource Development

Extension Activities

Intellectual Property Management and Revenue generation

Awards and Recognitions

Patents/Copy rights/Mobile Applications

Deputations/Linkages and Collaborations

RTI Activities

Significant Events

Personnel

Publications

Appendices

# Technologies Assessed and Transferred

## Transferable Technology generated.

- ✓ **DRR Dhan 53:** A MAS derived, durable bacterial blight resistant high-yielding, fine-grain type rice variety having the major bacterial blight resistance genes, *Xa21+xa13+xa5+Xa38* with seed to seed maturity of 130-135 days and average yield of 5.5-6 t/ ha.
- ✓ **DRR Dhan 54 [IET 25653 (RP 5943-421-16-1-1-B)]:** It is non-lodging with strong and sturdy culm, long panicles and seed to seed duration of 115-120 days. It has multiple pest and disease resistance for major insect pests and diseases such as leaf blast, neck blast, Gallmidge and rice thrips and moderate resistance to plant hoppers and stem borer and desirable grain quality traits with an average yield of 5-5.5 kg/ha under aerobic conditions. It is recommended for aerobic ecosystems of Haryana, Odisha, Bihar, Jharkhand, Gujarat and Telangana.
- ✓ **DRR Dhan 55** [IET 26194(RP 5591-123-16-2)], a medium duration (120-125 days) aerobic variety resistant to gall midge and rice thrips and moderately resistant to Leaf blast, Neck blast and plant hoppers. It is suitable for aerobic ecosystems of Bihar (Zone III) and Chhattisgarh (Zone V).
- ✓ **DRR Dhan 56(IET 26803):** An early duration variety with long slender grains. This variety is tall erect, highly vigorous, non-lodging, non-shattering and dark green in colour. The plant comes to flowering within 89 days, plants are 102 cm tall and it produces good biomass and has long panicles. It has high head rice recovery (64.1%) and desirable intermediate amylose content (23.15%). It is resistant to leaf blast and false smut, moderately resistant to Bacterial leaf blight and tolerant to stem borer. The variety has been recommended for cultivation in irrigated conditions of Punjab and Haryana.
- ✓ A novel, quick, bulk sample based assay has been developed for accurate assessment of genetic purity of seeds of WA-CMS lines.
- ✓ A unique line showing resistance to diverse virulent isolates of sheath blight as well as hotspot locations of India for sheath blight tolerance was identified from huge EMS mutagenized population of Samba Mahsuri and also used as a donor in sheath blight resistance programme. The unique genetic stock has been registered at NBPGR as INGR 20080.
- ✓ A stabilized mutant line (TI-26) showing strong culm in anatomical and histological analysis by scanning electron microscope has been identified. This line also being used as a donor in improvement of strong culm nature. This unique genetic stock, registered at NBPGR as INGR 20079.
- ✓ An elite rice line with high grain zinc concentration in both brown (33.5ppm Zn) and polished (31ppm Zn) grain was registered with NBPGR, New Delhi INGR20003 [IET 23814 (RPBio5478-185M)]. It is a recombinant inbred line identified from the cross Madhukar x Swarna.
- ✓ A process patent on development of a nano formulation of the secondary metabolite compound *viz.,* 6-pentyl-2H-pyran-2-one is developed in collaboration with IIT Kanpur, ICAR-IIRR and UOH Hyderabad will be submitted after due permissions from all the institutes.
- ✓ BIPM with Habitat management for conservation biological control.

# Human Resource Development

During the period under report, 14 farmers training programs were organized in both on and off campus. Overall 805 farmers were trained on improved rice production technologies and other identified interventions to enhance yield and profitability.

| Sl. No. | Name of the Training | Sponsored by | Venue | Date | Number of Participants |
|---|---|---|---|---|---|
| 1. | Capacity building of SC rural youth for climate resilient rice cultivation | IIRR SCSP | ICAR-IIRR, Hyderabad | 22-24 January, 2020 | 87 |
| 2. | Pest management | IIRR SCSP | Pothugal, Nagarkurnool, Telangana | 17 February, 2020 | 45 |
| 3. | Soil testing | IIRR SCSP | Mallaipally, Wanaparthy, Telangana | 28 February, 2020 | 120 |
| 4. | Pre-season /varietal selection | IIRR SCSP | Pallegudem, Khammam, Telangana | 03 March, 2020 | 150 |
| 5. | Good agricultural practices in Rice | IIRR SCSP | Venkatayapalem, Khammam, Telangana | 29th August, 2020 | 40 |
| 6. | One day Farmers Training on Sustainable Rice Production Technology | IIRR TSP | Bellampalle KVK | 16th Sep., 2020 | 22 |
| 7. | One day Farmers Training on Sustainable Rice Production Technology | IIRR TSP | Bellampalle KVK | 5th Oct., 2020 | 28 |
| 8. | One day Farmers Training on IPM in rice | IIRR TSP | Bellampalle KVK | 8th Oct, 2020 | 31 |
| 9. | One day Farmers Training on Nutrient Management in Rice | IIRR TSP | Bellampalle KVK | 15th Oct., 2020 | 30 |
| 10. | Good agricultural practices in Rice | IIRR SCSP | Gaigollapally village of Kusumanchi Mandal of Khammam | 17th October, 2020 | 90 |
| 11. | One day Farmers Training on Sustainable Rice Production Technology | IIRR TSP | Bellampalle KVK | 2nd Nov., 2020 | 30 |
| 12. | One day Farmers Training on Water Management | IIRR TSP | Bellampalle KVK | Nov 16. 2020 | 32 |
| 13. | Training on ICM in Paddy | IIRR SCSP | ICAR-KVK Perambalur, Tamil Nadu | 19 December 2020 | 75 |
| 14. | Vermi compost preparation | IIRR SCSP | Chandepally, Telangana | 23 December 2020 | 25 |

**Virtual training on "Sensitization on AICRIP intranet** (www.aicrip-intranet.in) functionalities to activate PI privileges" was organized on 23rd December, 2020 at IIRR.

A group of seventeen members comprising of PIs of AICRIP, scientists, technical officers of IIRR actively participated in the training programme. Important functionalities of AICRIP intranet were demonstrated with the admin and user privileges. PI privilege of Intranet was demonstrated menu by menu in sequence with test PI privilege.

## Extension Activities



### Mahila Kisan Divas

As part of Mahila Kisan Divas, 63 farm women were felicitated for their multiple roles as farmers, home- makers and technology adopters. Mahila Kisan Divas was celebrated on 15th October, 2020 by ICAR-IIRR to signify the important contribution of Women Farmers for achieving food and nutritional security of the nation. Three levels of programs were organized by the Institute on this occasion. An e-poster competition was organized on the themes of, "Role of Women in Agriculture & Technologies for Women Farmers'' which drew enthusiastic participation by the scientists and project personnel of the Institute with interesting titles like, Role of Women in Indian Rice Farming, Women in Agriculture-the unsung warriors for food security, Farming a GIFT of WOMEN - call it a legacy, Developing She Teams and Empowering Farm Women with Soil Testing Kits, Agro techniques for welfare of women in rice cultivation and Women's entrepreneurship development through Rice Based Health Care Products. In the ICAR-IIRR project villages, farm women were felicitated for their multiple roles as farmers, home- makers and technology adopters. Their crucial role in adapting to changing climate and technological innovations was highlighted and they were motivated to learn, adopt and adapt to mechanized and high value agriculture.

### National Farmers' day (Kisan Diwas)

The Institute has organized National Farmers' day (Kisan Diwas) on 23rd December, 2020 at Rajendranagar, Hyderabad to provide knowledge on soil testing and soil test based fertilizer recommendation with the AI based soil testing instrument. Dr. Brajendra has welcomed the dignitaries and introduced about the instrument "**KRISHI RASTAA**" (Rapid Automated Soil Testing & Agronomy

Advisory), developed by Krishi Tantra (M/s Klonec Automation Systems Pvt. Ltd.,) an Agri-Tech start-up company. A demonstration and training on KRISHI RASTAA was given by Mr. Sandeep Konda (CEO), Mr. Anand (COO), Dr. Manoj Kumar (Soil Scientist), Mr. Nikhil and Mr. Sandesh of Krishi Tantra team

### Tribal Sub-Plan activities

Overall 2430 tribal farm families of Andhra Pradesh (300), Assam (250) Chhattisgarh (350), Jharkhand (300), Jammu and Kashmir (280) Karnataka (300), Kerala (250) and Telangana (400) were benefitted with cafeteria of rice related technologies. The targeted farm household were given improved rice varieties, and other critical inputs capable to breaking the yield barriers. The inputs include metal plough, neem coated urea, micro nutrients, herbicides, sprayers, tarpaulins, rodenticide and storage pins. The yield increase was observed minimum of 8% in Jharkhand and maximum of 21% in Telangana and Andhra Pradesh. By imparting the subject matter training about the technical know-how and do-how of rice cultivation, the extension gaps were minimized along with technological gaps.

### IIRR-SCSP Activities

Under the ICAR-IIRR-SCSP, paddy seed was distributed to 2,630 SC rice farmers of 8 (eight) districts of Telangana *viz.,* Ranga Reddy, Khammam, Nagarkurnool, Nalgonda, Wanaparthy, Warangal, Karimnagar and Yadadri Buvanagiri district and Guntur district of Andhra Pradesh. Drying sheets (650), sprayers (290), fertilizers (120), pheromone traps and lures (58), herbicide (58), insecticide (58) and fungicide (58) were distributed to the SC beneficiaries under IIRR-SCSP program.

A training program on 'Integrated Crop Management in Paddy' was organized in collaboration with KVK, Perambalur sponsored under ICAR-IIRR-SCSP. Pheromone traps, lure, light traps, Azolla, panchagavya, Jeevamirtham, Pest repellent, *T. Chilonis, T. japonicum,* NSKE 5%, Vermicompost, Azospirillum, Phosphobacteria, *T. viride, P. fluorescens* were distributed to 75 SC farmers of Perambalur district of Tamil Nadu. Pheromone traps, lure, light traps, Vermicompost, Azadirachtin, Azospirillum, Phosphobacteria, *T. viride, P. fluorescens*, Azolla, *T. Chilonis* and *T. japonicum* were distributed to 80 SC farmers of Nagapattinam district of Tamil Nadu.

'Field Day' was organised in Venkatayapalem village of Khammam district of Telangana on 29th August, 2020. On 5th March, 2021, SKUAST, Jammu organized a field Day at Chatha, Jammu, in collaboration with ICAR-IIRR under ICAR-IIRR-SCSP. Off-campus and on campus training programs were organized on various aspects of rice production technologies. The SC rice farmers were trained on 'Integrated Nutrient Management', 'Integrated Pest Management', 'Integrated Weed Management', preparation of Vermi-compost and Water saving technologies. Fifteen training programs were organised by ICAR-IIRR in collaboration with KVK Sikkal, Tamil Nadu, KVK, Perambalur, Tamil Nadu, RASS KVK, Andhra Pradesh, KVK, Mandya, Karnataka and SKUAST, Jammu.

### Farmers Field evaluation of new herbicide formulations for dry direct seeding

Agronomy section of IIRR organized field evaluation program of new herbicide Penoxsulam (2.67% W/W) OD in dry direct seeding rice cultivation in Rangapur village, Vikarabad District, Telangana State, through DOT Centre, PJTSAU during *Kharif* 2020. As part of the demonstration program, seed of improved aerobic variety DRR Dhan 46 and RP Bio 226, pre-emergence herbicide Pendimethalin and post emergence herbicide Penoxsulam 2.67% W/W OD were distributed to the farmers.

## Intellectual Property Management and Transfer/Commercialization of agricultural technology Scheme

During 2020, More than 100 entries of seed was provided to various institutes and private companies through MTA. Several applications for germplasm registration were screened and certified by ITMU members for soft registration with NBPGR, New Delhi. As an authorized institute, IIRR received several import permit applications which were scrutinized and forwarded to NBPGR and EXIM committees for processing.

A high-yielding, bacterial blight resistant, fine-grain type, low glycemic index (GI) developed by ICAR-IIRR, Hyderabad in collaboration with

CSIR-CCMB, Hyderabad has been licensed for a sum of Rs. 10 lakhs to M/s Sri Krishna Rice Mills, Chhattisgarh for seed production and marketing of low GI rice grains.

INGR 15002 developed in the background of PR114 with resistance to leaf blast and neck blast and found that it carry novel blast resistance genes *i.e.,* Pi68 was licensed with two companies *viz.,* (i) Ankur Seeds Pvt. Ltd (ii) Bioseed Research India (DSCL)

**Access: Benefit-Sharing documentation meeting** was held on "Technology Commercialization Case Studies Documentation: ICAR-Indian Institute of Oilseeds Research (IIOR)", on 03.01.2020 at ICAR-IIRR, Hyderabad.

Virtual online meeting conducted with Agrinnovate India Limited on 14.09.2020 for commercialization of ICAR-IIRR developed Rice Based Health Care Products (1) Rice Riche Pain Relieving Gel (2) Rice Riche Cream for Cracked Heel and Dry Skin (3) Rice Riche Moisturizing Lotion and (4) Rice Riche Face Scrub.

Dr. M. Sheshu Madhav, Principal Scientist (Biotechnology) & Chairman of ITMU, IIRR participated online Review on Progress on ZTMC Activities and One Day Workshop on 'IPR & Technology commercialization: Status and Opportunities in ICAR, organized by ICAR-IIMR, Hyderabad on Sep 15, 2020.

### Revenue Generation

An amount of Rs. 1,84,40,489.00 was received through testing of varieties and hybrids, contractual services for the evaluation of breeding lines for quality, diseases, insects and also assessing the efficacy of new molecules/ chemicals.

### Revolving Fund

IIRR is actively involved in production of quality seed in research farms and farmers' fields and supplying it to Pvt. Seed companies, Govt. seed agencies and also to farmers earning huge revenue. A profit of Rs. 13,15,294 was generated for the financial year 2020.

### Externally funded projects

Thirteen new externally funded projects have been sanctioned during 2020 (Appendix 5) with a budget outlay of 509 lakhs. A total of 39 externally funded projects are currently being handled at the Institute (Appendix 6) with a sanctioned budget of Rs. 1687 lakhs.

## Awards and Recognitions

- ✓ Best E-Poster Award: Awarded to Dr. R. Abdul Fiyaz and team for the theme "The Role of Women in Agriculture" during Mahila Kisan Diwas celebrated on 15th October, 2020 at ICAR-IIRR, Hyderabad.
- ✓ Best Research Paper–Crop Improvement: Awarded to Swapnil, Balachandran, S.M., Ulaganathan, K., Divya B., Praveen M., Hari Prasad A. S., R. A. Fiyaz, *et al.* 2020. Molecular mapping of QTLs for yield related traits in recombinant inbred line (RIL) population derived from the popular rice hybrid KRH-2 and their validation through SNP genotyping. Scientific Reports 10: 13695 by Director, ICAR-Indian Institute of Rice Research. Hyderabad.
- ✓ Best poster award: Awarded to G. Padmavathi, V. Jhansi Lakshmi, L. V. Subba Rao and M. Sheshu Madhav. 2020. Identification of new quantitative trait loci for resistance to brown planthopper in rice landrace Sinnasivappu. 1st Indian Rice Congress on "Rice Research and Development for Achieving Sustainable Development Goals" in Theme-I: Enhancing rice productivity and quality 8-9th Dec, 2020, ICAR-NRRI, Cuttack, Odisha. IRC/TM-1/ PP-60.

- ✓ Best Oral Presentation Award: Awarded to Honnappa, Diwan, J. R., Gireesh, C., Manoj, C. A., Muralidhara, B, R M Sundaram, Kalyani B, Santosha Rathod, Senguttuvel, P, Kemparaju P, Subbarao L V., Anantha, M. S* 2020. Allele mining strategy to identify the low phosphorus tolerant introgression lines with superior alleles in rice. Theme 8: Advances in molecular biology of abiotic stress tolerance In the International E-Conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity' organised by the Department of Biotechnology and Crop Improvement, College of Horticulture, Bengaluru, India during 24-27th November, 2020.
- ✓ Best Oral Presentation Award: Awarded to Basavaraj, P.S., Murali, B., Manoj, C.A., Anantha, M.S., Sheshu Madhav, M., Senguttuvelu. P. Santosha Rathod., Prakasam, V., Srinivas Prasad, M., Subba Rao, L.V., and Gireesh, C. 2020. Identification of blast (*Magnaporthe oryzae)* resistant lines from *Oryza glaberrima* accessions. International E Conference on Multidisciplinary approaches for plant disease management in achieving sustainability in agriculture. During October 6-9th, 2020. College of Horticulture, UHS Campus GKVK, Bengaluru, India.
- ✓ Best Oral Presentation Award: Awarded to Gireesh C, Muralidhara B, Basavaraj P S, Ishwarya Lakshmi V G, Ajitha V, Manoj C A, Anantha M S, Senguttuvelu P, Bidyasagar Mandal and Subbarao L V. 2020. Development of an Advanced Backcross Nested Association Mapping (AB-NAM) Population derived from *Oryza. sativa* cv. IR 64 /*O. glaberrima* In Theme 4 : Trait mapping and marker/genomics assisted breeding in the International E-Conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity' organised by the Department of Biotechnology and Crop Improvement, College of Horticulture, Bengaluru during 24-27th November, 2020.
- ✓ Post Doctoral Fellowship: Awarded to Dr. P. Revathi, Senior Scientist (Plant Breeding), Hybrid Rice- Crop Improvement Section, IIRR, Hyderabad has joined ICAR-Post Doctoral Fellowship (PDF) on 12th October, 2020 under mentor Dr. A. K. Singh, Director, Division of Genetics, IARI, New Delhi under the 'Strengthening and Development of Higher Agricultural Education in India' Scheme of Agricultural Education Division (ICAR) to support the bright and talented researchers to pursue Post- Doctoral programme to build capacity in frontier areas of national interest in Agriculture and Allied Sciences.
- ✓ Dr. R.M. Sundaram was elected and inducted as a Fellow, National Academy of Sciences (2020).
- ✓ Dr. R.M. Sundaram was selected as Member of Institute Management Committee of ICAR-National Institute of Abiotic stress management (ICAR-NIASM), Baramati.
- ✓ Dr. R.M. Sundaram is serving as Editor/ Academic Editor of Journal of Plant Biochemistry and Biotechnology, PLoS One, Indian Journal of Genetics and Plant Breeding and Journal of Rice Research.
- ✓ Dr. M.S. Madhav was conferred as Fellow of Rice Association (FRA).
- ✓ Dr M.S. Madhav received the "Rythu Nestham Award" under scientist category.

- ✓ Dr. M.S. Madhav was included as Editorial Board Member of two prestigious journals PLOS One and BMC Plant Biology.
- ✓ Dr. Satendra K Mangrauthia was included as Editorial Board Member of two prestigious journals Frontiers in Plant Science and BMC Plant Biology.
- ✓ R. M. Kumar – Certificate of Excellence – awarded by Asian Journal of research in Crop science – 2020 (No- SDI/HQ/PR/Cert/61460/RMA).
- ✓ Best Article Award: "System of Rice Intensification (SRI): A Resource Conserving Method of Rice" Venkataravana Nayaka G. V. and Mahender Kumar R. 32049 Date awarded: 04-11-2020 Agriculture & Food: e-Newsletter.
- ✓ Dr. M. N. Arun appointed as Executive Editorial board member and Review committee member ARCC Journals from March, 2020 (1. Legume Research -An International Journal, 2. Indian Journal of Agricultural Research, 3. Agricultural Reviews, 4. Agricultural Science Digest).
- ✓ Dr. Gobinath has been awarded with the "Jagar Nath Raina Memorial Award for All India Research at Doctorate level-2020" for Ph.D. thesis work by SADHNA (Society for Advancement of Human and Nature) Dr. Y.S. Parmar University of Horticulture and Forestry, Solan (Himachal Pradesh).
- ✓ Dr. M. Srinivas Prasad received the Fellow of Indian Phytopathological Society during 7th International Conference Phytopathology at ICAR-IARI, New Delhi, India, January 16-20, 2020.
- ✓ Dr. M. Srinivas Prasad received ''Fellow of A.P. Academy of Sciences'' for the year 2020 from Andhra Pradesh Academy of Sciences (APAS).
- ✓ Dr. B. Nirmala, Senior Scientist (Agricultural Economist) is selected as Associate Fellow of Telangana Academy of Sciences for the year 2019.
- ✓ Dr. R. Abdul Fiyaz elected as Fellow of Indian Society of Genetics and Plant Breeding for the year 2020.
- ✓ Dr. Jyothi Badri is inducted as editor of the journal "Frontiers in Genetics".
- ✓ Dr. R. Abdul Fiyaz selected as Associate Editor of the Journal of Cereal Research (NAAS Rating 4.57; 2021) published by Society for Advancement of Wheat and Barley Research.
- ✓ Dr. Shaik N Meera selected for the post of Senior Technical Expert on Digital Agriculture and Extension System at IFAD (1 Dec 2020 to 20 Nov 2021).


University of Horticultural Science, Bagalkot, India
Department of Plant Pathology
College of Horticulture, Bengaluru

CERTIFICATE

This is to certify that Dr. Gireesh C has been awarded the best Oral presentation award under the Theme 2: Host plant resistance on "Identification of blast (Magnaporthe oryzae) resistant lines from Oryza glaberrima accessions of rice" in the International E-Conference on "Multidisciplinary approaches for plant disease management in achieving sustainability in agriculture" organised by Department of Plant Pathology, College of Horticulture, Bengaluru, University of Horticultural Sciences, Bagalkot, India during 6-9th October, 2020.

(K M Indiresh) Vice Chancellor UHS, Bagalkot | (R C Jagadeesha) Dean COH, Bengaluru | (V Devappa) Organizing Secreatary COH, Bengaluru

Mail us on : plantpathologycohbengaluru@gmail.com & To download e-copy visit www.plantpathologycohbengaluru.in


University of Horticultural Sciences, Bagalkot, India
Department of Biotechnology & Crop Improvement
College of Horticulture, UHS Campus, GKVK Post, Bengaluru - 560 065

CERTIFICATE

This to certify that
Gireesh C, Muralidhara B, Basavaraj P S, Ishwarya Lakshmi V G, Ajitha V, Manoj C A, Anantha M S, Senguttuvelu P, Bidyasagar Mandal, and Subbarao L V
have secured the First Best Oral Presentation Award for their work on Development of an Advanced Backcross Nested Association Mapping (AB-NAM) Population derived from Oryza. sativa cv. IR 64 /O. *glaberrima* under the session on the Theme 4 : Trait mapping and marker/genomics assisted breeding in theInternational E-Conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity' organised by the Department of Biotechnology and Crop Improvement, College of Horticulture, Bengaluru during 24-27th November, 2020.

(K M INDIRESH) Vice Chancellor | (R C JAGADEESHA) Dean | (B FAKRUDIN) Organizing Secretary

# Patents / Copy rights / Mobile Applications

- Patent application, **"A process for preparation of stabilizer free silicic acid for foliar application"** submitted for grant of Indian patent.
- A Web Based Rice Expert system for major varieties, pests and diseases of Rice crop (http: //www.ricexpert.in – Copyright No. SW-13760/2020)
- A web-based rice expert system has been developed using rule based Artificial Intelligence system for diagnosing insect pest and disease problems of rice crop. This expert system consists of series of questions and answers to diagnose the problem, to browse directly major pests/diseases/ varieties, to access information on better crop protection measures, commonly used pesticides for rice and frequently asked questions. The Questionnaire was aided with drop down boxes along with images of symptoms of pests and diseases for easy identification of the symptoms. This facility is therefore expected to aid and enhance the performance of progressive farmers and agricultural extension personnel and reduce the time required to tackle biotic stresses without waiting for an expert advice. Further this system can be integrated with mobile phones to reach each and every farmer of the country.
- A Web based Radiation Use Efficiency Calculator for Rice Genotypes (Copyright No. SW-13541/2020)
- Radiation Use Efficiency (RUE) is one of the key parameters in measuring the crop biomass and plays a major role in assessing the yield performance of genotypes.


- RUE can be derived from radiation interception and utilization. Manual process of computing RUE is tedious and time consuming. Web based exclusive RUE computation models for rice genotypes are limited. A web-based Radiation Use Efficiency Calculator was developed for Rice genotypes to facilitate computation of RUE at different phenological stages of rice crop. This software was validated with experimental data under All India Coordinated Rice Improvement Programme (AICRIP). This software is presently available in the IIRR website (https://icar-iirr.org/index.php/services/rue-pti-calculator). This can be customised to any other crop. Registered users can access the software.


7th Annual Hill Rice Research Group Meeting

## Deputations

- ✓ Dr. P. Revathi, Senior Scientist (Hybrid Rice) was deputed to visit San Diego CA, USA to present paper in "The Plant and Animal Genome XXVIIII Conference during 11.01.2020 to 15.01.2020.
- ✓ Dr. Satendra Kumar Mangruathia, Senior Scientist (Biotechnology) attended training in area of genome editing of micro RNAs at Louisiana State University, USA under Borlaug International Agricultural Science and Technology Fellowship from 15th Dec 2019 to 8th March, 2020.
- ✓ Dr. P. Revathi, Senior Scientist is selected for Post Doctoral Fellowship (PDF) at IARI, New Delhi for the period 12.10.2020 to 11.10.2021.
- ✓ Dr. Shaik N Meera, Principal Scientist appointed for the post of Senior Technical expert on Digital Agriculture and extension system at International Fund for Agriculture development (IFAD) at Cairo, Egypt for a period of one year from 01.12.2020 to 30.11.2021.

## RTI Activities

- Totally 6 queries and one appeal were received through RTI portal and answers were uploaded within the stipulated time.
- Quarterly and Annual RTI returns were submitted in CIS and RTIMIS portals
- Annual Transparency Audit document (self-appraisal) was prepared and uploaded in CIS portal.

Frequently asked Questions (FAQs), RTI manuals and transparency audit documents were uploaded in IIRR website.

## Significant Events

### 7th Annual Hill Rice Research Group Meeting

The 7th Annual Hill Rice Research Group Meeting was held on 19th February, 2020 at ICAR-IIRR, Hyderabad. Dr. S.R. Voleti, Director ICAR-IIRR briefed the AICRIP guidelines and discussed in brief about the EFC recommendations. During the inaugural session of the workshop, Newsletters of ICAR-IIRR were released. Dr. L.V. Subba Rao, PI, AICRIP-Varietal Improvement presented the consolidated progress report on varietal development under Hill trials conducted during 2019 while Dr. A.V.S.R. Swamy, Principal Scientist, Plant Breeding presented the detailed report on the trials and performance of entries and the entries promoted to next year of testing.

### International women's day celebrated

International Women's Day was celebrated on March 8, 2020 by ICAR-IIRR. Speaking on the occasion the Director (A), Dr. S.R. Voleti appreciated and highlighted the significant contribution of all the women personnel of the institute representing the scientific, technical, administrative and supporting farm staff cadre.

International women's day

## 55th Annual Rice Group Meeting (ARGM)

The 55th ARGM was held during 11th May to 13th May, 2020 through virtual mode and attended by Honorable DG, ICAR, Dr. T. Mohapatra, DDG, CS, Dr. T.R. Sharma and all the co-operators of AICRIP, Private industry personnel and subject matter experts. Dr. D. Maithi, Director, ICAR-NRRI welcomed the participant delegates followed by brief highlights of research progress during 2019 under AICRIP by Dr. S.R. Voleti, Director, ICAR-IIRR. Dr. T. Mohapatra highlighted the country's self-sufficiency in food production despite the serious COVID-19 situation. He emphasized on the need to expedite research in the areas of hybrid rice production, nitrogen use efficiency, water use efficiency, pre-breeding, speed breeding, multiple pest resistance and harmonious integration of IPM research in different institutes. The ICAR officials complimented ICAR-IIRR for conducting first Virtual Annual Rice Group meeting.

## Varietal Identification Committee (VIC) Meeting

The Varietal Identification Committee (VIC) meeting, a component part of ARGM was held at a later date on 10th June, 2020 in virtual mode under the chairmanship of Dr. T.R. Sharma, DDG (Crop Science), ICAR. A total of 31 proposals were received for VIC including 22 varietal and 9 hybrids from ICAR institutes, universities and private seed companies. The proposals were critically examined for their overall, zonal and state yield performance over the years, biotic/ abiotic stresses, performance in agronomic trials and quality features.

Virtual 55 ARGM VIC Meeting - 10 June, 2020

## Institute Management Committee (IMC) meeting

The XXIV Institute Management Committee meeting was held on 8th June, 2020 at ICAR-IIRR. The IMC meeting was chaired by Dr. S.R. Voleti, Director, IIRR and attended by members, Dr. R. Jagadeeshwar, Director of Research, PJTSAU, Dr. S.K. Pradhan, Principal Scientist, NRRI, Cuttack, Shri. Z. H. Khilji, Chief Finance and Accounts Officer, NAARM, Shri. K. Srinivasa Rao, Finance and Accounts Officer, IIRR Shri. B. Satish, Senior Administrative Office (Member Secretary). The agenda was discussed and proceedings submitted to Council for approval.

Institute Management Committee Meeting - 8 June, 2020

## Research Advisory Committee (RAC)

The RAC meeting was held on 16th June, 2020 through virtual mode. The Chairman, Prof. Achilles Tragi, University of Delhi South Campus, New Delhi chaired the meeting and the RAC members *viz*. Dr. Leena Kumari, N. Raghuram, Mayabini Jena, P.C. Rao, Prem Lata Singh, Y.P. Singh, ADG (FFC), Dipankar Maiti, Director, NRRI participated in the meeting. The RAC Chairman and Members complemented the efforts of IIRR scientists in continuing the research experiments even during the pandemic times of Covid-19. It was recommended to accelerate the work on analyzing Big-data, protein digestibility bio-availability experiments, utilization of improved B-lines and R-line, gene editing, direct seeded rice, aerobic rice, carbon sequestration rate, soil physical, chemical and microbiological parameters, heat stress tolerance, stem rot and sheath rot, popularization of IPM impact and analysis of IIRR technologies.

## Institute Research Council (IRC) meeting

The Institute Research Council (IRC) Meeting 2020 was held from 23rd-25th June, 2020 through virtual mode. Dr. G.S. Laha, Secretary, IRC welcomed all the IRC members and briefed regarding the meeting. Dr. S.R. Voleti, Director, IIRR, Chairman IRC emphasized the role of

Research Advisory Committee meeting

rice research in food security of India. The scientists made their presentations followed by brief discussions and recommendations. It was suggested that the rice lines having 10.6% protein content should be used for progeny breeding, promising lines developed using tropical *japonica* should be tested for fertility restoration trait, the microbial community in different rice ecosystem should be characterized, strategies to percolate, popularize IIRR technologies, its impact among the farmers should be evaluated.

Virtual Institute Research Council (IRC) Meeting Day I - 23 June, 2020

## CRP on Bio-fortification – Review Meeting

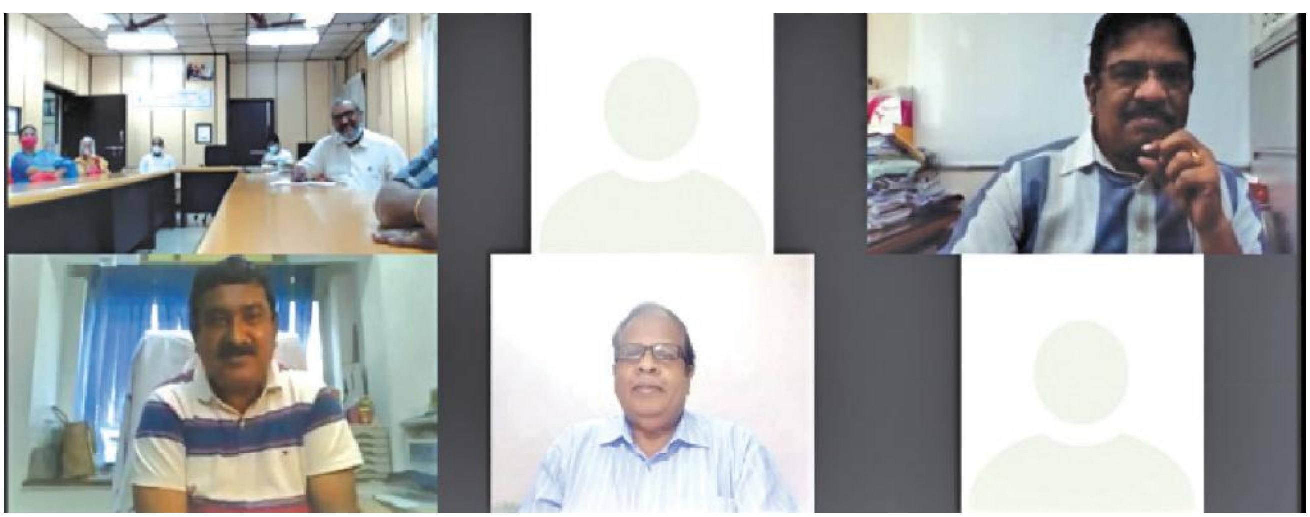
Internal Review of CRP Bio-fortification 2017-2020 by the Coordinator was held through video conferencing on 14th August, 2020. Further A meeting to review the progress of CRP on Bio-fortification in selected crops for nutritional security was held on 18th August, 2020 under the Chairmanship of Dr. T.R. Sharma, DDG (CS), ICAR. Dr. H.S. Gupta, Former Director General, BISA and Director, IARI, and Dr. H.S. Balyan, Senior Scientist, INSA were invited as external experts. Dr. D.K. Yadava, ADG (Seed), Dr. S.R. Voleti, Director, IIRR, Hyderabad & Coordinator, Dr. Sujay Rakshit, Director, IIMR, all the crop PIs and scientists from collaborating centres participated in the review meeting.

## हिंदी चेतना मास समारोह

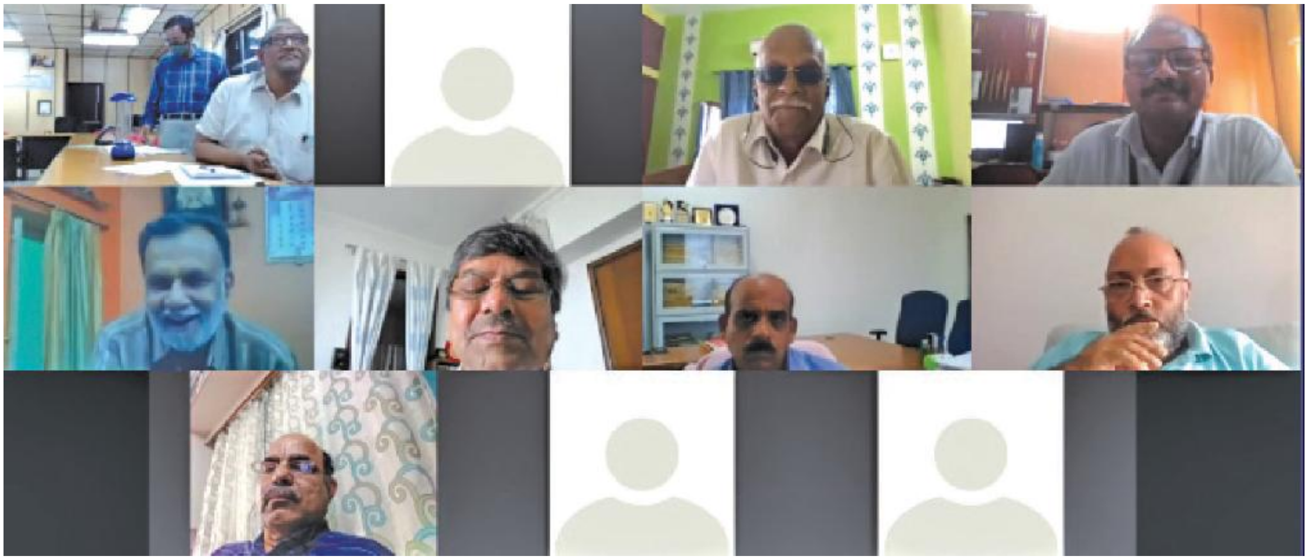
भाकृअनुप - भारतीय चावल अनुसंधान संस्थान, हैदराबाद में 14 सितंबर से 13 अक्तूबर, 2020 के दौरान हिंदी चेतना मास समारोह का आयोजन किया गया। डॉ. गुरुराज कट्टी, प्रभारी निदेशक, भाचाअनुसं ने आभासी (वर्चुअल) रूप में 14 सितंबर, 2020 को उक्तसमारोह के उद्घाटन की घोषणा की। डॉ. महेश कुमार, वरिष्ठ तकनीकी अधिकारी (राजभाषा), भाकअनुसं एवं प्रभारी, हिंदी कक्ष, भाचाअनुसं ने समारोह में उपस्थित लोगों का स्वागत किया तथा हिंदी दिवस एवं राजभाषा हिंदी के महत्वपर प्रकाश डालते हुए हिंदी चेतना मास समारोह से संबंधित जानकारी प्रदान की। उन्होंने हिंदी दिवस के अवसर पर जारी श्रीनरेन्द्र सिंहतोमर, माननीय कें द्रीय कृषिएवं किसान कल्याण मंत्रीके संदेश का वाचन किया तथा डॉ. त्रिलोचन महापात्र, सचिव, कृषिअनुसंधान एवं शिक्षाविभाग तथा महानिदेशक, भारतीय कृषिअनुसंधान परिषद के द्वारा जारी अपील (वीडियो) का प्रदर्शन भी किया। श्रीमती वनिता, प्रवर श्रेणी लिपिक ने श्रीकैलाश चौधरी, माननीय कें द्रीय कृषिराज्यमंत्रीजी के संदेश का वाचन किया।


डॉ. कट्टीने इस अवसर पर अपने संबोधन में कहा किहमें संपर्कभाषा का दायित्वनिभा रही हिं दी का उपयोग करने में झिझक महसूस नहीं करनी चाहिए और हमें टिप्पण व मसौदा लेखन में उसका ज्यादा से ज्यादा उपयोग करना चाहिए। इसके अलावा उन्होंने बताया किकोई भी भाषा सीखना हमारे लिए लाभप्रद ही होता है। उन्होंने इतनी विकटपरिस्थितियों में भी हिं दी चेतना मास का आयोजन करने हेतु संबंधित कार्यकर्ताओं की सराहना भी की और कहा किहमें उक्तमास के दौरान आयोजित प्रतियोगिता में उत्साह एवं उमंग के साथभाग लेना चाहिए। उक्तचेतना मास के दौरान हिं दी में 4 विभिन्नप्रतियोगिताओं का आयोजन किया गया तथा विजेताओं को नकद पुरस्कार प्रदान किए गए। अंत में श्री बी सतीश, वरिष्ठ प्रशासनिक अधिकारी के द्वारा धन्यवाद ज्ञापन के बाद समारोह का समापन हुआ। इस पूरे कार्यक्रम का समन्वय तथा संचालन डॉ. एस आर वोलेटी, निदेशक, भाचाअनुसं के दिशा-निर्देश में डॉ. महेश कु मार, श्रीबी सतीश तथा श्रीमती वनिता के द्वारा किया गया।

### Virtual IBSC Meeting of IIRR on September 4, 2020



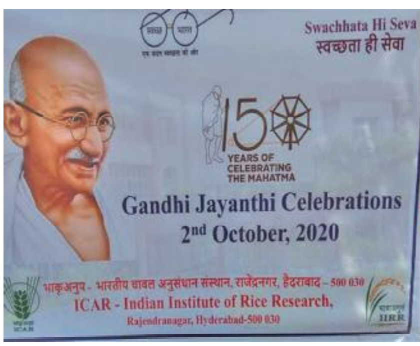
## Virtual Interactive meeting for QRT and IMC on September 8, 2020



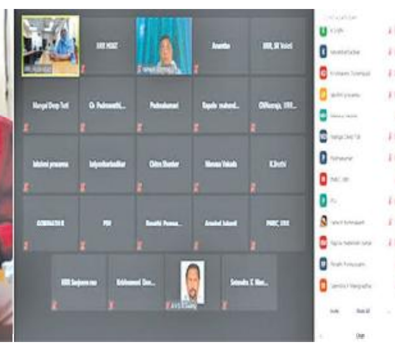
An interactive meeting among QRT and IMC members was conducted virtually on 8th September, 2020 to access the requirement of the Institute and provide recommendations for better performance of the Institute.

## Swatch Bharat Activities

The Institute celebrated 150th birth anniversary of Father of Nation "Mahatma Gandhi" and Swatchta Hi Seva on 2nd October, 2020. The staff voluntarily undertook various activities such as cleaning the institute premises and at R C Puram farm.




Gandhi Jayanthi Celebrations at IIRR - 2 October, 2020



## Vigilance awareness week ("SATARK BHARAT, SAMRIDDH BHARAT)

Vigilance Week was observed at this Institute during 27th October to 2nd November 2020. On this occasion, the Director administered oath to all the staff on the vigilance awareness.

Vigilance Awareness week - 27 October, 2020

# Personnel & Staff

## Scientific Staff

| Name | Designation |
|---|---|
| Dr. S.R. Voleti | Director (A)- superannuated in December 2020 |
| **Plant Breeding** | |
| Dr. L.V. Subba Rao | Principal Scientist |
| Dr. AVSR Swamy | Principal Scientist |
| Dr. G. Padmavathi | Principal Scientist |
| Dr. J. Aravind Kumar | Principal Scientist |
| Dr. Gireesh. C | Senior Scientist |
| Dr. Suneetha Kota | Senior Scientist |
| Dr. Jyoth Badri | Senior Scientist |
| Dr. M.S. Anantha | Senior Scientist |
| Dr. R. Abdul Fiyaz | Scientist |
| Dr. Suvarna Rani .C | Scientist |
| **Hybrid Rice** | |
| Dr. A.S. Hari Prasad | Principal Scientist |
| Dr. P. Senguttuvel | Senior Scientist |
| Dr. P. Revathi | Senior Scientist |
| Dr. Kemparaju K.B | Senior Scientist |
| Dr. K. Shruti | Scientist |
| **Biotechnology** | |
| Dr. S.M. Balachandran | Principal Scientist- superannuated in October 2020 |
| Dr. C.N. Neeraja | Principal Scientist |
| Dr. R.M. Sundaram | Principal Scientist |
| Dr. M Seshu Madhav | Principal Scientist |
| Dr. S.K. Mangrauthia | Senior Scientist |
| Dr. Divya P.S | Senior Scientist |
| Dr. Kalyani Kulkarni | Scientist |
| **Agronomy** | |
| Dr. R. Mahendra Kumar | Principal Scientist |
| Dr. B. Sreedevi | Principal Scientist |
| Dr. Mangal deep Tuti | Senior Scientist |
| Mr. S. Saha | Scientist |
| Dr. Aarti Singh | Scientist |
| **Soil Science** | |
| Dr. K. Surekha | Principal Scientist |
| Dr. M.B.B. Prasad Babu | Principal Scientist |
| Dr. DVK Nageswara Rao | Principal Scientist |
| Dr. Brajendra | Principal Scientist |
| Dr. P.C. Latha | Principal Scientist |
| Dr. Bandeppa | Scientist |
| Mr. R. Gobinath | Scientist |
| Ms. V. Manasa | Scientist |

| Name | Designation |
|---|---|
| **Physiology & Biochemistry** | |
| Dr. D. Subrahamanyam | Principal Scientist |
| Dr. P. Raghuveer Rao | Principal Scientist |
| Dr. D. Sanjeeva Rao | Scientist |
| **Agril. Engineering** | |
| Dr. Vidhan Singh | Principal Scientist |
| **Agril. Chemicals** | |
| Dr. M.M. Azam | Principal Scientist |
| **Computer Applications** | |
| Dr. B. Sailaja | Principal Scientist |
| **Entomology** | |
| Dr. G.R. Katti | Principal Scientist- superannuated in September 2020 |
| Dr. B. Jhansi Rani | Principal Scientist |
| Dr. V. Jhansi laxmi | Principal Scientist |
| Dr. N. Somashekar | Principal Scientist |
| Dr. A.P. PadmaKumari | Principal Scientist |
| Dr. Chitra Shanker | Principal Scientist |
| Dr. Ch. Padmavathi | Principal Scientist |
| Dr. Y. Sridhar | Principal Scientist |
| Mr. S. Chavan | Scientist |
| **Plant Pathology** | |
| Dr. M. Sreenivas Prasad | Principal Scientist |
| Dr. G.S. Laha | Principal Scientist |
| Dr. D. Krishnaveni | Principal Scientist |
| Dr. C. Kannan | Principal Scientist |
| Dr. Ladha Lakshmi | Senior Scientist |
| Dr.V. Prakasam | Scientist |
| Dr. K. Basavarj | Scientist |
| Mr. S. Jasudas Gompa | Scientist |
| **Transfer of Technology & Training** | |
| Dr. P. Muthuraman | Principal Scientist |
| Dr. Amtul Waris | Principal Scientist |
| Dr. Shaik N. Meera | Principal Scientist |
| Dr. Jeya kumar | Principal Scientist |
| Dr. Lakshmi Prasanna | Senior Scientist |
| Dr. B. Nirmala | Senior Scientist |
| Dr. S. Arun Kumar | Senior Scientist |
| Dr. Santosha Rathod | Scientist |
| **National Professor** | |
| Dr. N. Sarla | National Professor till Feb 2020 |
| Dr. Divya Balakrishnan | Scientist |
| **Emeritus Scientist** | |
| Dr. P. Ananda Kumar | Emeritus Scientist |

## Technical Staff

| | |
|---|---|
| Dr M N Arun | Assistant Chief Technical Officer |
| C. Sadanandam | Assistant Chief Technical Officer |
| Srinivasan Amudhan | Assistant Chief Technical Officer |
| Chirutkar Prakash | Assistant Chief Technical Officer |
| Uddaraju Chaitanya | Senior Technical Officer |
| K Chaitanya | Senior Technical Officer |
| M Ezra | Senior Technical Officer |
| U.Pullaiah | Senior Technical Officer |
| M Vijay Kumar | Senior Technical Officer |
| Mohd. Tahseen | Technical Officer |
| A. Narsing Rao | Technical Officer-superannuated in Dec, 2020 |
| Emkolla Nagarjuna | Technical Officer |
| Mohd. Sadath Ali | Technical Officer |
| K. Ramulu | Technical Officer |
| P.Vittalaiah | Technical Officer-superannuated in August 2020 |
| Dr Y Roseswara Rao | Technical Officer |
| Kova Shravan Kumar | Technical Officer |
| P Chandrakanth | Senior Technical Assistant |
| A Venkataiah | Senior Technical Assistant |
| Tupakula Venkaiah | Senior Technical Assistant |
| C. Muralidhar Reddy | Senior Technical Assistant |
| K Janardhan | Technical Officer (Driver) |
| Bidyasagar Mandal | Senior Technical Assistant-transferred to ICAR-NRRI, Cuttack |
| K.H. Devadas | Senior Technical Assistant |
| B. Venkaiah | Senior Technical Assistant |
| T. Narender Prasad | Senior Technical Assistant |
| Koteswara Rao Potla | Senior Technical Assistant |
| K Narasimha | Senior Technical Assistant (Driver) |
| M. Chandrakumar | Technical Assistant |
| S. Vijay Kumar | Technical Assistant |
| A Ramesh | Senior Technician (Driver) |
| V Srinivas | Technician |
| R. Sathemaiah | Technician |
| S. Yadaiah | Technician |

## Administrative Staff

| | |
|---|---|
| Sathish B | Senior Administrative Officer |
| K Srinivasa Rao | Finance & Accounts Officer |
| K Kousalya | Asst. Administrative Officer |
| Sudha Nair | Asst. Administrative Officer |
| R. Udaya Kumar | Private Secretary |
| Aparna Das | Private Secretary |
| Uppalapati Rama | Assistant |
| P. Lakshmi | Assistant |
| S Prabhakar | Assistant- superannuated in July 2020 |
| B. Vidyanath | Assistant |
| T.D. Pushpalatha | Assistant |
| K. Sudhavalli Tayaru | Assistant |
| Shaik Ahmed Hussain | Assistant |
| S. Hemalatha | Personal Assistant |
| Sandiri Rama Murthy | Personal Assistant |
| Bommakanti Ramesh | Personal Assistant |
| Vanitha | UDC (Upper Division Clerk) |
| Bharath Raju | UDC (Upper Division Clerk) |
| G. Satyanarayana | UDC (Upper Division Clerk) |
| K Mallikarjunudu | UDC (Upper Division Clerk) |
| Kota Jashwanth | LDC ( Lower Division Clerk) |
| S. Rekha Rani | LDC ( Lower Division Clerk) |
| Ashfaq Ali | Stenographer Gr, III |
| Navneet Kumar | Stenographer Gr, III |
| Chander | Skilled Supporting Staff (SSS) |
| M Anthamma | Skilled Supporting Staff (SSS) |
| B Susheela | Skilled Supporting Staff (SSS) |
| Ahmed Ullah Khan | Skilled Supporting Staff (SSS) |
| V Golu Naik | Skilled Supporting Staff (SSS) |
| Z. Shankaraiah | Skilled Supporting Staff (SSS) superannuated in October 2020 |

# Publications

## (i) Papers in research journals (National/ international):

Ajay Kumar E, K Surekha, K Bhanu Rekha and S Harish Kumar Sharma. 2020. Effect of Various Sources of Zinc and Iron on Grain Yield, Nutrient Uptake and Quality Parameters of Finger Millet (*Eleusine coracana* L.). *International Research Journal of Pure & Applied Chemistry*, 21(2): 46-55.

Ajay Kumar, E, Surekha K, Bhanu Rekha K and Harish Kumar Sharma S. 2020. Grain Quality Parameters as Influenced by Various Sources of Zinc and Iron. *International Journal of Current Microbiology and Applied Sciences, ISSN: 2319-7706,* 9 (4): 1- 9.

Amtul Waris and N Sunder Rao (2020) Factors influencing adoption of climate resilient paddy production practices in Andhra Pradesh, India *Oryza* 57 ( 3):240-250 DOI https://doi.org/10.35709/ory.2020.57.3.9

Amtul Waris, B. Nirmala, N. Sunder Rao and B. Jangaiah (2020) Socio-economic profile and constraints faced by rice farmers in tribal areas of Nalgonda district of Telangana, *Agriculture Update* 15 (1 and 2 ): 56-61

Anirudh Kumar, Rakesh Kumar, Debashree Sengupta, Subha Narayan Das, Manish K P, Abhishek Bohra, Naveen K S, Pragya Sinha, Hajira S K, Irfan Ahmad Ghazi, Gouri Sankar Laha and Sundaram R M 2020. Deployment of Genetic and Genomic tools towards gaining a better understanding of *Rice-Xanthomonas oryzae* pv. *oryzae* interactions for development of durable bacterial blight resistant Rice. *Frontiers in Plant Sciences* 11: 1152 doi: 10.3389/fpls.2020.01152.

Anitha, G., Shanker, C., Shashibhushan, V. and Srinivas, C. 2020. Diversity analysis of coccinellids in *Kharif* Rice. *Journal of Entomology and Zoology Studies.* 8 (4), 1876-1878.

Anupama K, Pranathi K and Sundaram RM 2020. Assessment of genetic purity of bulked-seed of rice CMS lines using capillary electrophoresis. *Electrophoresis* (published online, 1st May 2020, doi: https://doi.org/10.1002/elps.201900429).

Anusha G, Eswari KB, Lakshmidevi G, Jai Vidhya LRK, Narender Reddy S, Krishnam Raju A, Divya Balakrishnan, Subrahmanyam Desiraju, Aravind Kumar Jukanti, Subba Rao LV and Jyothi Badri. 2020. Genetic analysis of dormancy and shattering traits in the backcross inbred lines derived from *Oryza sativa* cv. Swarna / *O. nivara* Ac. CR100008 *Oryza* 57(1):1-13 https://doi.org/10.35709/ory.2020.57.1.1.

Aravind Kumar Jukanti, PutlihAdzraPautong, Qiaoquan Liu, NeseSreenivasulu (2020), Low glycemic index rice—a desired trait in starchy staples, *Trends in Food Science & Technology*, 106: 132-149, ISSN 0924-2244, https://doi.org/10.1016/j.tifs.2020.10.006.

Arvind Kumar, Anitha Raman, Shailesh Yadav, Verulkar SB, Mandal NP, Singh ON, Swain P, Ram T, Jyothi Badri, Dwivedi JL, Das SP, Singh SK, Singh SP, Santosh Kumar, Abhinav Jain, Chandrababu R, Robin S, Shashidhar HE, Hittalmani S, Satyanarayana P, ChallaVenkateshwarlu, Janaki Ramayya, Shilpa Naik, Swati Nayak, Manzoor H. Dar, Hossain SM, Amelia Henry and Piepho HP (2020) Genetic gain for rice yield in rainfed environments in India, *Field Crops Research* https://doi.org/10.1016/j.fcr.2020.107977.

Azam MM, Jahan A, Maheshwari KU, Ram T, and Waris A. (2020). Glycemic Index of Selected Indian Rice Varieties. *International Research Journal of Pure & Applied Chemistry, 21(24): 137-146.*

Babu P M, Neeraja C N, Rathod S, Suman K, Uttam G A, Chakravartty N,Lachagari V B R, Chaitanya U, Subbarao Rao L V and Voleti S R 2020 Stable SNP Allele Associations With High Grain Zinc Content in Polished Rice (*Oryza sativa* L.) Identified Based on ddRAD Sequencing. *Front. Genet.* 11:763. IF-3.789.

Balakrishnan D, Malathi S, AK Raju, YV Rao, S Mesapogu, Kavitha B and Sarla N. 2020. Detection of Chromosome segment substitution lines and yield QTLs with additive, epistatic and QTL × environment interaction effects from *Oryza sativa*/ *O. nivara* IRGC81832 cross (2020). *Scientific reports.* 10:7766 |https://doi.org/10.1038/s41598-020-64300-0.

Publications

Basavaraj, PS, Bharamappanavara Muralidhara, C A Manoj M S Anantha, Santosha Rathod, Ch Damodar Raju, P Senguttuvel, MS Madhav, M Srinivasaprasad, V Prakasam, K Basavaraj, Jyothi Badri, L V Subbarao, R M Sundaram, C Gireesh. 2020. Identification and molecular characterization of high yielding, blast resistant lines derived from *Oryza rufipogon* Griff. in the background of 'Samba Mahsuri' rice. *Genetic Resource and Crop Evolution* https://doi.org/10.1007/s10722-020-01104-1.

Basavaraj, PS, Gireesh, C, Muralidhara, B, Manoj, C A Anantha, MS and Ch Damodar Raju. 2020. Genetic analysis of backcross derived lines of *Oryza rufipogon* in the background of Samba Mahsuri a for yield enhancing traits in rice. *Electronic Journal of Plant Breeding.* Vol 11(4):1120-1127.https://doi.org/10.37992/2020.1104.181.

Beerelli K, Balakrishnan D, Sarla Neelamraju.2020. Variability and correlation of yield traits in BIL x BIL populations derived from Swarna x *O. nivara. Journal of Rice Research.* 13(1): 1-8.

Bharamappanavara M, Siddaiah A M, Ponnuvel S, Lokesha Ramappa, Basavaraj Patil, Manoj Appaiah, Sheshu Madhav M, Sundaram RM, Shashidhar Kadadanamari Shankarappa, Tuti M D, Sreedevi Banugu, Brajendra P,Santosha Rathod, Kalyani M B, Suneetha K, Subbarao L V, Mondal T K & Gireesh C 2020. Mapping QTL hotspots associated with weed competitive traits in backcross population derived from *Oryza sativa* L. and *O. glaberrima* Steud. *Scientific Reports* 10, 22103.

Bhaskar Rao T, Chopperla R, Prathi N B, Balakrishnan M, Prakasam V, Laha G S, Balachandran S M, Mangrauthia S K, 2020 A Comprehensive Gene Expression Profile of Pectin Degradation Enzymes Reveals the Molecular Events during Cell Wall Degradation and Pathogenesis of Rice Sheath Blight Pathogen *Rhizoctonia solani* AG1-IA. *Journal of Fungi,* 6, 71.

Chandu G, Balakrishnan D, Satendra K Mangrauthia, Sarla Neelamraju, 2020. Characterization of elite rice genotypes for grain Fe, Zn using Energy Dispersive X-ray Fluorescence Spectrophotometer (ED - XRF). *Journal of Rice Research.*

Chandu G, Krishnam Raju Addanki, Balakrishnan, D, Satendra K Mangrauthia, P. Sudhakar, A. Krishna Satya and Sarla Neelamraju.2020. SSR markers for grain iron zinc and yield-related traits polymorphic between Samba Mahsuri (BPT5204) and a wild rice *Oryza rufipogon*. *Electronic Journal of Plant Breeding.* Vol. 11(3):841-847. https://doi.org/10.37992/2020.1103.138.

Chopperla R, Mangrauthia S K, Bhaskar Rao T, Balakrishnan M, Balachandran S M, Prakasam V, Channappa G A 2020. Comprehensive Analysis of MicroRNAs Expressed in Susceptible and Resistant Rice Cultivars during *Rhizoctonia solani* AG1-IA Infection Causing Sheath Blight Disease. I*nternational Journal of Molecular Sciences,* 21:7974. https://doi.org/10.3390/ijms21217974.

De Silva NPS, B Kavitha, M Surapaneni, AK Raju,VG Shankar, Balakrishnan, D, S Neelamraju. 2020. Polymorphic SSR markers among *Oryza sativa* cv. Swarna and its derived advanced backcross lines with wild introgressions from *O. nivara The J. Res. PJTSAU* 48 (3&4) 27-37.

De Silva NPS, Balakrishnan, D, V G Shankar, B Kavitha, AK Raju, P Prashanthi, Y Poli, D Subramanyam, N Sarla. 2020. Phenotypic analysis and correlation studies of recombinant inbred lines derived from nterspecific crosses of *Oryza sativa* and *Oryza nivara*. *Journal of rice research,* 13(2 ): 16-26.

Dixit S, Singh U M, Singh A K, Alam S, Venkateshwarlu Ch, Nachimuthu V, Yadav S, Ragavendran A, Selvaraj R, Nagamallika Devi M, Ramayya P J, Badri J, Ram T, Jhansi Lakshmi V, Lakshmidevi G, Jai Vidhya L R K, Padmakumari A P, Laha G S, Prasad M S, Seetalam M, Singh V K and Kumar A. 2020. Marker Assisted Forward Breeding to Combine Multiple Biotic-Abiotic Stress Resistance/Tolerance in Rice. *Rice.* 13:29. https://doi.org/10.1186/s12284-020-00391-7

Gobinath R, Datta SP, Singh RD and Manasa V, 2020. Effect of mode and source of iron nano particles on the biological properties of the calcareous soil. *International journal of chemical studies*, 8(4): 3334 -3337.

Ishwarya Lakshmi,VG, Sreedhar, M, Gireesh, C and Vanisri, S. 2020. Genetic variability, correlation and path analysis studies for yield and yield attributes in

African rice *(Oryza glaberrima)* germplasm.Electronic *Journal of Plant Breeding.* 11(2): 399-404. http://www.ejplantbreeding.org/index.php/ EJPB/ article/ view/3318.

Jamaloddin Md, Durga Rani V Ch, Swathi G, Anuradha Ch,Vanisri, S, Rajan C P D, Krishnam Raju S, Bhuvaneshwari V, Jagadeeswar R, Laha G S, Prasad M S, Satyanarayana P V, Cheralu C, Rajani G, Ramprasad E, Sravanthi P, Arun Prem Kumar N, Aruna Kumari K,Yamini K N, Mahesh D, Sanjeev Rao D, Sundaram R M, Sheshu Madhav M 2020. Marker Assisted Gene Pyramiding M A G P for bacterial blight and blast resistance into mega rice variety "Tellahamsa". *PLoS One* 15(6): e0234088 .

Jyothi Badri, Jai Vidhya LRK, Lakshmidevi G, Subhakara Rao I, Nandini V, Chiranjeevi M, Laha GS and Subba Rao LV (2020) Performance of zinc rich rice cultivar - DRR Dhan 48 in farmers' fields. *Journal of Rice Research,* 13 (2): 73-76

Katara J L, Verma R L, Parida M, Ngangkham U, Molla K A, Kalyani M B, Mukherjee M C P, Samantaray S, Ravi N R, Singh O N, Mohapatra T. 2020. Differential expression of genes at panicle initiation and grain filling stages implied in heterosis of rice hybrids. *International Journal of Molecular Sciences,* 21 (3), 1080.

Kulkarni S R, Ulaganathan K, Sundaram R M, HariPrasad A S, Fiyaz R A and Balachandran SM 2020. Production of doubled haploids from rice hybrid KRH-2 through anther culture and their evaluation for agro-morphological traits. *Journal of Rice Research* 13: 33-50.

Kumar A, Kumar R, Sengupta D, Das, S N, Pandey M K, Bohra A, Sharma N K, Sinha P, Hajira Sk, Ghazi I A, Laha G S and Sundaram RM. 2020. Deployment of Genetic and Genomic Tools toward Gaining a Better Understanding of Rice-*Xanthomonas oryzae* pv. *oryzae* Interactions for Development of Durable Bacterial Blight Resistant Rice. *Frontiers in Plant Science,* 11:1152. doi: 10.3389/fpls.2020.01152.

Ladhalakshmi D, Preeti, Bhaskar M, Koteshwar P, Laha G S, Dilip T, Sundaram R M, Prakasam V and Prasad M S 2020. Incidence of false smut on rice genotypes and the influence of weather factors on the disease. *Journal of Rice Research* 13: 61-66.

Lanah S, S Vanisri, S Mulinti, RA Fiyaz, ChV D Rani, T Ramesh and SAHussain. 2020. Genetic variation for yield traits in magic indica plus population and Indian rice germplasm. *The J. Res. PJTSAU,* 48 (1&2) 89-93.

Madhubabu P, Surendra R, Suman K, Chiranjeevi M, Abdul Fiyaz R, Sanjeeva Rao D, Chaitanya U, Lella V Subba Rao, Ravindra Babu V and Neeraja CN. 2020. Assessment of genetic variability for micronutrient content and agro-morphological traits in rice (*Oryza sativa* L.). *Indian Journal of Genetics and Plant Breeding,* 80(2): 130-139.

Mahadeva Swamy H K, Anila M, Kale R R, Rekha G, Bhadana V P, Anantha M S, Brajendra Balachiranjeevi C H, Hajira SK, Laxmi Prasanna B, Pranathi K, Dilip P, Kousik M B V N, Harika G, Surekha K, Mahender Kumar R, Cheralu C, Gouri Shankar V, Laha GS, Prasad M S, Subba Rao L V,Sheshu MAdhav M, Balachandran S M and Sundaram R M 2020. Marker assisted improvement of low soil phosphorus tolerance in the bacterial blight resistant, finegrain type rice variety, Improved Samba Mahsuri. *Nature Scientific Reports* 10: 21143; https://doi.org/10.1038/s41598-020-78186-5.

Manasa V, Hebsur NS and Gobinath R. 2020. Effect of nano iron oxide application on iron availability in calcareous Vertisols. *International journal of chemical studies*, 8(4):3317 -3321.

Manasa V, Hebsur N S, Patil PL, Hebbara M, Aravindkumar BN, Gobinath R. 2020. Fertility Status of Groundnut Growing Calcareous Vertisols of Dharwad District, Karnataka. *International Research Journal of Pure and Applied Chemistry*. 21 (14): 7-19.

Manasa V, Hebsur NS, Malligawad L H, Gobinath R and Ramakrishna B. 2020. Effect of Water Soluble Fertilizers on Yield, Oil Content and Economics of Groundnut. *Current Journal of applied Science and technology*, 39 (23): 89 -90.

Mawuli K. Azameti. Vishalakshi B. Umakanth B. Marathi B. Srinivas Prasad M. Sheshu Madhav M 2020. Molecular characterization of popular rice (*Oryza sativa* L.) varieties of India and association analysis for blast resistance. *Genet Resour Crop Evol.* https://doi.org/10.1007/s10722-020-00976-7.

Muralidhara B, Anantha M S, Senguttuvel P, Lokeh R, Patil B, Manoj A, Sheshu Madhav M, Sundaram R M, Shashidhar K S, Tuti M D, Sreedevi B, Brajendra P, Rathod S,Barbadikar K B, Suneetha K, Subba Rao L V, Mondal T K, Gireesh C 2020. Mapping QTL hotspots associated with weed competitive traits in backcross population derived from *Oryza sativa* L. and *O. glaberrima* Steud. *Nature Scientific Reports* 10: 22103; https://doi.org/10.1038/s41598-020-78675-7.

Nirmala B, Subba Rao L V, Sundaram R M, Muthuraman P, Swamy A V S R, Fiyaz R A, Chiranjeevi M and Chaitanya U 2020. An estimate on the adoption of ICAR-IIRR released varieties and their impact on rice production in India during 2015-20. *Journal of Rice Research* 13: 67-72.

Patil, R., Nagaraj, DM. Rathod, S. and Polisgowdar, BS. (2020). Accuracy testing of box Jenkins models in forecasting potential evapotranspiration for Raichur district. *Journal of Pharmacognosy and Phytochemistry* 2020; 9(2): 826-830.

Patil, R., Polisgowdar, BS. Rathod, S., Kumar, US., Reddy, GVS. And Rao, S. (2020). Drought Modelling and Forecasting using Stochastic and Neural Networks for Ballari District. *Journal of the Indian Society of agricultural Statistics*, MS-JISAS05(32)19(12)-53.

Prasad GSV, G Padmavathi, K Suneetha, MS Madhav and K Muralidharan. 2020. Assessment of diversity of Indian aromatic rice germplasm collections for morphological, agronomical, quality traits and molecular characters to identify a core set for crop improvement. *Cabi Agric Bio Sci.*, 1-13.

Prathap Reddy N, Bharat Bhushan Rao CH, Surekha K and Hussain SA. 2020. Influence of enriched nitrogen sources at different levels on yield attributes and yield of transplanted rice. *Journal of Pharmacognosy and Phytochemistry*, 9(3): 2294-2297.

Prathap Reddy N, Bharat Bhushan Rao CH, Surekha K and Hussain SA. 2020. Effect of enriched nitrogen sources at different levels on nutrient uptake of transplanted rice. *International Journal of Chemical Studies*, 8(5): 2463-2466.

Rachana Bagudam, Eswari KB, Jyothi Badri, Lakshmi Devi G, JaiVidhya LRK, Bhavani P, Gattu Swathi, Bharath M, Raghuveer Rao P, Jukanti Aravind Kumar, Abdul Fiyaz R, Neeraja CN, Subba Rao LV and Ram T (2020) Morphological and molecular characterization of new plant type core set for yield and culm strength traits in rice (*Oryza sativa* L.) *Journal of Plant Biochemistry and Biotechnology*. https://doi.org/10.1007/s13562-020-00581-w.

Raghurami Reddy M, Satendra K. Mangrauthiaa, S. Venkata Reddyc, P. Manimaranc, PoliYugandharb,P. Naresh Babua, T. Vishnukiran, *D. Subrahmanyam*, R.M. Sundaram, S.M. Balachandran. 2020. PAP90, a novel rice protein plays a critical role in regulationof D1 protein stability of PSII. *Journal of Advanced Research*, 30: DOI: 10.1016/j.jare.2020.11.008.

Rama Devi S J S, Kuldeep Singh, Umakanth B, Vishalakshi B, Vijaya Sudhakara Rao K, Suneel B, Sharma S K, Gopala Krishna Murthy Kadambari, Prasad M S, Senguttvel P, Divya P S, Sheshu Madhav M 2020. Identification and Characterization of a large effect QTL from *Oryza glumaepatula* revealed Pi68 (t) as putative candidate gene for rice blast resistance. *Rice* (Springer). 13(1)1-13.

Ramakrishna Chopperla, Satendra K Mangrauthia, Talluri Bhaskar Rao, Marudamuthu Balakrishnan, Sena Munuswamy Balachandran, Vellaisamy Prakasam and Gireesh Channappa. 2020. A Comprehensive Analysis of MicroRNAs Expressed in Susceptible and Resistant Rice Cultivars during *Rhizoctonia solani* AG1-IA Infection Causing Sheath Blight Disease.*International Journal of Molecular Sciences*. 21, 7974; https://doi.org/10.3390/ijms21217974.

Rao VR, Adilakshmi D, Satyanarayana PV, Girija Rani M, Chamundeswari N, Ravi Kumar BNVSR, Suryanarayana Y, Padmavathi, G, Bhuvaneswari V, Krishnam Raju S, Mallikarjuna Rao and Nanda Kishore M. 2020. MTU 1223 (Varsha), a high yielding, non-lodging rice variety released for Rainfed shallow lowland ecology of Odisha and Bihar. *International Journal of Chemical Studies*. 8(6): 1625-1630.

Ratnakar, V., Jhansi Lakshmi, V., Sreenivas, C., Jagadeeshwar, R. and Satendra K Mangrauthia. 2020. Bioefficacy of commonly used insecticides against rice brown planthopper, *Nilaparvata lugens* (Stal). *The Journal of Research PJTSAU*. 47(4):28-32.

Ravindra Ramrao Kale, M Anila, HK Mahadeva Swamy, V P Bhadana, Ch V Durga Rani, P Senguttuvel, D Subrahmanyam, SK Hajira, G Rekha, M Ayyappadass, B Laxmiprasanna, E Punniakotti, M BV N Kousik, Swapnil Kulkarni, T Dilip, Pragya Sinha, G Harika, K Pranathi, K Chaitra, MS Anantha, P Brajendra, LV Subbarao, S M Balachandran, SK Mangrauhuia, Raman Meenakshi Sundaram. 2020. Morphological and molecular screening of rice germplasm lines for low soil P tolerance. *J. Plant Biochem. Biotechnol*, https://doi.org/10.1007/s13562-020-00586-5.

Ray, M., Singh, KN., Ramasubramanian, V., Paul, RK. Mukherjee, A. and Rathod, S. (2020). Integration of Wavelet Transform with ANN and WNN for Time Series Forecasting: An Application to Indian Monsoon Rainfall. *National Academy Science Letters*, 1-5. https://doi.org/10.1007/s40009-020-00887-2.

Revathi Ponnuswamy*, Arun Kumar Singh, Meenakshi Sundaram Raman, Lella venkata Subbarao and Neeraja C.N. 2020. Conversion of partial restorer Swarna into restorer by transferring fertility restorer Rf gene(s) through marker assisted back cross breeding (MABB) in rice. *Scientific Reports* 10:1101 https://doi.org/10.1038/s41598-020-58019-1.

Saha S, Bandyopadhyay S, Mitra B, Patra PS and Paul T. 2020. Response of wet direct-seeded rice to methods of zinc application. *Journal of Rice Research* 13(1): 59-65.

Saha S, Tuti MD, Kumar RM, Bandeppa and Singh TV. 2020. Suitability of elite genotypes for wet-direct seeding in rice-rice system in Vertisol. *Oryza* 57(1):36-42

Saha, A., Singh, K.N., Ray, and Rathod, S, (2020). A hybrid spatio-temporal modelling: an application to space-time rainfall forecasting. *Theor Appl Climatol* 142, 1271–1282 (2020). https://doi.org/10.1007/ s00704-020-03374-2.

Saha, A., Singh, KN., Gurung, B., Rathod, S. and Yeasin, Md. (2020). Robust Regression in the Presence of Leverage:An Application to the Baseball Data. *Journal of the Indian Society of agricultural Statistics*. 74 (3): 181-186. http://isas.org.in/jsp/volume/vol74/issue3/1-Amit%20Saha.pdf.

Sahu B, Yugander A, Khar N, Lakpale N, Ladhalakshmi D, Sundaram R M, Prasad M S and Laha GS 2020. Identification of broad-spectrum bacterial blight resistance in diverse rice germplasm. *Indian Journal of Plant Protection* 48: 117-121.

Sailaja B, PadmaKumari A P, Krishnaveni D, Gayathri S, Nagarjuna Kumar S and Voleti SR. 2020. Online rice expert system for extension professionals. *Multilogic in Science* VOL. X, ISSUE XXXIV, JULY 2020 ISSN 2277-7601.

Sakthivel K, Kumar A, Gautam R K, Manugundan K, Laha G S, Velazhahan R, Singh R and Yadav I S. 2020. Intra-regional diversity of rice bacterial blight pathogen, *Xanthomonas oryzae* pv. *oryzae*, in the Andaman Islands, India: revelation by pathotyping and multilocus sequence typing. *Journal of Applied Microbiology*. doi:10.1111/jam.14813.

SaniiLanah, Vanisri S, Abdul Fiyaz R, Sreedhar Mulinti, Durga Rani CHV, Ramesh T. 2020. Correlation studies in magic indica plus population and Indian rice germplasm. *International Journal of Chemical Studies.* 8(5): 901-903.

Sanjeeva Rao D, Neeraja CN, Madhu Babu P, Nirmala B, Suman K, Rao LVS, Surekha K, Raghu P, Longvah T, Surendra P, Kumar R, Babu VR and Voleti SR (2020) Zinc Biofortified Rice Varieties: Challenges, Possibilities, and Progress in India. *Front. Nutr.* 7:26. doi: 10.3389/fnut.2020.00026.

Satturu, V, Vattikuti, JL, J, DS, Kumar, A, Singh, RK, M, SP, Zaw, H, Jubay, ML, Satish, L, Rathore, A, Mulinti, S, Lakshmi VG, I, Fiyaz RA, Chakraborty, A, Thirunavukkarasu, N. 2020. Multiple Genome Wide Association Mapping Models Identify Quantitative Trait Nucleotides for Brown Planthopper (*Nilaparvatalugens*) Resistance in MAGIC Indica Population of Rice. *Vaccines*, 8:608.

Senguttuvel P, V Jaldhani, N Sravan Raju, D Balakrishnan, P Beulah, V Bhadana, S K Mangrauthia, CN Neeraja, D Subrahmanyam, P R Rao, A S Hariprasad & S R Voleti (2020). Breeding rice for heat tolerance and climate change scenario; possibilities and way forward. A review, *Archives of Agronomy and Soil Science*, DOI: 10.1080/03650340.2020.1826041.

Shilpi Dixit, Uma Maheshwar Singh, Arun Kumar Singh, Shamshad Alam, Challa Venkateshwarlu, Vishnu Varthini Nachimuthu, Shailesh Yadav, Ragavendran Abbai, Ramchander Selvaraj, M. Nagamallika Devi, P Janaki Ramayya, Jyothi Badri, T Ram, Jhansi Lakshmi G. Lakshmidevi, Jai Vidhya LRK, AP Padmakumari, GS Laha, MS Prasad, Malathi S, Vikas Kumar Singh and Arvind Kumar (2020) Marker Assisted Forward Breeding to Combine Multiple Biotic-Abiotic Stress Resistance/Tolerance in Rice (2020) 13:29 https://doi.org/10.1186/s12284-020-00391-7.

Shruti Kumari, S.K. Chakrabarty, P.K. Bhowmick, VikramJeet Singh and A.S. Hari Prasad, 2020. Validation of hybrid rice seed vigour traits using SSR marker (*Oryzasativa* L.), *Indian J. Genet*. 80(2) 204-208.

Singh MS, Jhajharia D, Devi KL, Kumar SR, Devi AP and Fiyaz RA 2020. Onion cultivation under low cost low plastic tunnels for restricting over winter in eastern Himalayan region. *International Journal of Current Microbiology and Applied Sciences,* 9(8): 650-657.

Sreedevi B, Singh A, Thakur C, M. Prasant Kumar, Vinod Mehra, R. Mahender kumar and Srivastava G K. 2020. Weed Control by Single Post-emergence Combination Herbicide Florpyrauxifen-Benzyl + Cyhalofop Butyl in Aerobic Rice. *Current Journal of Applied Science and Technology* 39(3): 109-122.

Suneel B, Gopi P, Karteek J, Ershad M D, Laha G S, Padmakumari A P, Sundaram R M, Sonti R V, Patel H K, Sudhakar P, Krishna Satya A and Sheshu Madhav M 2020. Assessment of Agro-morphological Characters among Complete Panicle Emergence Mutants of Samba Mahsuri BPT-5204. *Current Journal of Applied Science and Technology*. 39: 113-125.

Suryendra. P J, P. Revathi, Arun Kumar Singh, B.C. Viraktamath. 2020. Marker assisted recurrent selection for genetic male sterile population improvement in rice. *Electronic Journal of Plant Breeding*. 11(1): 149 -155.

Swapnil K, Balachandran S M, Ulaganathan K, Divya B, Praveen M, Hari Prasad A. S, Fiyaz R A, Senguttuvel P, Pragya Sinha, Ravindra R K, Rekha G, Kousik M B V N, Harika G, Anila M, Punniakoti E, Dilip T, Hajira S. K, Pranathi K, Ayyappa Das M, Mastanbee Shaik, Chaitra K, Koteswara Rao P, Sunil S G, Manish K P and Sundaram R M 2020. Molecular mapping of QTLs for yield related traits in recombinant inbred line (RIL) population derived from the popular rice hybrid KRH2 and their validation through SNP genotyping. *Nature Scientific Reports* 10: 13695.

Tuti MD, Pal RS, Mahanta D, Pandey BM and Bisht JK. 2020. Soil Chemical and Biological Activities under Vegetable Intensive Colocasia-based Cropping System in Indian Sub-Himalayas. *Communications in Soil Science and Plant Analysis* 51(7): 948–962.

Vijay Kumar S, Prasad M S, Rambabu R, Bhaskar B, Sundaram R M, Prakasam V, Ladhalakshmi L, Laha G S and Seshu Madhav M 2020. Marker assisted introgression of broad spectrum blast resistance gene *Pi-2* into an elite rice cultivar, Samba Mahsuri. *Indian Journal of Plant Protection* 47: 54-163.

Vikram Singh Gaur, Gireesh Channappa, Mridul Chakraborti, Tilak Raj Sharma and Tapan Kumar Mondal. 2020.'Green revolution' dwarf gene sd1 of rice has gigantic impact. *Briefings in Functional Genomics,* 19(5-6):390-409. https://doi.org/10.1093/bfgp/elaa019.

Vishnukiran T, Neeraja C N, Jaldhani V, Vijayalakshmi P, Raghuveer Rao P, Subrahmanyam D, *et al.* 2020. A major pleiotropic QTL identified for yield components and nitrogen content in rice (*Oryza sativa* L.) under differential nitrogen field conditions. *PLoS ONE* 15(10): e0240854. https://doi.org/10.1371/journal.pone.0240854.

Yalaga Rama Rao, Mohammad Wahid Ansari, Anil Kumar Singh, Niharika Bharti, Varsha Rani, Amit Verma, Ramwant Gupta, Ranjan Kumar Sahoo, Zahid Hameed Siddiqui, Zahid Khorshid Abbas, Gurdeep Bains, Brajendra, S.K. Guru, Randeep Rakwal, Narendra Tuteja and Vellanki R Kumar. 2020. Ethylene mediated physiological response for in vitro development of salinity tolerant tomato, *Journal of Plant Interactions*, 15(1) :406-416, DOI: 10.1080/17429145.2020.1820591.

Yamini S N, Bharati N B and Laha G S. 2020. Population dynamics of *Xanthomonas oryzae* pv. *oryzae* in cultivars with different levels of resistance. *Journal of Pharmacognosy and Phytochemistry,* 9(4): 1329-1331.

## Books/Book Chapters/ Technical Bulletins

Abdul Fiyaz R., Ajay B.C., Ramya K.T., Aravind Kumar J., Sundaram R.M., Subba Rao L.V. 2020. Speed Breeding: Methods and Applications. In: Gosal S., Wani S. (eds) Accelerated Plant Breeding, Volume 1. Springer, Cham. https://doi.org/10.1007/978-3-030-41866-3_2.

Amtul Waris (2020) Gender Implications for climate smart agriculture in Women & Diversity, edt. N S, Rathore, Lalita Vatta and Ragini Ranawat. International Books & Periodical supply Service, New Delhi 654 pages 117-125.

B. Sreedevi, 2020. Climate Smart Aerobic System of Rice Cultivation. 132-140. Agriculture Development and Economic Transformation in Global Scenario. Mahima Publications, Varanasi, India. ISBN: 978-81-943375-3-9.

B. Sailaja., Ch. Padmavathi., D. Krishnaveni., G. Katti., D. Subrahmanyam., M.S. Prasad. 2020. Decision-support systems for pest monitoring and management. DOI: 10.19103 /AS.2020.0069.18. In book: Improving data management and decision support systems in agriculture. Burleigh dodds Scientific Publishing.

B. Nirmala, Amtul Waris and P. Muthuraman (2020). ICAR-IIRR-SCSP Annual Report 2019-20. ICAR-Indian Institute of Rice Research, Hyderabad. p.62.

Gobinath R., Bandeppa, Manasa V., Rajendiran S., Kiran Kumar, Ranjan Paul and. Basavara K. (2020). Nanoparticle-Mediated Adsorption of Pollutants: A Way Forward to Mitigation of Environmental Pollution: Microorganisms for Sustainability. In Microbial Rejuvenation of Polluted Environment. (Eds. Deepak G Panpatte and Yogeshvari K Jhala), Springer Nature, Singapore, pp 317-348.

Immanuel C. Haokip, R.P. Premalatha, Homeshwari Devi M., Chetan Jangir, Sunil B.H., Sumanta Kundu, Surekha K and Srinivasa Rao Ch. (2020). Climate Change Adaptation and Mitigation through Soil Management. Book Chapter. (*In*): Ch. Srinivasarao, Tavva Srinivas, R.V.S. Rao, N.S. Rao, Senthil S. Vinayagam and P. Krishnan (Eds). Climate Change and Indian Agriculture: Challenges and Adaptation Strategies, ICAR-National Academy of Agricultural Research Management, Hyderabad, Telangana, India. pp 105-130.

Nivetha N., Asha A.D. Bandeppa., Jyoti Kumar Thakur., Ajinath S. Dukare., Bishwajeet Paul and Sangeeta Paul (2020). Microbial-Based Nanoparticles as Potential Approach of Insect Pest Management: Microbes for Sustainable Insect Pest Management. In Sustainability in Plant and Crop Protection (Eds. Md. Aslam Khan Wasim Ahmad ), Springer, pp 135- 157.

Singh D, Tapa S, Mahawar H, Kumar S, Manjunath M and Latha PC. 2020. Relevance of Plant Associated Microorganisms in Climate Smart Agriculture. In Ch. Srinivasrao *et al* (Eds): Climate Change and Indian Agriculture: Challenges and adaptation strategies, ICAR-NAARM, Hyderabad, Telangana, India pp 245-270.

## Technical and Popular articles

Abdul Fiyaz R., B. Harika, K. Chaithanya, D. Shivani, M. Chiranjeevi, H.D. Jawahar, M.M. Azam, A. Waris, Ramya K.T., Manjunatha T., B.C. Ajay, L.V. Subba Rao. Rice Bran Oil: Ruchiki Ruchi Mariyu Arogyaniki Aathma Bandhuvu. Vyavasayam, 6(11): 44-46.

Amtul Waris (2020) Enhancing income of small holder farmers: appropriate strategies and policies RASHTRIYA KRISHI 15 (1): 77-80.

Bandeppa, Savitha S and Verma P. 2020. Development in Designing *Escherichia coli* for Better Utilization of Lignin. *Biomolecule Reports*, BR/08/20/01.

Basavaraj K, Jesudasu G S, Prakasam V, Ladhalakshmi D, Gobinath R, Suvarna Rani, Manasa V, Bandeppa. 2020. Biosensors: As a tool for detection of Plant Pathogens. Food and Scientific reports 1(7): 84-88.

Gobinath R, Manasa V, Bandeppa S, Suvarnarani Ch, Basavaraj, Suvarnarani Chimmili and Shruti K. 2020. Rice straw management- An efficient component of waste to wealth in Agriculture. *Food and Scientific Reports*, 1(6), 1-2.

Jasudasu GS, Basavaraj K, Ladhalaxmi D and Prakasam V. 2020. Decision support systems: Models for strategic and planned plant disease management. Food and Scientific reports 1(8): 13-15.

Jyothi Badri, Rachana Bagudam, Subhakara Rao Isetty, Divya Balakrishnan, Aravind Jukanti, Abdul

Fiyaz R and Subba Rao LV (2020) Identification of novel sturdy culm genotypes for lodging resistance in rice. IIRR Newsletter 18 (2):7-8.

Ladhalakshmi D, Bhaskar M, Laha G S, Prakasam V. and Srinivas Prasad M. 2020. Mass multiplication of *Ustilaginoidea virens* conidia using rice leaf as a substrate. Indian Phytopathology News 3(3): 2-3.

Laha G S, Jasudasu G S, Basavaraj K, Prakasam V and Ladhalaxmi D. 2020. Potential of plant growth promoting rhizo-bacteria in increasing crop yield. Food and Scientific reports 1(6): 61-63.

Rathod, S., Gireesh, C and Anantha, M.S. (2020). Genomic Selection in Plant Breeding. Food and Scientific Reports. December 2020, 1(12): 55-57.

Rathod, S., Saha, A and Kanchan Sinha, K (2020). Introduction to Survival Analysis and Application in Agricultural Research. Food and Scientific Reports. April 2020, 1(4): 28-30.

Rathod, S., Saha, A and Kanchan Sinha, K (2020). Particle Swarm Optimization and its applications in agricultural research. Food and Scientific Reports. April 2020, 1(4): 37-41.

Subba Rao LV, Chiranjeevi M, Jukanti AK, Jyothi Badri, Fiyaz RA and Laxmi Bhavani P (2020) Inception and Progress of Distinctness, Uniformity and Stability (DUS) traits at ICAR-IIRR-A status report. IIRR Newsletter 18 (2):5.

Suvarna Rani Ch, Padmavathi G, Jyothi B, Suneetha K, Basavaraj K, Gobinath R, Manasa V, Sruthi K and Bandeppa S. 2020. Importance of Resistant Starch in human health. Food and Scientific Reports, 1 (9): 53-55.

Swarna R, Manasa V, Gobinath R, Sruthi K, Deepika C and Jinu J. 2020. Bio-fertilizers for improving soil health. *Food and Scientific Reports*, 1(7): 74-76.

Tuti MD, R Mahender Kumar and B Sreedevi. 2020. Mechanical transplanting for enhancing productivity and profitability in rice. Indian Farming 70(04): 25-26.

Vijayakumar S, Gobinath R, Sivasankari, Nayak AK and Aravindhan S. 2020). Can Zero Budget Natural farming double the farmer's income?. *Kerala Karshakan*, 35.

## Papers presented in Seminars/Symposia

Anupama Ksushalrao Dhawande, Jhansi Lakshmi, V., and Subba Rao L. V. 2020. Rice germplasm accessions possessing resistance to white backed planthopper, Sogatella furcifera (Horvath) (Homoptera: Delphacidae). IRC/TM-3/PP- Poster presentation in 1st Indian Rice Congress - 2020 held at ICAR-National Rice Research Institute, Cuttack, Odisha-753006 during December 8-9, 2020 in virtual mode.

Arun MN, R Mahender Kumar, K Surekha, Ch Padmavathi, MS Prasad, D Srinivas and B Venkatanna. 2020. Evaluation of single dose nitrogen and phosphorous fertilizers in rice (*Oryza sativa* L.) for their nutrient use efficiency and sustainable production. Webinar on Plant Science and Biosecurity organized by Innovinc International and Auburn Agricultural University USA from October 12-13th, 2020.

Azam MM, Haz DJ, Fiyaz RA, Surekha K, Voleti R. 2020. Variability of silica content in different components of paddy grains. IUPAC International Conference on, "Agrochemicals Protecting Crops, Health and Natural Environment –Discovery and development of synthetic and natural products for health and pest's management" (APCHNE 2020) held in New Delhi during January 7-10, 2020. Abstracts: IL -29, page-46.

Azam MM, Surekha K, Tuti MD, Humera Q. and Kumar RM. (2020). Potential of value added products of silica for improving crop yield. 1st Indian Rice Congress – 2020, December 8-9, 2020 | ICAR-NRRI, Cuttack 753006, Odisha, India. IRC/TM-2/PP-61, page No. 503.

B Sreedevi, Laha GS, Kannan C, Latha PC, A. Sandhyarani and Anthaiah M. 2020. Seed and Seedling vigor enhancement for improved establishment in Aerobic rice cultivation. Presented in Virtual Mode in 1st Indian Rice Congress - 2020 Rice Research and Development for Achieving Sustainable Development Goals December 8-9, 2020 Organized by Association of Rice Research Workers ICAR - National Rice Research Institute, Cuttack 753006, Odisha, India.

Balakrishnan D and Yoshimichi Fukuta. 2020. Characterization of blast resistance in cssls derived from wild accessions using standard differential blast isolates. 1st Indian Rice Congress-2020. December 8-9, 2020, Cuttack (Odisha), India.

Gobinath, R., Manasa, V., Surekha, K and Latha P C. (2020). Effect of new nutrient carrier (nano ZnO) on growth and Zinc concentration in Rice. Paper presented at the 11th Bengaluru India Nano, held at The lalit Ashok, Bengaluru during March 2-4, 2020.

Jhansi Lakshmi, V., Sreedevi, B., Katti, G. R., Rajamani, K., Sravani, N., Jangaiah, B., Ladha Lakshmi, Prakasam, V and Sreenivasa Prasad M. 2020. Effect of herbicides and fungicides on rice brown planthopper and its predators. OP no 32 page no 95. Oral presentation in 4th IUPAC International conference on Agrochemicals protecting crops, health and natural environment organized by Institute of pesticide formulation technology, ICAR-IARI, Department of chemicals and petrochemicals and Society for promotion of sustainable agriculture from January 7-10, 2020 at NAAS COMPLEX in New Delhi.

Jyothi Badri, Lakshmidevi G, Jaividhya LRK, Uma Maheswar Singh, GS Laha, MS Prasad, Padma Kumari AP, Jhansi Lakshmi V, Subba Rao LV, Vikas Kumar Singh, Arvind Kumar and Ram T (2020) Marker assisted forward breeding for multiple trait resistance in rice. 1st Indian Rice Congress on "Rice Research and Development for Achieving Sustainable Development Goals" in Theme-I: Enhancing rice productivity and quality 8-9th Dec, 2020, ICAR-NRRI, Cuttack, Odisha. IRC/TM-1/PP-78: 182-184.

Kumar RM, Sudhakara TM, Saha S, Singh A, Srinivas D, Singh TV, Surekha K, Duttarganvi S, Prasad Babu MBB, Arun MN, Sreedevi B, Nirmala B, Waris A and Tuti MD. 2020. SRI (system of rice intensification) and its modifications on water input saving for sustainable productivity. 1st Indian Rice Congress, December 8-9, 2020. ICAR-National Rice Research Institute, Cuttack, India.

Ladhalakshmi D, Bhaskar M,. Laha G S, Sundaram R M, Prakasam V, Latha P C and Srinivas Prasad M. 2020. Refined method for mass multiplication of *ustilaginoidea virens* conidia for effective screening of rice genotypes. 1st Indian Rice Congress – 2020; Rice Research and Development for Achieving Sustainable Development Goals. Theme - III: Biotic-stress management in rice, December 8-9, 2020; ICAR-NRRI, Cuttack 753006, Odisha, India, p 648-649.

Madhusudan N, Beulah P, Jaldhani V, Manasa Y, Nagaraju P, Sundaram RM, Anantha MS, Gireesh C, Laha GS, HariPrasad AS and P Senguttuvel. Improvement of APMS6B for phosphorus use efficiency by introgression of PuP1 and evaluation under P starved field conditions. International conference on advances and future outlook in biotechnology and crop improvement for sustainable productivity. Organized by department of biotechnology and crop improvement, college of Horticulture, Bengaluru, during 24-27th November, 2020.

Nirmala Bandumula 2020. Economic impact of rice crop based interventions under SC Sub Plan in Nagarkurnool district of Telangana. Paper presented at National conference on climate change and emerging frontiers in biological sciences held during 14-15 March, 2020, Organized by Anwarul Uloom College, Hyderabad.

Nirmala Bandumula, Mahender Kumar R, Amtul Waris And Muthuraman, P. (2020) Economics and Energetics of Direct Seeded Rice: A Case Study of Andhra Pradesh in Extended Summaries of 1st Indian Rice Congress – 2020 on Rice Research and Development for Achieving Sustainable Development Goals held during December 8-9, 2020 organized by ICAR-NRRI, Cuttack, Odisha, India. p 865-866.

P.A. Lakshmi Prasanna (2020) Rice exports from India-product and geographic diversity-implications. Extended summary in First Indian Rice Congress on Rice Research and Development for achieving sustainable development Goals organized by Association of Rice Research Workers during 8-9 December, 2020 pp:829-830.

Padmavathi Chintalapati, Divya Balakrishnan, Sridhar Yerram, Sarla Neelamraju and Gururaj Katti. 2020. Application of novel phenotyping protocol for leaf folder resistance in wild introgression lines derived from *Oryza nivara* and QTL mapping. Paper presented in 1st Indian Rice Congress – Rice research and development for achieving sustainable development goals, held by ICAR-NRRI, Cuttack during December 8-9, 2020.

Padmavathi, G., Jhansi Lakshmi, V., Subba Rao, L. V. and Sheshu Madhav, M. 2020. Identification of new quantitative trait loci for resistance to brown

planthopper in rice land race Sinnasivappu. IRC/TM-1/PP-60 Poster presentation in 1st Indian Rice Congress - 2020 (an International Conference) held at Poster presentation in 1st Indian Rice Congress - 2020 held at ICAR-National Rice Research Institute, Cuttack, Odisha-753006 during December 8-9, 2020 in virtual mode. BESTPOSTER (First).

Prakasam V, Lydia Ch, Ajit kumar Savani, Priyanka C, Patil Sukesh, Laha G S, Prasad M S and Mamta Sharma. 2020. Poster presentation on Impact of weather variables on rice sheath blight disease. 1st Indian Rice Congress (an International Conference) held at ICAR-National Rice Research Institute, Cuttack, Odisha-753006.

Prakasam V., C. Priyanka, Ravindra Khale, Jyothi Badri, Ch Lydia, Ladha Lakshmi G.S. Laha, M.S. Prasad and R.M. Sundaram (2020) Comprehensive patho-phenotyping and molecular mapping of RIL population of Wazuhophek/Improved Samba Masuri against sheath blight of rice. 7th International Conference on "Phytopathology in Achieving UN Sustainable Development Goals 16-20th Jan 2020, Indian Phytopathological Society, New Delhi

Prameela M, Rajeswari B, Krishnaveni D, Sudhakar R, Keshavulu K and Narender Reddy C. 2020. An integrated approach for management of stem rots disease of rice. Paper presented in Extended Summaries: 1st Indian Rice Congress – 2020. " Rice Research and Development for Achieving sustainable Development Goals" organized by Association of Rice Research Workers Cuttack, Odisha, India, from December 8-9, 2020 held at Cuttack 753006, Odisha, India.

Ramanjineyulu P, Krishnaveni D, Srinivas T, Padmodaya B, Mangrauthia S K and Ravindrareddy B. 2020. Incidence of stem rot (*Sclerotium oryzae* Catt.) of rice in major rice growing states of southern India. Poster presented in Extended Summaries: 1st Indian Rice Congress – 2020. " Rice Research and Development for Achieving sustainable Development Goals" organized by Association of Rice Research Workers Cuttack, Odisha, India, from December 8-9, 2020 held at Cuttack 753006, Odisha, India.

Revathi Ponnuswamy, V Mahesh Jagadale, Sandeep G, Satendra Mangrauthia and Meenakshi Sundaram Raman. 2020. Identification and mapping of heterotic loci (HLs) from *Oryza rufipogon* to enhance yield potential of hybrid rice parental lines. Plant Animal Genome conference (PAG) XXVIII, Jan 11th to 15th, 2020, San Diego, California, USA.

Revathi Ponnuswamy. 2020. Genetic male sterility facilitated recurrent selection for developing multiple stress resistance restorer lines in rice. Plant Animal Genome conference (PAG) XXVIII, Jan 11th to 15th, 2020, San Diego, California, USA.

Saha S, Bandyopadhyay S, Mitra B, Patra P S and Mukhopadhyay D. 2020. Effect of zinc fertilization on phosphorus and zinc content of indigenous rice varieties in Sub-Himalayan region of West Bengal. International Web-Conference on "New Trends in Agriculture, Environmental & Biological Sciences for Inclusive Development, 21-22 June, 2020.

Saha S, Bandyopadhyay S, Mitra B, Patra P S, Mukhopadhyay D and Roy B. 2020. Zinc use efficiency of indigenous rice varieties influenced by zinc application methods. 1st Indian Rice Congress, December 8-9, 2020. ICAR-National Rice Research Institute, Cuttack, India.

Saritha K., Gopala Krishnamurthy, Jyothi Badri, L.V. Subba Rao and G. Padmavathi (2020) Pyramiding of QTLs for drought tolerance (qDTY1.1, qDTY 2.1, qDTY2.2 and qDTY 3.1) in rice. 1st Indian Rice Congress on "Rice Research and Development for Achieving Sustainable Development Goals" in Theme-I: Enhancing rice productivity and quality 8-9th Dec 2020, ICAR-NRRI, Cuttack, Odisha. IRC/TM-1/PP-135: 307-309.

Shilpakala, V., Jhansi Lakshmi, V., SeshuMadhav, M., Venkateswarlu, N. C., Subba Rao, L. V., Sarada Jayalakshmi, R. and Padmavathi, G. 2020. Evaluation of rice germplasm for brown planthopper, Nilaparvatalugens (stål) resistance using gene specific markers and phenotypic methods. IRC/TM-3/PP-39. Poster presentation in 1st Indian Rice Congress - 2020 (an International Conference) held at ICAR-National Rice Research Institute, Cuttack, Odisha-753006 during December 8-9, 2020 in virtual mode under the theme Biotic Stress Management in rice.

Sruthi K., K. B. Eswari, Ch. Damodhar Raju, M. Sheshu Madhav, A. Dhandapani, M.B. Bala Satya Sree, K. SrikrishnaLatha, P. Beulah, P. Nagaraj, P. Koteswararao, M. Sadath Ali, P. Senguttuvel, P. Revathi, K.B. Kemparaju, Divya Balakrishnan, Jyothi Badri, R. M. Sundaram and A.S. Hari Prasad (2020) Breeding superior hybrid rice parental lines through inter sub-specific hybridization. 1st Indian Rice Congress on "Rice Research and Development for Achieving Sustainable Development Goals" in Theme-I: Enhancing rice productivity and quality 8-9th Dec 2020, ICAR-NRRI, Cuttack, Odisha. IRC/TM-1/PP-23: 66-67

Subhashree Priyadarshini, Jhansi Lakshmi, V., Seshu Madhav, M. and Sreenivas, C. 2020. Screening of rice genotypes for resistance to brown planthopper, Nilaparvata lugens (stål) population of Khammam district of Telangana state. IRC/TM-3/PP-20. Poster presentation in 1st Indian Rice Congress - 2020 held at ICAR-National Rice Research Institute, Cuttack, Odisha-753006 during December 8-9, 2020 in virtual mode.

Sunil Vailla, Jhansi Lakshmi, V., Chiranjeevi, K., Sarao P. S. and Sampathkumar, M. 2020. Effect of elevated $CO_2$ and temperature on the feeding behaviour of rice brown planthopper, Nilaparvata lugens (stål) populations. IRC/TM-3/OP-6. Oral presentation in 1st Indian Rice Congress - 2020 held at ICAR-National Rice Research Institute, Cuttack, Odisha-753006 during December 8-9, 2020 in virtual mode.

Surekha, K, Kumar R. M., DVKN Rao, Manasa V., Gobinath R., Neeraja C. N., Brajendra, Subrahmanyam D., Azam M. M and Voleti S. R. 2020. Genotypic variability assessment for nitrogen use efficiency and its improvement in irrigated rice. Paper presented at the 1st Indian Rice Congress, Held by NRRI at Cuttack during December 8-9, 2020. Extended summary. Pp 507-508.

Suvarna Rani Chimmili, Ananda Kumar CR, Subashini G, Raveendran M, Robin S, Padmavathi G, Aravind Kumar J, Jyothi B, Divya B, Sruthi KandSubba Rao LV (2020) Evaluation of Lutein content and assessment of antioxidant potential of á carotenoid in medicinal landrace of rice 'Kavuni' 1st Indian Rice Congress on "Rice Research and Development for Achieving Sustainable Development Goals" in Theme-I: Enhancing rice productivity and quality 8-9th Dec 2020, ICAR-NRRI, Cuttack, Odisha. IRC/TM-1/PP-148: 340-342.

Tuti MD, R Mahender Kumar, B Sreedevi, Singh A, Saha S, Bandeppa and V Sunitha. 2020. Enhancing productivity and resource use efficiency of rice-maize system through conservation agriculture. 1st Indian Rice Congress – 2020, Rice Research and Development for Achieving Sustainable Development Goals, December 8-9, 2020, ICAR-NRRI, Cuttack, p 370.

Venkatanna B., Mahender Kumar R., Chandrakala C., Srinivas D., Prasad Babu K.V and Latha P.C., 2020. Long term impact of water management and nitrogen application on soil microbial population and activity in paddy soil. In: E- SOUVENIR - International e - conference on Advances in Microbial Biotechnology and Biotherapeutics (AMTB - 2020) held at Osmania University Hyderabad, during 10 - 12 September 2020, pp33.

# Appendix-1

## Promising Entries in Varietal Trials, *Kharif* 2019

| S. No. | IET No. | Designation | Cross combination | Source trial | Yield (kg/ha) | FD days | GT | Promising for |
|---|---|---|---|---|---|---|---|---|
| 1. | IET 28608 | CSR 449S-13 | CSR 30/CSR 36 | IVT- AL & ISTVT | 3343(overall)<br>3744 (ALK)<br>3986 (INS) | 87<br>84<br>84 | LS | Alkalinity (ALK) and Inland salinity (INS) on overall and in Zone II |
| 2. | IET 28606 | CSRM1-7 | IR71730-51-2/ NSIC Rc106 | IVT- AL & ISTVT | 3870(ALK)<br>4143 (INS) | 77 | LS | Alkalinity and Inland salinity in Zone II |
| 3. | IET 28601 | CSR 89-IR 15 | KDML 105/ IR 4630-22-2-5-13/ IR20925-33-3-1-28 | IVT- AL & ISTVT | 3712 (ALK)<br>3564 (ALK)<br>3872 (INS) | 87<br>83<br>86 | LS | Alkalinity in Zone II & III and Inland salinity in Zone II |
| 4. | IET 28591 | CSR-RIL-06-178 | IR 4630/CSR 11 | IVT- AL & ISTVT | 3708 (ALK)<br>3781 (INS) | 90<br>89 | LB | Alkalinity and Inland salinity in Zone II |
| 5. | IET 28598 | CSR M1-45 | BG 94-1/Pokkali | IVT- AL & ISTVT | 3599(ALK) | 105 | LS | Alkalinityin Zone II |
| 6. | IET 26468 | JKRH 2354 (Hybrid) | - | AVT 2-E TP | 7503 | 90 | LB | Chhattisgarh |
| 7. | IET 26477 | RH-150025 (Hybrid) | - | AVT 2-E TP | 7045 | 91 | SB | Chhattisgarh |
| 8. | IET 26999 | Indam 100 -012 ( Hybrid) | - | AVT 1-Basmati | 7039 | 90 | LS | Uttar Pradesh |
| 9. | IET 27394 | TMRH 139 | - | AVT 1 MS | 6132 | 92 | MS | Zone IV |
| 10. | IET 25802 | ARRH 7576 (Hybrid) | - | AVT 1 MS | 6063 | 101 | MS | Tripura |
| 11. | IET 27117 | ORJ 1135 | RR 615 mutant | AVT 1 MS | 5062 | 101 | MS | Maharashtra |
| 12. | IET 27951 | HURS18-2-IR98976-20-1-2-2 | IR1L152 / Sabitri | AVT 1 Aerob | 4839 | 73 | LS | Zone II |
| 13. | IET 26194 | RP 5591-123-16-2 | MTU 1010 / IR 79915-B-83-4-3 | AVT 1 Aerob | 5210 | 80 | LB | Bihar |
| 14. | IET 27294 | [RP-6113-Patho BB-9 (GSY-BB-IPB-2-9)] (NIL of ISM | Improved Samba Mahsuri*3/PAU 3554 | AVT1-L | 5064 | 100 | MS | Promising for the Improved Samba Mahsuri growing areas of the country |
| 15. | IET 26435 | TRC 2016-14 | TRC 2016-14 Pyzum / Samba Mahsuri | AVT 1- Boro | 7695 | 94 | LS | Promising in Zone IV for the state of Tripura |
| 16. | IET 25912 | CR 2667-5-1-2-1-1 | Gayatri / AC.38599 | AVT 1-SDW | 4765 | 114 | SB | Promising for state of Odisha in Zone III |
| 17. | IET 25819 | VL 32224 | Vivekdhan 82 / VL 31629 | AVT 2-E (H) | 6482 | 97 | LB | Promising for the state of UK and HP in Medium Northern Hills region |
| 18. | IET 26605 | VL 20073 | VL 6394/VL 122 | AVT 1-U (H) | 1953 | 88 | SB | Promising in medium elevated hills of UK |
| 19. | IET 26576 | SKAU 500 | (K 1356-6-4) SR-1 / Dular | AVT 2-E (H) | 7380 | 102 | SB | Promising for J&K under High hills. |

# Appendix-2

## Promising hybrids identified in different hybrid rice trials (2019)

| Name of the Hybrid | IET No. | DFF | Promising in |
|---|---|---|---|
| **IHRT-E** | | | |
| LP 19201 | 28111 | 95 | Overall |
| LP 18204 | 28113 | 92 | Overall |
| RH 169269 | 28122 | 90 | Overall |
| **IHRT-ME** | | | |
| PHI 19107 | 28136 | 97 | Overall |
| PHI 19108 | 28139 | 102 | Zone III, VI & VII |
| NK 5251++ | 28143 | 99 | Zone VII |
| **IHRT-M** | | | |
| PHI-19104 | 28162 | 101 | Overall |
| HRI 202 | 28160 | 102 | Zone III & VII |
| RNE 0148 | 28174 | 104 | Zone II & VI |
| **IHRT-MS** | | | |
| PHI 19101 | 28180 | 104 | Overall |
| MEPH 155 | 28177 | 101 | Zone VI |
| HRI 203 | 28181 | 101 | Zone VI |

# Appendix-3

## Variety wise breeder seed production during *Kharif*, 2019 (as per DAC indent)

**(Quantity in Quintals)**

| S. No. | Name of Variety | Allocation as per BSP-I | Actual Production | Surplus (+) Deficit (-) | Name of the Producing centre |
|---|---|---|---|---|---|
| 1 | Abhishek (IET-17868) (RR-272-829) | 4.77 | 8.77 | 4.00 | CRURRS, Hazaribagh |
| 2 | ADT-37 | 13.50 | 13.50 | - | TNAU, Coimbatore |
| 3 | ADT-39 | 5.00 | 5.00 | - | TNAU, Coimbatore |
| 4 | ADT-43(IET 14878) | 0.10 | 0.10 | - | TNAU, Coimbatore |
| 5 | Ajit | 4.70 | 8.00 | 3.30 | RRS, Chinsurah |
| 6 | Akshaya | 1.00 | 8.00 | 7.00 | ANGRAU, Guntur |
| 7 | Amara (MTU-1064) | 7.50 | 40.00 | 32.50 | ANGRAU, Guntur |
| 8 | Anjali (IET-16430) RR-347-166) | 3.04 | 8.25 | 5.21 | CRURRS, Hazaribagh |
| 9 | Ankit (CR 2702) (IET 21627) | 2.10 | 1.00 | -1.10 | NRRI, Cuttack |
| 10 | Annada | 10.20 | 10.00 | -0.20 | NRRI, Cuttack |
| 11 | ASD 16 | 1.50 | 1.50 | - | TNAU, Coimbatore |
| 12 | Athira (PBT 51) | 0.40 | 1.00 | 0.60 | KAU, Pattambi |
| 13 | Badshah Selection-1 | 3.60 | 4.50 | 0.90 | IGAU, Raipur |
| 14 | Bahadur | 0.20 | 51.55 | 51.35 | AAU, Jorhat |
| 15 | Bahadur Sub-1 | 40.45 | 73.15 | 32.70 | RARS, Titabar |

| S. No. | Name of Variety | Allocation as per BSP-I | Actual Production | Surplus (+) Deficit (-) | Name of the Producing centre |
|---|---|---|---|---|---|
| 16 | Bamleshwari (IET14444) | 12.00 | 12.00 | - | IGAU, Raipur |
| 17 | Basmati Kasturi (IET-8580) | 4.20 | 5.28 | 1.08 | CSKHPKVV, Malan |
| 18 | BasmatI-370 | 2.58 | 5.00 | 2.42 | RRS, Kaul |
| 19 | Bhadra (Mo-4) | 3.50 | 5.00 | 1.50 | RRS, Monocompu |
| 20 | Bharani (NLR 30491) | 7.00 | 20.00 | 13.00 | ANGRAU, Guntur |
| 21 | Bhogavathi | 0.60 | 14.70 | 14.10 | ARS, Radhanagari |
| 22 | Bhuvan (IET 7804) | 0.60 | 0.00 | -0.60 | OUAT, Bhubaneshwar |
| 23 | Bina dhan-10 | 0.35 | 0.00 | -0.35 | ICAR-IIRR, Hyderabad |
| 24 | Bina dhan-11 | 17.60 | 11.50 | -6.10 | ICAR-IIRR, Hyderabad |
| 25 | Bina dhan-12 | 0.90 | 1.50 | 0.60 | ICAR-IIRR, Hyderabad |
| 26 | Bina dhan-17 | 0.20 | 0.20 | - | ICAR-IIRR, Hyderabad |
| 27 | Birsamati | 2.34 | 2.40 | 0.06 | BAU, Ranchi |
| 28 | BirsaVikas dhan-109 | 4.68 | 3.85 | -0.83 | BAU, Ranchi |
| 29 | BirsaVikas dhan-110 | 2.34 | 2.40 | 0.06 | BAU, Ranchi |
| 30 | BNKR-1 (Dhiren) IET 20760 | 3.90 | 2.90 | -1.00 | RRS, Bankura |
| 31 | BPT 3291 (Sona Mahsuri) | 5.00 | 5.00 | 0.00 | ANGRAU, Guntur |
| 32 | BPT-5204 | 38.98 | 322.00 | 283.02 | ANGRAU, Guntur |
| 33 | BR-2655 | 1.70 | 6.00 | 4.30 | UAS, Bangalore |
| 34 | BRRI Dhan-69 | 0.20 | 0.20 | 0.00 | ICAR-IIRR, Hyderabad |
| 35 | BRRI Dhan-75 | 0.20 | 0.00 | -0.20 | ICAR-IIRR, Hyderabad |
| 36 | CGZR-1 | 5.00 | 5.10 | 0.10 | IGAU, Raipur |
| 37 | Chandra (IET 23409) (MTU-1153) | 17.50 | 0.00 | -17.50 | ANGRAU, Guntur |
| 38 | Chandrahasini (IET-16800) | 20.00 | 20.10 | 0.10 | IGAU, Raipur |
| 39 | Chandrama (IET 9354, 10419) | 20.00 | 13.20 | -6.80 | Gerua, Assam |
| 40 | Chenab (SKAU-23) | 1.00 | 2.00 | 1.00 | SKUAT, Khudwani |
| 41 | Chinsurah Rice (IET 19140) (CNI 383-5-11) | 1.00 | 1.50 | 0.50 | RRS, Chinsurah |
| 42 | CN 1272-55-105 (IET 19886) | 0.50 | 2.00 | 1.50 | RRS, Chinsurah |
| 43 | CNR-2 (IET 20235) | 2.50 | 2.00 | -0.50 | RRS, Chinsurah |
| 44 | CO-51 | 32.40 | 32.40 | - | TNAU, Coimbatore |
| 45 | Cottondora Sannalu (MTU-1010) | 351.73 | 440.00 | 88.27 | ANGRAU, Guntur |
| 46 | CR 1009 Sub- 1 | 9.20 | 4.00 | -5.20 | NRRI, Cuttack |
| 47 | CR -1014 | 0.30 | 0.00 | -0.30 | NRRI, Cuttack |
| 48 | CR -1017 (Dharithri) | 1.90 | 0.40 | -1.50 | NRRI, Cuttack |
| 49 | CR Boro dhan-2 (IET 17612) | 0.30 | 1.00 | 0.70 | NRRI, Cuttack |
| 50 | CR Dhan-10 (IET 18312) | 1.00 | 0.00 | -1.00 | NRRI, Cuttack |
| 51 | CR Dhan-201 (IET 21924) | 1.00 | 1.00 | - | NRRI, Cuttack |
| 52 | CR Dhan-203 | 9.50 | 10.00 | 0.50 | NRRI, Cuttack |
| 53 | CR Dhan-209 | 1.00 | 0.00 | -1.00 | NRRI, Cuttack |
| 54 | CR Dhan-300 (IET 19816, CR 2301-1) | 2.60 | 3.00 | 0.40 | NRRI, Cuttack |
| 55 | CR Dhan-301 | 1.70 | 0.00 | -1.70 | NRRI, Cuttack |

| S. No. | Name of Variety | Allocation as per BSP-I | Actual Production | Surplus (+) Deficit (-) | Name of the Producing centre |
|---|---|---|---|---|---|
| 56 | CR Dhan-303 | 14.50 | 14.50 | - | NRRI, Cuttack |
| 57 | CR Dhan-304 (IET 22117) | 2.10 | 3.90 | 1.80 | NRRI, Cuttack |
| 58 | CR Dhan-305 (IET 21287) | 1.60 | 1.50 | -0.10 | NRRI, Cuttack |
| 59 | CR Dhan-307 (Maudami) (CR 2599) | 5.00 | 26.40 | 21.40 | NRRI, Cuttack |
| 60 | CR Dhan-310 | 44.10 | 48.00 | 3.90 | NRRI, Cuttack |
| 61 | CR Dhan-401 (Reeta) (IET 19969) | 1.50 | 0.00 | -1.50 | NRRI, Cuttack |
| 62 | CR Dhan-405 | 1.00 | 1.00 | - | NRRI, Cuttack |
| 63 | CR Dhan-501 | 20.00 | 0.00 | -20.00 | NRRI, Cuttack |
| 64 | CR Dhan-505 (IET 21719) | 26.50 | 11.10 | -15.40 | NRRI, Cuttack |
| 65 | CR Dhan-601 (IET 18558) | 23.10 | 24.60 | 1.50 | NRRI, Cuttack |
| 66 | CR Dhan-800 | 1.90 | 27.00 | 25.10 | NRRI, Cuttack |
| 67 | CR Dhan-801 | 1.50 | 2.50 | 1.00 | NRRI, Cuttack |
| 68 | CR Sugandh Dhan-907 (IET 21044) | 3.40 | 0.90 | -2.50 | NRRI, Cuttack |
| 69 | CR-204 | 3.00 | 3.00 | - | NRRI, Cuttack |
| 70 | CR-205 | 3.00 | 3.00 | - | NRRI, Cuttack |
| 71 | CR-206 | 3.00 | 3.00 | - | NRRI, Cuttack |
| 72 | CR-311 | 3.00 | 3.00 | - | NRRI, Cuttack |
| 73 | CSR-30 | 6.02 | 12.95 | 6.93 | CSSRI, Karnal |
| 74 | CSR-36 | 3.50 | 5.50 | 2.00 | CSSRI, Karnal |
| 75 | CSR-43 | 3.00 | 6.40 | 3.40 | CSSRI, Karnal |
| 76 | CSR-46 | 2.00 | 6.40 | 4.40 | CSSRI, Karnal |
| 77 | CSR-56 | 2.00 | 4.80 | 2.80 | CSSRI, Karnal |
| 78 | Danteshwari (IET 15450, R 302-111) | 9.00 | 9.00 | - | IGAU, Raipur |
| 79 | DRR Dhan-39, Jagjeevan (IET 19487) | 6.00 | 6.00 | - | ICAR-IIRR, Hyderabad |
| 80 | DRR Dhan-43 | 1.90 | 2.40 | 0.50 | ICAR-IIRR, Hyderabad |
| 81 | DRR Dhan-44 | 36.40 | 10.00 | -26.40 | ICAR-IIRR, Hyderabad |
| 82 | DRR Dhan-45 | 5.95 | 2.50 | -3.45 | ICAR-IIRR, Hyderabad |
| 83 | DRR Dhan-46 | 3.10 | 8.50 | 5.40 | ICAR-IIRR, Hyderabad |
| 84 | DRR Dhan-50 (IET 25671) | 15.30 | 8.50 | -6.80 | ICAR-IIRR, Hyderabad |
| 85 | DRR Dhan-51 | 0.50 | 2.40 | 1.90 | ICAR-IIRR, Hyderabad |
| 86 | Dubraj Section 1 | 3.30 | 3.90 | 0.60 | IGAU, Raipur |
| 87 | ErraMallelu (WGL- 20471) | 5.40 | 5.50 | 0.10 | PJTSAU, Hyderabad |
| 88 | Gayatri (IET -8022) | 2.10 | 0.60 | -1.50 | NRRI, Cuttack |
| 89 | Geetanjali (IET -17276, CRM-20007-1) | 1.00 | 3.50 | 2.50 | NRRI, Cuttack |
| 90 | Gitesh (TTB 103-3-1) | 25.00 | 46.75 | 21.75 | RARS, Titabar (AAU, Jorhat) |
| 91 | Giza 14 | 0.30 | 0.40 | 0.10 | SKUAST, Chatha |
| 92 | Gontra Bidhan-1 (IET 17430) | 44.85 | 44.85 | - | BCKVV, Nadia |
| 93 | Gontra Bidhan-3 (IET 22752) | 18.05 | 20.70 | 2.65 | BCKVV, Nadia |
| 94 | Gontra Bidhan-4 | 0.30 | 0.00 | -0.30 | BCKVV, Nadia |
| 95 | Govind | 0.20 | 47.00 | 46.80 | GBPUAT, Pantnagar |

| S. No. | Name of Variety | Allocation as per BSP-I | Actual Production | Surplus (+) Deficit (-) | Name of the Producing centre |
|---|---|---|---|---|---|
| 96 | GR- 13 (GAR -13) | 0.10 | 0.25 | 0.15 | GAU, Nawagam |
| 97 | Gurjari | 0.10 | 0.25 | 0.15 | GAU, Nawagam |
| 98 | Hazaridhan | 2.92 | 2.92 | - | CRURRS, Hazaribagh |
| 99 | HKR-127 (HKR-95-222) | 4.44 | 8.00 | 3.56 | RRS, Kaul |
| 100 | HKR-47 | 5.72 | 10.00 | 4.28 | RRS, Kaul |
| 101 | HKR-48 | 0.50 | 2.50 | 2.00 | RRS, Kaul |
| 102 | HPR-1156 (IET 16007) | 10.00 | 6.17 | -3.83 | CSKHPKVV, Malan |
| 103 | HPR-2143 | 13.80 | 14.99 | 1.19 | CSKHPKVV, Malan |
| 104 | HPR-2612 (Palm Basmati 1) | 12.00 | 18.45 | 6.45 | CSKHPKVV, Malan |
| 105 | HUR- 917 | 0.15 | 16.00 | 15.85 | BHU, Varanasi |
| 106 | HUR-1304 | 5.00 | 11.00 | 6.00 | BHU, Varanasi |
| 107 | HUR-1309 | 5.00 | 10.00 | 5.00 | BHU, Varanasi |
| 108 | IET 5656 (Swarnadhan) | 1.20 | 1.20 | - | ICAR-IIRR, Hyderabad |
| 109 | IGKVR- 1 | 92.80 | 98.40 | 5.60 | IGAU, Raipur |
| 110 | IGKVR- 2 (IET 19795) | 38.00 | 46.20 | 8.20 | IGAU, Raipur |
| 111 | IGRKVR -1244 (R1244-1246-1-605-1) | 40.00 | 40.20 | 0.20 | IGAU, Raipur |
| 112 | Improved Chinnor | 2.75 | 46.71 | 43.96 | JNKVV, Jabalpur |
| 113 | Improved Jeera Shankar | 2.75 | 103.75 | 101.00 | JNKVV, Jabalpur |
| 114 | Improved Lalat | 14.20 | 9.00 | -5.20 | NRRI, Cuttack |
| 115 | Improved Samba Mahsuri | 22.30 | 23.00 | 0.70 | ICAR-IIRR, Hyderabad |
| 116 | Indira Aerobic -1 (R 1570-2649-1-1546-1) | 15.00 | 15.90 | 0.90 | IGAU, Raipur |
| 117 | Indira Baranidhan -1 (RF-17-38-70) | 25.00 | 25.20 | 0.20 | IGAU, Raipur |
| 118 | Indrayani (IET 12897) | 66.10 | 128.50 | 62.40 | ARS, Vadagaon (MPKV, Rahuri) |
| 119 | Intan | 1.00 | 2.00 | 1.00 | ARS, Mugad |
| 120 | IR-36 | 16.40 | 16.50 | 0.10 | IGAU, Raipur |
| 121 | IR-64 | 74.20 | 75.00 | 0.80 | IGAU, Raipur |
| 122 | IR-64 Drt 1 (IET 22836) (DRR Dhan-42) | 133.00 | 57.00 | -76.00 | ICAR-IIRR, Hyderabad CRURRS, Hazaribagh |
| 123 | Jaya | 68.95 | 9.00 | -59.95 | ICAR-IIRR, Hyderabad |
| 124 | JGL -8047 (Bathukamma) | 5.10 | 5.50 | 0.40 | PJTSAU, Hyderabad |
| 125 | JGL-11470 (Jagtial Mahsuri) | 0.60 | 0.80 | 0.20 | PJTSAU, Hyderabad |
| 126 | JGL-1798 | 1.15 | 1.50 | 0.35 | PJTSAU, Hyderabad |
| 127 | JR -503(Richa) (IET- 16783) | 3.20 | 0.00 | -3.20 | JNKVV, Jabalpur |
| 128 | JR- 81 | 2.05 | 1600.58 | 1598.53 | JNKVV, Jabalpur |
| 129 | JR-767 | 16.50 | 20.66 | 4.16 | JNKVV, Jabalpur |
| 130 | JRB -1 | 2.05 | 120.70 | 118.65 | JNKVV, Jabalpur |
| 131 | Jyothi | 14.30 | 15.00 | 0.70 | KAU, Pattambi |
| 132 | Kalachampa | 10.00 | 30.00 | 20.00 | SSTL, BBSR, Govt of Odisha |

| S. No. | Name of Variety | Allocation as per BSP-I | Actual Production | Surplus (+) Deficit (-) | Name of the Producing centre |
|---|---|---|---|---|---|
| 133 | Karjat-184 | 0.50 | 2.00 | 1.50 | RARS, Karjat |
| 134 | Karjat-3 | 2.00 | 12.00 | 10.00 | RARS, Karjat |
| 135 | Karjat-5 | 0.60 | 6.00 | 5.40 | RARS, Karjat |
| 136 | Karjat-7 | 1.50 | 15.00 | 13.50 | RARS, Karjat |
| 137 | Karjat-8 | 0.50 | 3.00 | 2.50 | RARS, Karjat |
| 138 | Karma Mahsuri (IET 19991) | 15.00 | 15.00 | - | IGAU, Raipur |
| 139 | Ketekijoha | 25.00 | 41.50 | 16.50 | RARS, Titabar |
| 140 | Khandagiri | 8.30 | 8.30 | - | OUAT, Bhubaneshwar |
| 141 | Khitish (IET -4094) | 10.30 | 15.50 | 5.20 | RRS, Chinsurah, NRRI, Cuttack |
| 142 | KHP- 11 | 0.50 | 4.00 | 3.50 | UAHS, Shivamogga |
| 143 | KMD- 2 (Abhilash) | 1.25 | 2.00 | 0.75 | ARS, Mugad |
| 144 | KNM-118 | 30.10 | 32.00 | 1.90 | PJTSAU, Hyderabad |
| 145 | Kranti (R-2022) | 10.40 | 3648.68 | 3638.28 | JNKVV, Jabalpur |
| 146 | Krishna Hamsa | 0.05 | 0.50 | 0.45 | ICAR-IIRR, Hyderabad |
| 147 | Lalat (IET- 9947) | 42.98 | 43.00 | 0.02 | OUAT, Bhubaneshwar |
| 148 | Luna Sampad (IET 19470) | 1.30 | 0.55 | -0.75 | NRRI, Cuttack |
| 149 | Luna Sankhi | 0.60 | 6.60 | 6.00 | NRRI, Cuttack |
| 150 | Luna Suwarna (IET 18697) | 1.60 | 0.40 | -1.20 | NRRI, Cuttack |
| 151 | Lunisree | 0.50 | 0.00 | -0.50 | NRRI, Cuttack |
| 152 | Mahamaya (IET-10749) | 74.10 | 90.00 | 15.90 | IGAU, Raipur |
| 153 | Mahsuri | 1.10 | 1.20 | 0.10 | ICAR-IIRR, Hyderabad |
| 154 | Manaswini (IET19005) | 2.10 | 2.10 | - | OUAT, Bhubaneshwar |
| 155 | Mandakini (OR 2077-4, IET 17847) | 3.20 | 3.20 | - | OUAT, Bhubaneshwar |
| 156 | Maruteru Sannalu (MTU-1006, IET-14348) | 1.00 | 2.00 | 1.00 | ANGRAU, Guntur |
| 157 | Mo21(Prathiksha) | 0.75 | 5.00 | 4.25 | RRS, Monocompu |
| 158 | Mrunalini (OR 1898-18) (IET18649) | 5.00 | 5.00 | - | OUAT, Bhubaneshwar |
| 159 | MTU- 61 (Indra)(MTU-1061) | 8.00 | 40.00 | 32.00 | ANGRAU, Guntur |
| 160 | MTU-1075 (IET18482) | 25.10 | 75.00 | 49.90 | ANGRAU, Guntur |
| 161 | MTU-1121 (Sri Dhruthi) | 113.10 | 216.00 | 102.90 | ANGRAU, Guntur |
| 162 | MTU-1156 | 40.50 | 194.00 | 153.50 | ANGRAU, Guntur |
| 163 | MTU-7029 (Swarna) | 348.76 | 410.00 | 61.24 | ANGRAU, Guntur |
| 164 | Narendradhan (NDR359) | 5.52 | 32.15 | 26.63 | NDUAT, Faizabad |
| 165 | Narendradhan-97 | 1.20 | 14.00 | 12.80 | NDUAT, Faizabad |
| 166 | Naveen (CR-749-20-2) (IET-14461) | 8.84 | 10.00 | 1.16 | NRRI, Cuttack |
| 167 | NDR-2065 (IET17476) | 20.00 | 63.50 | 43.50 | NDUAT, Faizabad |
| 168 | Nellore Mahsuri (NLR-34449) | 12.00 | 135.00 | 123.00 | ANGRAU, Guntur |
| 169 | Pankaj | 0.30 | 0.00 | -0.30 | OUAT, Bhubaneshwar |
| 170 | Pantdhan-10 (IET-8616) | 0.30 | 7.00 | 6.70 | GBPUAT, Pantnagar |
| 171 | Pantdhan-12 (IET-10955) | 3.10 | 6.00 | 2.90 | GBPUAT, Pantnagar |

| S. No. | Name of Variety | Allocation as per BSP-I | Actual Production | Surplus (+) Deficit (-) | Name of the Producing centre |
|---|---|---|---|---|---|
| 172 | Pantdhan-18 (IET-17920) (UPRI-99-1) | 1.20 | 16.00 | 14.80 | GBPUAT, Pantnagar |
| 173 | Pantdhan-24 | 25.00 | 38.00 | 13.00 | GBPUAT, Pantnagar |
| 174 | Pantdhan-26 | 0.30 | 10.00 | 9.70 | GBPUAT, Pantnagar |
| 175 | Pardhiva (NLR-33892) | 4.00 | 9.00 | 5.00 | ANGRAU, Guntur |
| 176 | Parijat (IET-2684) | 5.00 | 3.80 | -1.20 | OUAT, Bhubaneshwar |
| 177 | PAU-201 | 6.50 | 6.50 | - | PAU, Ludhina |
| 178 | PDKV Kisan | 0.50 | 5.00 | 4.50 | ARS, Sakoli |
| 179 | PDKV Tilak | 1.00 | 25.90 | 24.90 | ARS, Sindewahi |
| 180 | Phalguni (IET-18720) (CRAC 2224-1041) | 0.50 | 0.50 | - | NRRI, Cuttack |
| 181 | Phule Samruddhi (VDN-99-29) | 0.50 | 38.00 | 37.50 | ARS, Vadagaon (MPKV, Rahuri) |
| 182 | PKV HMT | 71.96 | 52.00 | -19.96 | ARS, Sindewahi |
| 183 | Pooja (IET-12241) | 32.50 | 42.50 | 10.00 | NRRI, Cuttack |
| 184 | PoornaBhog | 0.30 | 0.00 | -0.30 | NRRI, Cuttack |
| 185 | Poornima (IET 12284, 1281-PP-31-1) | 10.40 | 10.50 | 0.10 | IGAU, Raipur |
| 186 | PR 122 (RYT 3129) | 17.70 | 20.00 | 2.30 | PAU, Ludhina |
| 187 | PR-111 | 6.68 | 10.00 | 3.32 | PAU, Ludhina |
| 188 | PR-113 | 63.30 | 65.00 | 1.70 | PAU, Ludhina |
| 189 | PR-114 | 17.81 | 20.00 | 2.19 | PAU, Ludhina |
| 190 | PR-116 | 3.28 | 7.00 | 3.72 | PAU, Ludhina |
| 191 | PR-118 | 10.94 | 15.00 | 4.06 | PAU, Ludhina |
| 192 | PR121 | 45.12 | 50.00 | 4.88 | PAU, Ludhina |
| 193 | PR-123 | 1.20 | 4.00 | 2.80 | PAU, Ludhina |
| 194 | PR-124 | 7.76 | 8.00 | 0.24 | PAU, Ludhina |
| 195 | PR-126 | 25.18 | 30.00 | 4.82 | PAU, Ludhina |
| 196 | PR-127 | 18.03 | 20.00 | 1.97 | PAU, Ludhina |
| 197 | Prabhat | 2.00 | 32.00 | 30.00 | ANGRAU, Guntur |
| 198 | Pratap-1 (RSK-1091-10-1-1) | 0.10 | 0.00 | -0.10 | MPUAT, Kota |
| 199 | Pratikshya (OR S201-5)(IET-15191) | 32.40 | 22.00 | -10.40 | OUAT, Bhubaneshwar |
| 200 | PTB-45 (Matta Triveni) | 1.00 | 2.50 | 1.50 | KAU, Pattambi |
| 201 | Punjab Basmati -4 | 0.04 | 1.00 | 0.96 | PAU, Ludhina |
| 202 | Punjab Basmati -5 | 0.04 | 1.00 | 0.96 | PAU, Ludhina |
| 203 | PUSA 1592 | 0.58 | 1.00 | 0.42 | DSST & IARI, New Delhi |
| 204 | Pusa Basmati -1 (IET-10364) | 29.29 | 30.00 | 0.71 | BEDF, New Delhi, ICAR-IARI, Regional Stn. Karnal |

| S. No. | Name of Variety | Allocation as per BSP-I | Actual Production | Surplus (+) Deficit (-) | Name of the Producing centre |
|---|---|---|---|---|---|
| 205 | Pusa Basmati 1121 | 60.00 | 66.00 | 6.00 | BEDF, New Delhi, ICAR-IARI, Regional Stn, Karnal |
| 206 | Pusa Basmati-1509 (IET-21960) | 60.00 | 65.00 | 5.00 | BEDF, New Delhi, ICAR-IARI, Regional Stn, Karnal |
| 207 | Pusa Basmati-6 (IET-18005) | 21.13 | 22.00 | 0.87 | ICAR-IARI, Regional Stn, Karnal |
| 208 | Pusa Sugandh-2 (IET-16310, Pusa-204-1-126) | 0.40 | 0.00 | -0.40 | DSST & IARI, New Delhi |
| 209 | Pusa Sugandh-3 (IET-16313, Pusa-2504-1-3-1) | 20.50 | 0.00 | -20.50 | DSST & IARI, New Delhi |
| 210 | Pusa Sugandh-5 (IET-17021) | 66.71 | 69.00 | 2.29 | DSST & IARI, New Delhi |
| 211 | Pusa-1850 | 2.00 | 2.00 | - | ICAR-IARI, Regional Stn, Karnal |
| 212 | Pusa-44 | 40.00 | 40.00 | - | ICAR-IARI, Regional Stn, Karnal |
| 213 | Pusa-6 (IET 22290) (Pusa 1612-7-6-5) | 0.60 | 2.00 | 1.40 | DSST & IARI, New Delhi |
| 214 | Pushpa (IET-17509) | 1.70 | 0.00 | -1.70 | RRS, Bankura |
| 215 | Rajendra Mahsuri1 | 31.28 | 32.00 | 0.72 | RAU, PUSA |
| 216 | Rajendra Bhagavati | 62.30 | 63.00 | 0.70 | RAU, PUSA |
| 217 | Rajendra Kasturi | 1.80 | 2.00 | 0.20 | RAU, PUSA |
| 218 | Rajendra Suwasini | 1.50 | 2.00 | 0.50 | RAU, PUSA |
| 219 | Rajendra Sweta | 4.20 | 5.00 | 0.80 | BAU, Sabour |
| 220 | Rajeshwari-1 | 1.00 | 2.00 | 1.00 | RAU, PUSA |
| 221 | Rajshree (TCA80-4) (IET-7970) | 0.40 | 1.00 | 0.60 | RAU, PUSA |
| 222 | Ranidhan (IET19148) | 14.30 | 14.30 | - | OUAT, Bhubaneshwar |
| 223 | Ranjeet (IET-12554) | 13.50 | 0.00 | -13.50 | RARS, Titabar (AAU, Jorhat) |
| 224 | Ranjit | 20.70 | 22.80 | 2.10 | AAU, Jorhat |
| 225 | Ranjit Sub-1 | 41.10 | 175.20 | 134.10 | RARS, Titabar (AAU, Jorhat) |
| 226 | Rashmi (JR-201) | 11.30 | 30.43 | 19.13 | JNKVV, Jabalpur |
| 227 | Rasi (IET-1444) | 0.30 | 0.50 | 0.20 | ICAR-IIRR, Hyderabad |
| 228 | Ratna | 0.10 | 1.00 | 0.90 | NRRI, Cuttack |
| 229 | Ratnagini-1 | 0.60 | 59.00 | 58.40 | ARS, Ratanagiri |
| 230 | Ratnagiri- 8 | 0.50 | 25.50 | 25.00 | ARS, Ratanagiri |
| 231 | Ratnagiri-24 (RTN24) (IET-19812) | 0.50 | 8.60 | 8.10 | ARS, Ratanagiri |
| 232 | Ratnagiri-6 | 0.50 | 20.60 | 20.10 | ARS, Ratanagiri |
| 233 | Ratnagiri-7 | 0.50 | 16.50 | 16.00 | ARS, Ratanagiri |

| S. No. | Name of Variety | Allocation as per BSP-I | Actual Production | Surplus (+) Deficit (-) | Name of the Producing centre |
|---|---|---|---|---|---|
| 234 | RGL 2537 | 11.00 | 31.50 | 20.50 | ANGRAU, Guntur |
| 235 | RNR 15048 (Telangana Sona) | 31.20 | 35.00 | 3.80 | PJTSAU, Hyderabad |
| 236 | RTN-5 (Ratnagiri-5) | 3.00 | 10.50 | 7.50 | ARS, Ratanagiri |
| 237 | Sabhour Shree | 35.00 | 101.10 | 66.10 | BAU, Sabour |
| 238 | Sabhour Surbhit | 35.00 | 36.20 | 1.20 | BAU, Sabour |
| 239 | Sabita (IET-8970) | 4.20 | 4.00 | -0.20 | RRS, Chinsurah |
| 240 | Sabour Deep | 15.00 | 35.75 | 20.75 | BAU, Sabour |
| 241 | Sakoli-9 | 0.50 | 4.50 | 4.00 | ARS, Sakoli |
| 242 | Sambha Sub-1 (IET21248) | 14.30 | 6.00 | -8.30 | NRRI, Cuttack |
| 243 | Samleshwari (IET-17455) | 8.30 | 9.90 | 1.60 | IGAU, Raipur |
| 244 | Sampada (IET19424) | 31.00 | 11.40 | -19.60 | ICAR-IIRR, Hyderabad |
| 245 | Sampriti (BNKR-BB12) (IET-21987) | 2.00 | 2.00 | - | RRS, Bankura |
| 246 | Sarala (CR-260-77) (IET-10279) | 3.90 | 5.00 | 1.10 | NRRI, Cuttack |
| 247 | Sarjoo-52 | 11.10 | 90.00 | 78.90 | NDUAT, Faizabad |
| 248 | Satyabhama | 6.00 | 3.00 | -3.00 | NRRI, Cuttack |
| 249 | Savitri (IET5897, CR 1009 | 4.25 | 0.00 | -4.25 | NRRI, Cuttack |
| 250 | Shabhagidhan (IET-19576) | 149.88 | 165.05 | 15.17 | CRURRS, Hazaribagh |
| 251 | Sharavathi (IR-57773) | 1.00 | 4.00 | 3.00 | UAHS, Shivamogga |
| 252 | Shatabdi (IET-4786) | 56.90 | 60.00 | 3.10 | NRRI, Cuttack, RRS, Chinsurah |
| 253 | Shiats Dhan-1 (AAIR2) (IET20928) | 5.00 | 0.00 | -5.00 | SHUATS, Prayagraj, UP |
| 254 | Shiats Dhan-2 | 2.00 | 0.00 | -2.00 | SHUATS, Prayagraj, UP |
| 255 | Shiats Dhan-3 | 2.10 | 0.00 | -2.10 | SHUATS, Prayagraj,UP |
| 256 | ShobhinI (RNR2354) (IET21260) | 1.00 | 1.00 | - | PJTSAU, Hyderabad |
| 257 | Shreyas | 0.30 | 6.00 | 5.70 | RRS, Monocompu |
| 258 | Shyamala (IET 12561, R259-WR-37-2) | 0.10 | 1.20 | 1.10 | IGAU, Raipur |
| 259 | SITA | 1.15 | 6.75 | 5.60 | BAU, Sabour |
| 260 | SubourArdhajal | 35.00 | 132.10 | 97.10 | BAU, Sabour |
| 261 | Sujala (CNR-2) (IET 20235) | 12.30 | 2.00 | -10.30 | RRS, Chinsurah |
| 262 | Surendra (IET-12815) | 0.90 | 0.90 | - | OUAT, Bhubaneshwar |
| 263 | Swarna Shreya | 16.50 | 23.00 | 6.50 | ICAR-Patna |
| 264 | Swarna Sub-1 (CR-2539-1, IET 20266) | 210.85 | 180.00 | -30.85 | NRRI, Cuttack |
| 265 | Tarunbhog Selection- 1 | 3.00 | 3.60 | 0.60 | IGAU, Raipur |
| 266 | TellaHamsa | 1.50 | 1.50 | - | PJTSAU, Hyderabad |
| 267 | Thanu | 2.45 | 4.00 | 1.55 | UAS, Bangalore |
| 268 | Thunga (IET 13901) | 4.75 | 8.00 | 3.25 | UAHS, Shivamogga |
| 269 | TRY3 | 0.10 | 0.10 | 0.00 | TNAU, Coimbatore |

| S. No. | Name of Variety | Allocation as per BSP-I | Actual Production | Surplus (+) Deficit (-) | Name of the Producing centre |
|---|---|---|---|---|---|
| 270 | Uma | 14.10 | 14.50 | 0.40 | RRS, Monocompu |
| 271 | Vallabh Basmati - 24 (IET 20827) (MAUB -171) | 0.20 | 1.00 | 0.80 | SVBPUA & T Meerut |
| 272 | Vandana (RR167-182) | 2.92 | 4.78 | 1.86 | CRURRS, Hazaribagh |
| 273 | Varshadhan (CRLC-899) (IET-16481) | 5.30 | 5.00 | -0.30 | NRRI, Cuttack |
| 274 | Vijetha (MTU1001) | 106.90 | 180.00 | 73.10 | ANGRAU, Guntur |
| 275 | Vishnubhog Selection-1 | 2.30 | 5.00 | 2.70 | IGAU, Raipur |
| 276 | VL Dhan 157 (VL31611) (IET22292) | 2.50 | 2.50 | - | VIHA, Almora |
| 277 | VL Dhan-158 | 0.20 | 1.00 | 0.80 | VIHA, Almora |
| 278 | VL Dhan-68 (VL31611) (IET22283) | 8.00 | 15.00 | 7.00 | VIHA, Almora |
| 279 | VL Dhan-85 (IET 16455, VL3613) | 0.60 | 0.70 | 0.10 | VIHA, Almora |
| 280 | Warangal Sannalu (WGL32100, IET 18044) | 12.50 | 13.00 | 0.50 | PJTSAU, Hyderabad |
| 281 | WGL-347 | 1.00 | 1.50 | 0.50 | PJTSAU, Hyderabad |
| 282 | WGL-44 | 1.00 | 2.00 | 1.00 | PJTSAU, Hyderabad |
| | **Total** | **4397.29** | **11958.57** | **7561.28** | |

## Hybrids

| S. No. | Name of the Centre | Name of hybrid | Allocation as per BSP-I | Production | Surplus (+) Deficit (-) |
|---|---|---|---|---|---|
| | UAS, Bangalore | Karnataka Rice Hybrid – 2 (IR 58025A) (KRH-2) | 0.1 | 0.25 | **0.15** |
| | | Karnataka Rice Hybrid – 2 (IR 58025B) (KRH-2) | 0.1 | 0.2 | **0.1** |
| | | Karnataka Rice Hybrid - 2 (KMR - 3R) (KRH-2) | 0.1 | 0.2 | **0.1** |
| | | KRH-4 A-Line | 0.12 | 0.6 | **0.48** |
| | | KRH-4 B-Line | 0.08 | 0.2 | **0.12** |
| | | KRH-4 R-Line | 0.08 | 0.5 | **0.42** |
| | | **Total** | **0.58** | **1.95** | **1.37** |
| 2 | RARS, Karjat | Sahyadri-5 RTN-13A | 0.06 | 0.13 | **0.07** |
| | | Sahyadri-5 RTN-13B | 0.02 | 0.26 | **0.24** |
| | | Sahyadri-5 RTN-R-5 | 0.03 | 0.34 | **0.31** |
| | | Sahyadri-4 IR-58025-A | 0.15 | 0.55 | **0.4** |
| | | Sahyadri-4 IR-58025-B | 0.05 | 0.28 | **0.23** |
| | | Sahyadri-4 IR-58025-R | 0.04 | 0.21 | **0.17** |
| | | Sahyadri-3 (F) | 0.1 | 0.4 | **0.3** |
| | | Sahyadri-3 (M) | 0.03 | 0.25 | **0.22** |
| | | Sahyadri-3 (R) | 0.03 | 0.18 | **0.15** |
| | | **Total** | **0.51** | **2.6** | **2.09** |
| | | **Total (Hybrids)** | **1.09** | **4.55** | **3.46** |
| **Grand Total** | | | **4398.38** | **11963.12** | **7564.74** |

-

# Appendix-4

## List of Institute projects during 2020

| S. No. | Project Code | Project Title | PI and Co-PI |
|---|---|---|---|
| **CROP IMPROVEMENT DIVISION** | | | |
| **Plant Breeding** | | | |
| 1 | *GEY/CI/BR/9* | Enhancing nutritional quality of rice through bio-fortification | **L V Subba Rao**<br>G Padmavathi, K Surekha<br>B Sreedevi, CN Neeraja<br>D Sanjeeva Rao, J Arvind Kumar<br>T Longvah (NIN) |
| 2 | *GEY/CI/BR/16* | Traditional and molecular approaches for breeding improved rice varieties with resistance to planthoppers | **G Padmavathi**<br>C Gireesh, V Jhansi Lakshmi<br>M Sheshu Madhav<br>P V Satyanarayana, Maruteru<br>Nanda Kishore, Maruteru |
| 3 | *GEY/CI/BR/9* | Development of Rice Cultivars with High Grain Protein Content and Quality Traits | **J Aravind Kumar**<br>LV Subba Rao, D Subramanyam<br>RA Fiyaz, Jyoti Badri<br>Ch Suvarna Rani |
| 4 | *GEY/CI/BR/22* | Identification and introgression of agronomically important traits from wild species of rice | **C Gireesh**<br>MS Ananth, Divya B<br>K Suneetha, G Padmavathi<br>Jyothi Badri, Senguttvel<br>KB Kemparaju, RM Sundaram<br>Sheshu Madhav, GS Laha<br>V Prakasham, Y Sridhar<br>V Jhansi Laksmi, P Raghuveer Rao |
| 5 | *GEY/CI/BR/23* | Breeding high yielding rice lines possessing multiple biotic stress resistance/ tolerance through conventional and molecular approaches | **R Abdul Fiyaz**<br>R M Sundaram, Sheshumadhav<br>L V Subba Rao, M S Anantha,<br>M S Prasad, G S Laha |
| 6 | *GEY/CI/BR/25* | Broadening the genetic base of *indica* rice varieties and modify plant type by introgressing traits from Tropical *japonica* | **Jyothi Badri**<br>LV Subba Rao, Divya Balakrishnan<br>J Aravind Kumar, P Revathi<br>P Raghuveer Rao, V Prakasam<br>CH Padmavathi, B Sreedevi<br>Ch Suvarna Rani |
| 7 | *GEY/CI/BR/24* | Breeding high yielding Rice cultivars for tolerance to low phosphorus and nitrogen | **M S Anantha**<br>C Gireesh, R M Sundaram<br>R Abdul Fiyaz, P Senguttuvel<br>R Mahender Kumar, K Surekha<br>Brajendra, Raghuveer Rao<br>Aarthi Singh, Ch Suvarna Rani<br>P C Latha |

| S. No. | Project Code | Project Title | PI and Co-PI |
|---|---|---|---|
| 8 | *ABR/ CI/BR/28* | Exploring wild introgression lines and mutants to identify novel genes/QTLs for yield contributing traits. | **Divya Balakrishnan**<br>N Sarla, D Subrahmaniyam<br>G Padmavathi, Jyothi B<br>P Revathi, C Gireesh<br>Ladha Lakshmi, B Kalyani<br>Suvarna C |
| 9 | *GEY/CI/BR/10* | Genetic improvement of elite aromatic short and medium grain rices. | **Suvarna Rani Chimmili**<br>L V Subba Rao, G Padmavathi<br>M Sheshu Madhav<br>J Aravind Kumar, Jyothi Badri<br>Divya Balakrishnan<br>M S Anantha, C Gireesh |
| **Hybrid rice** | | | |
| 10 | *GEY/CI/HY/13* | Development and evaluation of three line hybrids with better grain quality and resistance to major pests and diseases. | **A S Hari Prasad**<br>P Senguttuvel, P Revathi<br>KB Kemparaju, K Sruthi<br>RM Sundaram |
| 11 | *GEY/CI/HY/15* | Genetic enhancement of hybrid rice parental lines suitable for aerobic and tolerance to salinity conditions through conventional and molecular approaches | **P Senguttuvel**<br>AS HariPrasad, RM Sundaram<br>Sheshu Madhav, B Sreedevi<br>C Gireesh, MS Anantha<br>G Padmavathi, Mahender Kumar<br>R Gopinath, N Somasekhar<br>D Subrahmanyam |
| 12 | *GEY/CI/HY/12* | Development of superior restorers and Identification of new restorer (*Rf*) genes for WA-CMS system in rice by conventional and molecular approaches | **P Revathi**<br>Jyothi Badri<br>Satendra K Mangrauthia<br>Divya Balakrishnan<br>M Srinivas Prasad<br>V Jhansilakshmi |
| 13 | *GEY/CI/HY/16* | Genetic improvement of maintainers for yield and attributing traits with introgression of yield enhancing genes | **K B Kemparaju**<br>AS Hari Prasad, K Shruti<br>C Gireesh, RM Sundaram |
| 14 | *GEY/CI/HY/14* | Establishment and validation of heterotic gene pools in hybrid rice | **K Sruthi**<br>A S Hari Prasad, P Senguttuvel<br>P Revathi, B Kemparaju<br>R M Sundaram |
| **Biotechnology** | | | |
| 15 | ABR/CI/BT/9 | Improvement of rice against biotic and abiotic stresses through transgenic approach | **SM Balachandran**<br>A P Padmakumari, Ch Padmavathi<br>D Subrahmanyam, S K Mangrauthia |
| 16 | *ABR/CI/BT/6* | Identification of genes for grain filling in rice (*Oryza sativa* L.) | **C N Neeraja**<br>S R Voleti, LV Subba Rao<br>M S Madhav, SM Balachandran<br>Divya Shyamala Devi<br>D Sanjeeva Rao, Kalyani M B |

| S. No. | Project Code | Project Title | PI and Co-PI |
|---|---|---|---|
| 17 | *ABR/CI/BT/10* | Genomic studies on grain yield heterosis and WA-CMS trait in rice | **R M Sundaram**<br>S M Balachandran, MS Madhav<br>A S Hariprasad, P Revathi<br>P Raghuveer Rao, K Sruthi |
| 18 | *ABR/CI/BT/16* | Exploring the mutant resources for rice improvement | **M Sheshu Madhav**<br>R M Sundaram, Kalyani M B<br>D Sanjeeva Rao, B Sreedevi<br>P Senguttuvel, L V Subba Rao<br>C Gireesh, A P Padma Kumari<br>V Jhansi Laxmi, Ch Padmavathi<br>Y Sridhar, G S Laha<br>M S Prasad, D Ladhalakshmi |
| 19 | *ABR/CI/BT/13* | Candidate gene identification for manipulating growth related genes in rice through computational and expression studies | **P S Divya**<br>S M Balachandran<br>D Subrahmanyam |
| 20 | *ABR/CI/BT/14* | Exploring RNAi Technology for Management of Rice Diseases | **Satendra Kr Mangrauthia**<br>S M Balachandran, G S Laha<br>D Krishnaveni, P Revathi<br>V Prakasam, Kalyani M B |
| 21 | *ABR/CI/BT/15* | Molecular and functional characterization of useful root traits in rice | **Kalyani M Barbadikar**<br>M Seshu Madhav<br>D Subrahmanyam<br>P Senguttuvel, S M Balachandran<br>Divya P S |
| **CROP PRODUCTION DIVISION** | | | |
| **Agronomy** | | | |
| 22 | *RUE/CP/AG/14* | Strategic research on enhancing water Use efficiency and productivity in irrigated rice system | **R Mahender Kumar**<br>B Sreedevi, L V Subba Rao<br>K Surekha, Ch Padmavathi<br>P C Latha, M Sreenivas Prasad<br>N Somashekhar, P Muthuraman<br>P Raghuveer Rao<br>S Ravichandran, B Nirmala<br>B Sailaja, Shaik N Meera<br>DVK Nageswar Rao, Vidhan Singh<br>MBB Prasad Babu<br>K Srinivas, CRIDA<br>(For Biochar work) |
| 23 | *RUE/CP/AG/13* | Improved Agro-techniques for sustainable aerobic rice based cropping systems | **B Sreedevi**<br>N Somasekhar, P C Latha<br>P Senguttuvel, Mangal Deep Tuti<br>C Kannan, DVK Nageswararao<br>R Mahender Kumar, B Jhansirani |

| S. No. | Project Code | Project Title | PI and Co-PI |
|---|---|---|---|
| 24 | *SSP/CP/AG/15* | Sustainable intensification of rice-maize system through conservation agriculture | **Mangal Deep Tuti**<br>R Mahender Kumar, B Sreedevi<br>Soumya Saha, Aarti Singh<br>B Nirmala, T Vidhan Singh<br>Bandeppa, M N Arun |
| 25 | *RUE/CP/AG/17* | Comparative study of organic and conservation agriculture for enhanced resource use efficiency, yield and quality of rice | **Aarti Singh**<br>V Manasa, M D Tuti<br>Anantha MS, D Sanjeeva Rao<br>K Sruthi, T Vidhan Singh<br>S Chavan, R M Kumar, M N Arun |
| 26 | *RUE/CP/AG/18* | Development of climate smart and economic weed management technologies for changing rice establishment systems | **B Sreedevi**<br>R Mahender Kumar, N Somasekhar,<br>P Senguttuvel, Mangal Deep Tuti |
| 27 | *SSP/CP/AG/16* | Development of sustainable agro-techniques for direct seeded rice | **Soumya Saha**<br>R Mahender Kumar,<br>Mangal Deep Tuti, Bandeppa,<br>Satish N Chavan, T. Vidhan Singh |
| **Soil Science** | | | |
| 26 | SSP/CP/SS/11 | Assessment of Genotypic variability in nitrogen use efficiency and improving NUE in irrigated rice | **K Surekha**<br>DVK Nageswara Rao, CN Neeraja<br>RM Kumar, SR Voleti, MS Anantha,<br>V Manasa and Gobinath R |
| 27 | CCR/CP/SS/17 | Studies on emission of greenhouse gases (GHGs) from rice soils and their mitigation | **MBB Prasad Babu**<br>R Mahender Kumar, PC Latha<br>Brajendra |
| 28 | RUE/CP/SS/16 | Study of rice vegetation in terms of crop stress to model the yield using NDVI | **DVK Nageswara Rao**<br>K Surekha, R Mahender Kumar<br>B Sridevi, Ch Padmavati<br>V Prakasam |
| 29 | SSP/CP/SS/18 | Studies on Soil Organic Carbon Status, Mapping and stocks in Rice Soils of India | **Brajendra**<br>B Sailaja, MBB Prasad Babu<br>P Muthuraman |
| 30 | SSP/CP/SS/19 | Prospecting endophytic actinobacteria of rice for sustainable rice production | **PC Latha**<br>Bandeppa, MBB Prasad Babu |
| 31 | SSP/CP/SS/15 | Microbial population dynamics in different rice establishment method in relation to nutritional availability and acquisition. | **Bandeppa**<br>P C Latha, K Surekha<br>Mangal Deep Tuti<br>Kalyani M Barbadikar |
| 32 | RUE/CP/SS/19 | Evaluation of ZnO nanoparticles on performance of rice | **Gobinath R**<br>K Surekha, Brajendra<br>PC Latha, V Manasa |
| 33 | RUE/CP/SS/20 | Efficacy of hydrogel on yield and soil properties of rice | **V Manasa**<br>K Surekha, R Gobinath<br>Bandeppa, Aarti Singh, MM Azam |

| S. No. | Project Code | Project Title | PI and Co-PI |
|---|---|---|---|
| **Plant Physiology and Biochemistry** | | | |
| 34 | *CCR/CP/PP/11* | Evaluation of genotypic variability in leaf photosynthetic efficiency and its associated factors in rice | **D Subrahmanyam**<br>S R Voleti |
| 35 | *GEY/CP/PP/* | Role of Silicon in inducing abiotic stress tolerance in rice | **P Raghuveer Rao**<br>Dr D Sanjeeva Rao, Mangaldeep Tuti |
| 36 | *GEQ/CI/BR/26* | Investigation into the role of major metabolites on rice grain quality | **D Sanjeeva Rao**<br>C N Neeraja, D Subrahmanyam<br>M S Madhav, P Senguttuvel<br>Jyothi Badri |
| **Agricultural Engineering, Computer Applications and Chemicals** | | | |
| 37 | *RUE/CP/ENG/6* | Selective mechanization in rice cultivation | **T Vidhan Singh**<br>R Mahender Kumar, B Nirmala |
| **Computer Applications** | | | |
| 38 | *TTI/CP/CA/4* | Wireless Sensor Networks integrating with Rice DSS model for real time advisories | **B Sailaja**<br>Shaik N Meera, D Subrahmanyam<br>K Surekha, Santhosh Mithra (CTCRI, Thiruva- nanthapura) |
| **Agricultural Chemicals** | | | |
| 39 | *RUE/CP/AC/1* | Post Harvest Treatment of Rice and Rice By-Products for Health Benefits and on-farm application | **M M Azam**<br>P C Latha, R Mahendra Kumar<br>R Abdul Fiyaz, K Surekha<br>Amtul Waris, V Manasa<br>T Vidhan Singh, S R Voleti<br>D Sanjeeva Rao, GR Katti<br>MS Prasad, GS Laha<br>AP Padmakumari<br>V. Prakasam,<br>Aparna Kuna (PJTSAU) |
| **CROP PROTECTION DIVISION** | | | |
| **Entomology** | | | |
| 40 | *IPM/CPT/ENT/3* | Chemical control of rice insect pests as a component of rice | **Gururaj Katti**<br>V Jhansilakshmi, AP Padmakumari<br>Chitra Shanker |
| 41 | *IPM/CPT/ENT/21* | Botanicals for sustainable management of major pests of rice | **B Jhansi Rani**<br>Chitra Shanker, M M Azam<br>M Srinivas Prasad |
| 42 | *HRI/CPT/ENT/11* | Assessment of host plant resistance to rice planthoppers *viz.,* brown planthopper *Nilaparvata lugens* and whitebacked Planthopper *Sogatella furcifera* and their management | **V Jhansi Lakshmi**<br>D Sanjeeva Rao<br>Y Sreedhar |

| S. No. | Project Code | Project Title | PI and Co-PI |
|---|---|---|---|
| 43 | *IPM/CPT/ENT/22* | Investigations on Nematodes of Importance to Rice Cultivation | **N Soma Sekhar**<br>S N Chavan, P C Latha<br>M Sheshu Madhav |
| 44 | *HRI/ CPT/ENT/23* | Insect-plant interactions with special reference to rice pests – yellow stem borer and gall midge | **A P Padmakumari**<br>Y Sreedhar<br>S R Voleti |
| 45 | *IPM/ CPT/ENT/26* | Biointensive pest management with emphasis on biological control of rice pests | **Chitra Shanker**<br>Gururaj Katti, B Jhansi Rani<br>N Somasekhar, C Kannan |
| 46 | *HRI/CPT/ENT/27* | HPR and Semiochemical approaches for the management of insect pests of rice | **Ch Padmavathi**<br>Y Sridhar, Divya Balakrishnan<br>Gururaj Katti |
| 47 | *IPM/CPT/ENT/24* | Bioecology and Management of Emerging Insect and Mite pests of rice | **Y Sridhar**<br>B Jhansi Rani, M Sheshu Madhav<br>Gireesh, D Sanjeeva Rao<br>S Chavan |
| 48 | *IPM/CPT/ENT/25* | Development of Entomopathogenic Nematodes (EPN) for Biointensive Integrated Pest Management in Rice | **Satish N Chavan** (Study Leave)<br>N Somasekhar, Gururaj Katti<br>A P Padmakumari, C Kannan |
| **Plant Pathology** | | | |
| 49 | *HRP/CPT/PATH/15* | Assessment of host plant resistance to rice blast disease and its management | **M Srinivas Prasad**<br>M S Madhav, S M Balachandran<br>V Prakasam, Divya Balakrishnan |
| 50 | *HRP/CPT/PATH/13* | Assessment of resistant sources and monitoring of pathogen virulence in bacterial leaf blight of rice | **G S Laha**<br>D Krishnaveni, D Ladhalakshmi<br>R M Sundaram, S K Mangrauthia |
| 51 | *HRP/CPT/PATH/14* | Assessment of host plant resistance and development of diagnostic tools for rice tungro virus disease | **D Krishnaveni**<br>G S Laha, C N Neeraja<br>Chitra Shanker, SK Mangrauthia<br>D Ladhalakshmi |
| 52 | *HRP/CPT/PATH/20* | A consortia approach to the biological management of diseases in rice | **C Kannan**<br>M Srinivas Prasad, D Krishnaveni<br>G S Laha, V Prakasam<br>D Ladhalakshmi, Chitra Shanker<br>P C Latha, B Sridevi |
| 53 | *HRP/CPT/PATH/23* | Variability in *Ustilaginoidea virens* and management of false smut disease | **D Ladhalakshmi**<br>G S Laha, D Krishnaveni<br>C Kannan, V Prakasam<br>K Basavaraj, Divya Balakrishnan<br>Sanjeeva Rao |
| 54 | *HRP/CPT/PATH/22* | Population dynamics of *Rhizoctonia solani* and sustainable management of rice sheath blight disease | **V Prakasam**<br>M S Prasad, G S Laha<br>D Ladha Lakshmi, Jyothi Badri |

Appendices

| S. No. | Project Code | Project Title | PI and Co-PI |
|---|---|---|---|
| 55 | *HRP/CPT/PATH/24* | Survey, host plant resistance to brown spot disease of rice and its management. | **K Basavaraj**<br>M S Prasad, G S Laha<br>D Ladhalakshmi, V Prakasam<br>S Jasudasu Gompa<br>Divya Balakrishnan, -C Gireesh |
| 56 | *HRP/CPT/PATH/25* | Host plant resistance and Characterization of pathogens of Sheath rot & Stem rot diseases of Rice | **S Jasudasu Gompa**<br>G S Laha, M S Prasad<br>Basavaraj K, V Prakasam<br>D Ladhalakshmi |
| **TRANSFER OF TECHNOLOGY & TRAINING** | | | |
| 57 | *TTT/EXT/15* | Climate change and rice farming: Farmers perception and adaptation strategies | **P Muthuraman**<br>Shaik N Meera, S Arun Kumar<br>P Jeyakumar, Brajendra |
| 58 | *TTT/EXT/16* | Smart Village Strategy for accelerated rice technology transfer | **Dr Amtul Waris**<br>P Muthuraman, Shaik N Meera<br>P Jeykumar, PA Lakshmi Prasanna<br>Arun Kumar S, S Rathod |
| 59 | *TTT/EXT/11* | Maximizing the impact of rice technologies through ICT applications | **S N Meera**<br>S Arun Kumar, P Muthuraman<br>Amtul Waris, Chitra Shanker<br>D Krishnaveni, B Sailaja Brajendra<br>P Senguttuvel, S R Voleti |
| 60 | *TTI/TTT/ECON/3* | IPR - Competition interaction in rice seed sector – Emerging scenario-implications for enhancing quality seed use. | **P A Lakshmi Prasanna**<br>L V Subba Rao, AS Hari Prasad<br>Amtul Waris, S N Meera<br>B Nirmala, S Arun Kumar<br>Divya P Symaladevi |
| 61 | *TTT/ECON/4* | Economics, Energy and Sensitivity Analysis of selected Rice production technologies | **B Nirmala**<br>P Muthuraman, Amtul Waris<br>R Mahender Kumar<br>A S Hari Prasad, T Vidhan Singh<br>P Senguttuvelu |
| 62 | *TTI/TTT/EXT/14* | Innovations in group based extension approaches: Accelerating rice technology transfer through farmer based organisations | **S Arun Kumar**<br>Shaik N Meera, Amtul Waris<br>P Jeya Kumar<br>P Muthuraman |
| 63 | *TTI/TTT/EXT/13* | On-Farm Adoption of IPM Technologies and impact analysis | **P Jeyakumar**<br>Ch Padmavathi, C Kannan<br>B Sridevi, Amtul Waris<br>S Arun Kumar, Santosh Rathod |
| 64 | *TTI/TTT/STAT/4* | Statistical modeling and soft computing approaches for genomic selection in Rice | **Santosha Rathod**<br>C N Neeraja, R M Sundaram<br>C Gireesh, P Senguttuvel |

# Appendix-5

## Externally funded projects sanctioned during 2020

| S. No. | Title of the Project / Schemes | Name of the PI & Co-PI | Funding Agency | Duration | Budget (lakh Rs) |
|---|---|---|---|---|---|
| 1 | Mainstreaming rice landraces diversity in varietal development through genome wide association studies: A model for large-scale utilization of gene bank collections of rice" DBT Network project coordinated by IARI and NBPGR | **C. N. Neeraja**<br>L.V. Subbarao, C. Gireesh<br>J. Aravind Kumar<br>D. Ladhalakshmi<br>Anantha M. S<br>R. Abdul Fiyaz | DBT | 2020-25 | 143.35 |
| 2 | Development of haplotype based near isogenic lines (Haplo-NILs) for enhanced genetic gain in rice | Jyothi Badri<br>J Aravind Kumar,<br>MS Prasad,<br>Jhansi Lakshmi,<br>AP Padma Kumari<br>V PRakasam | DBT | 2020-23 | 118.00 |
| 3 | Marker-assisted introgression of genes associated with yield enhancement and resistance against bacterial blight and blast diseases into an elite rice variety, 'Jaya' | R. Abdul Fiyaz<br>R.M. Sundaram, G.S. Laha,<br>J Aravind Kumar,<br>L.V. Subba Rao and<br>Basavaraj K. | DST-SERB | 2020-23 | 36.96 |
| 4 | Mapping genomic regions associated with bacterial leaf blight resistance derived from Oryza glaberrima | C Gireesh | DST-SERB | 2020-23 | 27.57 |
| 5 | Accelerating Genetic Gain in Rice (AGGRi) Alliance | AVSR Swamy | IRRI | 2020-24 | 37.50 |
| 6 | Direct Seeded Rice Consortium (DSRC) | Mahender Kumar | IRRI | 2020-22 | 6.50 |
| 7 | Increasing the Health potential in rice by lowering glycaemic index response in high yielding lines (Low GI Rice) | Aravind Kumar J | IRRI | 2020-22 | 4.50 |
| 8 | Supporting Rice Sector with Digital Extension Strategies (Rice Doctor)- Increasing productivity of rice-based cropping systems and farmers' income in Odisha | Chitra Shanker<br>D. Krishnaveni<br>Brajendra, | IRRI | 2020-21 | 4.00 |
| 9 | Evaluation of UAV Application of Adama Insecticides for the Management of Insect Pests of Rice | Y Sridhar | Adama India Pvt. Ltd | 2020-22 | 8.70 |
| 10 | Evaluation of BAS 560 00 I for bioefficacy against brown planthopper and white backed planthopper and phytotoxicity in Rice | B. Jhansi Rani<br>Dr. Y. Sridhar | BASF India Limited | 2020-22 | 9.80 |
| 11 | Bio-efficacy of ITK based botanicals against insect pests of rice | B. Jhansi Rani<br>Y. Sridhar | NIF, Gujarat | 2020-22 | 13.30 |

Appendices

| S. No. | Title of the Project / Schemes | Name of the PI & Co-PI | Funding Agency | Duration | Budget (lakh Rs) |
|---|---|---|---|---|---|
| 12 | Global Challenges Research Fund (GCRF) South Asian Nitrogen Hub (SANH) | D Subrahmanyam (PI)<br>C N Neeraja | GCRF-UK | 2020-25 | 92.00 |
| 13 | Evaluation of ecoSolv water device and ecoAgra advanced agriculture surfactant on yield and water productivity of irrigated rice | R. Mahender Kumar | ecoSolv technologies | 2020-21 | 7.26 |
| | **Total** | | | | **~509.44** |

# Appendix-6

## Ongoing Externally funded projects during 2020

| S. No. | Title of the Project / Schemes | Name of the PI & Co-PI | Funding Agency | Duration | Budget (lakh Rs) |
|---|---|---|---|---|---|
| 1 | CRP- Biofortification in selected crops for nutritional security. | C N Neeraja (PI), K Surekha<br>Kalyani M Kulkarni,<br>D Sanjeeva Rao,<br>L V Subba Rao, R M Sundaram<br>Amtul Waris, U Chaitanya | ICAR | 2017-2025 | 198.5 |
| 2 | ICAR-Consortia Research Platform on Molecular Breeding in Crops. | R M Sundaram (PI),<br>LV Subba Rao<br>R Abdul Fiyaz, C Gireesh<br>M S Anantha, P Senguttuvel<br>S M Balachandran,<br>M S Madhav, M S Prasad, G S Laha, A P Padmakumari, V Jhansi Lakshmi | ICAR | 2017-2025 | 38.125 |
| 3 | ICAR-Plan Scheme: "Incentivizing Research in Agriculture" Project: Genetic modifications to improve biological nitrogen fixation for augmenting nitrogen needs of cereals | R M Sundaram (PI)<br>P C Latha<br>S Bandeppa<br>Kalyani M Barbadikar<br>MBB Prasad Babu | ICAR | 2017-2025 | 104.00 |
| 4 | ICAR-Plant Scheme: "Incentivizing Research in Agriculture". Project: Molecular genetic analysis of resistance/tolerance to different stresses in rice, wheat, chickpea and mustard including sheath blight complex genomics. | R M Sundaram (PI)<br>G S Laha<br>V Prakasam<br>D Ladha Lakshmi<br>Jyothi Badri | ICAR | 2017-2025 | 48.01 |
| 5 | CRP on Agro-biodiversity. | L V Subba Rao (PI)<br>C Gireesh, M S Anantha | ICAR | 2014-2020 | 4.0 /year |

| S. No. | Title of the Project / Schemes | Name of the PI & Co-PI | Funding Agency | Duration | Budget (lakh Rs) |
|---|---|---|---|---|---|
| 6 | Mega Seed Project. | L V Subba Rao (PI), AVSR Swamy<br>R Abdul Fiyaz, U Chaitanya | ICAR | 2006-Long term | 8.0/year |
| 7 | National Seed Project. | L V Subba Rao (PI), G Padmavathi<br>R Abdul Fiyaz, U Chaitanya | ICAR | 1992 – Long term | 3.5/year |
| 8 | CRP on Hybrid Technology (Hybrid Rice) | A S Hari Prasad (PI)<br>P Senguttuvel, P Revathi<br>K B Kemparaju | ICAR | 2015-2020 | 112.89 |
| 9 | AICRP – Biocontrol | Chitra Shanker (PI) | ICAR | 2017-2021 | 4.00 |
| 10 | ICAR-Emeritus Scientist Project -Molecular responses of rice under aerobic conditions | P Ananda Kumar (PI) | ICAR | 2019-2020 | 20.0 |
| 11 | Application of Next-Generation Breeding, Genotyping, and Digitalization Approaches for Improving the Genetic Gain in Indian Staple Crops | L V Subba Rao<br>R Abdul Fiyaz<br>P Revathi | ICAR-BMGF | 2018-22 | 18.00 |
| 12 | Genetic improvement of rice for yield, NUE, WUE, abiotic and biotic stress tolerance through RNA Guided Genome Editing (CRISPR/Cas9/Cpf1) | S K Mangrauthia (PI) | ICAR-NASF | 2018-21 | 83.85 |
| 13 | Upscaling of high yielding/elite Sambha Mahsuri mutant line SM93 for product translation | M Sheshu Madhav (PI) | CSIR | 2018-2020 | 145.0 |
| 14 | Development of climate resilient lines of the bacterial blight resistant and low glycemic index rice variety, Improved Samba Mahsuri | R M Sundaram (PI)<br>G S Laha, L V Subba Rao<br>S M Balachandran, M S Prasad<br>M S Madhav, R Abdul Fiyaz<br>P Senguttuvel | CSIR FTT Scheme | 2019-22 | 31.26 |
| 15 | CSIR 800 (Blight Out). | L V Subba Rao (PI)<br>R M Sundaram, P Muthuraman<br>G S Laha, U Chaitanya | CSIR-CCMB | 2012-2020 | 25.0 / year |
| 16 | DBT sponsored Project on “Marker-assisted introgression of yield enhancing genes to increase yield potential of Indian rice varieties. | R M Sundaram (PI)<br>M S Madhav, S M Balachandran<br>P Senguttuvel<br>Jyothi Badri | DBT | 2016-2021 | 82.504 |
| 17 | Maintenance, characterization and use of EMS Mutants of Upland Variety Nagina 22 for functional genomics in rice-Phase-II | S K Mangrauthia (PI)<br>S R Voleti<br>Divya Balakrishnan | DBT | 2015-2021 | 93.03 |

Appendices

| S. No. | Title of the Project / Schemes | Name of the PI & Co-PI | Funding Agency | Duration | Budget (lakh Rs) |
|---|---|---|---|---|---|
| 18 | From QTL to Variety: Genomics-Assisted Introgression and Field evaluation of Rice Varieties with Genes/QTLs for yield under Drought, Flood and Salt Stress | G Padmavathi (PI)<br>Jyothi Badri, G S Laha<br>Jhansi lakshmi<br>Satendra K Magrauthia | DBT | 2018-21 | 71.95 lakhs |
| 19 | Exploring Chromosome Segment Substitution Lines from inter-specific crosses to decipher the genetics of grain weight and earliness | Divya Balakrishnan (PI) | DBT BioCare | 2019-2022 | 43.10 |
| 20 | Imparting sheath blight resistance in rice (A DBT flagship project) | R M Sundaram (PI)<br>C Kannan, V Prakasam<br>G S Laha | DBT | 2019-22 | 108 |
| 21 | Characterization of strong culm SambhaMahsuri mutants and identification of candidate genes associated with strong culm | M Sheshu Madhav (PI)<br>Kalyani M Barbadikar | DST | 2018-2021 | 27.7 |
| 22 | DST-ICRISAT Center of Excellence on Climate Change Research for Plant Protection (CoE-CCRPP): Pest and disease management for climate change adaptation. | V Prakasam (PI)<br>M S Prasad, G.S. Laha,<br>Ch. Padmavathi,<br>Chitra Shankar,<br>Sheshu Madhav,<br>S.K. Mangruthia,<br>D. Subrahmanyam and<br>P. Muthuraman | DST | 2018-2023 | 87.96 |
| 23 | Technological empowerment of tribal farm women through good agricultural practices and eco-entrepreneurship development in rice based cropping systems in Deverkonda mandal of Telangana | Amtul Waris (PI) | DST-SEED | 2017-2020 | 51.97 |
| 24 | RNA-seq based mapping of robust root system architecture for identification of candidate genes | Kalyani M Barbadikar (PI) | DST-SERB | 2018-2021 | 44.18 |
| 25 | Advance breeding technologies to speed up genetic gain, create durable resistance to biotic and increase Indian farmers and consumers food and nutritional security | L V Subba Rao (PI)<br>R Abdul Fiyaz | IRRI | 2017-22 | USD 8900 |
| 26 | ICAR-IRRI Development of high Zinc rice varieties. | L V Subba Rao (PI)<br>C N Neeraja<br>M S Ananatha | IRRI | 2017-22 | USD 6000 |
| 27 | ICAR-IRRI Seed dissemination and production of nucleus & breeder seed of stress tolerant varieties. | L V Subba Rao (PI)<br>R Abdul Fiyaz | IRRI | 2017-22 | USD 7000 |
| 28 | ICAR- IRRI Collaborative Work Plan (2017-2022) Crop & resource management for irrigated cereal systems. | R Mahender Kumar (PI) | IRRI | 2017-22 | 8 lakh |

| S. No. | Title of the Project / Schemes | Name of the PI & Co-PI | Funding Agency | Duration | Budget (lakh Rs) |
|---|---|---|---|---|---|
| 29 | Accelerating Impact & Equity: Adoption & impact Assessment under ICAR-IRRI Collaborative project #3. | Shaik N Meera (PI)<br>S Arun Kumar | IRRI | 2016-2020 | 14.10 |
| 30 | IRRI – India Sub project: Insect-Pest and Disease Forecasting and Decision Support Systems in rice. | Ch Padmavathi | IRRI | | |
| 31 | Biofortification of rice (Harvest Plus) | G Padmavathi (PI)<br>LV Subba Rao<br>K. Surekha<br>M.B.B. Prasad Babu<br>C.N. Neeraja<br>M. Sheshu Madhav | CIAT & IFPRI | 2018-20 | 80.00 |
| 32 | DUS Tests in Rice | L V Subba Rao (PI)<br>J Aravind Kumar<br>Jyothi Badri | PPV & FRA | 2008 – Long term | 13.0 |
| 33 | Identification of heterotic yield QTLs in Swarna X *Oryza* rufipogon introgression lines (ILs) and transferring into parental lines of hybrid rice to enhance the magnitude of heterosis | P Revathi(PI) | SERB | 2018-2021 | 33.59 |
| 34 | Characterization and understanding the genetics of resistance of *Ustilaginoideavirens* and Identification of false smut disease tolerant sources in rice | D Ladha lakshmi (PI) | SERB | 2019-2022 | 33.30 |
| 35 | Evaluation of New Formulation Pymetrozine against rice BPH- Acute toxicity and persistence studies | G Katti (PI)<br>V Jhansi Lakshmi | Adama India ltd | 2019-2020 | 19.16 |
| 36 | Evaluation of BAS 750-02-F400 g/l SC (Mefentrifluconazole 400 g/l SC) against sheath blight and grain discoloration of rice" | V Prakasam (PI), M S Prasad, K Basavaraj, G S Jasudasu, M Surendran, Moncompu, Ramanathan, TNRRI, Aduthurai | BASF India | 2018-2022 | 17.00 |
| 37 | Evaluation of Bioefficacy of BCS CL 73507SC 200 against eggs and larvae of yellow stem borer, *Scirpophagaincertulas* (Walker)" | G Katti (PI)<br>A P Padmakumari | Bayer Crop Science | 2019-2021 | 40.76 |
| 38 | Evaluation of Bio-efficiency of Penoxsulam 2.67% OD in wet direct sown rice | B Sreedevi (PI) | Corteva Agri Sciences | 2019-21 | 7.08 lakhs |
| 39 | Evaluation of Iron Coated seed for Direct Seeded Rice (DSR) | R Mahender Kumar (PI) | JFE Steel Pvt. Ltd | 2017-20 | 15 lakhs/ year |

# Completion Reports of Externally Funded Projects:

### Genetic Improvement of Hybrid Rice Parental Lines for enhancing yield heterosis-(A.S. Hari Prasad)

A set of 150 tropical japonica germplasm lines were evaluated and 19 promising genotypes (having improved plant type, wide compatibility genes, strong culm) were selected and crossed with the promising restorers. After handling the segregating generations in pedigree method of breeding, around 100 stable genotypes possessing desirable plant traits were selected. These lines were phenotyped for major yield related traits and grain quality traits. These lines were also screened for the presence of *Rf3, Rf4* and *S5n* genes for fertility restoration and wide compatibility traits using reported markers. Genotypes with various allelic combinations of *Rf4, Rf3 andS5n,*best general combiners and promising hybrids were identified.


Fig. High level of resistance to BL and BB in ILs during *kharif* 2020

### Marker assisted Introgression of different traits to develop new generation varieties (DBT) (PI-Dr Jyothi Badri)

- IET 29219 in the background of Swarna with resistance to BB, BLB and drought tolerance is promoted to AVT1-IM for 2nd year of testing on overall basis.
- Identified high yielding introgression lines (ILs) with 2-11 gene/QTLs introgressed in the background of Krishna Hamsa (9) and WGL14 (9) for multiple biotic (BL-*Pi2* and *Pi54* and BB-*xa5, xa13* and *Xa21*; additionally gallmidge-*Gm4 & Gm8* in case of WGL14 background) and abiotic stress (drought tolerance-*qDTY1.1, qDTY2.1, qDTY3.1* and *qDTY12.1*) resistance are under AICRIP testing in various trials during *kharif* 2021.
- Identified and confirmed 51 ILs with high level of resistance (score ≤3) to BB (both field and glass house) and 40 ILs with high level of resistance (score ≤3) to BL during *kharif* 2020 (3rd year of screening). Of them, 44 FBLs with phenotypic acceptability score of 1 are evaluated for yield traits both during *kharif* 2020 and *rabi* 2021. High yielding introgression lines were nominated to station trial-*kharif* 2021.
- $BC_2F_4$ lines (561) in the background of WGL14 and Krishna Hamsa were evaluated for BB/BL/yield traits during *rabi* 2021 at two locations and selected 19 HY lines with resistance to BB and BL. About 200 lines were selected with resistance to BB and tolerance to sheath blight
- Evaluated about 300 germplasm from 3k subset against sheath blight and BPH during *kharif* 2020 and *rabi* 2021 and about 135 genotypes with resistance/tolerance score are again under screening for sheath blight during *rabi* 2021 for confirmation.

### ICAR National Professor Project; Development of chromosome segment substitution lines (CSSLs) of rice from elite

**x wild crosses and mapping QTLs/ genes for yield traits (PI-Dr Sarla Neelamraju, Co-PI Dr Divya Balakrishnan)**

- Development of Chromosome segment substitution lines (CSSLs) using elite x wild crosses was carried out under ICAR National Professor Project at IIRR, Hyderabad. Since such an important genetic resource has not been developed previously in India, the goal was to develop a set of marker defined CSSLs to serve as a national resource for basic research. This would enable rapid fine mapping of any trait for which the CSSLs differ significantly from the parent. The project was initiated on 14th Feb, 2013 and completed on 13th Feb, 2020 including two years extension.
- Popular mid-early *rabi* variety Cottondra Sannalu (MTU1010) and late duration *kharif* variety Swarna (MTU7029) were selected as recurrent parents and onewild accession of *Oryza rufipogon* (IC309814) and one of *O. nivara* (IC283150) with high photosynthetic efficiency were used as donor parents to develop new CSSLs.
- In all, 154 CSSLs of MTU1010/*O. rufipogon* IC309814 [cross RP6166] representing 99% of *O. rufipogon* genome were identified from 306 $BC_4F_2$ linesgenotyped using 161 polymorphic SSR markers. In Swarna/ *O. rufipogon* IC309814 [cross RP6167],106 CSSLs were identified from 282 $BC_2F_2$ genotyped using 121 polymorphic SSR lociand the CSSLs represented 95.86% of *O. rufipogon*as homozygous and overlapping chromosome segments substituting Swarna segments. QTLs for yield and related traits were mapped in $BC_2F_2$ with MTU1010 and Swarna and $BC_4F_2$ with MTU1010.
- Backcross introgression lines (BILs) from interspecific crosses were shared with scientists in IIRR, Hyderabad; NRRI, Cuttack; NIPB, Delhi; RARS, Maruteru, ANGRAU; IIAB, Ranchi and JIRCAS, Japan to evaluate for yield and tolerance to various abiotic and biotic stressesand the seeds were deposited in the National repository of ICAR- NBPGR. Themarker defined CSSLs and phenotypic data on lines significantly different from recurrent parent for each trait are available for sharing with NARES partners on MTA with IIRR.


**Fig. Development of CSSLs ofSwarna / *O. rufipogon* (IC309814) and MTU1010 x *O. rufipogon* (IC309814)**

Appendices

## DBT Project: Mass Production and field release techniques of *Tetrastichus schoenobii* Ferriere-an egg parasitoid of rice stem borer (PI-Chitra Shanker, Pr Scientist; Co-PIs–Dr M Sampath Kumar, Scientist; Dr Gururaj Katti, Pr Scientist &Head)

The project proposal was put forth with the objectives of developing and standardizing mass production technology for the egg parasitoid of stem borer, *Tetrastichus schoenobii* and to standardize methods for transport, field release and conservation of released parasitoid. *S. incertulas* and *S fusciflua* can be maintained in the laboratory and green house in situ. Latter is also amenable for rearing on baby corn and artificial diet. Oviposition substrate of blotting paper treated with linalool can be used for the host rearing. One-to-two-day old egg masses are effective for parasitisation of *T schoenobii*. UV irradiation did not significantly affect the parasitisation. Adults of *T schoenobii* can live from 7-10 days in the laboratory when provided with food source and host egg masses. Temperature of 23-25 o C was conducive for maintenance of culture. *T schoenobii* disperses to a distance of 10m effectively in the field. The Male female ratio is 1:1.5 under lab conditions. The development time can range from 10-15 days after exposure of eggs to parasitoids. Transport at egg stage is effective for five to seven days of transport time. A release rate of 4000 per acre or higher is required for effective management. Growing bund crops like marigold and organic practices enhance the parasitisation by *T schoenobii.*

*Rearing of S. fusciflua* **an alternate host of** *T schoenobii*

**T schoenobii parasitising stem borer egg mass**

**Field release and evaluation of** *T schoenobii* **at Warangal, Telangana**


Waste to Wealth

# Acknowledgements

*Constant motivation, encouragement, support and guidance received from Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR, Dr. T. R. Sharma, DDG (CS); Dr. Dinesh Kumar ADG(FFC)(A); and Dr. D. K. Yadava, ADG(Seed) are gratefully acknowledged.*

*We are thankful to all the Vice-Chancellors, Directors of Research and other concerned officers of the State Agricultural Universities and Directors of State Department of Agriculture for their support and cooperation in implementing the AICRIP.*

*Appreciation is extended to the all the scientists of the headquarters and cooperating centers for the successful implementation of research activities which are reflected in the Annual Report and also to the administrative and technical support from the head quarters and cooperating centers.*

*We thank all the scientists of IIRR for their contribution to Annual Report, Administrative, Technical staff; for their assistance in compilation of the report.*

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch

भाकृअनुप-भारतीय चावल अनुसंधान संस्थान

ICAR-Indian Institute of Rice Research

(An ISO 9001:2008 Certified Institute)

Rajendranagar, Hyderabad - 500 030