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GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming

ABSTRACT

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Cuttack, Odisha, India

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GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming

December 16-17, 2021

Abstract

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Abstract

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PREFACE

GenNext technologies are required to address the interlinked challenges of food security and accelerating climate change. Increased productivity and enhanced resilience are two important aspects in rice farming. New technologies are required to produce more and better food to improve nutrition security and boost incomes. Simultaneously, efforts are required to reduce vulnerability to drought, pests, diseases and other climate-related risks and shocks; and improve capacity to adapt and grow in the face of longer-term stresses like shortened seasons and erratic weather patterns. The symposium deliberated different aspects of GenNext technologies under four major themes. The symposium deliberated on various aspects of rice from genetic development to societal issues like new breeding tools of rice technology, genome editing, smart farming, etc.

We have received overwhelming responses from the rice researchers from the country and abroad. A total of 200 extended summaries were accepted for the symposium. There were more than 360 participants including registered delegates. This compilation was not possible without the support from the scientists from ICAR-NRRI. At the end, we thank all the participants of this Symposium without whose handwork and dedication for rice research, it was not possible to document the present trend of rice science. The great enthusiasm shown by honourable delegates is praiseworthy.

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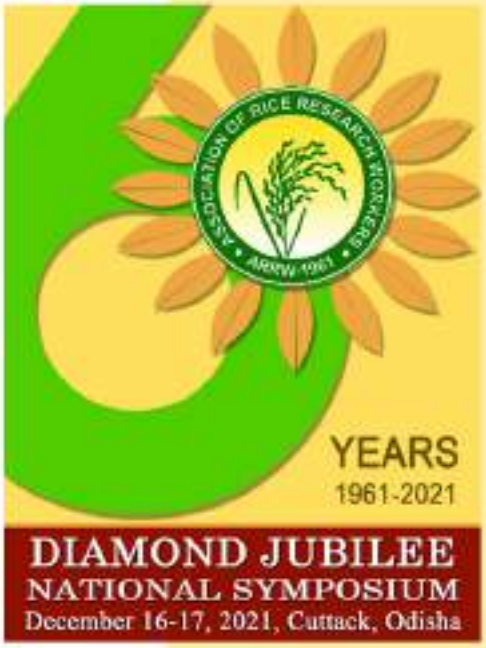

Theme I

GenNext Technologies in Rice Breeding

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/1

Rice Disease Survey and Patho-database using modern GIS Technology – Sivagangai District

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ABSTRACT

Rice is one of the most cultivated crops in the world in over a hundred countries. As per reports by interest groups, rice consists of a total harvested area of approximately 158 million hectares, producing more than 700 million tons annually. Fungus, bacteria are responsible for disease that occur on rice plants are Leaf blast, Brown spot, Sheath blight and Leaf scald. We recorded rice diseases like Rice Blast, Bacterial Blight, Sheath Blight, Brown spot still the rice pathologists were in the serious problems to new rice varieties. Rice disease sampling survey sites of Sivagangai (Keeladi, Athikarai, Thirupuvanam, Illanyankudi, Kallal) and recorded with their passport data. Major infections like *Helminthosporium oryzae* (Brown spot of rice), *Magnoporthe grisea* (Rice blast), *Sarocladium oryzae* (Sheath blight), *Rhizoctonia solani* (Sheath rot), bacterial blight (*Xanthomonas oryzae*) were recorded based on their symptomatology. GPS technology and GIS technology were used to mark the sites of disease infection along with Google map data. To determine the disease data pattern image processing algorithms were used.. We process towards to develop online rice disease database and mobile application with precise location marks and to understand the disease spreading technology.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/2

The Hidden Insights of Certain Un Explored Traditional Rice Varieties of Tamil Nadu

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ABSTRACT

Traditional rice varieties are have a certain special characterization. The hidden insights characters are directly connected with their paddy name origination. Here we discuss about the five Traditional Rice varieties and their benefits. The Five traditional rice varieties are (1) KattuYanam (2) ThuyaMalli (3) Thanga Samba (4) Kothamalli Samba (5) Seeraga Samba.

KattuYanam: It is the one kind of Traditional Rice Variety, Kadu means Forest and Yanai means Elephant. This crop in the field grows more than 7 foot tall and even an elephant can disappear amidst the crop. Hence the name to this paddy is a indigenous healthy rice variety is KattuYanam. **Benefits**: It controls Diabetes, Immunity booster.

Thuyamalli:IntamilThuyamalli means Pure Jasmine. The name derived from the grains that look like a Jasmine buds. **Benefits:** They keep the nervous system healthy and strong.

Kothamalli Samba: The grains resemble coriander seeds and hence the name. The shape of the grains resembles coriander seeds and hence the name. Its Rice will be fragrant. **Benefits**: Highly resistant to pest and disease.

Thanga Samba: Thanga samba is one of the traditional rice varieties, due to its rice color which likes like gold, Thangam means Gold and Samba is a season of the crop. **Benefits**: Improves Stamina.

Seeraga Samba: The rice of this variety resembles the shape of a spice Cumin seeds and Samba refer season for the crop. The rice is very fine and aromatic rice, the highest price amongst all indigenous paddy varieties of Tamil Nadu. **Benefits**: It is high in Potassium.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/3

Marker-assisted gene pyramiding for conditioning blast resistance in aromatic landrace '*MushkBudji*'

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ABSTRACT

MushkBudji (MB) is a short bold aromatic rice grown within altitudinal range of 1750 to 1900 msl in Kashmir valley. Cultivated for its pleasant aroma and taste, the produce fetches four to five folds more remuneration compared to contemporary high yielding varieties. However, high susceptibility to rice blast pathogen *Magnaportheoryzae*, has resulted in considerable decline in its area since past few decades. Thus an initiative was taken to incorporate genetic resistance in the background of MB. The genes which have been found to perform well under rice growing regions of Himalayas include *Pi54* (Sharma et al., 2002; Singh et al., 2012) and *Pi9* (Khanna et al. 2015). We in our previous study incorporated *Pi54* in combination with gene *Pita* in MB (Khan et al., 2018). Presently, we aimed at pyramiding of *Pi9* and *Pi54* in MB following marker-assisted backcross breeding (MABB) strategy from two different donors DHMAS70Q 164-1b and IRBL9W, respectively, through simultaneous-but-stepwise transfer. Foreground selection was exercised in BC_1F_1 and BC_2F_1 generations using gene based markers Pi9 Pro and Pi54 MAS. Marker-assisted background selection was employed using 123 and 87 SSR/SNP markers for lines carrying *Pi54* and *Pi9*, respectively, in BC_2F_1 generation. Fourteen BC_2F_1 lines were compared for overall genome wide recovery, among which, MB-2, MB-3 and MB-12 recorded RPG recovery of 93.54, 92.74 and 92.74%, respectively. Fifteen BC_2F_1 plants carrying *Pi9* registered a genomic recovery in the range of 77.01 to 96.55%. The selected plants in BC_2F_1 were crossed to yield inter-cross F_1 and F_2 populations. The two-gene pyramided lines (PLs) were analysed through ~1500 KASP markers and showed high recurrent parent genome recovery towards MB. The PLs showed resistance to leaf and neck blast under controlled and open field conditions. Multi-location testing of advance generation PLs helped us to generate information on stability of performance for yield and maturity. The lines shall be released as improved versions of landrace *MushkBudji*.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/4

Gujarat Anand Rice 22 (NWGR-8001): A high yielding, mid-late rice variety with long slender grain

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ABSTRACT

The research work was carried outat Main Rice Research Station, AAU, Nawagam to develop a superior high yielding, mid-early, longslender genotype of rice with better cooking and milling qualities. The genotype NWGR-8001 (IET-29278) was evaluated during the *kharif* season of 2010-11 to 2020-21 under state level multi-location trials. The experimental results revealed that the genotype NWGR-8001had5613 kg/ha grain yield, which was 22.5 and 15.1 per cent higher over the check varieties GR 7 (4616 kg/ha) and GAR 3 (4829 kg/ha), respectively in middle Gujarat. It bears 50 per cent flowering in 89-105 days, mid-late maturity (119 to 135 days), medium tall (111-157 cm) height and possess good number of productive tillers (7-10), higher number of grains/panicle (162-189), test weight (22-29 g) and length of panicle(23-30 cm). It possess good grain quality traits *viz.,* high head rice recovery (62.80%), medium amylose content (24.76%) and length: breadth ratio (4.53) and long slender grains having milled grains (7.20 mm), high cooked kernel length up to 10.9 mm, volume expansion ratio was 4.33. It was moderate resistance to all major diseases and moderately tolerance to major insect-pests of rice.During 2021-22 the genotype NWGR-8001 was proposed as Gujarat Anand Rice 22 for its release and it was recommended by State Varietal Release Committee, Gujarat for commercial cultivation under irrigated transplanted condition in Middle Gujarat as a variety Gujarat Anand Rice-22 (GAR-22).

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/5

Gujarat Rice 21: A high yielding, mid-earlyrice variety with better nutritional quality

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ABSTRACT

The research work was carried out at Main Rice Research Station, AAU,Nawagam to develop a superior high yielding, mid-early, medium slender grain variety of rice with better cooking and milling qualities. The genotype NWGR-15022 (IET-28733) was evaluated during *kharif* season of 2017-18 to 2020-21in the state level multi-location trials *viz.* PET-E, SSVT-E and LSVT-E. The experimental results, revealed that the genotype NWGR 15022 had grain yield of 5345 kg/ha which was 44.9, 23.0 and 7.0 *per cent* higher over the check varieties *viz.*, GR 4 (3798 kg/ha),GR 12 (4298 kg/ha) and Mahisagar(4994 kg/ha), respectively. Morphologically, found mid-early in flowering (86-107 days), medium maturity (116 to 137 days), medium tall (110-126 cm height) and possessed good numbers of productive tillers (8-12), higher number of grains/panicles (282.0), test weight (14.6g) and length of panicles (20.0-27.0 cm.). It possess good grain quality traits *viz.,* high head rice recovery (69.44%), medium amylose content (25.42%) and L/B ratio (3.41) and medium slender grains having milled kernel (5.46 mm), cooked kernel length was found up to 9.2 mm, volume expansion ratio was 4.63. It exhibited higher Fe and Zn content than check varieties. In the state level screening trials fordifferent pests and diseases it was found moderately resistant to major diseases and moderately tolerance to major insect-pests of rice. During 2021-22the genotype was proposed as Gujarat Rice 21 for its release as a variety and it was recommended by the State Varietal Release Committee, Gujarat for its commercial cultivation under irrigated transplanted condition in Gujarat.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/6

A Study On Rice (*Oryza Sativa*Lin.) Cold Tolerance Screening at Germination and Seedling Stage

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ABSTRACT

Rice is the fore most important and staple crop and food for one third of the world. Rice is grown from hill to plain, tropical to temperate in different agro-climatic region and seasons in the world. Rice is the crop having wider diversity with its growing season to cultivation in practice with weather variability, genetic diversity and face with different biotic and abiotic challenges during cultivation and growth phases, whereas temperature is one of them importance stress in the climate changing world. Low temperature or cold affect on rice crop from seeding to it's all most all the growth phases *i.e.* germination, seedling, tillering and pollen development cum seed set, whereas; germination, seedling and pollen development are the most sensitive and critical phases to rice for its growth and development whichis ultimatelyaffect on yield and rice economy. Looking to the cold effect and damage on rice crop production due to cold an experiment was designed with rice genotypes from diverse background along with popular varieties. An experiment was conducted for screening rice varieties at germination and seedling stage along with check varieties (CU 48, IR 64). Screening experiment was conducted in the laboratory, department of genetics and plant breeding, IRDM Faculty centre (RKMVERI), Narendrapur during 2019-20 following SES, IRRI. Germination test was conducted at 15^{0c} and 28^{0c} with 69 genotypes. Germination (%), coleoptile, root and shoot development recorded and varieties found to be tolerance *i.e.* Co 51, Bhalum 3, Bhalum 5, BINA Dhan -11, Gourab, CU 48, Mirikikuin, Ajaya, Khasa, Maharaja, Lemont, Muktashri, Rajendra Bhagabati, Karma Masuri and MTU 1010; varieties were found to be highly sensitive to cold *i.e.* Khitish, Koshar, Sarita, Satabdi and Zeera(PRR 3014) at germination. Coleoptile development was persisted highest in Bhalum 5 followed by Khasa, Karma Masuri, ADT 43, Bhalum 3, Gourab, Lemont, Rajendra Bhagabati, Tetep, Muktashri, Co 51 and Barhashaland trend found lower in the bold varieties like Koshar, Mirikikuinand K 475. Cold tolerance screening experiment was conducted for seedling stage at 15^{0c} in cold chamber with 100x close light flux and treated for 14 days and observations were recorded at 7^{th} and 14^{th} days interval. Observation wererecorded on seedling mortality, seedling health, vigor and health score followed by recovery. Under the study, varieties were found to be cold tolerance at seedling stage *i.e.* IR 36, IRAT 177, SS 1, Luna Sampad, Muktashi, Shraboni, Sabita, Nilanjana, Co 51, Shyamala, Kinuhikari, Samba Masuri, Radha,ADT 43 and China Irri and on the other hand sensitive MTU 1010, Ranjit, Sasarang, Barhashal, IR 64, Satabdi and BR 29. Therefore, those varieties were found to be suitable on cold response may be used in further breeding programme as well as crop cultivation with respect to varietal adaptability of the region and season respectively with better germination and seedling followed by crop yield and economic gain.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/7

Biolistic approach for development of transgenic rice

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ABSTRACT

Today genetically modified crops developed through gene transfer technologies are in cultivation in more than thirty countries. Transgenic technologies offer advantage as they provide gene transfer from any source of interest. Advanced high throughput sequencing techniques over last few years had made genome sequencing of many species available and the information generated can be used for genetic transformation of rice.The present research is an attempt to evaluate and utilize biolistic mode of transformation for gene transfer in rice. Being a direct method of gene transfer, this approach is known to be genotype independent and has several advantages over the *Agrobacterium* mediated mode of gene transfer. Since the recipient cells of the host (rice) play a crucial role in gene transfer, callus induction and regeneration potential of thirteen elite rice cultivars was assessed to identify suitable genotypes for gene transformation in rice. In an effort to develop a cost effective transformation protocol, different micro carriers like tungsten, gold and MMT were evaluated for gene transfer in rice and the results were promising.In the studies directed towards improvements in protocol, the performance of Green Florescent Protein (GFP), a visual marker gene was compared against GUS, the well-established reporter gene. The results support the use of GFP as a selection marker. Since the visual selection markers like GUS and GFP; antibiotic selection markers like *hpt* and *bar* may not pass the strict biosafety regulations, *phosphomannonse isomerase (pmi)*, a sugar based positive selection marker, was evaluated so as to ensure the transgenics developed are acceptable. In an effort to provide durable resistance to sheath blight, a major biotic stress for which no donor is available in rice gene pool for breeding programs;*Chitinase-11* gene was successfully transferred into rice and its expression was evaluated in the putative transgenic plants and the results are highly encouraging. The generated information can be of great help in improving the transformation protocols of rice and transgenics developed with the *Chitinase* gene can help in addressing complex diseases like sheath blight.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/8

Marker assisted selection for durable bacterial leaf blight resistance in rice

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ABSTRACT

Rice (*Oryza sativa* L.) as a staple food provides 27percent of calorie and 20 percent protein for more than half of the world population Its productivity is reduced due to several biotic and abiotic factors. Among biotic factors, bacterial leaf blight (BLB) caused by *Xanthomonas oryza*epv. *oryzae* (*Xoo*) is a potential threat to rice cultivation throughout the world .. Development of host plant resistance for the devastating diseases is necessary for the sustainability of rice grain yields. Pyramiding of resistance genes from different sources into widely adapted but susceptible varieties is necessary. Conventional breeding tools are inefficient for gene pyramiding, These bottlenecks can be addressed by marker-assisted selection (MAS), Currently, about 44 resistance genes or loci have been identified in cultivated and wild rice against *Xoo.* Long arm of rice chromosome 11 is rich in *R* genes for bacterial blight disease resistance: *Xa-10, Xa-3, Xa-4, Xa-21, Xa-22, Xa-23, Xa-26* . Several bacterial blight (BLB) resistance genes have been associated with tightly linked DNA markers, and some of them have been cloned (*Xa1,Xa -3, xa5, xa13, Xa21, Xa26, Xa27*) and used for breeding BLB-resistant rice cultivars. Because of the availability of linked markers like RG 556, RG 136, pTA248 , RM 317, RM 224, RM 13, derived from the resistance genes, it is now possible to pyramid several genes, into susceptible elite rice cultivars. Several rice varieties pyramided with multiple BLB resistance genes conferring broad spectrum resistance to multiple *Xoo*strains have been released for commercial cultivation. Notable among them, Angke(Xa4 + xa5) was released in Indonesia, Improved Lalat*(Xa4 + xa5 + xa13 + Xa21)*, Improved Tapaswini*(Xa4 + xa5 + xa13 + Xa21)*,, Improved PusaBamati 1(*xa13 + Xa21*), Improved Samba Mahsuri(*xa5 + xa13 + Xa21*), Improved PR 106 (xa5 + xa13+ Xa21), Improved Mahsuri, Swarna and IR 64 (Xa4 + xa5 + xa13+ Xa21),Pusa Basmati 1728 etc in India.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/9

Comparative analysis of molecular architecture of catalase enzyme encoded by CAT gene involved in stress response in different species of rice to design climate resilient cultivars

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ABSTRACT:

Catalase is an important scavenging enzyme of oxidoreductase class involved in the decomposition of toxic hydrogen peroxide (H2O2) into non-toxic molecular oxygen(O2) and water(H2O) molecules in all aerobic cells to protect cells from toxic effects of H2O2. These enzymes(catalases) are implicated in the low & high temperatures stress response, salinity tolerance, iron toxicity stress tolerance, cadmium stress tolerance and many other biotic stress response processes in rice. As these enzymes play a vital role in stress response in rice, understanding their molecular anatomy and architecture would provide insight for developing interventions to increase rice productivity. Due to the lack of three dimensional structural informations on catalases in rice, molecular basis of catalase in stress response is not completely understood. In this investigation, we built the three-dimensional model of catalases from two different subspecies of rice namely *Oryza sativa subsp. indica* and *Oryza sativa subsp. japonica* using their amino acid sequence as targets with the help of 3D-structural information of *Bacillus pumilus* (4qol.1.A.pdb) as template using molecular modelling.Further, we compared the active site and regulatory regions of catalases of different species of rice namely *Oryza glumipatula*, *Oryza nivara*, *Oryza rufipogon*, *Oryza meridionalis*, *Oryza barthii*, *Oryza meyeriana var. granulata*, *Oryza punctata* (Red rice), *Oryza glaberrima* (African rice), *Oryza brachyantha* (malosina) and *Oryza longistaminata*, along with the *indica* and *japonica* subspecies of *Oryza sativa* using multiple sequence alignments. Structural analysis of modelled catalases clearly showed a homotetrameric structure with the presence typical catalase domain having a beta barrel with heme binding motifs and tetramer-forming residues in each momomeric units. Multiple sequence alignment showed conservation of active site framework residues with few variations in different species of rice. Informationsembeded in these catalase models and multi-species sequence alignment would be helpful in designing molecular marker for marker-assisted breeding to design climate resilient cultivars and designing functional genomic studies to understand the role of catalases in oxidative stress response processes at molecular level.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/10

Broadening genetic base of rice resistance to biotic and abiotic stresses through wide hybridization

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ABSTRACT

Variability in the cultivated germplasm for novel traits such as resistance to rice tungro virus, sheath blight, yellow stem borer, drought and salt tolerance is limited. This necessitated search for the genes in secondary and tertiary gene pool of genus Oryza. Fortunately, wild species are an important reservoir of useful genes for resistance to major disease, pests and tolerance to abiotic stresses. Wide hybridization in Oryza is normally difficult to achieve because many wild species of genus Oryza are difficult to cross with cultivated rice because of difference in chromosome number or genetic constitution. Fertilization may occur, but the embryo is aborted. Embryo rescue is used to maintain the hybrid embryos and F1s through several cycles of back crosses until fertility is restored. Interspecific hybridization has been attempted by a number of workers and resulting hybrids and progenies have been used for taxonomic and phylogenic analysis with limited efforts to transfer desirable traits from wild species to cultivated rice. Transfer of grassy stunt virus resistance from one accession of O. nivara has been achieved successfully. Another species belonging to the AA genome, O. longistaminata has been exploited for transfer bacterial blight resistance gene to cultivated rice. Wild species with genomes non-homologous to the AA genome of O. sativa such as O. officinalis(CC), O. australiensis(EE) and O. minuta(BBCC) possessing resistance to brown planthooper , white backed planthopper , bacterial blight and blast have been used to transfer these desirable alien traits to cultivated rice. Therefore, wide hybridization is one of the key component in programme aiming at transferring alien genes from diverse sources surmounting sexual barriers. Advances in embryo rescue, anther culture, chromosome engineering and genetics have facilitated in the transfer of genes and in precise monitoring and characterization of alien introgression from different genomes of Oryza into cultivated rice. Integrating conventional breeding with advanced methods of alien introgression offers great potent to develop disease and insect resistant varieties.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/11

Shift in wavelength along with single standard appears promising for amylose estimation in rice.

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ABSTRACT

Amylose content is considered as a crucial indicator of rice grain quality. Iodine-blue method is popular for amylose estimation and it was subjected to many changes with respect to sample preparation, standards and wavelengths. Among these, Juliano (1971) version is widely followed. However, the interference of amylopectin at 620nm leads to higher amylose values. Therefore, commercially available amylose and amylopectin samples were used to identify a better wavelength to minimize the amylopectin interference in amylose estimation.

Individual potato amylose (0.4mg/ml) and amylopectin (1mg/ml) solutions were prepared. Five ml of each standard solution was separately taken into a series of volumetric flasks, 1ml 1N glacial acetic acid, 2ml of potassium iodide were added, made upto 100ml with distilled water, incubated for 20minutes in dark and the solutions were separately scanned in a UV-Visible spectrophotometer from 400 to 820 nm. Test solutions with 75% as total starch with varying amylose content (0, 10, 20, 25 and 30%) were prepared and amylose content was estimated at 620nm and 800nm. The estimated values at 800nm are close to the actual amylose content in the test solutions except for 0% amylose (75% amylopectin). Hence, this study reports 800 nm as a new wavelength for the estimation of amylose using single standard from very low to high amylose categories of rice.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/12

Characterization of improved colored rice genotypes for DUS, nutritional traits and antioxidant activity

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ABSTRACT

Rice (*Oryza sativa* L.) is the predominant staple food crop for more than half of the world's population and is playing a pivotal role in human nutrition, energy supply and food security.White rice is the most commonly consumed rice, but there are several rice cultivars such as black and red rice which are rich inanthocyanins. Due to increased health consciousness and demand for colored rice, many coloured land races are becoming popular nowadays among farming community. But many of these land races are photo-sensitive and possess tall plant stature, low yield potential, bold grain types with poor cooking quality. Hence, for the development of improved colored rice genotypes with desirable quality traits, a breeding program was initiated at ARS, Bapatla. Among these, twelve improved coloured genotypes were characterized for 31 DUS characters which includes 14 quantitative and 17 qualitative traits. In addition, these genotypes were analyzed for ten grain quality, nutritional and functional properties also. In the present study, twelve improved colored rice genotypes *viz.,* BPT 2841, BPT 2848, BPT 3136, BPT 3137, BPT 3145 (black pericarp colored genotypes), BPT 2858, BPT 3111, BPT 3140, BPT 3141, BPT 3143, BPT 3178, BPT 3182 (red pericarp colored genotypes) were grown in RBD with 3 replications following recommended cultivation practices at Agril. Research Station, Bapatla during kharif,2020. Three plants from each replication were characterized for 31 DUS traits with appropriate procedures as per the DUS test guidelines of PPV& FR Act,2001. The unpolished rice samples were used for estimation of grain quality, nutritional traits and anti-oxidant activity by following standard procedures. The mean data was used for estimation of descriptive statistics, Shannon diversity index by employing suitable statistical procedures. The results of phenotypic frequencies & trait distribution revealed that most of the genotypes possess green basal leaf sheath color, lack of anthocyanin coloration of leaf, long leaf blade length, medium leaf blade width, erect flag leaf, medium number of panicles/plant, drooping & well exerted panicles and recorded very low test weight. The results of Shannon-Weaver diversity indices revealed that attitude of flag leaf (0.81) showed high diversity while time of maturity (0.65) followed by curvature of panicle main axis (0.64), panicle exertion (0.63), decorticated grain color (0.62) and panicle length (0.60) exhibited moderate diversity. Among the genotypes tested, eight possess medium slender grain type, two long slender and one each with short bold and short slender grain type. Except one genotype, all others exhibited the desirable intermediate amylose content while the alkali spreading value ranged between 3.0-5.0. Intermediate amylose and alkali spreading value which determines the soft and flaky texture of cooked rice was manifested by BPT 2848, BPT 2841, BPT 2858, BPT 3136, BPT 3141 and BPT 3111. High anti-oxidant activity was recorded by BPT 3111 (110.09 mg AAE/100g) followed by BPT 3140 (108.83 mg AAE/100g) and BPT 3141(105.57 mg AAE/100g). The Zn content ranged from 27.0ppm (BPT 3136) to 18.0ppm (BPT 2848) while the Fe content varied from 19.4 ppm (BPT 2858) to 9.1ppm (BPT 3136). Among the genotypes under study, BPT 2858, BPT 3111, BPT 3136, BPT 2848, BPT 3140 and BPT 3143 recorded more than 10.0% protein content. In the present study, the genotypes identified with desirable physical & cooking quality traits coupled with improved nutritional traits may be included in daily diet to get the potential health benefits of colored rice.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/13

Effect of weed management strategies under different crop establishment methods in rice crop at New Alluvial Zone of West Bengal

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ABSTRACT

As our population soars nearly 10 billion people by 2050 and about 3 billion more mouths to feed more than there were in 2010. Therefore, production could be outstripped by demand. Stagnation of rice yield due to transplanted puddled rice (TPR), a widely practiced method of rice establishment affects soil physical and chemical properties besides requiring a large amount of labor and water. Growing more food with same production or even reduced costs and sustaining quality of natural resource base are major concern. The shortage of labor, water and depleting soil fertility issues causing increasing interest in shifting from TPR to direct seeding of rice (DSR).Keeping in view, a field experiment laid out in split plot design with 3 replications comprising of 4 crop establishment methods as main plots (M) *viz.* Wet DSR under puddled, Wet DSR under unpuddled, Transplanting under puddled and Transplanting under unpuddled and 6 weed management practices assub plots (S) *viz.,* Pre-emergence herbicide Pretilachlor 750 g haÉ¹*fb* by Post-emergence herbicide Bispyribac sodium @ 25 g haÉ¹, Pre- emergence herbicide Pretilachlor 750 g haÉ¹+ Hand weeding at 40 DAS/ DAT, Intercropping with Sesbania, Hand weeding twice at 20 and 40 DAS/ DAT, Unweeded Control, Weed free in Satabdi (IET 4786) variety of rice at D - block farm, --Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, during *kharif* season of 2019-20. The rice crop gave a maximum number of effective tillers per m^2(328), grain yield (4.38 t/ha), straw yield (5.35 t/ha) and harvest index (45.03%) with the combination of Transplanting under puddled and Weed free (M_3S_6) and minimum number of effective tillers per m^2 (222), grain yield (1.34 t/ha), straw yield (2.31 t/ha) and harvest index (36.76 %) with the combination of Wet DSR under unpuddledand Unweeded Control (M_2S_5).

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/14

Feature importance and association of SNPs and INDELs with grain length of OsPPKL1 gene using supervised machine learning models

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ABSTRACT

Grain size is a key breeding target as it influences quality, yield and the knowledge of the rice domestication processes. Several genes associated with grain length are well characterized in rice. Machine learning algorithms are nowadays used for prediction of individual allelic effect of a gene regulating targeted phenotype. The aim of this work is to identify the feature importance of a major grain length associated gene using supervised machine learning model namely random forest classifiers (RF). A 178 SNPs identified in 2100 rice genotypes of OsPPKL1 (Protein Phosphatase with kelch like domain) associated with grain length was retrieved from SNP Seek database of rice. The machine learning Boruta wrapper algorithm identified 43 out of 178 SNPs association with grain length. Further, training and testing data with all possible ntree (100 nos.) and mtry(25 nos.) combinations using random forest machine learning models predictedmultiple R square 0.2214 and 0.2511, respectively indicating around 25% phenotypic value association with this gene. Additionally, root mean square deviation (RMSE) for the important variants was found to be ~ 0.886 mm of grain length. Besides, mean decrease in accuracyfor feature importance plot showed two SNPs (Chr03:25050292 and Chr03:25045967) are highly important for predicting grain length in rice. Thus, supervised machine learning models identified the contribution of grain length phenotypic association of OsPPKL1 gene and two SNPs characterized using machine learning model could be utilized in precision molecular breeding for grain length improvement.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/15

Identification and Characterization of Rice Blast Resistance in Indian Rice Landraces under Kashmir agro-ecosystem

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ABSTRACT

Blast disease caused by *Magnaporthe oryzae* is a major production constraint in temperate ricegrowing ecologies. Identification of effective donors for blast resistance is required for the mapping of novel alleles which can be utilized in marker assisted selection to develop blast resistant varieties in rice. Although more than 100 genes for resistance to blast have been mapped, the location effectiveness of the genes may vary so that not all the genes can be utilized freely. The phenotyping process is also important for understanding the racial profile or general virulence behaviour of the local isolates. A set of 1000 diverse landraces of India were screened against blast disease under uniform blast nursery (UBN) at MRCFC, Khudwani, SKUAST-K during *Kharif* 2021. Seed was sown in a raised bed nursery in 100cm long rows with an inter-row spacing of 10cm. To ensure uniform spread of disease, *MushkBudji, a* highly susceptible rice landrace of Kashmir was used as infector row. It was planted after every ten test entries and also sown around the border. Field screening was carried out following the 0–9 Standard Evaluation Scale of IRRI (1996). Out of 1000 accessions, 585 were found resistant (0-3) and 284 showed moderate resistance reaction (4-5). The disease score of 6-7 and 8-9 was recorded for 67 and 64 accessions respectively. The identified resistant sources may serve as new donors and can be further investigated for the underlying genes/ QTLs.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/16

Local Indian rice landraces diversity enabled identification, characterization and efficiently harnessing its properties to broaden the gene pool of novel genetic resources of rice for bakanae disease management

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ABSTRACT

Bakanae disease of rice is considerably increasing in rice growing areas of country, leading to qualitative and quantitative yield losses under field conditions withincidence up to 40%. Local rice landraces have notbeen characterized againstbakanae disease resistance so far. The screening of 1000 Indian rice landraces against *Fusariumfujikuroi was undertaken* during *kharif* 2021 at MRCFC, SKUAST-K. The experiment was conducted under artificial controlled condition, and allowing identification of accessions with high-to-moderate levels of resistance to bakanae disease. The phenotypic evaluation of external disease symptoms at seedlings stage was scored according to the disease scale of 0 to 4 following Ooi, (2002), in order to estimate disease severity index (DSI). DSI was calculated for each treatment following Ooi (2002) within 20 and 40 days after inoculation. Varieties with DSI less than 1.6 were scored as resistant and those having DSI above 1.6 to 7.86 as susceptible. Out of 1000 accessions only 217 (22%) were resistant and 773 (78%) were susceptible. There were 10 lines (2%) which did not germinate. The identified 217 resistant landraces against the disease are valuable genetic resources. The information obtained in current study shall be quite helpful in identifying novel resources of resistance, their utilization in development of acore set of landraces which represents entire diversity for broadening gene pool and harnessing properties for rice improvement programme.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/17

Marker-assisted introgression of major QTLs, qDTY1.1, qDTY2.1, qDTY2.2, and qDTY3.1 for grain yield under drought stress into the background of DRR Dhan 50

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ABSTRACT

Drought is one of the major abiotic stresses limiting rice production grown under rainfed low lands and uplands, leading to 13–35% yield loss (Shamsudin*et al.,* 2016). In view of changing climate and reduced groundwater table, it is estimated that globally >50% of the arable land will get affected by drought by 2050. Hence the present study aims to genetically enhance drought tolerance of an elite rice variety DRR dhan 50 (Sub1, qDTY2.1 and qDTY3.1) by introgressing two more major QTLs for grain yield under drought (qDTY1.1 and qDTY2.1) from the donor SAB 4-7-5. Marker-assisted backcross breeding is a promising approach facilitating accelerated breeding for improved drought tolerance.Parents were validated for target QTLs using linked SSR markers *viz.*, RM521 and RM5791 (qDTY2.1), RM16030 (qDTY3.1), RM12091 and RM431 (qDTY1.1) and RM279 (qDTY2.2). Using 750 genome-wide SSR markers parental polymorphic survey was carried out between donor and recurrent parent, of which 101 markers showed polymorphism. To introgress qDTY1.1andqDTY2.2 intothe genetic background of recurrent parent (DRR Dhan 50), it was crossed with donor (SAB 4-7-5). Further, the recurrent parent was backcrossed with true F_1 heterozygotes confirmed by foreground markers linked to four drought QTLs and generated 200 BC_1F_1 plants. Based on the marker-assisted selection, the 2nd back cross was made between RP, and two confirmed BC_1F_1 heterozygotes possessing recurrent parent genome recovery of 73 to 75% and phenotypic similarity with recurrent parent and produced BC_2F_1 seeds. The segregating population of 79 BC_2F_1 were grown under normal field conditions. Upon molecular screening with foreground markers, three individuals were found heterozygous with all 4 QTLs. Background selection with 101 genome-wide polymorphic SSRs revealed 81.19 to 88.12% of recurrent parent genome recovery. Selfing of these 3 BC_2F_1 plants produced around 450 BC_2F_2 seeds each,among which foreground, background selection and phenotypic response for drought stress in BC_2F_2 population are under progress.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/18

Characterization of diverse rice germplasm for agro-morphological traits under control and reproductive drought stress

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ABSTRACT

30 rice genotypes of diverse origin along with 8 diverse check varieties namely DRR Dhan 44, Sukadhan 5, MTU1010, Sahbhagi Dhan, IR64, Swarna Shreya, Sabour Shree (Local Check-1) and Sabour Deep (Local Check-2) were evaluated in two experiments conducted simultaneously under control and reproductive stage field drought stress during *Kharif* 2020. In drought experiment, water was withheld before 25-30 days of 50% flowering. All the genotypes were analysed for nine important agro-morphological traits *viz.*days to 50% flowering, plant height (cm), panicle length (cm), number of tillers per plant, no. of tillers plant^{-1}, grain yield plot^{-1} (g), number of filled grain panicle$^{-1,}$ number of unfilled grain panicle^{-1}, total number of grains panicle^{-1} and panicle fertility percentage. Results revealed that all of the traits under study were having a decreasing trend under reproductive stage drought when compared with the control condition. Panicle length, no. of tillers plant^{-1}, grain yield plot^{-1} (g) and panicle fertility% were found to be having relatively sharp decline under reproductive stage drought confirming that these traits were comparatively more sensitive towards the water stress condition at reproductive stage.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/19

Mapping quantitative trait loci for stay-greenness under varying levels of nitrogen in rice

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ABSTRACT

Rice is an important cereal food staple of the world. Nitrogen use efficiency (NUE) in rice is of importance because 30-35% of the applied nitrogen is utilised. Secondary traits such as stay-greenness can help in improving NUE thereby enhancing grain yield. In this study, a RIL population from the cross SG16-4/Pusa677 contrasting for stay greenness, was evaluated under two N regimes along with checks (Nidhi, Panvel, Rasi, and Nagina 22) in alpha lattice design with two replications. ANOVA for yield and yield related traits under N regimes showed significant variation among the RILs. Stay-green trait exhibited strong association with plant height, flag leaf length, days to 50% flowering, grains per panicle and total plant nitrogen. NUpE and NUtE parameters showed strong correlation with yield and yield contributing traits irrespective of N dose. A linkage map spanning 1910.8 cM was generated using genotypic data from 230 RILs using 104 SSR markers polymorphic between the parents. A major QTL (*qSG1.1*) was mapped on chromosome 1 by inclusive composite interval mapping (ICIM) for total chlorophyll content. Besides this, a total of nine and thirteen QTLs were mapped under normal N level and native N conditions, respectively for N use parameters. Majority of the QTLs explaining high phenotypic variation were mapped on chromosome 1. QTLs identified for stay-greenness and NUE parameters were not co-localized. Validation of the QTLs through multi-environment testing and fine mapping can help unravelling the basis of NUE in rice.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/20

Physiological and Biochemical Characterization of Rice Genotypes for Drought Stress Tolerance

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ABSTRACT

Drought stress impacts over 23 million hectares of rainfed rice around the world. As a result of the current climate change, the situation is anticipated to worsen. Drought has a negative impact on agricultural growth factors, resulting in lower yields. The extent of the damage is determined by the scale of the stress, the duration of the stress, and the plant's growth stage. Changes in the rice plant's morphological, physiological, biochemical, and molecular processes reflect the negative outcomes.Thus, identification of drought-tolerant rice genotypes resilient to changing climate is need of the hour.The present study was conducted to evaluate the performance of seven rice genotypes using morphological, physiological and biochemical parameters, under induced drought (water stress) conditions at seedling level. Seedlings of all the genotypes were grown in soilless hydroponic system with ½ strength Hoagland's solution for 21 days. Later drought stress was imposed by feeding seedlings with 20% PEG6000 in Hoagland's solution for 7 days along with control treatment (without PEG). At the end of the stress period sampling was done to record the root and shoot lengths and various physiological parameters viz., total chlorophyll content, cell membrane stabilityindex, relative water content were estimated. Proline and MDA content were also estimated as biochemical parameters. The results obtained from the study revealed the existence of significant variation in the seven genotypes studied for different physiological and biochemical parameters.Outof the seven genotypes studied, HT-18 (AC-34973)had performed better than the tolerant check Sahbhagi Dhan and showed better root and shoot growth, maintained higher total chlorophyll content (2.6 mg/ gmFW), relative water content (61.3%) and membrane stability index (52.9%), it had also shown higher proline content (20.52 ìmoles/gmFW) and lesser MDA content (0.068)under stress. The present study identified HT-18 (AC-34973) as seedling level drought tolerant genotype.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/21

Identification of rice genotypes with higher cellular level tolerance to heat stress by employing temperature induction response

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ABSTRACT

Rice is a major staple food cropthat is consumed by more than half of the global population. Production of rice is decreasing due to variousabiotic factors like salinity, heat, chilling, drought etc. To develop climate resilient varieties that can cope with various abiotic stresses, one of the proven and effective strategy is incorporating stress tolerance into high-yielding varieties. Thus, identifying rice genotypes that are tolerant to multiple abiotic stresses and resilient to changing climate is need of the hour. The present study wasaimed at screening and identifying rice genotypes possessing higher heat stress tolerance at cellular level. A novel approach called temperature induction response (TIR) technique was used to phenotype a set of diverse rice genotypes for tolerance at cellular level.The genotypes showed significant genetic variability in parameters linked with intrinsic tolerance. Genotypic variation in seedling mortality during recovery from challenging temperature (54°C) ranged significantly from 46 to 100% in non-induced seedlings and 26 to 65% in induced seedlings. HT-20 (AC-34975), followed by HT-18 (AC-34973) and N-22showed better intrinsic tolerance mechanism. Higher Chlorophyll Stability Index (CSI) was observed in HT-20 (82.65%) followed by HT-18(80.57%) and N-22 (78.24%). Lowest CSI was recorded in IR-64 (59.74%) after induction. HT-20, HT-18 and N-22 recorded the lowest content of malondialdehyde (MDA) after the induction treatment. The ability of a plant to respond to the induction treatment is a good reflection of its "intrinsic tolerance" ability at the cellular level. Activity of antioxidant enzymes increased in seedlings subjected to induction temperature followed by challenging temperature (induced seedlings) to non-induced seedlings. Peroxidase and SOD activity increased in all the genotypes under induced condition. Genotypes HT-20 and HT-18exhibitedlower seedling mortality, higherCSI, less reduction in shoot and root growth, and better reactive oxygen species scavenging system, which are very critical for cellular level tolerance. Thus, the present study identified genotypes HT-20 (AC-34975) and HT-18 (AC-34973)as possessing tolerance to heat stress owing to their higher cellular level tolerance.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/22

Molecular characterization of rice gremplasms for *S5* locus using PCR based functional markers

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ABSTRACT

Rice is a major food crop grown and consumed all over the world. Nearly 87% of rice production comes from Asia and India has major share in the total output of production and revenue. Rice occupies an area of 44 mha in India while hybrid rice occupies merely 3.1 mha. The magnitude of heterosis exploited from different crosses can be summarized as: *indica* x *japonica* > *indica* x *javanica*> *japonica* x*javanica*> *indica* x *indica* > *japonica* x *japonica*. In India, most of the released hybrids are in *indica* background. Hence the productivity of rice could be increased by utilizing the high heterosis from *indica* x *japonica* crosses. The major problem in inter-subspecific cross between *indica* and *japonica* is hybrid semi sterility. The sterility is governed by nearly 50 genes among which *S5* locus is major locus and well characterized governing embryo sac sterility in inter subspecific crosses. There are some genotypes which give fertile hybrids when crossed with either *indica* or *japonica* called as wide compatible varieties (WCVs). *Indica* possess *S5-i*, *japonica* has *S5-j* and WCV has neutral allele *S5-n* at *S5* locus. Only two varieties Nagina 22 and Dular are being used as promising WCVs over the world. Therefore, it is necessary to characterize the rice germplasm through molecular screening using PCR based functional markers of *S5* locus to identify wide compatible varieties carrying neutral allele *S5-n*. The present study includes a total of 967 rice genotypes which includes 297 IRG lines, 180 *tropicaljaponica* lines and 490 germplasm lines were used for molecular screening using functional markers. The markers being used were S5-InDel for neutral allele, S5-ELSP (F), S5-IASP (R) for indica allele and S5-JASP (F), S5-ELSP (R) for *japonica* allele. After molecular screening it was found that 171 lines carries neutral allele (*S5-n*), 140 lines carries *japonica* allele *(S5-j*) and 656 lines carries *indica* allele (*S5-i).* These WCVs identified could be well utilized to obtain fertile hybrids in crosses between *indica / japonica* and combine and transfer beneficial genes between the two ecotypes of rice.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/23

Phylogenetic Orthology inference of Amino Acid Permease gene (aap) family in different *Oryza* species

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ABSTRACT

AAPs are amino acid transporters localized in plasma membrane which are important in a variety of plant metabolic processes related to nitrogen and carbon metabolism. AAP gene family specifically transports different groups of amino acids between cells and regulates the nitrogen and protein synthesis. Besides, AAP gene expression is negatively correlated with the number of tillers in rice. Down regulation of expression of AAP gene could enhance the bud growth, effective tiller number, and enhances the grain production. Though AAPs have multifaceted function, reports of evolutionary understanding in different AA genomes of rice are limited. Altogether, 343 homologous protein sequences of AAPs were used to construct a phylogenetic tree to investigate intra- and inter-species divergence within AA genomes of rice. Phylogenetic tree revealed two separate clusters for all major structural classes of AAPs, implying that the sequences of AAPs proteins are conserved across structural classes. Further, orthology analysis identified ten clusters which are common between AAP homologs of *O.rufipogan*, *O. sativa indica*, *O. sativa japonica, O. barthii,*and*O. nivara*and about 15 orthologous clusters were absent in *O. sativa indica* as compared to *O. sativa japonica* and *O. rufipogan*. Thus, indica specific imprints of AAPs gene family variation need to be better understood for its functional characterization and utilization in rice improvement.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/24

Cytochrome P450 Monooxygenase gene family evolutionary patterns in cultivated (*Oryza sativa* L.) and wild rice (*Oryza rufipogan* L.)

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ABSTRACT

The cytochrome P450s (CYPs) is one of the biggest gene family of enzymes that regulates plant metabolism architecture and evolution. CYPs are mostly localized in the endoplasmic reticulum and are involved in production of many metabolites. For example, phytoserotonin found in a variety of tissues in plants is one of the examples of CYPs regulated metabolite synthesis. In this study, we focus on three diploid *Oryza* species comprising of two cultivated and one wild relatives with AA genome namely, *O.sativa*var.*indica*, *O.sativa*var.*japonica* , and *Oryza rufipogon* respectively. The complete genomic sequences, protein sequences, and annotation information for three *Oryza* species, were downloaded from Ensembl and retrieved using the RGAP and RAP-DB databases of rice. A reference protein involved in phytoserotonin synthesis namely CYP71A1 was used for the retrieval of homologous sequences. The phylogenetic tree comprising of 772 homologous CYPs were divided into three major clades. Further, these three major clades were clustered into eight sub clades with different number of homologs. Besides, orthologous cluster analysis identified 172 clusters of which 22 clusters were specific to *O. rufipogan* and *O. sativa japonica* and 32 clusters were unique to *O. rifipogan* and *O. sativa indica*. This finding clearly indicates CYPs gene family underwent divergence even after the separation of *indica* and *japonica* ecotypes from *O. rufipogan*. Therefore, characterization of ecotype specific clusters will provide additional insights into rice evolution and divergence.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/25

Genetic Variability, Path Analysis and Diversity Studies in Rice (*Oryza sativa* L.) Genotypes

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ABSTRACT

The experiment was carried out at Agricultural Research Station, Shirgaon, Dist. Ratnagiri (MS)in *kharif* 2020 to assess the extent of genetic variability, path analysis and diversity for yield and yield related traits in fifty genotypes of rice.High heritability estimates along with high genetic advance as percent of mean, high GCV & PCV were recorded for number of tillers per panicle, number of filled grains per panicle, number of spikelets per panicle, test weight and L/B ratio. Therefore, improvement of these characters would be more effective in crop improvement programme.Path coefficient analysis revealed that, the characters *viz.*, plant height, number of tillers per plant, grain breadth, L/B ratio, straw yield and harvest index had positive direct effect on grain yield per plant. Hence, phenotypic selection for these characters would help in selecting high yielding genotypes in rice.Based on the relative magnitude of D^2 values, the 50 genotypes were grouped into six clusters.The Cluster I was the largest which consisted of 45 genotypes. The maximum inter-cluster distance was observed in cluster IV and VI followed by cluster III and VI indicated wide range of variation among the clusters formed. Hence, the genotypes underlying in these clusters could be used in hybridization programme for further crop improvement in rice. Grain yield per plant (g) (16.51%) recorded highest contribution towards genetic divergence.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/26

Identification of potential donors of *PSTOL1* gene through gene-based functional markers in Manipur rice germplasm

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ABSTRACT

Phosphorus is an essential macronutrient to all the crops and it plays a major role in various plant growth and development. Low availability of phosphorus in the soil significantly affects rice growth and yield. A major quantitative trait locus for phosphorus deficiency tolerance, *Pup1*also known as *PSTOL1*(*phosphorus starvation tolerant 1*), encoding a specific protein kinase was recently mapped and cloned in the traditional *aus*-type rice variety, Kasalath which significantly enhances grain yield in phosphorus-deficientsoil. Due to acidic nature of soil in the NE states of India, phosphorus deficiency is predominant in the rice cultivated area. Therefore, it is prerequisite to identify the potential donors of *PSTOL1* gene in locally cultivated rice germplasm for the development of phosphorus tolerant rice varieties through precision breeding like MAS.In the present study, a set of 92 rice including popular cultivars and landrace collected from different parts of Manipur were genotyped for presence of the favourable allele of *PSTOL1* gene using a set of eleven functional locus specific gene-based markers viz. *Pup1*-K4, *Pup1*-K5, *Pup1*-K20, *Pup1*-K29, *Pup1*-K41, *Pup1*-K42, *Pup1*-K43, *Pup1*-K46, *Pup1*-K48, *Pup1*-K52 and *Pup1*-K59. Out of the total 92 genotypes, eleven genotypes were found to be negative for all the eleven markers. The clustering analysis of these 92 genotypes using scoring data of 11 markers depicted separation of 92 genotypes into three major groups. The Group-I consists of 20 genotypes carrying only favourable allele of *Pup1*-K5 marker. The Group-II consists of three genotypes *viz.* Acefuchisho, Ching pourenamubi and Naga special which have only two favourable alleles of *Pup1*-K5 and *Pup1*-K52 markers. The Group-III consists of the remaining 69 genotypes which are distributed into many subgroups. A distinct sub-groupof Group-III were consisted of only 8 genotypes*viz*. Churachanpur Phou, Dharam Phou, InsatangMakokching, Chakhao, ManuiKhamei, Kemeste, Arunachal-1 and Lesem Jang and found to be positive for all 11 markers which would be further useful as the potential donors for development of high yielding P-tolerant rice varieties and for mining of novel allele of *PSTOL1*gene conferring tolerance to phosphorus deficiency.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/27

Callus mutagenesis using EMS to study mutagenic response of aromatic rice landraces

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ABSTRACT

Callus mutagenesisis foundto bemore effective than seed mutagenesis because cells located on the surface of embryogenic callus are more exposed to chemical mutagens than complex cells of seed embryo. A study was carried out to find the efficiency and effectiveness of 0.2% ethylmethane sulphonate (EMS) mutagen on four local aromatic rice landraces Kalikati, Basumati, Gangabali and Karpurajeera by treating the calliinitiated from their mature embryos for 2 hours, 4 hours and 6 hours duration. The experiment was conducted at tissue culture laboratory of Biotechnology Division, National Rice Research Institute (ICAR), Cuttack during November 2018 to October 2019 and at RRTTS, Bhawanipatna (OUAT) during December 2019 to December 2020. It was observed that the shoot regeneration efficiency of treated calli in Kalikati (62.8,42.1,26.9) and Basumati (41.3,32.1,22.6) reduced with increasing duration of treatment while in Gangabali (82.4,86.2,94.1) and Karpurajeera (70.3,76.1,88.5) it increased with duration, compared to control (66.5,58.1,76.3,68.2, respectively). Maximum frequency of chlorophyll mutations per 100 M_2 plants obtained in M_2 generation was with 6 hours duration treatment. The frequency and spectrum of viable mutations per 100 M_2 plants was maximum in 2 hours duration in Basumati followed by Gangabali. Among chlorophyll mutants, *viridis* were most frequent followed by *xantha*, *albina* and *chlorina*in all the genotypes. Grain mutants, plant height mutants, panicle mutants, increased tillering ability mutants and grain yield mutants were prominent in the genotypes. Total 27 economically useful mutants were selected from Basumati (11), Gangabali(8), Kalikati(4) and Karpurajeera(4) for advancing to M_3 generation. Reduction in plant height was from 17.6% to 20.1 % inBasumati and 17.4% to 28.1% in Gangabali compared to parent. Increased tillering ability ranged from 43.7 to 61.2% in Gangabali while increase in yield ranged from 15 to 21% in Basumati and 17.4% to 23.2% in Kalikati. Desirable mutants obtained by EMS treatment established its mutagenic effect on calli of aromatic rice landraces.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/28

Genotypic evaluation of F_2 (IBT GM14×YPB 46) lines for *Gn1a* gene

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ABSTRACT

Occurrence of multiple biotic stresses in a single crop season has become more frequent than before. Institute of Biotechnology (IBT) is involved in developing rice lines with mutliple biotic stress resistance. So, we at IB, selected a rice line IBT GM14 developed through MAS, which is under the genetic background MTU 1010, possessing resistance to gall midge and bacterial blight already and attempted to improve it for high yield. The line IBT GM 14 was crossed with YPB46 possessing *Gn1a* gene in MTU 1010 background for enhancing the yield. The present study reports the genotypic evaluation of F_2 lines of the cross, IBT GM14×YPB 46, for *Gn1a* gene using Gn1a indel 3 marker. A total of 295 F_2 lines were screened through PCR analysis, of which 39 lines were homozygous positive, 121 lines were heterozygous for the gene and 135 lines were homozygous negative for the *Gn1a* gene. These lines could be forwarded further towards development of high yielding rice lines with multiple biotic stress resistance which would be valuable for rice farmers and also in future rice breeding programs

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/29

Genetic dissection of Panicle characters and grain yield through GWAS by using cgSSR Markers in rice (*Oryza sativa* L.)

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ABSTRACT

Yield enhancement in rice is one of the continuous exercises for plant breeders due to the growing demand for production of rice. Yield being a complex trait is governed by several other traits directly or indirectly. Panicle related traits like panicle length (PL), number of primary branches per panicle (NPB), number of grains per panicle (NG) and panicle weight (PW) directly affect grain yield (GY) in rice plant. Genetic dissection of genes/QTLs governing panicle related traits is necessary for increasing the yield potential in rice. Genome wide association studies (GWAS) is a technique based on the principle of linkage disequilibrium that is used to detect genes or QTLs that are underlying these complex traits. In this study, MLM model with EMMA approach was used to find significant loci associated with four panicle characters and grain yield in the panel rice genotypes by using 142 cgSSR markers. For five observed traits, we found 17 novel significant marker-trait associations on six chromosomes. Four markers were found to be associated with multiple traits indicating that these markers can be used in simultaneous selection of respective traits improvement. The percentage of phenotypic variance that could be explained ranged from 4% to 13%.Trait-associated cgSSR markers derived from corresponding or related genes ensure their utility in direct allele selection, while other linked markers aid in allele selection indirectly altering the phenotype of interest. Through a marker-assisted breeding approach, these marker-trait associations can be leveraged to accumulate favorable alleles for yield enhancement in rice.

ADJNS/TH-I/LT/30

Protein content and amino acid fractions of black rice

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ABSTRACT

Grain protein content (GPC) is a significant factor in the nutritional quality of rice. Among available rice germplasms, a wide range of variability in GPC (5– 18% with an average of 9.5%) was observed by the scientists at International Rice Research Institute (IRRI), Manila. Milled rice consists of about 78% starch, while protein represents the second most abundant constituent (6-7%). Conversely, rice bran contains high level of fat (5-10 %) and protein (11-15%), as well as fibre (7-11%). The study relating to protein content in black rice (*Mamihunger, Chakha, Kalobhat and Manipuri black*) and their products, though scanty, however , It was observed that crude protein contents of black rice were higher than red and brown rice. However, degree of milling decreased the level of proteins from the surface to the endosperm of brown rice (Lamberts et al., 2007).Highest total protein content of grain (PROT) was found in popped rice of *Mamihunger*(11.44%) followed by popped rice of *Chakha*(10.41%). Among all the products, the average quantity of protein was recorded highest from popped rice (9.83%) and lowest from boiled rice (7.2%). PROT was little higher in popped rice as compared to milled raw rice (9.41%) because of existence of bran layers in the products and higher sample volume resulting from lower moisture content. Therefore, it is evident that PROT of popped rice was not adversely affected due to thermal treatment. However, reduced PROT was recorded from beaten (av.8.91%) and puffed rice (7.86%) resulting from hydrothermal processing and non-existence in bran layers, respectively.Several studies suggest that rice proteins have anti-oxidative, anti-hypertensive, anti-cancer and anti-obesity properties. In our study, the cultivar *Kalobhat* showed highest total protein content (10.56%) and least (7.56%) with the check variety *Swarna sub-1*. The average quantity of amino acids content in milled raw rice was recorded highest in *Kalobhat* (5.45 mg/g) followed by *Mamihunger* (5.26 mg/g) whereas lowest was found in *Swarna sub-1* (1.27 mg/g). Among all the amino acids fractions, PHE (29.64 mg/g) and GLU (9.60 mg/g) were the most abundant in rice.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/31

Glycolate catabolic pathway derived bypassing photorespiratory rate enhances photosynthesis, biomass and yield in rice (*Oryza sativa* L.)

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ABSTRACT

In C3 plants like rice, photosynthetic productivity is limited by lower assimilation of CO_2 into organic carbon compounds as RuBisCO poorly discriminates between CO_2 and O_2, leads to photorespiration with loss of fixed carbon and nitrogen. In total, three molecules of atmospheric oxygen were consumed in the C2 oxidative photosynthetic cycle that elicits the release of one molecule of CO_2 along with the consumption of two molecules of ATP in chloroplast and two molecules of reducing equivalent. Despite these disadvantages, photorespiration has some important roles in plant because it recovers 75% of the carbon from phosphoglycolate as well as efficiently removes potent inhibitors of photosynthesis. Moreover, photorespiration dissipates excess photo-chemical energy under high light intensities, thus protecting the chloroplast from over-reduction. Photorespiration accounts for 20-50% reduction in grain yield in C3 crops. The process is essential to remove 2-phosphoglycolate produced due to the oxygenation activity of the RuBisCO enzyme. Numerous photorespiratory bypass modules have been introduced into various plants that result in the improvement of photosynthetic rate by elevated CO_2 concentration in the chloroplast. To evaluate the efficacy of employing genetic engineering approach to ameliorate the photosynthesis and grain yield of rice, *Escherichia coli* glycolate catabolic pathway (ECGC) genes were completely (full bypass: FB) or partially (partial bypass: PB) introduced into rice chloroplast. Five genes encoding glyoxylate carboligase (GCL), tartronic semialdehyde reductase (TSR) and three subunits of glycolate dehydrogenase (GDH) were introduced to get FB plants, whereas only the three subunits of GDH were introduced to get PB plants. PCR and Southern analysis confirmed stable integration of transgenes with a high level of expression in the advanced progenies. Both FB and PB transformed lines exhibited increased photosynthetic efficiency, biomass and grain yield than without transgene (WT) plants. The introduction of ECGC pathway upregulated the carboxylase activity of RuBisCO while downregulating its oxygenase activity fostering the functioning of Calvin-Benson cycle and resulting in increased carbon-assimilation that was manifested in their superior architecture and harvest index. These findings will support rice breeding and other cereal cropbreeding programs to increase yield under elevated temperature and arid conditions.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/32

Marker Assisted Pedigree Breeding (MAPB) for improvement of drought tolerance in restorer line of rice

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ABSTRACT

Drought stress is a major abiotic stress, limits yield to a greater extent in water limited conditions. Selection of yield under drought with molecular marker aided technology resulted in considerable progress in recent times. The yield advantage of irrigated hybrids over popular varieties is well documented, systematic efforts to improve hybrid parental lines for unfavorable ecologies is need of the hour. Introgressions of QTLs for drought tolerance in varieties had resulted in substantiate yield improvement and release of improved varieties under drought stress conditions. In the present study, a drought-tolerant donor Shabagidhan, consisting of 4 QTL's namely, q$DTY_{12.1}$, q$DTY_{1.2}$, q$DTY_{2.2}$& qDTY$_{6.1}$ utilized in crossing with a popular restorer line, KMR-3R male parent of KRH2 hybrid possessing two major fertility restorer genes namely *Rf3 & Rf4*. . Marker aided selection was carried out at each generation from F_1 to F_5 with foreground SSR markers viz., RM28048 RM28199, RM28166 for q$DTY_{12.1}$ and RM315for q$DTY_{1.2}$and RM211 for q$DTY_{2.2}$ and RM211, RM527for q$DTY_{6.1}$, RMS-SF-21-5 for *Rf3* and RM6100, RMS-PPR-9-1,for *Rf4.* Drought stress was imposed under field conditions at panicle initiation stage in 120 F_5 lines, of which among which 13 improved lines possessing fertility restoration and different combinations of drought QTLs were identified. The hybrids derived from improved restorer lines showed variability in drought response and first of its kind in improvement of drought tolerant hybrids for unfavorable environments.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/33

Machine Learning Models: a pivotal approach to detect association of SNPs and InDels with grain length of Growth Regulating Factor (*OsGRF4*) in rice

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ABSTRACT

The introduction of the *Sd1* gene during greenrevolution brought a dramatic change in rice production. However, to meet the ongoing demand, we need to increase productivity in terms of quality and quantity. In this target, crop output is determined by seed size, which has been widely researched in rice. Grain length, width, and thickness are the factors that influence rice grain size. A rice gene namely growth regulating factor (*OsGRF4/GS2*) is a transcription factor that has a regulatory role in grain development. It controls panicle length, grain length,and width. Machine learning has the ability to extract patterns and causal factors from massive amounts of data relating to specific phenotypes.This study aims to detect the phenotypic association of InDelsand SNPs associated with *OsGRF4* using supervised machine learning Random Forest models. A 104 SNPs identified in 2100 rice genotypes of *OsGRF4* (Growth regulating Factor 4) associated with grain length were retrieved from SNP Seek database of rice. The machine learning Boruta wrapper algorithm identified 37 SNPs as important features associated with grain length.Further, combination of different parameters namely ntree (100 nos.) andmtry (25 nos.) in random forest machine learning models predicted multiple R square 0.4392 and 0.4431, respectively in training and testing datasets indicating 44% phenotypic association. Additionally, root mean square deviation (RMSE) for important feature was found to be ~0.7321 mm of grain length. Besides, mean decrease in accuracy for feature importance plot showed two SNPs (Chr02:28864657 and Chr02:28866297) are highly important for predicting grain length in rice. Thus, machine learning identified these two important SNPs associated with grain length which can be exploited using genome editing for precise genetic improvement.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/34

Genetic architecture and population structure among rice line using gene specific grain yield related markers

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ABSTRACT

Rice (Oryza sativa L.) is a major food crop of the world. Increase in rice productivity keeping in pace with the world population is necessary to ensure the food security of the world. Genetic variability is the primary source of diversity in every crop development attempt. Genetic enhancement of yield requires the identification of promising alleles from the genepool and their introgression in the desired genetic background. For this purpose the diversity for yield *per se* and other yield attributing traits in the rice germplasm need to be assessed at different levels *viz.*, morphological and molecular levels. The goal of this study was to look at the genetic architecture and population structure at the molecular level among 35 rice genotypes. A panel of 35 rice genotypes were genotyped using 40 gene specific markers which are in linkage disequilibrium with yield and yield-contributing traits. Using the UPGMA based cluster analysis method, the 35 rice genotypes were divided into three groups. Based on distance-based proposal and model-based structural analysis, the population of 35 genotypes was divided into three sub-groups. According to the analysis of molecular variance (AMOVA) study, there is 20% dissimilarity between populations and 80% dissimilarity within populations. Thus, 35 genotypes were highly diverse based on phylogenetic analysis and forming 3 distant groups. These varieties showed a wider genetic base in relation to the gene-based marker employed for the present study. The outcome of the present investigation will help in the parental selection for hybridization programmes to improve the yield performance of rice varieties.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/35

Employing machine learning algorithms for the identification of common stress responsive pathways for biotic stress in rice

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ABSTRACT

Machine learning is a subset of artificial intelligence that identifies pattern and makes predictions related to biological meaning which is hidden in the different types of data. Biotic stress in rice is one of the major factors which contribute to yield loss.Though, differential gene expression and map based cloning are routinely used for the characterization of biotic stress responsive pathways, comprehensive analysis of multiple biotic stress responsive pathways is still in initial stage in rice. In the present study, microarray gene expression data of rice transcriptome against biotic stresses namely brown plant hopper, bacterial blight,blast, gall midge, nematode, stem borer, and rice stripe virus has been analyzed for the identification of common biotic stress responsive genes using machine learning models. The gene expression data was initially normalized and unsupervised machine learning models namely K means was used for clustering of the gene into three major clusters. Out of these three clusters, a thousand genes were retrieved and were subjected to supervised machine learning models for pattern identification and prediction using Boruta and random forest wrapper algorithms. Using the trained data, supervised models identified four genes which were capable of classifying the samples into non stress and stressed samples with an accuracy of 79.4%. The two genes identified were related to regulating glycolysis and fatty acid metabolism pathways indicating energy metabolism plays a significant role in disease or pest progression and severity. This knowledge would assist in framing newer genetic strategies for biotic stress control in rice.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/36

Combination of supervised and unsupervised machine learning models for identification of common multiple abiotic stress pathways in rice

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ABSTRACT

Machine learning has the potential to identify the patterns and causal factors from complex and large volume of data corresponding to particular phenotypes. Rice is an important crop wherein mechanistic insights into the abiotic stress response are still in progress. One of the approaches for understanding the abiotic stress response includes the whole transcriptome analysis. In this work, we have used the microarray data of the rice transcriptome against abiotic stresses namely drought, salt, high temperature, cold, and submergence for the identification of common abiotic stress genes responsive genes using machine learning models. Initially, quantile and min-max normalization was performed for the gene expression data to reduce the cross experimental errors. Then, unsupervised machine learning K-means model were used for grouping of data into four different clusters. Out of four clusters, a thousand genes were retrieved representing all the six clusters for further analysis. These thousand genes were analyzed using wrapper algorithm in Boruta package for the classification of control and stress samples. From this analysis, eight genes were identified to be capable of differentiating the non-stress and abiotic stress samples. The training and testing using random forest machine learning models showed prediction accuracy of 79% between stress and non stress samples using only eight identified genes. These eight genes were related to ABA signalling pathway, secondary metabolism, and glutathione antioxidant pathway and could regulate the common multiple abiotic stress responsive pathways in rice. Specifically, three genes with unknown functions were also identified which could be further characterized for abiotic stress response in rice for the development of multiple stress tolerant varieties.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/37

Genetic dissection of grain size traits through GWAS using genic markers in rice

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ABSTRACT

Grain size plays a major role in improving the yield potential and consumer preference in rice. As a result, the traits related to grain size have received more attention recently from researchers for genetic dissection and improvement of these traits. Since, these traits are quantitative traits governed by several genes, conventional breeding and selection for these traits is difficult. Bi-parental mapping populations only capture variations available between two parents, whereas GWAS (Genome wide Association Studies) captures variations in a population with a high resolution. In this study GWAS was used with the EMMA coupled MLM model for dissecting complete genetic control of four grain size traits by using 142 cgSSR markers derived from yield related candidate genes in a panel consisting of 88 rice genotypes. The vanRaden kinship algorithm based heatmap showed low relatedness among individuals of the panel. Structure analysis and principal component analysis ascertained the population structure by dividing panel into three subpopulations. For four grain size-related traits, a total of ten significant marker trait associations were discovered. Seven out of the ten MTAs explained more than 10% of the phenotypic variation of the trait, implying these might be major putative QTLs for respective traits. The markers derived from genes OsBC1L4, SHO1 and OsD2 showed association with two grain size traits implying that these markers can be used for marker assisted selection of both the traits. The new cgSSR markers found to be linked with grain size related features can have a substantial impact on plant breeding efforts to raise the number of causal alleles for these traits using marker-assisted rice breeding.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/38

Genome-wide association analysis for plant architecture and yield related traits using cgSSR markers in rice (*Oryza sativa L.*)

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ABSTRACT

Plant architecture is an important characteristic of rice which has a substantial impact on photosynthesis. Increase in photosynthesis leads to increase in yield potential of rice, so determination of QTLs/genes underlying these plant architecture related traits is necessary. The plant architecture related traits show a quantitative inheritance, as a result, genetic dissection of genes/QTLs underlying these traits is difficult by biparental mapping. GWAS approach is most promising approach to dissect these traits. We developed 142 candidate gene-based SSR markers and used them in GWAS study on a panel of diverse rice genotypes to determine marker-trait association for three plant type characters and grain yield. For four observed traits, 17 Marker-trait associations were detected. Three markers derived from genes *OsGID1*, *OsFBK12* and *OsMADS18* showed association with the traits which were previously reported to be controlled by these genes respectively. Many novel associations of genes with the traits were detected that had never been reported before. Two markers from gene *IDEF1* and *OsGID1* showed association with grain yield per plant. Three markers were found to have association with two traits each. These markers can be used in simultaneous selection for both the traits. The novel marker-trait associations reported in this study, can further be validated and then they can be utilized to increase rice grain production or plant architecture by using marker-assisted breeding programs.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/39

A novel rice QTL *qDI5.1* associated with straw digestibility in rice

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ABSTRACT

Rice straw is an important source of dry fodder for ruminants in India. About, 30–40% of the total rice straw is used by 90% of ruminant population in Southeast Asia. Highly digestible rice straw would likely decrease methane emission and improve animal health. To improve the straw utilization the information on variation for straw digestibility must be available and high digestibility traits can be a must have traits while breeding a variety. Thus, a panel of 133 rice genotypes used for straw digestibility analysis and using 133 SSR markers the genotyping of panel was completed. A significant phenotypic variation for digestibility (In-Vitro Organic Matter Digestibility, IVOMD) of straw was observed. The IVOMD ranged from 41.75 to 46.39 percent with a mean of 44.38 percent, which is very high difference in case of rice straw. The highest digestibility exhibited in the genotypes Kalburi, JagleBoro, IC282518 and IC277274. Marker trait association was analysed using GAPIT software to identify genomic region controlling the straw digestibility in rice. A total of 3 novel QTLs one each on chromosome number 1, 4 and 5 were identified. Individual QTLs counted for 5.4 to 17.8% of phenotypic variations. Among them, one QTL showed large effects with R^2 larger than 10%. Furthermore, two QTLs with minor effects for IVOMD were detected. The QTL, *qDI5.1* located on chromosome number 5 explained 17.8% of phenotypic variation for IVOMD of rice straw and the marker RM334 is linked to the QTL, *qDI5.1*. These results not only explain the genetic control of IVOMD, but also provide a foundation for cloning and selecting candidate gene for marker-assisted selection breeding in rice.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/40

Genetic Architecture and Association studies for Grain Yield and its attributing traits in Recombinant Inbred Lines (RILs) of Rice (*Oryzasativa* L.) under Sodicity Tolerance

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ABSTRACT

Sodicityin rice plants cause reduced germination rates, restricted plant growth, limited root development, low tillering, spikelet sterility. Since much work has been done on genetic analysis for grain production and its contributing variables, there hasn't been enough exposure to RIL genetics and their performance under Sodicity conditions. In view of this, a total of 250 RILs (F_7) were used, along with their parents PUSA-44 and CSR-43, to evaluate genetic variability, heritability, and correlation studies for grain yield and yield contributing characteristics. The experiment was conducted in naturally occurring high sodium soil of ANDUAT, Kumarganj, Ayodhya following alpha lattice design with two replications at two different dates of sowing. ANOVA revealed significant variation among the lines depicting inherent variability. Four attributes, *viz.,*plant height, effective tillers (ETs), spikelet fertilitypercent (SF%), thousand grain weight (TGW) and Grain Yield per panicle (GYPP) have high PCV and GCV estimates were observed for both the sowing dates indicating good scope for carrying out selection based on these traits. However, TGW and ETs values are depicting pertinent role of the environment so involve careful assessment in selection programs. For days to flowering, filled grain per plant, SF%, and GYPP, moderate heritability was discovered with a high GAM, indicating that these traits are less influenced by the environment. Correlation studies revealed significant and positive association with component traits. Mutual association between component traits exhibit variable responses under both the sowing dates validating genotype and environment interactions among traits with respect to yield.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/41

Assessment of genetic diversity using ssr markers for direct seeding traits in rice (*Oryza sativa* L.)

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ABSTRACT

About half of the world's population depends on rice for their survival. India has the largest area under rice and *Direct seeded rice* is becoming popular in recent years because of its low input demanding nature.Genetic diversity plays an important role in plant breeding and is commonly measured by genetic distance or genetic similarity. Molecular markers can reveal abundant difference among genotypes at the DNA level, and unaltered by environment. Among various PCR based markers, SSR markers are more popular and extensively used in rice because they are highly informative, mostly monolocus, codominant, easily analyzed and cost effective.

A study was conducted at Regional Agricultural Research Station (RARS), Maruteru, A.P with an experimental material comprised of 48 genotypes to study diversity for five important direct seeding traits *viz.,* anaerobic germination, seedling root length, seedling shoot length, rate of germination and culm diameter. A total of ten known simple sequence repeat (SSR) markers, *i.e.,* RM206, RM7, RM 17, RM 231, RM 234, RM 263, RM 201, RM 341, RM5509 andRM20557 were used for studying molecular diversity. Standard protocols were followed for the DNA isolation, amplification and gel documentation followed by scoring the bands. Standard statistical tools (SHAN; UPGMA) were used in preparing the similarity matrix and dendrogram to form clusters. The analysis was performed with the help of NTSYS-pc software 2.02.

All the ten SSR markers used in this study showed polymorphism;all the 10 SSR loci were polymorphic and produced 36 alleles. The number of alleles per locus generated by each marker varied from 2 to 5 alleles with an average of 3.6 alleles per locus. The polymorphic information content (PIC) values ranged from 0.305 to 0.797 with an average of 0.628. The 48genotypes were grouped into six major clusters at 35 % similarity level.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/42

Principal Component Analysis for grain yield, yield components and quality traits of slender grain rice genotypes

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ABSTRACT

The investigation was undertaken with 30 slender grain rice genotypes to estimate genetic divergence of the slender grain rice genotypes collected from Maruteru, Bapatla, Nellore, Ragolu, Machilipatnam, Jangamaheswarapuram and Utukur rice research centres of Andhra Pradesh state for grain yield, yield components and quality traits. Principal Component Analysis was carried out to evaluate the variation and to estimate the relative contribution of various traits towards total variability. The results revealed five principal components with eigen value > 1. These components contributed for a total variability of 72.56 per cent. Principal Component 1 (PC 1) contributed maximum of 22.83 per cent. However, PC 2 contributed to 17.99 per cent, while PC 3 had contributed 12.99 per cent. The PC 4 had contributed 11.04 percent and PC 5 only 7.68 per cent towards the total variability. The characters, namely, hulling percentage, plant height, ear bearing tillers per plant and days to 50 per cent flowering were observed to explain maximum variance in PC 1. The PCA scores of the genotypes were plotted in a graph to get the two dimensional scatter diagram, which revealed grouping of the genotypes into 18 distinct clusters, of which 11 clusters were noticed to be monogenotypic. The clustering was noticed to be random with no relation to geographic diversity, as genotypes from different centres were clusterd together and genotypes from the same cluster were grouped into different clusters. Among the genotypes, MTU 2578-5-2-4-1 genotype with high protein, zinc content and head rice recovery percentage; and NLR 3652 with high zinc, iron content and head rice recovery percentage were found to be most diverse. Hence, hybridization of these genotypes is predicted to result in desirable slender grain transgressive segregants with high yield, grain and nutritional quality.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/43

Meta-analysis of identified grain weight QTL provides insights into its genetic architecture in rice

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ABSTRACT

QTL for rice grain weight identified using bi-parental populations in various environments were found inconsistent and have modest role in marker assisted breeding and map based cloning program. Thus, identification of consistent and stable QTL across populations is critical to deploy in MAS breeding programs. Using QTL meta-analysis technique, we collated rice grain weight QTL information from numerous studies reported across populations and in diverse environments to find constitutive QTL for grain weight. The information from 114 original QTL spread over 12 rice chromosomes was used in QTL meta-analysis and discovered a total of 39 MQTL for grain weight on different chromosomes in rice genome. However, only three MQTL on chromosome 3 were found significant under different criteria with significant confident intervals. According to gene ontology, these three MQTL have 179 genes, of which 25 genes found to have role in developmental functions. MQTL3.1 includes the *OsAPX1*, *PDIL*, *SAUR*, and *OsASN1* genes, which are involved in grain development and have been discovered to play a key role in asparagine biosynthesis and metabolism, which is crucial for source-sink regulation. Further, identified MQTL were validated using tightly linked peak marker on a set of genotypes with extreme phenotype. The MQTL3.1 was successfully validated using linked marker RM7197 which can be used in marker aided breeding programs.MQTL that have been identified and validated in our study has significant scope in MAS breeding and map based cloning programs for improving rice grain weight.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/44

MTU 2433-1-3-1- A High Yielding Rice Culture Suitable for Semi deep water Ecosystem of Andhra Pradesh

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ABSTRACT

In recent years due to heavy and intense rainfall and cyclonic storms, paddy crop is experiencing damage due to flooding. If the flood water stagnation remains for more than a week the varieties are unable to sustain and there by the yield levels are drastically reduced. Hence, there is a need to develop submergence tolerant variety to minimize the yield losses. The culture, MTU 2433-1-3-1 is evolved from MTU1061/MTU1121. It is a long duration, high yielding, semi dwarf, medium slender with tolerance to complete submergence. It was evaluated under different station yield trials from 2017-2021under normal and complete submergence conditions at different locations of coastal areas of Andhra Pradesh. A total of 12 cultures were evaluated at five locations under complete submergence conditions of flash floods for ten days and stagnant flooding of 50cm water depth for 20 days at tillering stage and were evaluated at water depth of 40-60cm up to harvesting stage. The entry MTU 2433-1-3-1 (4084kg/ha) was found to be significantly superior over the checks MTU1140 (3602 kg/ha) and MTU 1172(2679 kg/ha).It also had recorded yield attributing characters namely., plant height(141.70cm), ear bearing tillers(242.50/m^2) and found to be superior over the checks MTU1140(133.60cm and 231.67/m^2 respectively) andMTU1172(121.05cm and 217.50/m^2 respectively). It is having good phenotypic scoring ability and well adoptive traits of elongation ability and Kneeing ability under complete submergence conditions, whereas under normal conditions (Submergence) the entry MTU 2433-1-3-1 (4557Kg/ha) was found to be significantly superior over the best check MTU 1140(4238Kg/ha) and MTU1172(4021Kg/ha) with good kneeing and elongation abilities. It has recorded high yield attributing characters of plant height (136.57cm) ear bearing tillers(256.67/m^2) and found to be superior over the checks MTU1140(128.40 cm and 249.67/m^2,respectively) and MTU 1172(117.60cm and 230.67/m^2,respectively). On farm research and multi location testing of the culture revealed that the farmers were satisfied with this entry since there is no yield penalty besides all other yield attributes and can be tested further in farmers' fields through extension functionaries.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/45

Characterization of Manipur rice germplasm for seed size using functional gene based markers

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ABSTRACT

The seed size is an important quantitative trait of rice governing both seed yield and seed quality. Seed size is a complex quantitative traits controlled by many genes/QTL and their allelic interactions. Seed size is influenced by seed length, seed width and seed thickness which collectively affect the seed weight. Therefore, understanding the molecular allelic interactions among the major gene/ QTL for seed size traits is of utmost important to increase and achieve potential yield in rice. In the present study, a set of81 rice germplasms collected different part of the Manipur was undertaken with an aim to study the allelic interaction of six major genes related to seed size: *SLG7, GW8, GS5, GS2, GS6* and *GL7*. The phenotypic data such as seed length, width, thickness, length-width ration and seed weight were collected and found to be normally distributed. The average mean of seed length was 9.242 ±0.732mm with a range of 7.51mm to 11.252mm. The average mean seed width was 3.067±0.397mm with a range of 2.398mm to 4.068mm. The average seed thickness was 2.034±0.164mm with a range of 1.764 to 2.554mm. The average seed length-width ratio was 3.081±0.517 with a range of 1.914 to 4.233. the average seed weight was 29.838±4.953g with a range of 20.52 to 50.88g. The Pearson correlation analysis of these five traits showed significantly correlated. Out of the six genes analyzed for Marker-traits association, two gene GS2 showed significantly associated with the seed weight traits (*P* value 0.04) and GS6 gene showed significantly associated with seed length (*P* value 0.027). These two genes which showed significantly associated with seed length and weight may be useful for further molecular characterization for rice breeding programme.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/46

Variability in physical, phyto-chemical and antioxidants of pigmented and non pigmentedrice

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ABSTRACT

Inclusion of pigmented rice in the breeding programme could be an efficient choice in improving nutritional quality of rice . Study of the variation in physical and phytochemical attributes, understanding the genetic architecture of physical and nutritional quality traits and finding the promising genotypes is also essential to initiate the breeding programme. In this study, both pigmented and non pigmented rice landraces (20) were evaluated to estimate the genetic parameters, heritability and association of physical, phyto-chemicals (amylose, total soluble sugar, protein content) and antioxidants (anthocyanins, gamma-oryzanols, total phenolics and total flavonoids). Existence of wider genotypic variation with high heritability combined with higher genetic advance for porosity, total soluble sugar, the phytochemicals in pigmented rice and length- breadth ratio of grain, thickness, diameter of grain, thousand grain weight and bulk density of grain in non pigmented rice suggested the possibility of desired trait improvement of pigmented rice. Thickness, grain weight, porosity, soluble sugar and protein content and all the antioxidant traits were found higher in pigmented rice. Higher thickness, grain weight and porosity of pigmented rice compared to non pigmented rice signifies that designing of processing machine will differ in pigmented and non pigmented rice with respect to these characters. This study, for the first time, establishes an association of physical traits with antioxidant compounds. The promising genotypes identified (Bodikaberi and Mahipaljeera) for the quality traits could be a valuable inclusion in future plant breeding programme for development of improved lines and also in value added products.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/47

Marker Assisted Gene Pyramiding of DTY QTLs in rice mega variety IR64-*SUB1*

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ABSTRACT

Rice yield stability requires attenuation because of the yield losses caused by various abiotic stresses such as drought, flood, salinity etc. Worldwide, drought affects approximately 23 million ha of rainfed rice. The yield loss magnitude depends on the growth stage, duration and the severity of drought Stress (Gana et al., 2011). Using grain yield under stress as the primary selection criterion, several QTLs contributing to yield under drought stress at the reproductive stage have been identified but there are only few efforts to introgress them to develop improved breeding lines.

To understand the interactions among different genetic loci QTL pyramiding is required. QTL pyramiding also improve the efficiency of marker-assisted selection for desirable loci in a breeding program. Shamsudin *et al*. (2016) identified positive digenic interactions of *qDTY2.2* and *qDTY3.1* with $qDTY_{12.1}$ enhancing overall expression of drought-related traits. Interaction of $qDTY_{3.2}$ with *qDTY1.1* and $qDTY_{12.1}$ reduces the flowering duration and subsequently increases grain yield under stress (Vikram et al., 2016). Similar interaction of *qDTY2.2* and *qDTY3.1* with *qDTY*12.1 in MRQ74 background (Shamsudin et al. 2016); and *qDTY2.2* + *qDTY*4.1 in IR64 background (Swamy et al. 2013) was observed. *qDTY1.1* showed positive interactions with *qDTY*2.1, *qDTY2.2*, and *qDTY3.1*, whereas *qDTY2.2* showed positive interactions with *qDTY*4.1, *qDTY*12.1, and *qDTY3.1*. *qDTY3.1* showed positive interactions with *qDTY1.1*, *qDTY2.2*, *qDTY*12.1, *qDTY*6.1, and *qDTY*6.2 (Kumar et al., 2018). The aim of the present study was to pyramid 3 drought QTLs, *qDTY3.1*, *qDTY2.2*, and *qDTY1.1* in IR64-*SUB1*, a variety having submergence tolerance QTL *SUB1* to develop high yielding multiple abiotic stress tolerant variety through marker assisted backcross breeding approach.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/48

High throughput androgenesis in development of doubled haploids fromelite *indica* rice hybrid CRHR32

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ABSTRACT

Rice (*Oryza sativa* L.) is a major staple food crop in the worldgrown over a wide range of agro-climatic conditions. Since, rice hybrid is considered as the best option showing significant yield advantages over inbreds globally, it fails to gain popularity among the farmers mainly for the high seed cost and quality of the producewhich can be effectively addressed using androgenic approach. Androgenesis is a paramount biotechnological mechanism for rapidly recovering fixed breeding lines with unique gene combinations that would otherwise dissipate over the course of a long period of segregating generations using traditional breeding procedures. A total of 150 doubled haploids (DHs) were generated from an elite *indica*rice hybrid, 'CRHR32' for which an androgenic method was developed by manipulating the physical and chemical factors. The spike pretreated at 10 °C for 2 and 8 days was effective for callusing and green plant regeneration. The maximum callus frequency was achieved in N6 medium + 2.0mgL^{-1} 2,4-diclorophenoxyacetic acid + 0.5mgL^{-1} 6-benzylaminopurine + 3% maltose. Calli induced in N6 media also showed signiûcant green shoot regeneration in MS+ 0.5mgL^{-1} 1-napthalene acetic acid + 0.5mgL^{-1} kinetin+ 1.5mgL^{-1}benzylaminopurine + 3% sucrose producing 186 green plants. Employment of 40 SSR markers could discriminate one heterozygote from 150 fertile regenerants. All DHs grown in the ûeld showed signiûcant variation for their morpho- agronomic traits. Homogeneity within each DH line confirms the gametic constitution from the F_1 pollen of CRHR32. Six DH lines produced higher grain yield than the hybrid parent(2.0-5.16%) which suggests the possibility of exploiting hybrid vigor in *indica* rice through development of DH lines of high yielding hybrids

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/49

Assessment of Genetic Diversity in Doubled Haploid population derived from *indica* rice hybrids

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ABSTRACT

Anther culture is a novel biotechnological technique which has drastically reduced the breeding cycle for the production of true homozygous lines.It could be employed to develop doubled haploids (DHs) that may perform at par with the hybrids alleviating the problems associated with the hybrid rice cultivation. Doubled haploids have several advantages, such as shortening the breeding cycle by immediate fixation of homozygosity, offering high-selection efficiency, widening genetic variability through the production of gametoclonal variants. Genetic diversity is an important criterion for plant breeders to outline plan for future breeding programmes. It is necessary for understanding genetic linkages, including parentage, as well as effective germplasm management. The fast development of molecular markers has made it possible to investigate plant genetic diversity and population divergence. Simple sequence repeats (SSRs), also known as microsatellites are frequently utilized in plants to explore genetic diversity and evolutionary relationships as allele-specific and codominant markers. Because of their abundance, these markers are useful for genetic mapping and population studies. The evaluation of genetic diversity and assessment of population differentiation in DH population of two indica rice hybrids were achieved using SSR markers and Neighbour Joining method. A total of 36 and 31 SSR markers were used across 23 and 47 doubled haploids generated from 2 indica rice hybrids "Arize8433DT" and "Arize Bold" through anther culture respectively. The mean polymorphism information content (PIC) values ranged from 0.3293 (Arize8443DT) to 0.3696 (Arize Bold). RM297 (Arize8443DT) and RM278 (Arize Bold) were found to be best markers for the identification of genetic diversity. The Jaccard's similarity coefficient in DHs derived from Arize8443DT and Arize Bold was found to be 0.74 and 0.72 respectively. The parent hybrids were distant from the doubled haploid population in separate clusters indicating the phenomenon of meiotic recombination in spontaneous chromosome doubling.The study shows the effectiveness of SSR marker based molecular fingerprinting which served as a sound basis in the identification of genetically distant as well as in the duplicate sorting of the morphologically close population.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/50

Farmers valued rice varieties: A case study on test weight and yield

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ABSTRACT

Rice is the major food crop in Odisha, India. Though, several varieties are released for rice cultivation in India, only few varieties are very popular which we term as farmers valued varieties (FVVs). However, the yield and yield related parameters determining the popularity of rice varieties among the farmers is not well understood. Here, we experiment on a comparative analysis of farmers preferred or valued varieties and other released rice varieties. For this, fifteen numbers of popular varieties grow by the farmers in Biridhi block, Jagatsinghpur district of Odisha was compared with other released varieties (45 nos) for test weight and single plant yield. The mean test weight between farmers valued varieties and other varieties showed that farmers valued varieties test weight was 4.3% less than other varieties. Further, scatter plot and regression analysis for the test weight and single plat yield showed there was negative relationship between test weight and single plant yield of farmers valued varieties. This finding indicated that test weight is not the major factor determining the popularity of the rice varieties among the farmers in Odisha, India. Further, superior genes of grain size in the farmers valued varieties might be characterized and utilized in rice improvement programs.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/51

Recent trend of commercialization hints for popularization of NRRI developed inbred rice varieties

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ABSTRACT

Rice is an important cereal crop of the world, especially in developing countries. Farmers of India, categorized under poor and marginal group fully depend on rice crop and rice-based farming. In recent years, the hybrids have taken over the farming practice as storm in south-east Asia. The cultivation of hybrids requires significant expertise and high grade farm machineries to harness the yield potential. But the farmers of India follow indigenous cultural practices. The ICAR-National Rice Research Institute, a premier rice research organization, so far has developed and released (State/National) 5 hybrids and 149 popular high yielding inbred varieties (HYVs) suitable fordifferent rice ecologies of the country. Popularization of rice varieties could be easily addressed through commercialization. During last one decade, NRRI has commercialized its own hybrids and inbred varieties through licensing to grow and market to different private sector organizations. During the period, 28 Memorandum of Understanding (MoUS) have been signed for commercialization of hybrids and 37 for inbred varieties. Since 2010, only hybrids were commercialized. Generally farmers are reluctant to switch over to new varieties in place of the varieties they are familiar with. However, in recent 5 years the trends have changed, where NRRI has recorded 37 commercialization MoUs for the inbred varieties. Public and private sector organizations are convinced on commercialization gains of different high yielding, inbred varieties which include climate resilience, nutritional security and economic benefit. The present situation holds encouragement as high yielding inbred varieties are gaining more popularity over hybrids which could solve the seed non-availability problem through farmers' communities and FPOs who could play important role towards the vision of doubling farmers' income.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/52

Morphological and gene expression analysis to characterise few aerobic and anaerobic genotypes of rice.

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ABSTRACT

With the scarcity of water, there is an immediate need to cultivate aerobic rice that will reduce the water usage. Five aerobic adapted (MAS-946-1, CR Dhan 202, Sabita, Swarna Shreya, DRR41) and five anaerobic adapted (BPT5204, MTU1010, Swarna, Godhra Bidhan, NDR-359) genotypes were used to study the morphological traits such as root length, root weight, shoot length, shoot weight and shoot dry weight. In polyhouse condition, MAS 946-1 has shown the highest root length (43.63 cm) in aerobic condition. While, Godhra Bidhan in anaerobic possesses the highest root weight (16.3g), shoot weight (24.6g) and shoot dry weight (5.2g) in anaerobic condition. Meanwhile, aerobic adapted (MAS946-1, CR Dhan 202 and Sabita) and anaerobic adapted (BPT 5204, Swarna and Godhra Bidhan) promising genotypes were selected on the basis of their characteristics to uncover the role of few important genes like LRR (Leucine rich repeat), AQU (Aquaporins), PHO (Phosphate transporter), NAS (N-amino synthase), Mt2c (Metallothionin), PHT1.6 (Inorganic phosphate transporter which are steadily expressed and contribute for aerobic adaptation by water transport and metal ion transport.in roots. Expression analysis was performed for these six genes by performing quantitative Realtime PCR. The results shown that LRR genes which causes hydrophobic interactions and protein degradation was exclusively expressed and upregulated under aerobic conditions of CR Dhan 202 and Swarna as compared to anaerobic adapted genotypes. Similarly, PHO which is responsible for P nutrient uptake in roots and LRR genes were uniquely upregulated and showed higher expression in Godhra Bidhan grown under aerobic condition. However, Sabita under aerobic condition shown higher expression than in others. This study is successful in comparing aerobic and anerobic genotypes and their expression and this data can be forwarded for further analysis.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/53

Screening of traditionalaromatic rice germplasm for valuable agronomic traits

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ABSTRACT

Aromatic rice cultivars constitute a small but special group of rice and are considered as a delicacy for their premium cooking/eating quality and flavour.More than 1000 indigenous aromatic cultivars are being cultivated throughout India.Many of these cultivars have small grains with strong aroma and are cultivated in small pockets by local farmers. But these cultivars are inherently low yielder due to their tall plant stature and low response to fertiliser. Therefore, it is a predominant thrust to develop short grain aromatic varieties with short stature and high yield potential to make its cultivation more remunerative. The present study was undertaken with objective to harness genetic variability available in a set of aromatic rice germplasm and to associate different yield attributing characters. Present experiment was carried out with 49 aromatic rice genotypes, evaluated for 18 qualitative and 12 quantitative traits at the experimental farms of NRRI, Cuttack during Kharif 2020. Statistical analysis showed that experimental materials possessed considerable amount of variability for all the tested characters. High heritability with high genetic advance was recorded for grain yield/plant, number of effective tillers and 100 grain weight.Therefore, selection based on phenotypic performance of these traits would be effective. The minimum duration required for 50% flowering varied from 102 days in IC380528 to 141 days in EC339875P with a mean value of 118 days. Similarly, seedling height varied from 13.60 cm in EC958012 to 25.26 cm in IC423027 with a mean value of 18.92 cm. Plant height is an important agronomic trait which is related to fertilizer responsiveness. Significantly short plant height of 86cm was observed in EC339875P followed by 90.7cm in IC380528. Maximum panicle length of 32cm was observed in IC380432 and IC471802. Number of effective tillers ranged from 2 (IC211554) to 22(IC280115). Grain length/ breadth ratio ranged from 2.14 (IC471802) to 4.5 (EC96669) with mean of 3.2. Similarly, highest grain yield/plant was observed in IC464046 (36.81gm) followed by EC-96669 (24.2 gm). Maximum 100 grain weight was observed in EC-96669 (3.51g) followed by IC-464046 (3.43g). Variation in grain length ranged from 11.8 mm (EC-96669) to 6 mm (IC471802, IC471803, IC380423, IC465000, IC513637 and IC514619). The promising genotypes in respect to yield performance coupled with short grain length were IC144674, IC260049, IC380432, IC471802 andIC513637. The identified germplasm lines with valuable traits could be highly valuable asset for aromatic rice improvement.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/54

Differential salt-tolerance mechanism of cultivated and wild rice: A comparison between *Oryza sativa* and *Oryza nivara*

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ABSTRACT

Cultivated rice (*Oryza sativa indica* and *Oryza sativa japonica*), in general, is sensitive to salt stress. However, this susceptibility differs with different genetic constituents and genetic groups of rice. Therefore, identification of the tolerant members from different genetic groups is necessary. For this, a study was conducted with 40 different accessions of *Oryza nivara*. Initially,the accessions were screened at 12 dS $m^{-1}$of salt along with IR29 (a susceptible check) and FL478 (a tolerant check). Based on the overall SES score of VSI, biomass degradation pattern, SPAD reading, chlorophyll degradation and efficiency of PS-II, we identified two elite wild members from*O.nivara* (W118 and W119) group. These members showed an improved level of salt-tolerance at early vegetative stage and could maintain a SES score of 3 or 5, at the end of 7^{th} day of stress. To understand the underlying mechanisms, we measured the tissue Na^+ and K^+ content from root, shoot and leaf portions and calculate the selective transport of K^+ over Na^+. Based on the results, less amount of selectivity of K^+ over Na^+ to the upper portion of cells was observed in case of tolerant accession of *O. nivara*; W118 and W119, as compared to the tolerant check FL478. In general, early vegetative stage salt tolerance mechanism relies on the effective exclusion of Na^+ from the upper plant part, where excessive accumulation of Na^+ hampers the essential cellular functions.As a high level of Na^+ was present in the leaf and shoottissues of W118 and W119, it indicates existence of tolerance mechanism other than ion exclusion in this species. In this case, even a very high sodium load at the leaves do not hamper the essential cellular functions of these genotypes, it could be because of very high tissue tolerance nature of these genotypes which possiblyfunctioning as dominant tolerance mechanism in *Oryza nivara*.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/55

Co-existence of ion exclusion and tissue tolerance mechanism is important for reproductive stage salinity tolerance in rice

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ABSTRACT

In rice, the salt-tolerance mechanism at early vegetative stage and reproductive stage seems to differ significantly, as many vegetative stage salt-tolerant genotypes cannot thrive the severity of salt stress at reproductive stage due to greater intensity and duration of stress. In the present study, we found two genotypes AC41585 and FL478 that are highly tolerant to salinity stress (12 dSm^{-1}), while another genotype Rashpanjor (IC575321) moderately tolerant to salt stress at this stage. Further, these genotypes were subjected to longer duration of salt stress (8dSm^{-1}) at reproductive stage, we observed AC41585 and Rashpanjor were clearly superior genotypes than FL478 and IR29 (susceptible check). Further, to understand the salt tolerance mechanism that is playing dominant roles at these two stages,a comparative study was undertaken using these four genotypes. At vegetative stage both FL478 and AC41585, the two most tolerant genotype had very low Na^+/K^+ ratio evident by higher selective transport of K^+over Na^+(ST) to the upper portions of the plant to maintain a favourable tissue ionic concentration due to increased*OsHKT1.5* gene expression. On the contrary, the genotype Rashpanjor showed moderate level of ion exclusion and relatively lower ST resulting in higher Na^+/K^+ ratio and moderate level of high selectivity of K^+ to the upper portions of cells and maintaining a high level of *OsHKT1.5* gene expression. But, at reproductive stage, FL478 was unable to maintain the overall biomass and production.Its overall salt tolerance nature was also compromised, though the plant was able to maintain a lower level of Na^+/K^+ ratio and high selectivity of K^+ at the initial period in middle leaf. However, with increased duration of stress the ion exclusion process was hampered due to a high energy demand for the process. Interestingly, Rashpanjor which didn't perform as best at early vegetative stage was found much superior at reproductive stage salt stress along with AC41585. The Na^+ accumulation pattern, chlorophyll retention ability and tissue tolerance score of these two genotypes were found to be much superior than FL478. Our results suggest that for reproductive stage salt tolerance in rice, the sole factor of ion exclusion might not be enough. The genotypes are blessed with increased tissue tolerance behaviour along with moderate to high ion exclusion strategy can withstand longer duration of stress as encountered during reproductive stage.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/56

Genome-wide characterization andmarker development of Hyper-Variable simple sequence repeats (Hv-SSR) markers in *Pyricularia oryzae*

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ABSTRACT

Rice is a cereal of prime importance and staple food for us. Rice production and productivity is reduced by a variety of biotic stresses such as diseases and insect pests. Among them, rice blast causes significant yield losses of about 10-30%. Blast disease is caused by *Pyricularia oryzae,* a fungus that lives in rice seeds and shows greater genetic diversity. To understand the evolutionary rate and diversity of blast fungus, in this work a genome-wide sequence search was carried out for identifying simple sequence repeats (SSR) in blast pathogen. Perfect SSR markers were identified from the pathogen's genome sequence and primer design using various parameters were designed using primer 3 program and validated through *in-silico* PCR. Among the identified motifs, mononucleotide (57.7%) repeats were found to be the most abundant followed by trinucleotide (22%), tetranucleotide (8.67%), dinucleotide (7.81%), pentanucleotide (2.08%) and hexanucleotide (1.83%) repeats. Further, ten hyper-variable SSR were used for genotyping against was blast pathogens and two isolate variability were perfectly identified using the allelic patterns of Hv-SSR markers. In conclusion, developed Hv-SSR markers in this study for *Pyriculariaoryzae* could be a useful tool for analysing genetic diversity and evolutionary rate of this disease causing pathogen.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/57

Development of candidate gene-based polymorphic markers to study the inheritance of low phytic acid content in segregating populations

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ABSTRACT

Seed phytic acid is considered as an anti-nutritional factor because it binds with minerals and reduces the bioavailability of micronutrients like zinc and iron.As a result, developing low phytic acid (LPA) genotypes is a must if rice's nutritional value is to be improved.Rice genotypes with LPA content, such as Bindli (0.8 percent), and high phytic acid content, such as Manipuri Black (2.98 percent), were identified in screening experiments conducted at the Crop Physiology and Biochemistry Division, ICAR-NRRI, Cuttack. Mapping population was developed by crossing Bindliand Manipuri Blackto map the genomic regions associated with low phytic acid content. Before mapping the trait, the allelic effects of previously reported candidate genes for low phytic acid were investigated. LPA-related, novel candidate gene-based molecular markers were designed for this purpose. Seven genes, OsLPA1 (LOC_Os02g57400), OsMIK (LOC_Os03g52760), LPA (LOC_Os04g55800), OsIPK1 (LOC_Os04g56580), OsABCC13 (LOC_Os03g04920), OsSultr3;4 (LOC_Os06g05160) and OsPT8 (LOC_Os10g30790), have been reported to associate with seed phytic acid/seed phosphorous content in rice. Sequence analysis revealed that all the genes, except OsIPK1, have variable sites (InDels and/or microsatellites) in their nucleotide sequence. For the six candidate genes, we designed fifteen gene-based markers (12 cgSSRs and 3 InDels). The genetic polymorphism for these genes was investigated in a group of 96 rice genotypes that had already been phenotyped for phytic acid content in the seed. Fourteen primers were amplified, out of which 12 were polymorphic. In terms of the PIC value, the marker for gene OsSultr3;4 targeting microsatellite variation (AAG)18 in 3'UTR, as well as two markers for OsLPA1 targeting microsatellite repeats (CTC)6, (CGC)7 in the 5'UTR, and (CT)10 in the 5'UTR, were found to be highly informative. Using the gene-based markers, we identified genetic polymorphism between Bindli and Manipuri Black for four genes viz., LPA, OsSultr3;4, OsMIK and OsLPA1. These polymorphic genic markers could be used to investigate the effect of 'Bindli alleles' on seed phytic acid content in segregating population. Furthermore, the polymorphic markers identified in this study could be used to introgress different alleles of genes linked to seed phytic acid content in rice.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/58

Identification of markers for yield-relatedand root traits in New Generation Rice using Marker-trait Association Analysis

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ABSTRACT

Irrigated rice contribute to the tune of 75% in the national rice production only from 55% of the rice area. New Generation Rice (NGR) is high-yielding rice conceptualised for breaking yield ceiling under favourable conditions based on the ideotype concept. It is a plant type having certain quantitative and physiological traits in irrigated rice endowed with heavy panicle, higher fertile spikelets, higher biomass basically contributed through longer and wider erects leaves along with slightly raised height, strong culm and superior harvest index. The present study has used 43 NGRgenotypes (some with high N-use efficiency) with 38 grain yield linked SSR markers, reported in earlier New Plant Type (NPT) rice. The panel was phenotyped for 17 yield androot traits in two replications following Randomized Block Design (RBD) under control irrigated situation at NRRI, Cuttack, Odisha. Based on the mean performance of genotypes, CR DHAN-314, 1312-2, Maudamani, SRA 149-1-2, K 263, 490, 1201, C356-18- 2-1, C-762-2-2-1-1-1, SRB-2-3-2, SR-1-3-1, SRB-6-2, SRA-142, CR DHAN-206, 1833 and J232, Y 35-1-1-2, N 370, SRB 4-1, etc were recorded with high grain yield potential, hence could be selected as promising. Genotyping was done using standard molecular method followed by marker-trait association analysis using MLM model by GAPIT package of R software. Twelve SSRs (out of 38) viz., RM1132, RM1309, RM168, RM171, RM19, RM201, RM204, RM25475, RM3276, RM3827, RM5709 and RM5711 were found to be linked with 10 grain yield-related traits viz., Tiller No, Flag leaf width, root length, root average diameter, root tips root weight, Fertile grains, sterile spikelets, thousand-grain weight and grain yield. The study validated two SSR markers, RM168 and RM5711 those were linked with grain yield and flag leaf width, respectively particularly in very high-yielding NPTs. Thus, the present marker-based association analysis supposed to take a lead in differentiating the genotypes with superior ideotype for high grain yield potential along with robust root traits. It could guide the breeders to prepare a strategy targeting traits specific genotypes for choosing donors for hybridization and prospective potential recombinants for improving grain yield in rice.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/59

Alpha amylase and total amylase activity act as an index for seed vigor in rice

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ABSTRACT

Rice is a major food crop all over the India. Seed and embryo size are thought as two critical factors seed health and vigorous seedlings. Seed vigor is multi-genic quantitative trait in nature. Vigorous crop establishment since early growth is the key increasing in further plant growth and development. Successful field emergence of rice seedling is an additive effect of different seed vigor and quality traits. However, there is a lack of reliability in terms of predicting the field establishment of direct seeded rice based on these seed vigor traits due to various environmental factors. A set of 69 genotypes for 13 different seed vigor traits along with total amylase activity (TAA) and alpha-amylase activity (AAA) were investigated which affecting the rice seedling establishment. Multiple statistical analyses reveal the significant ($p<0.001$) R^2, high co-heritability and high PCA of TAA and AAA with seed vigor trait viz; shoot length and seed vigour index explain how the genotype with highest SVI does possess the highest TAA or AAA value. Our present research suggests to use alpha-amylase and total amylase activity as an indicator for testing the high seed vigour in rice. This would help to identify and detect seeds with high vigor based on high alpha-amylase content as a result of which farmers and growers can get an *in vivo* pre-sowing analysis for choosing appropriate variety for direct seeded condition. Additionally, high SVI genotypes serve as suitable donor for crossing. Our study reveals that out of different seed vigor and seed quality traits, SVI is genetically associated with both TAA and AAA. To overcome the influence of unfavourable seasonal variation on rice production, one of the common practices among farmers is to grow non-DSR variety under DSR condition. But this practice comes with an uncertainty of successful crop establishment due to the combining effects of environment and various physical parameters on seed vigor. Furthermore, the selected genotypes for high SVI and other seed vigor related traits may serve as suitable donor for crossing.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/60

Rice Analog with Functional Additives-The GenNext Food

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ABSTRACT

Rice is one of the leading food crops and sustains two-third of the world's population, providing 20 per cent of the world's dietary energy supply and is the main staple food in many countries. Despite being a primary food, rice is low in protein and high in starch content. The low protein levels and other essential nutrients in rice causes deficiencies of protein and some essential amino acids in human being who take it as their primary diet. For example, lysine, the essential amino acid which is responsible for proper growth of the human bodyfound in very less quantity in rice. Another issue of concern is the breakage of rice kernels in the milling process, which is not generally accepted by consumers as food. Analog rice is an alternative food substitute for rice, shaped like a grain of ricefrom rice and other foods having functional properties. As broken kernels are not accepted by consumers that's why it can be mixed with some desired additives to improve their quality and extruded for the preparation of rice analogues. It can be done by both cold and hot extrusion methods. Analog rice is made in the industry by utilizing food ingredients such as sago, sorghum and corn.

Analog rice is created to meet personal nutritional needs and can be adapted to the health conditions of consumers. The nutritional content and composition of the ingredients can be adjusted to the local raw materials of the region. Similarly, carbohydrate sources can be obtained from cassava flour, sweet potatoes, taro, arrowroot and sago palm sugar etc. Sources of protein can be added from soy flour, kidney beans, or other types of beans. Fiber can be obtained from bran, millets or fruit pomace/wastes.

The advantages of usage of Analog rice e.g., the composition of raw materials can be adjusted according to the health needs of consumers, has a low glycemic index hence suitable for diabetics, nutrition can be optimized and can be made using locally available raw materials. In terms of taste and cooking method, analog rice is not much different from ordinary rice, but the color is not as white as rice. In addition, unlike ordinary rice, analog rice is more durable and does not need to be washed when it is cooked.

Analog rice functions as an alternative food substitute for rice so that it can be used as a diversified food product. The physical form that resembles rice grains and with functional properties can help consumers psychologically feel like eating rice and could be the GenNext food looking on to the futuristic demand of the health and wellness of human being as well as the ease and environment friendly operations.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/61

Phenotypic evaluation of seedling vigour related traits in selected introgressed lines of rice

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ABSTRACT

Under changing climatic conditions, depleting nutrients, water unavailability, the dry-direct seeded rice (DDSR) is becoming more popular; however, the uniform establishment of a crop under DDSR is critically dependent on early seedling vigour (ESV) and seedling development. Seedling vigour is determined by various traits *viz*. coleoptile length (CL), germination rate and early germination, these mesocotyl and coleoptile are important traits for seedling emergence from deeper levels of soil. Therefore lines with maximum mesocotyl length (ML) and coleoptile length are preferred for improving rice seedling emergence rate, predominantly under DDSR, with this aim study has been conducted to evaluate seedling vigour traits in 52 introgressed lines developed for improving the mega variety using upland donors along with checks Sahbhagidhan,IR-64, Swarna, Azucena and KMR-3 at ICAR-IIRR. The seedling vigour traits were evaluated under controlled laboratory conditions using the paper towel method in two replications (three plants in each replication) with a completely randomized design (CRD), for understanding the correlation between traits and to identify lines having high seedling vigour index (SVI). Analysis of variance for seedling vigour traits revealed highly significant variations for the studied traits. Estimation of correlation coefficients showed the presence of positive significant correlation for all the traits with seedling vigour index-I and II, among the studied lines the introgressed lines (derived from the crosses Azucena × Bala, KMR-3, BPT-5204, Dular and IR20)*viz*., ATR-473, ATR-385, ATR-279, ATR-472 and ATR-486 exhibited the highest CL, ML, SVI-I and SVI-II, similarly, KK-12 showed high CL, SVI-I and SVI-II, however, ATR-397 and ATR-275 showed high ML, SVI-I and SVI-II. The genotype ATR-387 exhibited the highest CL and SVI-II and KK-6 showed the highest ML, SVI-II and SVI-I respectively. These identified introgressed lines exhibiting the highest seedling vigour traits can be used for improving seedling vigour and adaptability under DDSR conditions, these lines could serve as a valuable resource for enhancing seedling vigour by using them as donors to improve the mega varieties to adapt to the DDSR system and these identified introgressed rice lines can be further evaluated under the direct-seeded condition.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/62

Evaluation of Qualitative Agro-Morphological Traits in Some Traditional Aromatic Rice Genotypes of Chhattisgarh

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ABSTRACT

Characterization is the most basic and important step in process of evaluation and cataloguing of germplasm for better conservation. To meet the continuously expanding needs of varietal improvement, the assemblage, evaluation, preservation and characterization of the entire existing germplasms are essential to more rewarding breeding efforts. Characterization of 54 rice germplasm was done using 53agro-morphological traits following Distinctiveness, Uniformity and Stability test (DUS) during kharif season of 2016 at Research cum Instructional farm, Department of Genetics and Plant Breeding, IGKV Raipur, (C.G.) India. Out of which presence of leaf auricle, leaf collar, leaf ligule, colour of leaf ligule, male sterility, presence of secondary branching and sterile lemma colour showed no variation. Whereas Pubescence of leaf blade surface, stem length, curvature of main axis of panicle, colour of tip of lemma, lemma and palea colour, length of awn, altitude of branches of panicle and leaf senescence showed high variations among genotypes under study. These can be used to identify phenotypically divergent sources for traits of interest in breeding programmes. This study will be useful for breeders, researchers and farmers to identify and choose the restoration and conservation of beneficial genes for crop improvement and also to seek protection under Protection of Plant Varieties and Farmer's Rights Act

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/63

Marker assisted improvement of an elite rice variety "Rajendra Sweta" for submergence tolerance

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ABSTRACT

The rice crop unpredictably suffers from frequent flash flood in major portion of the state of Bihar which damages the standing crop under current climate change scenario. Identification of a major submergence QTL, Sub1 and advancements in the molecular marker technology accelerated the development of submergence tolerant rice varieties through marker-assisted breeding approach. The availability of molecular markers facilitated the plant breeders in early and efficient selection of recombinants possessing the desirable allele combinations in rice breeding programs.In the present study, Rajendra Sweta anelite rice varietyis improved for submergence tolerance. To introgress submergence tolerance QTL,the crosses were made between Rajendra Sweta and Swarna Sub1. For foreground selection, Sub1BC2 marker linked to submergence QTL were used to select plants possessing the Sub1 QTL.SNP markers were used for the background selection on the selected lines.The improved lines were found superior over recurrent parent.The improved lines with submergence tolerance QTL in background of Rajendra Sweta rice variety has the immense potential to help farmers in reducing losses due to submergence.

ADJNS/TH-I/LT/64

Phenotyping of National Screening Nursery Rice Germplasm Against Brown Planthopper Under Glasshouse Conditions

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ABSTRACT

Brown planthopper, *Nilaparvata lugens* (Stål) (Homoptera: Delphacidae) (BPH) is one of the major insect-pest of rice. Besides causing direct damage to the crop it also act as a vector for transmitting diseases. Both nymph and adult suck sap primarily at the base of tillers from phloem tissues so their presence goes undetected, which leads to yellowing of lower leaves starting from leaf tip backwards, reduced vigour, stunting and ultimately drying of whole plant. Due to its feeding behavior at the base of the plants, the farmers are not able to control this pest effectively. The use of genetic resistance is the most effective measure for BPH management. Keeping this objective in mind a set of 60NRRI-National Screening Sursery-2 trial (NRRI-NSN-2) lines from National Rice Research Institute (NRRI) were phenotyped by Standard Seed Box Screeningmethod against BPH under glasshouse conditions during *kharif* 2020 at the Rice Research Farm, Dept. of Plant Breeding and Genetics, PAU, Ludhiana. The germplasm rows were sown randomly and each row contains 20 seedlings. The 12 day old seedlings were infested with 2nd - 3rd instar nymphs @ 6-8 nymphs per seedling and the experiment was replicated thrice. TN-1 and Ptb-33 were used as susceptible and resistant checks, respectively. Individual plants in each line were scored based on 0-9 IRRI scale, when 90% of the plants of the susceptible check line TN-1 were killed. Mean score of each line was classified as resistant (0-3.49), moderately resistant (3.50-5.49) and susceptible (5.50-9.00). In germplasm lines, the damage score for BPH varied from 2.00 to 8.50. Ten germplasm accessions, *viz.*, CRR 759-B-36-B-1, TTB 1048-60-1, MTU 1337, TTB 378, CRR806-21, CR 3900-135-8-5-4, Shabhagidhan, CR 4121-149-1-2, CR 4318-16103-15-2-3-4-7 and CR 4114-2-4-1-1-2-1were resistant to BPH. However, eleven germplasm accessions were moderately resistant to BPH population and rest were susceptible to BPH. This will help to breed durable BPH resistant rice varieties, which will forms the core of IPM without involving any extra cost to the farmers.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/65

Optimization of *in vitro* regeneration method for *indica* rice

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ABSTRACT

Without effective and repeatable regeneration system and stable genetic transformation, understanding the management of linked molecular systems is difficult. Genotypes, source of explants, combination and concentration of growth regulators and culture conditions are all important factors for development of effective regeneration.Despite the fact that rice has a well-established regeneration system compared to other crops,most indica rice types are still found to be recalcitrant to tissue culture. As a result, a pre-requisite event for the development of genome edited plants needs the refinement of tissue culture protocol for the formation of embryogenic calli and the regeneration of fertile plants from a single cell. In this report, we present high-frequency robust regeneration methods for Lalat, Khandagiri, and MTU-1010, three popular elite Indica cultivars. Mature seeds were employed as the starting material. The highest callus induction frequency () was observed in MS supplemented with 3.0 mg/l 2,4, D + 0.25 mg/l BAP observed followed by MS +2.5 mg/l 2.4 D + 0.5 mg/l kinetin. Besides, maximum shoot regeneration () was found in MS supplemented with 1.5 mg/l BAP +1mg/l kinetin + 0.1 mg/ l NAA. MTU1010 showed highest callusing whereas —Transfer of regenerants to rooting media followed by hardening showed 100% survival. The reproducible method of organogenesis could be well utilized for genome editing and transgenic work.

ADJNS/TH-I/LT/66

Nirmalya (IET 23429): A Non-lodging,Non-shattering and High-Yielding Rice Variety for Irrigated Early Ecosystem

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ABSTRACT

'*Nirmalya*' (CN 1756-3-3-1-MLD 17, IR 50 (♀) x ADT 41 (♂), IET 23429, National Identity No. IC 616395) was developed at Rice Research Station, Chinsurah, Hooghly as a promising high-yielding rice variety of early duration (108-112 d) with semi-dwarf stature (102 cm), short bold grain type (1,000-grain weight 22.0 g), photoperiod non-sensitiveness, resistance reaction to diseases (marginal against sheath rot, brown spot and bacterial leaf blight, and high against sheath blight) and insect pests (intermediate to high against stem borer, and high against leaf folder), higher grain productivity (5.04 t/ha in *kharif*), and good adaptability for growing under irrigated early ecosystem (both high and low fertility conditions) during all the three seasons (pre-*kharif*, *kharif* and *boro*) in West Bengal. The test entry (IET 23429) recorded 11.32-43.93, 13.52-29.02 and 8.43-41.91% higher grain yield over other entries and check varieties under the ICAR-AICRIP [Initial Varietal Trial (Early)-Transplanted (TP), Advanced Varietal Trial (AVT) 1 (Early)-TP and AVT 2 (Early)-TP] across a number of locations in India during *kharif*season of 2012, 2013 and 2014, respectively. It displayed 11.60-20.85% increase in grain yield over the check varieties (Ajit and IR 64) in multi-location state trials (pooled over the years of 2016, 2017 and 2018during *kharif*) in West Bengal. In nitrogen (N)-response trial (*kharif*, 2014), it recorded 19.66% yield advantage with the application of 80 kg N/ha, compared with that of 40 kg N/ha. The same entry exhibited only 4.11% yield advantages at higher dose (120 kg N/ha) over that of 80 kg N/ha, indicating its optimum response to the application of 40-80 kg N/ha for higher productivity. The variety is being preferred by the farmers for its resistance to lodging and shattering, and the consumers as well for multiple products (puffed rice, pressed rice, and parched rice) with good grain quality parameters (hulling 81.1%, milling 72.3%, head rice recovery 66.6-69.7%, kernel length 5.23-5.51 mm, and kernel breadth 2.32-2.29 mm). Because of its unique features, it was released on October 08, 2021 by the State Seed Sub-Committee from the Agriculture Department (Government of West Bengal) in the interest of farming community.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/67

Introgression of high yield *OsSPL14* and durable blast resistance *Pi54* genes for genetic improvement in Manipur black rice (*Chakhao*).

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ABSTRACT

Manipur black rice, known locally as *Chakhao* is a GI tag to Manipur State andis a specialty rice because ofitsunique color and fragrant aroma. The deep purple color of *Chakhao*is due to the presence of the water-soluble secondary metabolite, anthocyanin present in the pericarp of the rice grain. Due to the presence of high anthocyanin and other nutraceutical properties such as anti-inflammation, reduction of the risk of cardiovascular diseases and cancer, *Chakhao* grain is in huge demand in the national and international markets. Despite its superior properties and high demand, the cultivation of *Chakhao* is not very popular due to its inherent traits like low grain yield, lodging and susceptibility to abiotic and biotic stresses. Therefore, development of high yielding *Chakhao* genotypes with resistance to diseases is of utmost importance for its breeding program. In the present study, attempts have been made to improve *Chakhao* by pyramiding of high yield *OsSPL14*geneand durable blast resistant *Pi54*gene. A set of 40 landraces of *Chakhao* were collected from different parts of Manipur and screened for the presence of*Pi54*geneusing functional Pi54MAS and RM206 markers. Among the 18 *Chakhao* genotyped with positive allele of *Pi54* gene, one *Chakhao* line CHK-13with good grain quality was selected as the recipient for *OsSPL14*gene.CHK-13 was crossed with an *indica* high yielding rice cultivar, CR Dhan 307 havingfavorable allele of *OsSPL14* gene and the F_1s were selfed to produce $F_2$and F_3 population. A set of 147 F_3 lines were screened for the presence of both genes using Pi54MAS and SPL14-12SNP markers and 32 were found to be positive out of which, 16wereof black grain color. The phenotypic data such as grain size, grain weight and plant height were collected of these 16F_3 black grain lines. The average grain lengthwasfound to be 8.48mm, ranging from 7.32mm to 9.17mm while the grain width ranged from 2.24mm to 3.16mm with an average of 2.73mm. The grain thickness ranged from 1.19mm to 2.02mmwith an average of 1.73mmand weighed an average of 18.65g, ranging from 10.62g to 25g. The average plant height was 119.3cm with the shortest measuring 41.5cm and the tallest, 165cm. These 16 F_3 lines with black grain color will be genotyped using polymorphic markers for background selection and further characterized for grain quality, anthocyanin contents etc.

Theme - I : GenNext technologies for rice improvement

ADJNS/TH-I/LT/68

Analysis of alternatively spliced genes in rice hybrids and parental lines

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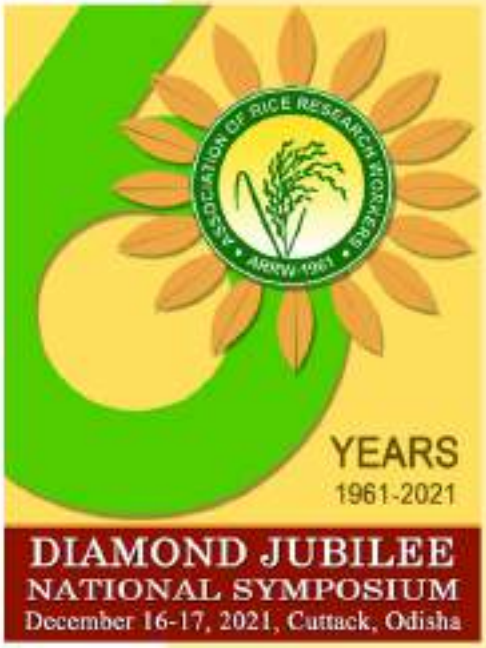
ABSTRACT

Alternative splicing (AS) is a regulated process during gene expression wherein a single gene codes for multiple proteins through differential splicing. In this process, particular exon of a gene may be included within, or excluded from, and the final processed messenger RNA (mRNA) produced from that gene will be coded into proteins. The proteins translated from alternatively spliced mRNAs will contain differences in their amino acid sequence and might also result in differential function. In this study, AS genes in two rice hybrids Ajay and Rajalaxmi and their parental lines (A, B and R lines) has been analysed at two developmental stages i.e., panicle initiation (PI) and grain filling (GF) stage using RNA-Seqdata. The splicing patterns were explored by RACKJ (Read Analysis & Comparison Kit in Java) software tool which computes the number of reads containing exons, introns and splicing junctions. Alternative spliced genes were identified in hybrids and parental lines due to exon skipping, intron retention, ADA (Alternative Donor and Acceptor site) detection event. Based on these analysis, maximum AS genes were found to possess intron retention even followed by ADA and exon skipping in both the rice hybrids and their parental lines. A total of 36 AS genes were selected for validation through qPCR analysis and four genes were analyzed through qPCR. The analysis showed two genes related to 40s ribosomal subunit and chloroplast differentiation were highly expressed in male sterile line (31A) line as compared to R and B lines of both Rajalaxmi and Ajay hybrids. This finding indicates the prominent difference of AS in parents and hybrids of rice.



Theme II

Precision Rice Production

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/1

Validation of STCR based fertilizer prescription equation of Rice var ADT 45 in UT of Puducherry

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ABSTRACT

To validate the fertilizer prescription equation, a field experiment was conducted at farmer's field at Karikalampakkam village, Puducherry with rice (ADT 45) .The soil of the experiment is classified under Bahour soil series of *Fine-loamy mixed isohyperthermic typic ustropept*. The experiment consisted of ten treatments *viz*., blanket recommendation, STCR-NPK alone for 6, 7 and 8 t ha^{-1} yield targets, STCR-IPNS for 6, 7 and 8 t ha^{-1} yield targets,farmer's practice , FYM alone and absolute control in RBD with three replication.

Fertiliser Prescription Equation

$FN = 3.06\ T - 0.33\ SN - 0.85\ ON$

$FP_2O_5 = 1.63\ T - 0.81\ SP - 1.02\ OP$

$FK_2O = 1.70\ T - 0.22\ SK - 0.85\ OK$

The grain yield of the test verification trial on rice revealed that, the yield ranged from 2.56 t ha^{-1} in control to 7.94 t ha^{-1} in STCR-IPNS 8 t ha^{-1}.With regard to STCR-NPK alone treatments for the targets of 6, 7 and 8 t ha^{-1}, the yield recorded were 5.46, 6.34 and 7.26 t ha^{-1} respectively. Under STCR-IPNS , the yield obtained were 5.48, 6.48 and 7.56 t ha^{-1} respectively. The farmer's practice recorded the yield of 3.98 t ha^{-1} but it was lower than blanket recommendation (4.12 t ha^{-1}).The highest achievement of the yield targets was recorded with STCR-IPNS 8 t ha^{-1} (99.3 %) followed by STCR - IPNS -7 t ha^{-1} (96.0 %), STCR -NPK –6 8 ha^{-1} (94.5 %), STCR - IPNS 6 t ha^{-1} (93.0 %) , STCR - NPK alone –7 T ha^{-1} (92.6 %) and STCR - NPK alone -6 t ha^{-1} (91.3 %).

The RR recorded for various treatments ranged from 5.14 kg kg^{-1} in farmers practice to 21.12 kg kg^{-1} in STCR -IPNS –6 t ha^{-1} .Among the STCR treatments , IPNS recorded relatively higher RR than NPK alone treatments. Blanket recorded 6.24 kg kg^{-1} , which is lower than all the STCR treatments

The results have clearly brought out the fact that STCR treatments recorded significantly higher grain yield over both blanket recommendation and farmer's practice.The results revealed that , the percent achievement of the targeted yields were within +/- 10 percent variation , which has proved the validity of the fertilizer prescribing integrated fertilizer doses for rice.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/2

Mechanised SRI (System of Rice Intensification) for energy efficiency and climate-resilient technology for sustainable Rice productivity in India

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ABSTRACT

SRI (System of Rice Intensification) method is gaining importance across world to enhance the productivity of resources in rice cultivation in irrigated rice ecosystem across the world and specific to India. Experiments addressing constraints of rice cultivation, lower crop productivity, poor water productivity, low input use efficiency, reduced availability of labour, and environmental degradation in India were conducted in different crop estblishment methods for SRI on clay loam soil at the Indian Institute of Rice Research (IIRR), India during 2012 to 2017 (5 wet and 5 dry seasons). SRI recorded significantly higher grain yield (6.21 t ha-1) over Normal Transplanting (NTP) (4.95 t ha-1) across the years. Mechanised SRI when compared with the Drum seeding method (DSR) reported a significantly higher grain yield of 6.32 t/ha over DSR (5.59 t/ha) and normal T.P(4.64 t/ha). Significantly lower average methane emission in SRI (40-50% reduction) compare to NTP, and GWP values were lower with MSRI than NTP and DS methods.MSRI method tested against other methods also recorded higher energy efficiency (10.64%) over DSR (10.11%). SRI, MSRI and DSR methods were significantly superior in terms of higher energy use efficiency over NTP (8.15%). Further, the modification of the SRI method to suit the location will enhance factor productivity of land, labor, water, and with a higher B:C ratio in the rice-growing system by mitigating climate change.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/3

Identification and characterization of plant growth promoting bacteria from rhizosphere of Basmati 370 in Jammu region

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ABSTRACT

Plant Growth Promoting Rhizobacteria (PGPR) present in rhizosphere promote plant growth and can serve as an alternative to chemical pesticides/fertilizers. The present study entitled "Isolation, identification and characterization of plant growth promoting bacteria from rhizosphere of Basmati rice (*Oryza sativa* L.) in Jammu region" was designed to isolate bacterial strains from rhizosphere of Basmati rice growing areas of Jammu region. The bacteria were screened for plant growth promoting (PGP) traits like protease activity, cellulase activity, amylase activity, phosphate solubilization activity, siderophore production and indole acetic acid production. The sequencing and blast homology of 16S rRNA gene of 11 PGPR from rhizosphere of Jammu district revealed that 8(72.7%) isolates belonged to *Bacillus,* 2(18.1%) belonged to *Pseudomonas* sp. Similarly, 16 isolates from Samba revealed that 4(25%) belonged to *Bacillus*, 3(18.75%) belonged to *Pseudomonas*sp, 2(12.5%) belonged to *Enterobacter* and *Aeromonas*sp, thus indicating dominance of Gram negative bacteria in this area. Further, 9 isolates from Kathua paddy fields revealed that 3(33.3%) belonged to *Pseudomonas* and *Enterobacter* sp. and 1(11.1%) belonged to *Aeromonas* sp. 5(83.3%) that belonged to *Bacillus* sp., was found dominant in rhizosphere of SJR 5 along with 1(16.6%) of *Stenotrophomonas* sp.The rhizobacterial isolates were further evaluated for antagonistic activity against three fungal pathogens viz. *Bipolarisoryzae*, *Magnaportheoryzae*, *Rhizoctonia solani*and one bacterial pathogen- *Xanthomonas oryzae*. *Bacillus* sp.and *Streptomyces* sp.showed effective antagonistic activity against *Bipolarisoryzae*, *Magnaportheoryzae* and *Rhizoctonia solani*.*Bacillus proteolyticus*(CB 80), *Pseudomonas mosselii*(CR 14 strain) and *Streptomyces hawaiiensis* (SE4 strain) showed significant antagonistic effect against *Xanthomonas oryzae.*

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/4

Energy efficiency, productivity, profitability and nutrient uptake of rice (*Oryza sativa* L.) under nutrient management and rice establishment methods in rice-groundnut cropping system

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ABSTRACT

Rice and rice based cropping systems form an integral part of agriculture whose spread and extent is predominant across the country with more precisely in eastern India. Inclusion of oilseeds and legumes in the cropping system has closer relationship between cropping system productivity, energy and environment. The field experiment was conducted during *kharif* season of 2019 and 2020 at Agronomy Main Research Farm, Odisha University of Agriculture and Technology, Bhubaneswar, comprised of two rice establishment methods, viz., direct seeding (DSR) and transplanting (TPR) and three nutrient management practices, viz., inorganic (100% soil test based fertilizer recommendation (STBF), organic source (green manuring + 1/3rdsoil test based nitrogen recommendation (STBN) through vermicompost + 1/3rd STBN through neem oil cake) and integrated nutrient management (green manuring + 50% STBN +100% P_2O_5 and K_2O) under factorial randomised block design with three replications. Results revealed that, transplanting of rice cv. 'CR DHAN 307' recordedyield (5.74 t ha^{-1}) improvement of 6.9 per cent over DSR with superior energy use efficiency (1.35), total N uptake (100.5 kg ha^{-1}), P uptake (28.1 kg ha^{-1}) and K uptake (108.4 kg ha^{-1}) but DSR fetched more net return (Rs. 37012.5 ha^{-1}) and benefit cost ratio(1.65). INM enhanced grain yield (6.06 t ha^{-1}) by 13.3 and 15.2 per cent over inorganic and organic source of nutrient management practices, respectively.

INM practice recorded maximum net return (Rs. 56180.5 ha^{-1}), benefit cost ratio (1.88), total N uptake (105.3 kg ha^{-1}), P uptake (29.8 kg ha^{-1}) and K uptake (114.4 kg ha^{-1}) whereas, organicapproach resulted significantly higher energy use efficiency (1.71).Thus, transplanting method of rice establishment with INMapproachis aviablemanagement practice for improving energy efficiency, productivity, profitability and nutrient uptake of rice in rice-groundnut cropping system.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/5

Precision Nutrient Management in Rice Based Cropping Systems for Enhancing Productivity, Profitability and Soil Fertility in Coastal belt of Maharashtra

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ABSTRACT

Konkan the coastal region of Maharashtra comes under high rainfall zone receiving > 3000 mm rainfall in > 95 rainy days during monsoon. Therefore, rice is major staple food crop grown in *kharif* season. Field experiment was conducted during 2013-14to 2015-16 at Regional Agricultural Research station, Karjat, Dist- Raigad to evaluate the effect of organic, inorganic and integrated production systems in various cropping systems. There were six production systems *viz;*100% organic package, 75 % organic package + Innovative organic practices, 100 % inorganic package, Farmer's practice, 50 % organic + 50 % inorganic package, 75 % organic + 25 % inorganic package and four cropping systems *viz*., Rice- Groundnut, Rice- Sweet corn, Rice-Mustard and Rice-*Dolichos* bean (for green pod vegetable). The experiment was conducted in a split plot design with three replications. Production system treatments were allotted to main plots while cropping systems were assigned to sub plots. The pooled results of 3 year revealed that the application of 100 per cent organic production system produced maximum and significantly higher total rice equivalent yield (REY) of 195.09 q ha^{-1} as compared to other production systems. Application of 100 per cent organic package realized maximum and significantly higher gross returns (Rs. 275072/- ha^{-1}) as compared to rest of the production systems. Whereas the net returns (Rs. 59218 ha^{-1}) and B: C ratio (1.35) was significantly higher under 100% inorganic package.Among the cropping systems, the maximum and significantly higher REY (222.04 q ha^{-1}), gross returns (Rs. 313082/- ha^{-1}) and net returns (Rs. 94483/- ha^{-1}) were observed under Rice-Sweet corn system as compared to other cropping systems studied. However, significantly the highest B: C ratio (1.45) was observed due to Rice – Groundnut system followed by Rice – Sweet corn system (1.44). In interaction effect, Rice-Sweet corn system grown with 100 per cent organic package produced maximum and significantly higher REY (256.02 q ha^{-1}) of the system as compared to rest of the treatment combinations followed by the same system grown under 75 per cent organic + Innovative organic practices (250.68 q ha^{-1}). The same cropping systems grown with 100 per cent inorganic package realized significantly the highest net returns (Rs. 117588/- ha^{-1}) and B: C ratio (1.64) as compared to rest of the treatment combinations except Rice-Groundnut system grown with 100 per cent organic package and 75 percent organic + innovative organic practices in case of net returns. The effect of different treatments on availability of soil nutrients was also studied after harvest of *Rabi* crops. The results showed thatapplication of 100 % organic package recorded maximum and significantly higher available N (288.42 kg ha^{-1}) and K_2O (389.84 kg ha^{-1}) in soil as compared to 100 % inorganic package and Farmer's Practice. Further,Rice-Groundnut system remained at par with Rice-*Dolichos* bean system and both the systems recorded significantly higher available N and P of soil over Rice- Sweet corn and Rice-Mustard systems.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/6

Molecular advancement in rice Arbuscular mycorrhizal fungal interactionfor efficient utilization of phosphorus

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ABSTRACT

Arbuscular mycorrhizal fungi (AMF) are the most common symbiotic relationship between crop plants and occur in the majority of natural habitats, providing a variety of important ecological services such as mobilizing phosphorus (P) and other important nutrients like N, K, Fe, Cu, Zn etc.to plants, promoting plant growth, improving soil structure, and fertility. P is essential for crop growth and productivity, and it is poorly bioavailable in soil but AMF absorbs P from the soil and transports it to the plants. The effects of AMFsymbiosis on rice have received less attention, owing to the fact that rice is primarily grown in wetland ecosystems, wherein plants are traditionally thought to be non-mycorrhizal. However, AMF facilitates rice plants to grow vigorously under wetland, upland, and aerobic cultivation in nutrient-deficient conditions by using various mechanisms like improving P uptake through activation and regulation of P- transporter *(PT)* genes. Based on molecular and genetic investigations, the basic process of plant nutrient uptake, growth promotion, immunity against phytophathogens and some other process like regulation of P transporters, modification of root architecture, some metabolic changes in plant system, and hormonal signaling changes due to AMF association in rice are discussed in this study.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/7

Rice Production in Telangana: Growth, Instability and Decomposition Analysis

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ABSTRACT

The present study was conducted to assess the growth rates and instability in area, production, and yield of rice in Telangana. Also, the relative contribution of area and yield to change in output was estimated by decomposition analysis. The study is based on secondary data for a period of 30 years i.e., 1990-91 to 2020-2021. The secondary data were obtained from various publications of Directorate of Economics and Statistics, Directorate of Rice Development, Patna. For this study, the whole period (1990-91 to 2020-2021) is divided into three sub-periods to have a period-wise examination of growth and instability patterns of the area, production, and productivity of rice and the sub-periods were as follows: period I (1990-91 to 1999-2000), period II (2000-01 to 2009-10) and period III (2010-2011 to 2019-20), and overall period (1990-91 to 2019-20). Compound Growth Rates were used to calculate the growth rates. The instability in area, production, and yield was measured with Cuddy Della Valle Index and Coppock's Instability. The study revealed that the growth rates for Telangana in the overall period were positive for area, production, and yield (2.1, 3.7, and 1.5 respectively). The Cuddy Della Valle Index for the overall period registered higher, medium, and low instability for production (35.1), area (26.4), and yield (7.6) respectively. The Coppock's Instability indices revealed that the degree of instability for area and production was higher during the period III in comparison to period I and II. One of the major reasons for this could be increased area under rice in period III, because of the assured irrigation due to completion of many major and minor irrigation projects and revival of tanks under Mission Kakatiya in Telangana. The decomposition analysis for study period (1990-2021) revealed that the area effect was highly responsible for the production variability (46.1 percent) in Telangana. The area effect in enhancing the rice production increased over a period of time. Since the scope to increase the area under rice cultivation is limited, the focus should be on the improvement of the yield to meet the future demand for rice.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/8

Cyanobacteria diversity under long-term exposure of elevated CO_2 in rice-rice cropping system

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ABSTRACT

Anticipated climate change, particularly elevated CO_2 and temperature are likely to affect soil labile carbon pool, enzymatic activities and nitrogen-transforming microbial dynamics in paddy soil. Researchers reported the consequences of short-term exposure of eCO_2 on soil physico-chemical and biological properties under open top chamber (OTC) experiment, however, very limited report of long-term exposure of eCO_2 on soil microflora especially nitrogen-fixing cyanobacterial diversity. Therefore, the present study aimed to assess the abundance and frequency of cyanobacteria under long-term exposure of eCO_2 through morphological and molecular approaches and also analysed its relation with soil properties. Results indicated that *Leptolyngbya*was dominant cyanobacterial genera in all the treatments of elevated CO_2 along with ambient CO_2 and outside controls. Moreover, Illumina MiSeq and heat map analysis through targeted cyanobacterial gene sequences also revealed the abundance of *Leptolyngbya.* Q-PCR based results indicated that decreased cyanobacterial abundance under OTC exposed with CO_2 continuously for 9 years. The Illumina MiSeq study of OTC soil was analyzed and it was revealed that the *S*ynechococcophycideae and Nostocophycideae were found to be abundant under eCO_2 (700 ppm) compared to aCO_2, whereas Oscillatoriophycideaeand Stigonemateleswere suppressed under eCO_2. Interestingly, Pleurocapsales was encouraged by continuous exposure of eCO_2. The dendrogram result of diazotrophic *nifH*gene under elevated CO_2 showed that the genus *Bradyrhizobium*followed by *Azospirillum*was found to be dominant in eCO_2 (700 ppm) and outside treatment conditions.The present study also revealed that the soil biological properties were more in surface soil (0-15 cm) as compared to deeper surface soil (15-30 cm) and also abundance of cyanobacteria was highly influenced by soil carbon and nitrogen pools. Overall, the present study revealed that the presence of *Leptolyngbya*as abundant cyanobacterial genera under ambient and elevated carbon dioxide which may be used as nitrogen bioinoculant for rice crop under anticipated climate change in future.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/9

Methane emission from mangrove and adjacent rice ecology in Sundarban, India

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ABSTRACT

Mangrove and rice are typically providing passage for methane (CH_4) emission from soil to the atmosphere through pneumatophore and rice aerenchyma, respectively. In Sundarban, the mangroves are mainly converted to rice-based system and aquaculture due to increased human population. The article attempts to estimate the CH_4 flux from different degraded mangrove sites and adjacent rice ecologies and their correlation with soil labile carbon pools and physicochemical properties. The CH_4 fluxes were measured at six locations of Sundarban (Sadhupur, Dayapur, Pakhiralaya, Mathurakhand, Satarkona and Bijoyanagar) during four seasons (summer, winter, pre-monsoon and monsoon) in both mangrove and rice. In mangrove, the average CH_4 flux was higher during monsoon followed by pre-monsoon, summer and winter. However, in rice higher CH_4 flux was observed during summer and monsoon as compared to pre-monsoon and winter. When comparing both the systems, the average CH_4 flux was higher in rice (2.665mg m^{-2} h^{-1}) as compared to mangrove (0.159mg m^{-2} h^{-1}). In mangrove, the soil labile carbon pools mainly, readily mineralizable carbon (RMC), microbial biomass carbon (MBC) and potassium permanganate oxidizable carbon ($KMnO_4$-C) were higher during summer than other seasons. Similarly, in rice the RMC, MBC, and $KMnO_4$-C contents were higher in summer followed by monsoon, winter and pre-monsoon. When comparing both the ecology, the RMC, MBC and $KMnO_4$-C contents were 79.6, 131.8 and 27.6% higher in mangrove than rice. The soil pH was ranged from 6.41 to 7.15 and 7.33 to 8.34 in rice and mangrove, respectively during the four seasons and six locations. Higher electrical conductance and salinity were observed in mangrove (ranged from 5.38 to 18.57 and 1.24 to 2.14 ppt, respectively) than rice (0.58 to 1.60 and 0.25 to 0.54 ppt, respectively)during the four seasons and six locations. The soil labile carbon pools (RMC, MBC and $KMnO_4$-C) and physico-chemical properties (pH, electrical conductance and salinity)were negatively corelated with CH_4 emission. Thereby, the shifting of mangrove to rice resulting more CH_4emissions from rice as compared to mangrove. There is a need to protect and rejuvenate the mangroves in the wetland ecologies to mitigate the climate change scenario.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/10

Environment-friendly utilizationof agricultural and industrial waste to mitigate methane emission in lowland rice ecology

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ABSTRACT

The increasing concentrations of greenhouse gases (GHGs) in atmosphere due to various anthropogenic activities is causing global warming.Among all agricultural production systems, rice alone accounts for 11% of GHGs emissions from agriculture. Among the GHGs, methane (CH_4) is emitted from soil to the atmosphere through rice aerenchyma. And globally, the CH_4 emission rate from rice paddy was assessed to be 4-19 % of total fluxes.At present, different techniques are being used to mitigate the GHGs emission from agricultural soils. Among them, the addition of industrial wastes (e.g., basic slags from steel industry and phosphogypsum from phosphate fertilizer manufacturing industries), agricultural wastes (rice straw) as amendments in rice soil have been shown the potential to mitigate GHGs emission in rice. The GHGs flux reduction potential was estimated during kharif rice (Cultivar- Swarna Sub1), 2021 as affected by soil amendment and compared to the recommended dose of fertilizer (RDF) practice. The eight (8) treatments imposed were (i) recommended dose of fertilizer (RDF), 80:40:40 :: $N:P_2O_5:K_2O$ kg ha^{-1}, and RDF along with (ii) RDF; nitrogen through ammonium sulphate (as a substitute of neem coated urea), (iii) rice straw-biochar (5 t ha^{-1}), (iv) phosphogypsum (2 t ha^{-1}), (v) rice straw-incorporation (5t ha^{-1}) (vi) rice straw-compost (5 t ha^{-1}), and (vii) basic slag (1 t ha^{-1}), (viii) Methanotroph inoculation (as root deep). The seasonal CH_4 emission was higher in rice-straw incorporation treatment (93.55 kg ha^{-1}) followed by rice-straw composting (92.8kg ha^{-1}) and RDF (88.8kg ha^{-1}). Comparing with the RDF, the CH_4 reduction percentage were higher in basic slag treatment (13.8%) followed by methanotrophs inoculated plots (10.7%). However, 5.0 and 4.3% higher CH_4 emission was observed in rice-straw incorporation and rice-straw composting treatment, respectively as compared to RDF. Therefore, use of these amendments could be considered as an effective option to mitigate CH_4 emission from lowland rice ecology in the climate change scenario.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/11

Integrated nutrient management in aromatic rice-onion cropping sequence

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ABSTRACT

The field experiment was conducted at Regional Research and Technology Transfer Station, Bhawanipatna, Kalahandi of Odisha University of Agriculture and Technology during 2017-18 and 2018-19 to study the effect of different integrated nutrient management practices on system yield and economics of aromatic rice–onion cropping sequence. The aromatic rice variety CR Dhan 907 was grown during *kharif* season with five treatments *viz*. T_1: Soil test based fertilizer recommendation (STBFR- 75: 22.5:30 kg ha^{-1} N:P_2O_5:K_2O),T_2: Green manuring (GM)+STBFR,T_3: FYM 5t/ha+STBFR,T_4:GM + 75 % STBFR+Biofertilizers (BF-Azosporillum and PSB @ 5 kg ha^{-1}each) and T_5:FYM+75 % STBFR +BF in RBD replicated thrice. The recommended dose of fertilizer for aromatic rice was 60:30:30 kg ha^{-1} N:P_2O_5:K_2O.The onion variety N53 was grown during *rabi* season in split-plot design taking the residual effect of*kharif*rice plots as main-plot and two INM practices; F_1:120:60:60 kg ha^{-1} N:P_2O_5:K_2O +FYM 5 t/ha+ BF and F_2:120:60:60 kg ha^{-1} N:P_2O_5:K_2O+Vermicompost 2.5 tha^{-1}(VC)+BFin sub-plots. The soil of the experimental site was clayeyloam with available N-214kg ha^{-1}(low), available P-44.1kg ha^{-1}(high) and available K- 264kg ha^{-1}(medium).Theresults revealed that higher aromatic rice grain yield (3886 kg ha^{-1})was realized with application of GM+100% STBFR. However, higher bulb yield of onion (13163 kg ha^{-1}) and net return (Rs.46932ha^{-1}) was with application of GM+75% STBFR+BF, where the rice equivalent yield (10130 kg ha^{-1}) and net return (Rs.78193^{-1}ha) of the system were 30 and 107% higher, respectively, than application of STBFR. Higher onion bulb yield(11647kg ha^{-1}) and net return (Rs.28526ha^{-1})were obtained with application of 120:60:60 kg ha^{-1} N:P_2O_5:K_2O+Vermicompost 2.5t ha^{-1} to onion than with FYM 5t ha^{-1} in place of vermicompost. Cultivation of aromatic rice variety CR Dhan 907 in medium land situation during *kharif* season with GM+75% STBFR (56.0:17.0:22.5 kg ha^{-1}N:P_2O_5:K_2O)+BF and growing onion variety N53 with 120:60:60kg ha^{-1} N:P_2O_5:K_2O+VC 2.5 tha^{-1}+BF produced maximum system yield and fetched higher return rupee^{-1}invested.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/12

Rice Production in Telangana: Growth, Instability and Decomposition Analysis

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ABSTRACT

The present study was conducted to assess the growth rates and instability in area, production, and yield of rice in Telangana. Also, the relative contribution of area and yield to change in output was estimated by decomposition analysis. The study is based on secondary data for a period of 30 years i.e., 1990-91 to 2019-20. The secondary data were obtained from various publications of Directorate of Economics and Statistics, Directorate of Rice Development, Patna.For this study, the whole period (1990-91 to 2019-20) is divided into three sub-periods to have a period-wise examination of growth and instability patterns of the area, production, and productivity of rice and the sub-periods were as follows: period I (1990-91 to 1999-2000), period II (2000-01 to 2009-10) and period III (2010-2011 to 2019-20), and overall period (1990-91 to 2019-20). Compound Growth Rates were used to calculate the growth rates. The instability in area, production, and yield was measured with Cuddy Della Valle Index and Coppock's Instability. The study revealed that the growth rates for Telangana in the overall period were positive for area, production, and yield (2.1, 3.7, and 1.5 respectively). The Cuddy Della Valle Index for the overall period registered higher, medium, and low instability for production (35.1), area (26.4), and yield (7.6) respectively. The Coppock's Instability indices revealed that the degree of instability for area and production was higher during the period III in comparison to period I and II. One of the major reasons for this could be increased area under rice in period III, because of the assured irrigation due to completion of many major and minor irrigation projects and revival of tanks under Mission Kakatiya in Telangana. The decomposition analysis for overall period (1990-91 to 2019-20) revealed that the area effect was highly responsible for the production variability (46.1 percent) in Telangana.The area effect in enhancing the rice production increased over a period of time. Since the scope to increase the area under rice cultivation is limited, the focus should be on the improvement of the yield to meet the future demand for rice.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/13

Field Performance of Double Haploid Lines from Aromatic x Non-aromatic Rice (*Oryza sativa* L.) hybrids for Yield, Yield contributing and Quality traits

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ABSTRACT

Doubled haploid (DH) system provides unique technology for attaining immediate homozygosity by reducing the number of generations (6-7 generations) in self-pollinated crops like rice. In the present investigation DH system was used in aromatic rice breeding programme particularly to develop short stature high yielding rice lines with good quality characteristics. Field experiment was conducted to evaluate fourteen rice genotypes i.e., seven elite anther culture derived DH lines from two hybrids (four DH lines from Pusa Basmati-1 x Malviya 36 and three from Taraori Basmati x Jaya), two corresponding F_1s, four parents and one local check (HUBR 2-1) in RBD in two replications for yield, yield components and quality traits.

Out of four DH lines developed from PB-1 x Malviya 36, AC_1 13 showed early flowering (102.33 days) followed by AC_1 21 (105.33). Out of three DH lines developed from the cross TB x Jaya, early flowering was observed in AC_2 20 (104.33 days). DH lines derived form PB-1 x Malviya 36, shortest plant height was exhibited by the AC_1 13 line (100.21 cm) and tallest was by AC_1 4 (107.57 cm). Where as in anther derived lines of TB x Jaya, AC_2 20 is dwarfer (88.68 cm) than other lines AC_2 7 (90.50 cm) and AC_2 49 (93.44 cm). The highest grain yield per plant was recorded in AC_1 21 (26.10 g) followed by AC_1 13 (25.51 g), which were obtained from the cross PB-1 x Malviya 36. In the promising three DH lines recovered from the TB x Jaya, AC_2 20 was reported higher grain yield per plant (26.76 g).

Out of four Pusa Basmati-1 x Malviya 36 DH lines, the line AC_1 21 performed well for yield contributing and quality traits. Out of the promising three DH lines recovered from the Taraori Basmati x Jaya, AC_2 20 recorded higher grain yields with desirable quality traits as compared to other DH lines and check. These few selected lines (for high grain yield with good grain quality traits), which displayed significant differences from control may be exploited in future for rice improvement.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/14

Effect of heat stress on biochemical activities of wheat varieties at different crop growth stages

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ABSTRACT

The present investigation entitled "Effect of heat stress on wheat varieties at different crop growth stages" was conducted at Student's Instructional Farm of the Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya (UP) during *rabi* season of 2020-21. The experiment was planned under SPD (Split plot Design) with three replications. The treatment consisted of three date of sowing viz; D1 (30th November), D2 (15th December) and D3 (30th December) data indicated that biochemical traits such as total chlorophyll content, total soluble sugar content in leaves of V1 and V2 were greatly reduced in late sown condition D3 (30th December). Reduction in these parameters was less in V1 (PBW-343) and V2 (HD-2967) as compared V3 (Halna) at early sowing i.e., D1 (30th November). V3 (Halna) showed better performance than V1 (PBW-343) and V2 (HD-2967) in late sown condition D3 (30th December). Proline contents in leaves increased with the age of the crop up to 75 DAS in all the date of sowing. The highest amount of proline content was recorded at 75 DAS in all the varieties under all the date of sowing. Overall physiological traits and biochemical traits of wheat crop were adversely affected by time of sowing due to onset of high temperature during crop growth and particularly grain filling. Variety i.e., V3 (Halna) reduced the detrimental effect of heat stress by improving physiological traits which ultimately helped in obtaining higher yield.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/15

Evaluation of different levels of Nitrogen (N), Phosphorus (P) and Biofertilizers on Rice (*Oryza sativa* L.)

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ABSTRACT

Rice is grown in over hundred countries and is the primary food for half of the people in the world. World population is expected to 8.5 billion by 2025 and to maintain the self-sufficiency in rice. The efficiency of fertilizer use for nitrogen is lower than 50 %, for phosphorus lower than 10 % and for potassium 40%. This low efficiency of fertilizer use is also associated with other losses by immobilization, volatilization, denitrification, leaching, and clay adsorption. Therefore, use of biofertilizer along with chemical fertilizers to maintain soil health as well as soil fertility and productivity is a need of the time. With this objectives a field experiment was conducted during the rainy (*Kharif*) seasons of 2013 to 2015 at Main Rice Research Station, Anand Agricultural University, Nawagam. The farm is located in hot semi-arid eco-region with medium deep black soils and geographically situated at (22.48^0 latitude, 71.38^0 longitude and 32.4 m above the mean sea-level). To study the response of different levels of Nitrogen (N), Phosphorus (P) and Biofertilizers on Rice under middle Gujarat Agro climatic zone, 12 treatment combinations consisting three levels of Nitrogen, two levels of Phosphorus and two levels of Biofertilizer were tried in factorial randomized block design with four replications. The three year experimental results revealed that different treatments for Nitrogen levels were found significant for most of the growth and yield contributing characters, while for phosphorus and biofertilizer found non-significant. In pooled data the N level N_3(120 kg N ha^{-1}) gave significantly higher grain yield of 5191kg ha^{-1}and found significantly superior over N level N_1. The result revealed that potential production and profit from the rice crop could be secured by applying 120 kg Nitrogen ha^{-1} only to get higher yield in middle Gujarat Agro climatic zone.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/16

Enhancing productivity of organic paddy cultivation under various management practices

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ABSTRACT

A field experiment was conducted on medium black soil with slightly alkaline in reaction at UPRS, VNMKV, Parbhani centre with objective to enhance productivity of organic paddy. Variety Parag was sown on July 5th, 2020 by keeping 30 cm distance in between two rows using 60 kg seed rate ha^{-1}. Recommended dose of fertilizer of 80:50:50 kg NPK/ha was applied. And in all nine treatments viz; T_1:Adhoc Organic POP recommendation: 30 kg N by FYM, 30 kg N by vermi-compost, 30 kg N by neem cake, Azospirillum (2 kg ha^{-1}) and P solubilising bacteria (2 kg ha^{-1}) (FYM 6 t/ha + VC 3 t/ha + NC 857 Kg/ha + Azo and PSB 2.0 Kg /ha), T_2: 100 % POP recommendation as organic (FYM @ 5 t ha^{-1}, 45 kg N by FYM, 22.5 kg N by vermi-compost, 22.5kg N neem cake) (FYM 5 t/ ha + FYM 9 t/ha+ VC 4.5 t/ha + NC 642 Kg/ha), T_3: 75 % POP recommendation as organic (FYM @ 5 t ha^{-1}, 33.75 kg N by FYM, 16.88 kg N by vermi-compost, 16.88 kg N by neem cake) (FYM 3.75 t/ha + FYM 6.75 t/ha+ VC 3.37 t/ha + NC 481 Kg/ha), T_4: FYM @ 10 t/ha + VC 2.5 t/ha + spray of liquid manure Jeevamrit @ 10% (FYM 10 t/ha + VC 2.5 t/ha), T_5: Bio-inoculated fortified compost @ 10 t/ha + All bio-fertilizers/bio-manure, T_6: Inorganic RDF (soil test based application of NPK), T_7: Vermicompost (8 t/ha) + spray of liquid manure Jeevamrit @ 10%, T_8: FYM @ 10 t/ha + VC 3.0 t/ha + cow dung slurry, T_9: Control were tested. Design of the experiment was Randomized block design, with three replications. Soil was low in Nitrogen, ferrous and zinc, medium in phosphorous and rich in potash. Highest rice grain yield (2776Kg/ha), GMR (97438/ - Rs/ha) and NMR (63245/- Rs/ha) was recorded with application of Inorganic RDF (soil test based application of NPK) (T_6 - Inorganic RDF (soil test based application of NPK) and was significantly superior over rest of the treatments. Among the organic sources of nutrients application of Vermicompost (8 t/ha) + spray of liquid manure Jeevamrit @ 10% (T_7 - Vermicompost (8 t/ha) + spray of liquid manure Jeevamrit @ 10%) recorded highest rice grain yield (2150 kg/ha), highest GMR (75477/- Rs/ha) and highest NMR (27155/- Rs/ha) and was significantly superior over rest of the treatment in case of rice grain yield, GMR and NMR, however it was found at par with treatment T_1 i.e. Adhoc Organic POP recommendation: 30 kg N by FYM, 30 kg N by vermi-compost, 30 kg N by neem cake,Azospirillum(2 kg ha^{-1}) and P solubilising bacteria (2 kg ha^{-1}) and T_2 i.e. 100 % POP recommendation as organic (FYM @ 5 t ha^{-1}, 45 kg N by FYM, 22.5 kg N by vermi-compost, 22.5kg N neem cake in case of rice grain yield whereas in case of GMR and NMR it was found at par with treatment T_1 i.e. Adhoc Organic POP recommendation: 30 kg N by FYM, 30 kg N by vermi-compost, 30 kg N by neem cake,Azospirillum(2 kg ha^{-1}) and P solubilising bacteria (2 kg ha^{-1}).

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/17

Nutrient management studies in rainfed rice intercropping systems

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ABSTRACT

A field experiment was conducted on medium black soil with slightly alkaline in reaction at Upland Paddy Research Scheme, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani with objective to find nutrient requirement of rainfed rice. Variety PBNR-03-02 was sown on July 1st, 2020 by keeping 30 cm distance in between two rows using 60 kg seed rate ha^{-1}. Recommended dose of fertilizer of 80:50:50 kg NPK/ha was applied. The seed was treated with carbofuron @ 2 gm/kg seed and azosprilium @ 10 gm/kg seed. Black gram and soybean were sown as intercrop as per the treatments and treated with Thiram @ 3 g/kg of seed and rhizophos @ 10 ml/kg of seed. Design of the experiment was split plot design, with three replications. Soil was low in nitrogen, ferrous and zinc, medium in phosphorous and rich in potash. In all 05 main treatments viz ; N_1: 75 % RDF of Rice, N_2: 100 % RDF of Rice, N_3: 75 % RDF of Rice + Sulphur 20 kg /ha, N_4: 100 % RDF of Rice + Sulphur 20 kg /ha, N_5: 75 % RDF of Rice + FYM 5/t ha and 05 sub treatments C_1: Rice (30 cm row spacing), C_2: Rice + Soybean (3:2 in replacement series), C_3: Rice + Black gram (3:2 in replacement series), C_4: Rice + Soybean (4:2 in replacement series), C_5: Rice + Black gram (4:2 in replacement series) were studied. Highest rice grain yield, soybean and rice equivalent yield was observed with 75 % RDF + 5 t FYM/ha and it was found to be significantly superior over rest of the treatments. In case of intercropping systems the highest rice grain yield was observed with sole crop, however, highest intercrop seed yield and rice equivalent yield was recorded with rice + soybean (3:2) intercropping system followed by Rice + Black gram (3:2 in replacement series).

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/18

Evaluation of paddy cultures for yield and yield contributing traits

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ABSTRACT

The experiment was conducted during *Kharif* 2020 at Upland Paddy Research Scheme, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Twelve promising upland rice cultures were tested for yield and yield contributing traits. The experiment was conducted in randomised block design with three replications. The rice culture PBNR 14-1 (3800 kg/ha) recorded highest grain yield over checks PBNR 03-2 (3033 kg/ha) and Avishkar (3137 kg/ha) followed by culture PBNR 14-3 (3717 kg/ha), PBNR 12-13 (3600kg/ha). These cultures were found promising for yield and quality attributes. The promising cultures were having long slender grains. The culture PBNR 12-13 was found early for maturity. Whereas, Avishkar was found to record maximum panicle length and total number of tillers.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/19

Effects of different foliar nutrition on yield and economics of transplanted *boro* rice (*Oryza Sativa*) in West Bengal

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ABSTRACT

A field experiment was conducted at farmer's field of Gunaidanga village, Malda of West Bengal during the *boro* season of 2020-2021 to studythe performance of different foliar nutrients on the growth and productivity of hybridrice variety "PAC 837". There were ten foliar nutrient treatments, *viz* T_1: Control (water spray); T_2: Zinc oxide (ZnO) @0.75%; T_3: Potassium chloride (KCl) @0.75%; T_4: Potassium sulphate (K_2SO_4) @0.75%; T_5: N-P-K 10-26-26 @1.5%; T_6: Sodium chloride (NaCl) @0.75%; T_7: Potassium dihydrogen sulphate (KH_2PO_4) @0.75%, T_8: Diammonium phosphate (DAP) @1.5%, T_9: Potassium nitrate (KNO_3) @0.75% and T_{10}: Muriet of Potash (MOP) @0.75%. These treatments were assigned in a randomized block design with four replications.Foliar nutrient treatments were applied twice, 1st at panicle initiation stage and 2nd at grain development stage with 100% recommended dose of fertilizer (RDF). From the salient features of the findings it was found thatsignificantly the highest grain (8953 kg ha^{-1})andstraw yield (8016 kg ha^{-1}) were recorded in foliar application of N-P-K 10-26-26 @1.5%. which was at par with foliar application of KH_2PO_4@0.75%, KNO_3@0.75%, DAP @1.5% and MOP @0.75%. Highest no of filled grain per panicle (109.81) was recorded in foliar application of KH_2PO_4@0.75% followed by N-P-K 10-26-26 @1.5%, DAP @1.5%, KNO_3@0.75% and MOP @0.75%. It was also observed that N-P-K 10-26-26 @1.5% kept lowest (34.56) number of unfilled grain per panicle *fb*DAP @1.5%. No significant differences were observed in panicle length and 1000 seed weight among the treatments. As per the benefit cost ratio(BCR) was concerned it was found thatthe highest BCR (2.16) was from foliar application ofN-P-K 10:26:26 *fb* DAP (2.13) and MOP (2.10) whereas control gave 2.03 BCR. So in conclusionsupplementary foliar application of N-P-K 10:26:26@1.5%, DAP @1.5% or MOP@0.75% with RDFcan be suggested to the farmers for getting higher yield as well as profit with respect to their traditional package of practices.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/20

Exploring the Possibility of Use of Customized Fertilizer in Transplanted Paddy in an Inceptisol of West Bengal

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ABSTRACT

A field experiment was conducted in an Inceptisol of West Bengal at Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Nadia during the boro season of 2021 to assess the efficiency of Customized Fertilizer Grade (N-P_2O_5-K_2O-S-Zn: 12:22:18:5:0.5) (marketed by Coromandel Ltd.) for transplanted paddy in terms of yield and quality produce of paddy, post harvest soil fertility and economic feasibility over conventional inorganic fertilizers by using established empirical models of STCR (Soil Test Crop Response) for fertilizer recommendation rates along with the state government scheduled doses. The experiment was laid out in a randomized block design with paddy (var. IET 4786) as test crop under the scope of soil test crop response based fertilizer recommendation for paddy. Results revealed that administration of Customized Grade Fertilizers (CF) on the basis of STCR based fertilizer recommendation targeting rice yield of 10 tha^{-1} turned up with maximum yields of rice grain and straw, which appeared at par with application of CF on the basis of STCR treatment based fertilizer recommendation targeting rice yield of 8 tha^{-1}. Such yields are found significantly higher than rice yields obtained through complex fertilizers (diammonium phosphate). Application of CF, in all occasions, improved growth and yield attributing parameters, NPK content & uptake and rice grain and straw yields. Better grain quality of rice have been ascertained through use of CF and manifested most conspicuously when applied on the basis of STCR recommendations. Best economic return (as envisaged with highest B:C) was achieved when CF was applied on the basis of STCR recommendation targeting 8 tha^{-1} rice yield.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/21

Interactive influence of arsenate and silicate on growth, photosynthetic parameters and carbohydrate metabolism in rice (*Oryza sativa* L.) seedlings

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ABSTRACT

Arsenic toxicity is a global concern owing to ever-increasing groundwater contamination, crops irrigation in many regions of the world including Bangladesh and West Bengal, India. Arsenic contaminated soil adversely affects economic development of Bengal due to its profound effects on growth and physiological activities of agriculturally important crops that possess human health risk. The effect of arsenate with or without silicate on growth, estimation of photosynthetic parameters by using LI-6400XT Portable Photosynthesis System and carbohydrate metabolism in rice (*Oryza sativa* L. cv. MTU-1010) seedlings were investigated. In the test cultivar, arsenic toxicity significantly decreased growth parameters while increased the level of oxidative stress markers. Rate of arsenate accumulation and its conversion to arsenite by arsenate reductase were significantly enhanced in all arsenate treated seedlings while in jointly treated seedlings with arsenate and silicate, arsenate accumulation and its conversion to arsenite decreased. Arsenate exposure hampered all the chloroplast pigment contents viz., chlorophyll-a, chlorophyll-b, carotene and xanthophyll as well as photosynthetic parameters viz., intercellular-CO_2-concentration, net-photosynthesis, transpiration-rate and stomatal-conductance in rice seedlings. Arsenic toxicity increased the accumulation of sugar contents but decreased starch contents indicating major adaptive mechanisms of plants under arsenic stress that contributes to osmoregulation and provides protection of biomolecules. The activities of sucrose phosphate synthase, acid invertase and starch phosphorylase were increased, while sucrose synthase activity was decreased. Co-application of silicate and arsenate showed significant alterations on all the examined parameters compared to arsenate treatment alone due to less accumulation of arsenic in the tissue leading to better growth and productivity in rice seedlings. Such studies will help to develop a cost effective and farmer friendly way to overcome this threat by the application of silicon enriched fertilizers in arsenic contaminated rice fields.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/22

Evaluation of arsenic accumulation in grains of different aromatic rice cultivars under Gangetic Plains of West Bengal

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ABSTRACT

An experimental field trial was conducted during Kharif season,2020, at farmer's field in Gontra village under Chakdaha block of Nadia district, West Bengal to assess the arsenic content on different aromatic rice cultivars. The field trial was laid out in Randomized Block Design (RBD) with 15 aromatic rice cultivars as treatment following same cultivation practices with recommended fertilizer (40:20:20 NPK kg/ha). The result of the experiment postulated that the aromatic rice cultivar Poreiton, one of the cultivars collected from Manipur, showed maximum arsenic accumulation in seed (Grain-0.93 mg/kg; Husk-1.68 mg/kg) and was found to be statistically at par with Wairi-Chakhao (Grain-0.87mg/kg; Husk-1.55mg/kg) and Lalbadshabhog (Grain-0.74mg/kg; Husk-1.52 mg/kg). Least arsenic accumulation was found in Tulaipanji (Grain-0.17mg/kg; Husk-0.71mg/kg). In 2014, World Health Organization already set arsenic level of rice which is safe for consumption as maximum of 0.2 mg/kg for white rice and 0.4 mg/kg for brown rice. From the result postulated from the field experiment, only the cultivar, Tulaipanji was found to be safe for consumption and other remaining cultivars need some mitigation processes through management of water, nutrients etc. so that the As content of rice must be within the safe limit as per WHO's guidelines.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/23

Study on genetic coefficients of popular rice (*Oryza sativa* L.) varieties of scarce rainfall zone of Andhra Pradesh for yield estimation

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ABSTRACT

Yield estimation is one of the primary challenges for successful implementation of Pradhan Mantri Fasal Bhima Yojana (PMFBY) Programme. A field experiment was undertaken at Regional Agriculture Research Station, Acharya N.G. Ranga Agricultural University, Nandyal, Andhra Pradesh during 2019-20 on vertisols under irrigated condition to derive genetic coefficients for popular rice varieties of the scarce rainfall zoneto increase the yield estimation accuracy. The treatments consisted of seven rice varieties (BPT 5204, NDLR 7, NDLR 8, NLR 3041, NLR 33358, NLR 34449 and BPT 2270) in randomized block design and replicated thrice. Higher Leaf Area Index (LAI) of 2.00 and 6.82 was observed in NDLR 7 at 30 Days After Planting (DAP) and 60 DAP respectively whereas higher LAI of 6.28 and 6.08 was observed in BPT 2270 at 90 DAP and harvest respectively. Among varieties higher root dry weight per square metre was observed in NLR 3041 at 30 DAP, 60 DAP, 90 DAP and harvest (70.4 g, 251.7 g, 413.7 g and 447.4 g respectively). Shoot dry weight per square metre differ among varieties at different stages. Higher shoot dry weight at 30 DAP, NDLR 8 (157.9 g), NLR 33358 (778.5 g), BPT 2270 (1326.3 g and 1812.1 g) was recorded. Among the varieties tested NLR 33358 was short duration (106 days) and BPT 2270 was long duration (164 days). Plant height and panicle length was non significant whereas higher productive tillers per square metre (400.4) and harvest index (47.4) was observed in NLR 33358. Higher seeds per panicle (250.7) was observed in NDLR 7. Lower test weight (12.82 g) and grain yield (6320 kg ha^{-1}) was observed in NLR 33358. Higher test weight (16.37 g) and grain yield (7907 kg ha^{-1}) was observed in BPT 2270.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/24

Phosphorus use efficiency of drought tolerant rice varieties grown in low phosphorus soil

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ABSTRACT

Among Indian rice growing soils, phosphorus (P) deficiency is widespreadand it has become the most limiting nutrient next to nitrogen. In order to identify superior released drought tolerant varieties with higher P-use efficiency and tolerant to low soil-P status a study was taken up at ICAR-IIRR farm, Rajendranagar, Hyderabad. Five high yielding drought tolerant varieties (DRR Dhan 42, DRR Dhan 44, DRR Dhan 46, DRR Dhan 51 and Rasi) during *rabi* 2019-20 were evaluated in plots received no phosphorus since last 35 years. The soil type of the experimental site is a clay vertisol with pH 7.6, available nitrogen of 214 kg/ha, available phosphorus of 9.1 kg P_2O_5/ha, available potassium of 310 kg K_2O/ha and organic carbon of 0.52%. The trial was laid out in RBD design with four replications. The highest no. of tillers/m^2 (324), no. of panicles/m^2 (297) and no. of grains/panicle (152) were observed with Rasi. The highest panicle weight (33 g) and test weight (20 g) were recorded in Rasi. The highest grain yield (4270 kg/ha) was recorded in Rasi, closely followed by DRR 44 (4074 kg/ha). The highest straw yield (8940 kg/ha) was recorded in DRR Dhan 44 followed by Rasi (8840 kg/ha).Similarly, available soil P status either at initial or final stage was found to be non-significant irrespective of varieties. However, after harvest of rice crop there is little increase in available soil P over initial available soil P at the tune of 0.1 kg/ha. This may be due to application of irrigation water or other non point sources. The highest P content in grain was found in Rasi (0.32%) followed by DRR Dhan 51 and DRR Dhan 44 (0.28%). This indicates **Rasi, DRR Dhan 44 and Dhan 51** are efficient in soil P uptake as well as good grain yielder.The results indicated that genetic variability exists among rice varieties in low available P soils and grain yield responses. This trait can be utilized for breeding elite rice cultures with superior grain yield stability and sustainability, under low available soil-P and high P-fixing soil conditions.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/25

Delta (Δ) yield is a better input to understand site-specific response of rice crop

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ABSTRACT

Large yield gap, the difference between potential and farmer yield imply more scope for improvement. Potential yield is location-specific making it necessary to aggregate local estimates spatially and temporally to produce average estimates for larger areas.

AICRIP conducts multi-location trials to identify genotypes of high yield potential along with appropriate crop management practices. Spatial variability of production factors in multiple locations lead to differential crop responses. 'Delta (Δ) Yield', the difference between average potential and realised yield, described the variability better than yield in an earlier instance and same was applied now to another dataset to test the repeatability.

Triplicated yield maximisation trial with varieties, BPT 5204, ADT 46 and CO 50 with treatments; Farmer Fertiliser Practice (T_1), recommended dose of fertiliser (T_2) and software, Nutrient Expert based recommendations (T_3) was conducted in Karaikal (2019-20). The recorded yield and calculated Δyield (using average potential is 6000, 6656 and 6338 kg ha^{-1} of the varieties, respectively) were analysed.

Analysis indicated sites showed significant differences in yield and Δyield. Mean difference in yield and Δyield of Site 1 and 3 were 1176 and 1832 kg ha^{-1}, respectively. Similarly, the significant difference between Site 5 and 3 was 1585 and 1903 kg ha^{-1}, respectively. Both attributes were significantly influenced by treatments and T_3 was superior to T_1 and T_2. CO 50 was superior to BPT 5204 and ADT 46 in both forms of expression however, with more difference between CO 50 and ADT 46 in Äyield. Analysis of individual treatments indicated that both T_1 and T_3 did not show any significant difference in yield and Δyield. T_2, which was a blanket recommendation irrespective of local variance in the supply potential of soil, showed the variance was more in Δyield by 8% (adjusted R^2) that needed attention. Summarily Äyield appeared to have more sensitivity to site differences and treatments when compared to yield.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/26

Contribution of mechanical and manual weeding for upland organic rice productivity in Meghalaya

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ABSTRACT

The upland rice production in organic production mode is environment friendly in terms of curtailing methane emission from rice paddies, economically premier due to higher market prices for organic products and increasing demand; while the weed menace is serious issue in upland rice. In this context, on-farm trail was conducted in farmer's field at Kyrdemkulai village (25^0 751' N, 91^0 832' E) in Ri-Bhoi district of Meghalaya with objective to study the impact of combinations and frequency of mechanical and manual weeding on productivity of rice (*ArizeTej Gold*) in *kharif* season of 2021. The experiment was a part of the project "Climate Smart Management Practices" funded by International Rice Research Institute, Philippines. The result showed that, grain and straw yield in weedy check was lower than weed free check by 1.46 t/ha and 5.16 t/ha, respectively indicating the volume of losses caused by weeds. The highest grain yield of 1.84 t/ha was recorded in weed free check which was remain on par with manual weeding three times (25-30, 45-50 and 60 days after sowing (DAS)). The manual weeding two times (25-30 and 45-50 DAS) was remained on par with combination of mechanical weeding (23-25 DAS) followed by manual weeding at 45-50 DAS, indicating the place of mechanization in upland rice. The mechanical weeding (hand held wheel weeder) at 23-25 and 40-45 DAS increase grain and straw yield by 0.65 t/ha and 2.36 t/ha, respectively over weedy check showing its significant economic contribution to rice productivity improvement in upland rice organic production system which is characterized by higher weed losses, restriction on use of agrochemicals and increasing manual labour wages.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/27

Performance of long duration rice cultures under organic farming during Kharif

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ABSTRACT

Intensive cultivation with excess and indiscriminate use of fertilizers and chemicals not only decreases yields but also soil fertility and caused residual effect on succeeding crops. Cultivation of rice under organic farming improves soil fertility and sustained yields over years without hampering the soil health by improvement in developing soil microorganisms. Organic manures play a direct role in supplying macro and micronutrients and indirectly by improving the physic chemical and biological properties of the soil besides supplying nutrients to the present crop and quite often leave substantial residual effect on succeeding crops in the cropping systems (Maskina and Meelu, 1984). The present study has been taken up at Agricultural Research Station, Nellore, A.P, India during *kharif*, 2007 to evaluate the long duration rice cultures along with prerelease rice cultures under organic farming. The experiment was laid out in RBD design with 3 replications and 7 varieties and prerelease cultures with a gross plot size of 8.4m x 5.0m. The spacing adopted was 20x15cm. Organic package followed was application of FYM @ 12 t/ha, Green manure incorporation (Dhaincha) (seed rate@30 kg/ ha), Application of azospirillum and PSB each @ 5 kg/ha, Neem cake @500 kg/ha and crop protection was done with neem oil both in nursery and mainfields.The varieties tested were V_1: NLR 33892(Parthiva), V_2: NLR 20017 (PRC), V_3: NLR 20002 (PRC), V_4: NLR 20022 (PRC), V_5: NLR 20084 (PRC), V_6: NLR 28523 (Sreeranga) and V_7: NLR 9674 (Nellore Molagolukulu). The results indicated that among the entries tested under organic farming significantly the highest grain yield (6114 kg/ha) was recorded with NLR 20022 which was on par wih NLR 33892 (Parthiva)(5776 kg/ha), NLR 28523 (Sreeranga)(5776 kg/ha) and NLR20002(5770 kg/ha) followed by NLR 9674 (Nellore Molagolukulu))(5400 kg/ha) and NLR 20084)(5207 kg/ha) which were in turn on par with each other. The lowest grain yield (4831kg/ha) was recorded with NLR 20017(4831 kg/ ha). Similar trend was also observed in yield attributes and straw yield.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/28

Amendment induced Soil Redox potential (Eh) Gradients: Effect on plant-soil–atmospheric continuum in rice cultivars

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ABSTRACT

Oxidation-reduction (Eh) and acid–base reactions (pH) both are regarded essential for the functioning of all living microorganisms. Redox potential (Eh) is primarily considered as a master variable for anaerobic paddy soil. A field experiment was conducted during the summer season of 2021 with three varieties of contrasting heights and genetic backgrounds- V_1: Sahbhagidhan (plant height: 85-90 cm), V_2: Naveen (plant height: 105 cm) and V_3: Rajalaxmi (plant height: 105-110 cm) was grown with three amendments *viz*. control (N_0: no amendment), phosphogypsum (N_1: 2.0 Mg ha^{-1}), manganese oxide (N_2: MnO_2 @ 0.5 kg ha^{-1}) and ferric oxide (N_3: Fe_2O_3 @ 10 mg kg^{-1} soil) to create differential Eh in soil system.

Plant morphological features were recorded at prominent growth phases (30-60-90 DAT) of the crop*viz*. plant height, leaf and tiller numbers, stem diameter, leaf area index, internode distance, panicle numbers etc. along with root traits. HPLC analysis showed presence of organic acids like oxalic, citric, tartaric and lactic acids from root exudates at different concentration in three varieties. Aerenchymal gas space from culm sections was measured from three rice cultivars to study the varietal and treatment differences. Soil pH andEhwas monitored throughout the important crop growth phases under the treatment of amendments. Soil parameters like C fractions (SOC, TOC, $KMnO_4$-C, WSC) and enzymatic activities (dehydrogenase, acid phosphatase, alkaline phosphatase, urease, â-glucosidase) in plant rhizosphere also got influenced by changing Eh values at different crop growth phases, hence shared a significant correlation with majority of them. The results further revealed that the peak of CH_4fluxes were recorded at about 67 days for Sahbhagidhan and Naveen varieties,but forRajalaxmithe same was seen at 74 days after transplanting. Among the amendments applied, the CH_4flux from the soil significantly varied in a trend control > phosphopysum > managenese oxide > ferric oxide. Further, the effect of ferric oxide showed a prominent effect in increasing grain yield in a tune of 10-16% in three rice varieties, while the variety Rajalaxmi recorded the highest yield.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/29

Economics and Water Productivity of Rice Under Different Land Levelling and Establishment Methods

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ABSTRACT

To increase productivity of crops, various types of efforts have been made by the farmers and agricultural researchers from time to time. For sustainable agriculture, the need is to increase the agricultural crops productivity as well conservation of natural resources. Water is a key factor in increasing agricultural production; its increasing scarcity has resulted into the emergence of various innovative and efficient water management techniques. In order to accomplish this, a field experiment was conducted during the *Rabi* season, 2020-2021 at Regional Agricultural Research Station, Polasa, Jagtial, with an objective to study the economics and water productivity of rice under different land levelling and establishment methods.The treatments include three land levelling practices as main plot treatments viz., laser land levelling (M1), conventional levelling (M2) and unlevelled (M3) and four sub-plot treatments viz., Semi dry rice (S1), Wet direct seeding (S2), Conventional transpalnting (S3) and Machine transplanting (S4) in strip plot design and replicated thrice.

Among land leveling practices higher gross returns (Rs. 87735 ha^{-1}), net returns (Rs. 49540 ha^{-1}) and B:C ratio (2.25) were recorded with laser land leveling and were significantly superior over conventional land leveling and control (unleveled). Among establishment methods, conventional transplanting significantly recorded highest gross returns (Rs.107616 ha^{-1}) and net returns (Rs. 64083 ha^{-1}) over machine transplanting, wet direct seeding and semi dry rice. While, higher B:C ratio was observed with conventional transplanting (2.47) and was comparable with machine transplanting (2.42) in turn, significantly superior to semi dry rice, wet direct seeding.

Similarly, laser land leveling significantly recorded higher water productivity (0.47 kg m^{-3}) and was significantly superior to conventional land leveling and unlevelled field condition. Among establishment methods, conventional transplanting recorded significantly higher water productivity (0.52 kg m^{-3}) which was followed by machine transplanting and wet direct seeding where as the lowest was observed with semi dry rice.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/30

Impact of various establishment methods on yield of rice under rainfed condition

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ABSTRACT

The water crisis is threatening the sustainability of the irrigated rice system and food security in Asia. Our challenge is to develop novel technologies and production systems that allow rice production to be maintained or increased in the face of declining water availability. Water shortage is becoming severe in many rice-growing areas in the world, prompting the introduction of water-saving aerobic rice, which is direct-seeded in non-puddled, nonflooded aerobic soil, aerobic rice systems can reduce water use in rice production by as much as 50% 'Aerobic rice' and 'upland rice' are both grown under aerobic conditions. This paper introduces principles that govern technologies and systems for reducing water inputs and increasing productivity. We concluded that, sanda technology mainly knows as double transplanting increases yield up to 8-10 %.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/31

GHG mitigation strategies in rice

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ABSTRACT

Rice production is both a victim and a contributor to climate change. Drought, flood, saltwater, and extreme temperatures devastate crops and risk the livelihoods of 144 million smallholder rice farmers each growing season. At the same time, traditional cultivation methods, such as flooding paddy fields and burning rice straw in open fields, contribute approximately 10% of global man-made methane, a potent greenhouse gas.Ninety percent of the world's rice is produced and consumed in Asia, and 90 percent of rice land is at least temporarily flooded. However, rice cropping systems are considered to be among the major anthropogenic sources of methane (CH_4) and nitrous oxide (N_2O). Estimates of global CH_4 emissions from paddy soils range from 31 to 112 Tg y^{-1}, accounting for up to 19% of total emissions, while 11% of global agricultural N_2O emissions come from rice fields. The AWD technology has also been proven to effectively mitigate greenhouse gas emission, specifically methane (CH_4), from rice production by 30-70%, without causing a yield reduction. During the dry phases, the methane-producing bacteria are inhibited, thus, setting a condition to reduce GHG emission.The soil in DSR remains aerobic for most of the time in the season which reduces methane emission.Greenhouse gas emissions are reduced through the use of machine transplanting because of a reduction of cultivation time and improving water-use efficiency. It is most effective in combination with laser land leveling, which reduces the amount of time and volume of water needed for irrigation. SSNM is also reduces greenhouse gas emissions as more efficient use of nitrogen reduces nitrous oxide emission from the field, and indirect emissions during the production of N-fertilizer.With SRI, soil moisture is kept at an optimum level, thus, reducing methane emission from rice production. Midseason drainage and intermittent irrigation greatly reduce methane emissions.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/32

Intensification of rice (*Oryza sativa* L.)-based cropping system for enhancing productivity and profitability under shallow lowlands of eastern India

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ABSTRACT

Rice is the principle food crop and rice-based cropping systems contributes major shares to the food basket of India. Rice-wheat is the most dominant cropping system as a country whole whereas in eastern India cropping systems like rice-rice, rice-pulses, rice-oil seeds, rice-maize, rice-vegetables plays important role for sustaining the food security of the region. Ecological intensification of the existing cropping systems either horizontal or vertical direction by adopting appropriate multiple cropping pattern will enhance the productivity, profitability and income of rice farmers with minimum environmental impact. To find out the suitable intensified rice-based cropping system for the shallow lowland rice ecologies different combinations of rice-based cropping sequences were evaluated atresearch farm of ICAR-National Rice Research Institute, Cuttack (20.5^0 N, 86^0 E and 23.5 m above mean sea-level) located in the 'East and south-eastern coastal plain agro-climatic zone' of Odisha during 2018 and 2019. The experiment was laid in randomized block design and replicated thrice. The treatments consist of T_1: Rice - rice, T_2: Rice - groundnut, T_3: Rice – blackgram, T_4: Rice - blackgram + toria, T_5: Rice - maize, T_6: Rice - maize + blackgram, T_7: Rice – maize + cowpea.Results of the experiment reveal that rice-maize cropping sequence recorded higher rice equivalent yield (10.92 t/ha) which was at par with the rice-rice and rice-groundnut cropping sequence and Rice-blackgram sequence registered lowest system yield (7.69 t/ha REY). Intensification of rice-maize cropping sequence with inclusion of blackgram or cowpea as an inter-crop in maize registered 10.9 and 20.5% increase in rice equivalent yield respectively as compared to rice-maize system. Rice – maize + cowpea recorded highest rice equivalent yield (13.16 t/ ha), net return (Rs.132480), B: C ratio (2.27) and land productivity (57.2 kg REY/day/ha). Thus, rice- maize + cowpea/blackgram cropping system could be recommended as an alternative to the conventional rice-rice sequence to enhance the land productivity and profitability under coastal eco-regions of eastern India.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/33

Effect of weed management strategies under different crop establishment methods in rice crop at New Alluvial Zone of West Bengal

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ABSTRACT

As our population soars nearly 10 billion people by 2050 and about 3 billion more mouths to feed more than there were in 2010. Therefore, production could be outstripped by demand. Stagnation of rice yield due to transplanted puddled rice (TPR), a widely practiced method of rice establishment affects soil physical and chemical properties besides requiring a large amount of labor and water. Growing more food with same production or even reduced costs and sustaining quality of natural resource base are major concern. The shortage of labor, water and depleting soil fertility issues causing increasing interest in shifting from TPR to direct seeding of rice (DSR).Keeping in view, a field experiment laid out in split plot design with 3 replications comprising of 4 crop establishment methods as main plots (M) *viz.* Wet DSR under puddled, Wet DSR under unpuddled, Transplanting under puddled and Transplanting under unpuddled and 6 weed management practices assub plots (S) *viz.,* Pre-emergence herbicide Pretilachlor 750 g haÉ¹*fb* by Post-emergence herbicide Bispyribac sodium @ 25 g haÉ¹, Pre- emergence herbicide Pretilachlor 750 g haÉ¹+ Hand weeding at 40 DAS/ DAT, Intercropping with Sesbania, Hand weeding twice at 20 and 40 DAS/ DAT, Unweeded Control, Weed free in Satabdi (IET 4786) variety of rice at D - block farm, --Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, during *kharif* season of 2019-20. The rice crop gave a maximum number of effective tillers per m^2(328), grain yield (4.38 t/ha), straw yield (5.35 t/ha) and harvest index (45.03%) with the combination of Transplanting under puddled and Weed free (M_3S_6) and minimum number of effective tillers per m^2 (222), grain yield (1.34 t/ha), straw yield (2.31 t/ha) and harvest index (36.76 %) with the combination of Wet DSR under unpuddledand Unweeded Control (M_2S_5).

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/34

Efficacy of Various Herbicides on Weed Dynamicin Dry Direct Seeded Upland Rice

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ABSTRACT

An experiment was carried out at Chiplima, Sambalpur,Odisha during the *rabi* season of two consecutive years, 2016 and 2017 to study the efficacy of various herbicides on density of weed flora , crop yield as well as economics in dry direct seeded rice under upland condition in West Central Table Land Zone in Odisha . Weed free treatment recorded significantly the lowest weed density as well as weed dry weight. Among the herbicides treatments, oxadiargylfb chlorimuron ethyl + metasulfuron methyl recorded lower density and dry weight of weeds and higher yield attributes.The higher grain yield was obtained in oxadiargyl fb chlorimuron ethyl + metasulfuron methyl (3.62 t /ha) which significantly superior to oxadiargyl and at par with rest of the herbicidal treatments.The higher net return(₹ 24713) andbenefit: cost ratio (1.68)was obtained from oxadiargyl fb chlorimuron ethyl + metasulfuron methyl among the herbicide treatments.Overall, the combination of oxadiargyl fb chlorimuron ethyl + metasulfuron methyl is economically profitable as compared to other treatments for successfully controlling the complex weed flora in upland direct seeded rice conditions.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/35

Comparative performances of polymer coated urea vis-à-vis neem coated and uncoated urea in relation to yield and N use efficiency of rice

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ABSTRACT

Polymer coated urea (PCU) has been identified as a controlled release N fertilizer having potential to reduce N loss and enhance N uptake. However there are several interacting soil, plant and microbial factors which may influence N release from PCU and its subsequent crop uptake. Field trials were conducted for consequent two seasons (Dry and Wet) in 2016 to evaluate the performance of PCU in terms of yield and N use efficiency in both puddled transplanted and direct seeded rice. The treatments were T1: No N; T2: 100% recommended dose of N (RDN) through uncoated urea applied in conventional schedule;T3: 100% RDN through neem coated urea (NCU) applied in conventional schedule;T4: 100% RDN through PCU applied in conventional schedule;T5: 75% RDN through polymer coated urea applied in conventional schedule;T6: 50% RDN through polymer coated urea applied in conventional schedule;T7: 100% RDN through polymer coated PCU applied on the basis of CLCC reading. The RDN was 100 and 80 kg N ha^{-1} respectively for dry and wet season. Results revealed that at 100% RDN, performance PCU in terms of yield was similar to that of NCU; however as compared to uncoated urea PCU produced 7.6-15.1 % and 5.8-6.6 % more yield in direct seeded and transplanted rice, respectively. The PCU at 100% RDN also resulted in 10-13% increase in N recovery efficiency (RE_N) over uncoated urea. Application of 75% of RDN as PCU however reduced the yield by 6.0-10.0 % and 5.8-6.8 %, respectively in direct seeded and transplanted rice as coampared to 100% RDN uncoated urea..The yield response curve of PCU indicated that the same levels of yield as obtained by applying 100% RDN as uncoated urea could be obtained by applying 91 - 79% of RDN and 88-89% of RDN as PCU in direct seeded rice and transplanted rice respectively. Thus PCU has the potential to save 9-21 % fertilizer N as compared to uncoated urea for same level of yield.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/36

High panicle branches: Is it desired parameter for varietal popularity among farmers?

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ABSTRACT

Rice and economy are highly interlinked in eastern states of India. In Odisha, rice is the major food crop cultivated by the farmers. Several rice varieties are popular among the farmers which are named as farmers valued varieties. The quantitative phenotypes and preferred rice varietal features of farmers cultivated (farmers valued) varieties must be identified for understanding the reasons for the popularity of the rice varieties among the farmers. Here, correlation and regression parameters were used to compare the farmers valued varieties and other released rice varieties for the traits namely number of panicles per hill, panicle length, and single plant yield. For the analysis, popular varieties (15 nos) grown by the farmers in Biridhi block, Jagatsinghpur district was compared with other all India released varieties (45 nos). The percent change analysis showed as compared to other released varieties, panicle branches and single plant yield was higher in farmers valued varieties by 14.39 % and 12.5 %, respectively. Further, regression analysis showed coefficient of determination (R2) between panicle branches and single plant yield is 12.93% in farmers valued varieties indicating most of the varieties grown by the farmers have higher number of panicle branches per panicle. Therefore, it is highlighted that number of panicle branches is one of the major traits for the popularity of rice varieties among the farmers. Further, increase in panicle branches by single unit has the potential to increase the yield of rice varieties by twelve percent.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/37

Variability assessment of Zag (red rice) for agro-morphological and blast resistance.

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ABSTRACT

Landraces found in the hotspots of rice diversity need to be properly characterized for their use in genetic improvement. Red rices are known from western Himalayas grown for their unique taste, texture and nutritional properties. Kashmir valley representing a unique temperate agro-ecosystem of India is home to number of landraces. One of them locally called Zag is an important red rice landraces, known for its polyphenols, anthocyanin and antioxidant properties besides, comparatively higher in iron and zinc content. The area under red rice is on declining trend because of its susceptibility to rice blast diseases caused by *Magnophortheoryzae*. The fungicidal use for blast disease management in paddy in hill and mountain ecosystem is not so popular, is uneconomic, and less safe. Therefore, incorporation of genetic resistance in the background of Zag is the most reliable option. In the backdrop of this fact the experiment was conducted at Mountain Research Center for Field Crops, SKUAST-K, Khudwani. For this purpose Zag variety was crossed to a blast resistant donor (DHMAS) and its backcross progenies were evaluated for blast resistance and agronomic traits viz., early flowering (85-95 days), early maturity (125-135 days) and optimum plant height (105-120cm). Out of 200 families only 35 families were selected carrying blast resistance along with better plant type characteristics. Such selected families were also evaluated for cooking quality characteristics and red pericarp in which K16-32-11, K16-32-14,K16-32-18, K16-32-20, K18-16,K18-20, K18-18, were found to be the most promising for said traits. The results obtained are expected to yield a tangible output in the form of improved, Zag, that could boost the farm economy of farmers in red rice grown region of Kashmir.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/38

Grain yield and water productivity of rice cultivars subjected to deficit irrigation management

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ABSTRACT

One of the major environmental constraint for sustainable rice cultivation is assured availability of irrigation water. A field experiment was conductedwith four rice varieties (Satyabhama, Annada, Ankit and Naveen) and five irrigation schedules based on customized color coded tensiometer developed by ICAR – National Rice Research Institute, Cuttack. The water management treatments were (a) Maintaining standing water (Control); (b) Re-irrigation at Field capacity; (c) Imposing moisture stress at active tillering stage; (d) Imposing moisture stress at heading stage; (e) Imposing moisture stress at grain filling stage. The experiment was conducted in Split plot design with water treatment as main plot and varieties as sub plot. The total water input decreased significantly under flooded condition as compared to other treatments. Imposition of WDS at active tillering stage resulted in yield reduction in all the varieties, however the reduction was significantly lower for varieties like Satyabhama, Ankit and Annada was as compared to Naveen. The deficit stress imposed at reproductive stage resulted in significantly higher yield decline as compared to vegetative stress. The decrease in grain yield was linked with the decrease in % spikelet fertility for different varieties under different WDS conditions. A reduction in stress related physiological parameters and increase in concentration of antioxidants contributed to endure the moisture deficit stress and maintaining higher grain yield in varieties like Satyabhama, Ankit and Annada.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/39

Effect of micro-irrigation regimes and Nitrogen levels on chaffy grain percentage of aerobic rice

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ABSTRACT

An investigation entitled "Performance of aerobic rice under drip irrigation with different levels of nitrogen" was carried out during *rabi* 2019-20 and 2020-21 on sandy clay loam soils of wetland farm of S.V. Agricultural College, Tirupati of Acharya N.G. Ranga Agricultural University, Andhra Pradesh. The experiment was laid out in split-plot design with three replications. The treatments consisted of four main plots *viz.*, I_1 (Drip irrigation at 1.25 Epan), I_2 (Drip irrigation at 1.5 Epan), I_3 (Drip irrigation at 1.75 Epan), I_4 (Drip irrigation at 2.0 Epan) and four sub plots *viz.*, N_1 (75% RDN - 90 kg N ha^{-1}), N_2 (100% RDN – 120 kg N ha^{-1}), N_3 (125% RDN – 150 kg N ha^{-1}), N_4 (150% RDN – 180 kg N ha^{-1}). Chaffy grains percentage (%) of aerobic rice varied significantly due to irrigation regimes, nitrogen levels and their interaction. Pooled data revealed that chaffy grains percentage was significantly higher with drip irrigation regime of 1.25 Epan (11.85 %) over 1.5 Epan (8.83 %) and 1.75 Epan (7.68 %) irrigation regimes. Whereas, 2.0 Epan (I_4) irrigation regime recorded lower chaffy grains percentage (7.47 %)which was however comparable with 1.75 Epan (7.68 %). Among the different nitrogen doses, significantly higher chaffy grains percentage was recorded with the application of 90 kg N ha^{-1} (12.50 %) compared to higher nitrogen doses. Whereas, the lower chaffy grains percentage was recorded with the application of 180 kg N ha^{-1} (6.54 %) followed by 150 kg N ha^{-1} (7.59 %) and 120 kg N ha^{-1} (9.20%). Among the different interaction combinations, the higher chaffy grains percentage was recorded with irrigation at 1.25 Epan along with 90 kg N ha^{-1} (13.14 %). Whereas, the lower chaffy grains percentage was recorded with scheduling drip irrigation at 2.0 Epan along with 180 kg N ha^{-1} (2.82 %) which was at par with drip irrigation at 1.75 Epan along with 180 kg N ha^{-1} (4.14 %).

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/40

Impact of climate-smart technologies on productivity and energy budgeting in rice-green gram cropping system

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ABSTRACT

A participatory research experiment was conducted in two consecutive cropping seasons (2018-19 and 2019-20) at Bateswar village in Salipur Block, Cuttack, to assess the impact of different climate-smart agricultural practices on the productivity and energy budgeting of the rice green gram cropping system. The cropping area is a river command area where rice is grown in the kharif season. This area experiences flood in the early stage and drought during later stage (terminal drought). As an intervention, the rice variety Pradhan Dhan (submergence tolerant) was grown by the farmers in the kharif season with the recommended packages and practices. To tackle both flood and drought, a rice variety CR Dhan 801 (both drought and flood tolerant) was grown with an additional application of 20% phosphate fertilizer over the recommended packages and practices. Climate-smart technologies for green gram were applied during the rabi season. The treatments arefarmers' practice (broadcasting of local variety with conventional tillage), CSA 1 (line sowing of HYV (IPM 2-3) on zero tillage having 30% rice residues on the soil along with RDF (20-40-40 kg ha^{-1})), CSA 2 (line sowing of HYV (IPM 2-3) with RDF (20-40-40 kg ha^{-1}) together with seed treatment with Rhizobium and PSB), Agro-intensification I (intercropping of maize with green gram and cowpea in furrow irrigated raised bed), Agro-intensification II (intercropping of green gramin okra with bitter gourd on the margins). From the experimental research, it was found that CR Dhan 801 gave a higher grain yield (4.95-4.96 t ha^{-1}) followed by Pradhan Dhan (4.88-4.9 t ha^{-1}). In both the years, there was a flash flood in the early season before transplanting of rice and the crop received normal monsoon rainfall throughout the growth period. In two consecutive cropping Rabi seasons, Agro-intensification I had the highestsystem yield while CSA 1 had the lowest system yield. The energy calculations in rabi showed that total input energy (MJ), total output energy (MJ) and energy ratio (output energy/input energy) were the highest in Agro-intensification I. However, energy productivity was highest in the farmers' practice (FP) because it used less input energy (no fertilizer, one irrigation before sowing) per unit of production compared to the other treatments. We conclude that Agro-intensification I performed better in both successive cropping seasons in terms of yield capacity and energy efficiency during rabi.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/41

Effect of different establishment methods on rice grain yield, soil organic carbon and energy use efficiency under zero tillage

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ABSTRACT

The main disadvantages of puddling are excessive water use anddestruction of soil structure apart from N Loss (de-nitrification). Prospects of moving from conventional tilled transplanted rice to zero tilled direct seeding of rice (ZT-DSR) has been widely researched and discussed. However, zero tilled transplanted rice (ZT-TPR) is a relatively new concept. Therefore, an experiment was conducted to study the effect of establishment methods of rice in ZT under DSR and TPR and to decipher their similarity/ dissimilarity, thereof. The main plot consisted of (1) wet direct seeded rice (WDSR) and (2) puddle transplanted rice (TPR). Sub-plots consisted of (1) with residue and (2) without residue retention with three replications. Therefore, a total of eight treatment combinations were: ZT-WDSR with residue (T1), ZT-WDSR without residue (T2), ZT-TPR with residue (T3), ZT-TPR without residue (T4), conventional-WDSR with residue (T5), conventional-WDSR without residue (T6), conventional-TPR with residue (T7), conventional-TPR without residue (T8). Hierarchical Agglomerative Clustering (dendrogram) was used to check the similarity/ dissimilarity among the treatments. The dendrogram showed two major clusters: cluster 1, includedconventional-WDSR and conventional-TPR with residue and without residue (T5, T6, T7 and T8); and cluster 2, included ZT-WDSR and ZT-TPR with residue and without residue (T1, T2, T3 and T4). T5 and T6 were the most similar group and having 2nd level of similarity with T8. Further, in cluster 2, T3 and T4 exhibited a second level of similarity. Again, ZT-WDSR with residue (T1) is similar to ZT-TPR with residue (T3), ZT-TPR without residue (T4) at 3rd level of similarity. The highlight is similar clustering of ZT-TPR (with and/or without residues) and ZT-WDSR with residue laying emphasis on the role of residue in WDSR. Therefore, it may be concluded that ZT-TPR or ZT-WDSR may not be recommended to be replaced by each other.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/42

Evaluation of *Sub1*-Introgressed Rice Genotypes under Varying Levels of Management in Flood-prone Areas

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ABSTRACT

A three-year field study was carried out during wet (*kharif*) season of 2016, 2017 and 2018 at Rice Research Station, Chinsurah, Hooghly, West Bengal to evaluate the performance of *Sub1*-introgressed rice genotypes under varying management practices in flood-prone areas. Six varieties *viz. Swarna-Sub1*, *Samba Mahsuri-Sub1*, *IR 64-Sub1*, *CR 1009-Sub1*, *BINA Dhan 11* (*Ciherang-Sub1*) and *BR 11-Sub1* in main plots and two levels of management (conventional and best management practice) in sub-plots were assigned in a split-plot design with three replications. Conventional farmers' management (FM) included higher seeding density (50 g m^{-2}) and inadequate nutrition (50-25-25 kg N-P_2O_5-K_2O ha^{-1}) without applying farmyard manure (FYM) and zinc (Zn) in nursery, followed by transplanting of weak and younger seedlings (26 days) with 4-5 seedlings $hill^{-1}$ in main field without any addition of Zn and post-submergence nutrients. The best management practice (BMP) included application of 5 t FYM ha^{-1} and 5 kg Zn ha^{-1}, lower seeding density (25 g m^{-2}) and adequate nutrition (100-50-50 kg N-P_2O_5-K_2O ha^{-1}) in nursery, followed by transplanting of healthy and aged seedlings (38 days) with 2-3 seedlings $hill^{-1}$ in main field along with the application of 2.5 kg Zn ha^{-1} and post-submergence nutrients (20-20 kg N-K_2O ha^{-1}). The varieties were exposed to artificial (complete) submergence for eight days at about one month after transplanting. On-farm validation experiments were also simultaneously made at farmers' fields in Chinsurah-Mogra and Serampore-Uttarpara Blocks of Hooghly district to evaluate famers' variety (FV, *Swarna*) + farmers' management (FM), FV + improved management (IM), improved variety (IV, *Swarna-Sub1*) + FM, and IV + improved management (IM). On-station results revealed that *CR 1009-Sub1* recorded significantly the highest grain yield (5.57 t ha^{-1}), which was followed by *BR 11-Sub1* (5.56 t ha^{-1}), *Swarna-Sub1* (5.04 t ha^{-1}), *BINA Dhan 11* (4.80 t ha^{-1}), *Samba Mahsuri-Sub1* (4.65 t ha^{-1}) and *IR 64-Sub1* (4.52 t ha^{-1}), irrespective of management levels. Regardless of varieties, BMP displayed about 6.97% yield advantages over the conventional one. As evidenced from the on-farm results over the locations, IV+IM registered 43.36, 19.22 and 5.57% yield gains over FV+FM, FV+IM and IV+FM, respectively.

Theme - II : Precision technologies for rice production

ADJNS/TH-II/LT/43

Modelling methane and nitrous oxide emission under different resource conservation technologies in rice based systems

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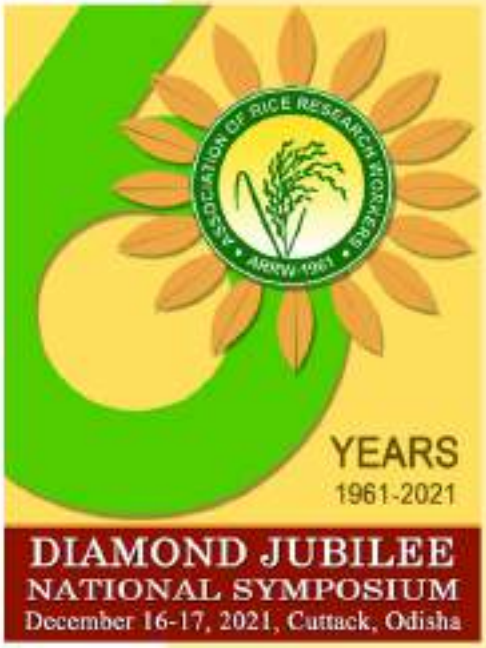
ABSTRACT

In this study, DNDC model was calibrated and validated for CH_4 and N_2O emission from different Resource conservation Technologies (RCTs) at National Rice Research Institute, Cuttack, India during *Kharif* season of 2015 and 2016. Five treatments under direct seeded rice (DSR) i.e., T1: conventional practice as control; T3: mechanical weeding and harvesting+ 75% N; T4: wet drum sowing + mechanical weeding and harvesting+ 75% RDF; T5: zero tillage + residue retention + chemical weeding + manual harvesting + 100% RDF; T6: Dry DSR + green manuring + mechanical weeding and harvesting + CLCC-N + 100% RDF. Six treatments under transplanted rice i.e., T1: conventional practice as control; T2: puddling + incorporation of paddy straw (5 t ha^{-1}) + 75% N + mechanical transplanting, weeding and harvesting; T3: puddling + green manuring +75% N+ mechanical weeding and harvesting (MH); T4: Unpuddled zero tillage + 100% RDF + chemical weeding + manual harvesting; T5: puddling + mechanical transplanting, weeding and mechanical harvesting + 100% RDF; T6: puddling + mechanical transplanting, weeding and harvesting+ real time N-management. During *kharif*2015, among DSR,simulation of CH_4 emission was highest (136.76 Kg C ha^{-1}) from T3 and lowest (125.34 Kg C ha^{-1} $season^{-1}$) from T5. In transplanted rice, highest emission was from T1 (65.67 Kg C ha^{-1} $season^{-1}$) and the lowest emission from T4 treatment (48.64 Kg C ha^{-1} $season^{-1}$). Similar to 2015, in 2016 also highest seasonal CH_4 emission (104.15 Kg C ha^{-1}) was from T3 among DSR treatments. In transplanted rice highest CH_4 emission for T2 (95.55 Kg C ha^{-1} $season^{-1}$) and low seasonal emission was simulated for T5(69.95 Kg C ha^{-1} $season^{-1}$). For N_2O emission transplanted rice condition field simulates greater range of fluxes than from direct seeded rice field.



Theme III

GenNext Technologies in Pest Management

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/1

Evaluation of resistance level in the rice germplasm against brown planthopper, *Nilaparvatalugens* (Stål.)

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ABSTRACT

Brown planthopper (BPH), Nilaparvatalugens (Stål.)is an important pest of rice, widely distributed in Asian subcontinents, cause extensive losses in rice production. Identification of the resistance levelin the rice genotypes against this pest is essential as N lugensis continuously evolving and earlier released resistant varieties were found to be susceptible to the new virulent. In the present study, eight rice genotypes were screened in the net house condition to access the resistance level of N lugens at Crop Protection Division, ICAR-National Rice Research Institute (NRRI), Cuttack during Kharif, 2021. Rice genotypes namely, Salkathi, PTB33, Hasanta, TN1, CR-2711-76, N/C2-89, CR-3006-8-2 and Naveen were screened against N. lugensby standard seed box screening for twice. Twenty pre-germinated rice seeds of each genotypes were sown evenly in rows and 12 days after germination, seedlings were infested with 9-10 N. Lugensnymphs. On 8th days after release, rice genotypesviz.Salkathi, CR-2711-76, N/C2-89, CR-3006-8-2 showed resistancereaction against N lugens, whereas seedlings of PTB33, Hasant, TN1 and Naveen were completely dried off due to N lugensinfestation. Further, in the vegetative stage also the resistance level of rice genotypes was accessed, in which seedlings were pot culturedfor 60 days and infested with 20-25 N. lugensnymphs.Similar to seedling stage, genotypes namely, Salkathi, CR-2711-76, N/C2-89, PTB33 and CR-3006-8-2 showed resistance reaction whereas Hasant, TN1 and Naveen succumbed to N. lugens infestation.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/2

Survey and relative abundance of Rice stem borers in Northern coastal districts of Andhra Pradesh

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ABSTRACT

A random survey was conducted in Srikakulam and Vizianagaram districts of northern costal Andhra Pradesh, South India during August to October, 2021 to know the incidence and species composition of different stem borers in rice ecosystem. The symptoms of damage by rice stem borersas indicated by dead hearts in peak tillering stage and white ears during reproductive phase was recorded to study the extent of damage.Incidence of rice stem borers and their relative abundance was assessed through destructive sampling of the tillers. The incidence of stem borers is in the range of 10.91 to 14.70 per cent in the surveyed mandals of Srikakulam (Amadalavalasa, Srikakulam and Seethampeta) and Vizianagarm (Merakamudidam, Therlam and Garividi) districts of AP. This study on species composition revealed the presence of Yellow stem borer(YSB) and Dark headed borer (DHB). Among the different surveyed mandals highest stem borer incidence of 14.70% was recorded in Merakamudidammandal which was predominantly with YSB population (85%). YSB was the most predominant species with 83.05 per cent followed by DHB with 16.95 % of the total larval population collected from infested tillers/ white ears after dissection. DHB incidence was recorded in Seethampeta, Merakamudidam and Therlammandals only. High incidence of DHB, *Chilopolychrysus*(80 % of the samples collected) was noticed in Seethampetamandal of Srikakulam, a high altitude region compared to YSB where the crop was in maximum tillering stage. The larval characters and damage caused by DHB was very much distinct from YSB as larvae fed voraciously results in extensive tunnelling (8 - 16 cm length) in the 3rd and 4th internodal regions and was completely filled with brown coloured excreta. The larval characters, damage symptoms and other biological parameters of DHB in comparison with YSB were discussed.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/3

Management of blast disease in rice by the combination of strobulirin andtriazole fungicides

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ABSTRACT

India has been facing problems with its basmati exports since 2018 after an European Union (EU) audit found Tricyclazole residues in 19% samples. At least 45 samples exceeded the maximum residue Level (MRL). Tricyclazole is a systemic fungicide that is used to control the rice blast disease, which can affect the crop at various stages. There are strict import norms imposed by the European Union on the levels of residue of this fungicide present in rice crop as they consider the chemical harmful to humans. India's basmati exports to the EU had declined around 60% from a year earlier to 1.62 lakh tones during April-December 2018. India suffer a loss of Rs 1700 crore as the shipment of basmati rice was not allowed to enter to EU countries due to high MRL of Tricyclazole. With Tricyclazole ruled out, farmers may, henceforth, have to go for fungicides that are considered less toxic. An attempt was made to test combinations of stroburilin and triazole fungicides as an alternative to Tricyclazole in Mushkbudji highly blast susceptible landrace of Kashmir. Field experiments were conducted over two successive years 2018 and 2019 in temperate rice growing areas in north India. All the fungicides effectively reduced leaf blast incidence and intensity, and neck blast incidence underfield conditions. Though Tricyclazole proved most effective against rice blast and recorded a leaf blast incidence of only 8.41%, yet the combination of fungicides, azoxystrobin+ difenoconazole and azoxystrobin + tebuconazole were highly effective recording a leaf blast incidence of 9.19 and 10.40%, respectively. The chemical combination mancozeb + carbendazim proved least effective in controlling blast and it recorded a disease incidence of 27.61%. Similar trend was followed in neck blast incidence with tricyclazole, azoxystrobin+ difenoconazole and azoxystrobin + tebuconazole showing highest level of blast reductions. It is evident from the current study that the tested fungicide combinations can be used as alternatives to tricyclazole which is facing the challenges of fungicide resistance development and other environmental concerns and has been banned from use in India and other countries. To the best of our knowledge this is the first study on the management of blast disease in MushkBudji rice.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/4

Biosynthesis of silver nanoparticle using *Aspergillus sp.* and evaluation of its efficacy against sheath blight causing pathogen *Rhizoctoniasolani* Kuhn

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ABSTRACT

Sheath blight caused by the fungal pathogen *Rhizoctonia solani* Kuhn is one among the most devastating diseases of rice. It is controlled by spraying of fungicides like validamycin, carbendazim, propiconazole, Iprodione etc. However, the rampant use of these fungicides has led to development of resistance towards this pathogen. Thus, it is necessary to look for newer chemical formulation to control the disease. Silver nanoparticle (AgNP) is known to have antimicrobial activity. However, it is often synthesized using chemicals which are environmentally toxic in nature. Therefore, a biosynthetic approach using the fungus *Aspergillus sp.* was followed for synthesis of silver nanoparticle. The fungus *Aspergillus* sp. was isolated from the soil samples collected from the fields of ICAR-NRRI, Cuttack, then allowed to grow in potato dextrose broth for 72 hours and the biomass was harvested by sieving. The biomass was kept in double distilled water for 48 hours and then filtered. The filtrate was then mixed with 1mM $AgNO_3$ and kept at 50°C on till the color of the reaction mixture turned brown. The absorbance of the reaction mixture was measured by UV-Vis spectroscopy and the synthesis of nanoparticle was confirmed by a peak in the range of 420-430 nm. The inhibitory effect of the synthesized AgNP was tested against the fungal pathogen *Rhizoctonia solani* Kuhn, the causal organism of the sheath blight disease of rice, at different concentrations *viz.* 5, 10, 15, 20, and 30 ppm. The AgNP was found to be inhibiting the growth of the fungal pathogen by 13 to 28 % at different concentrations. Further, *in vivo* studies will be carried out to evaluate the efficacy of the AgNP to control the sheath blight disease in field condition.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/5

Eco-friendly rice weevil (*Sitophilus oryzae* L.) management in domestic grain storage by using natural Zeolite

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ABSTRACT

Post-harvest losses are caused by both biotic (insects, mold, birds, mites, rodents etc.) and abiotic (moisture content, temperature and humidity etc.) factors. In India the total post harvest losses due to insect pests alone is ranging from 4.0–6.0% for cereals. Current control methods for these storage pests are mainly based on the use of synthetic insecticides and fumigants which resulted in the development of resistance to commonly used grain protectants and fumigants, thus there is an urgent need to apply an eco-friendly, safe and low-cost alternative for the chemical pesticides to protect the stored grains and seeds against storage insect pests for small scale domestic purpose. Non-toxic materials such as inert dusts have become an essential element in programs of integrated pest management. Zeolites are microporous, chemically inactive aluminosilicate minerals that found in nature and, like diatomaceous earth, it belongs to the group of inert dusts that contain natural silica. Natural zeolite is considered non-toxic and safe for human consumption (International Agency for Research on Cancer, IARC). Moreover, it has been listed by Codex Alimentarius Commission as granted substance in organic food production and in plant protection. Hence, laboratory studies were conducted to test the efficacy of natural zeolite formulation against *Sitophilus oryzae*at different dosages *viz.,* 0.25, 0.50, 0.75, 1.00, 1.25 and 1.50 g/ kg of grain stored. The results of our preliminary studies showed that the natural Zeolite formulation indicating very good control of test insect by registering 83% mortality when treated @ 1.5g/ kg grain stored after 21 days of treatment imposition. We are further investigating the insecticidal effect of natural zeolite against adults of different stored grain insect pests in addition to study their effect on the progeny production and development of the tested pests, subsequently evaluate the role of zeolite that can minimize or even exclude the use of toxic insecticides and encourage the use of natural inert dust in IPM programs.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/6

Impact of organic and inorganic source of silicon in imparting resistance against brown plant hopper *Nilaparvatalugens*(Stal) in rice ecosystem

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ABSTRACT

A field experiment was conducted during *Rabi* 2016 and 2017 in the Central Research Farm of Odisha University of Agriculture and Technology, Bhubaneswar, to evaluate the efficacy of different sources of organic (DAE and RHA)and inorganic form ($CaSiO_3$) of silicon at different doses were tested on rice *cv.*, TN1 against brown plant hopper in rice. The field experiment was laid out in Randomized Complete Block Design with three replications and each subplot measured (5m x 4m). Observations were recorded from 30DAT to 80 DAT randomly from ten plants from each plot treated with silicon amendments in variety TN1 during rabi season. A population build up to the tune of 15.59, 16.42 and 15.65 hoppers /hill have been registered by highest dose of DAE, $CaSiO_3$ and RHA respectively at the peak activity of hopper as against 57.27 hoppers/hill in control, exhibiting their supremacy in arresting the pest. However, the performance was at par with that of medium doses indicating the importance of these silicate fertilizers at moderate doses and the application of this compound in the rice ecosystem. Rice hull ash which is a renewable source of Si, abundantly available locally and a cheap source performed satisfactorily at 4.0 t/ha dose in inducing resistance against brown plant hopper hence should be recommended to rice farmers for field application as a component of integrated pest management in rice agro ecosystem

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/7

Evaluation of some newer molecules of fungicides for control of rice bakanae disease caused by *Fusarium fujikuroi*

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ABSTRACT

Rice bakanae disease, caused by *Fusarium fujikuroi* is one of the destructive seed-borne disease emerging as major threat in eastern Indian states including Odisha, West Bengal, Assam and Bihar. The disease may affect rice plants from pre-emergence to the crop maturity stage. The symptoms like abnormal elongation, seedling death, thin and chlorotic leaves, and formation of roots in each internode can be seen. Severely infected seedlings often die at early stages. A study was undertaken to evaluate newer fungicide molecules under *invitro* and seed treatment. Ten fungicides were evaluated first under in vitro. Maximum reduction of the mycepial growth was observed in combination of Picoxystrobin 7.05% + Propiconazole 11.71% w/w SC at all the tested concentrations (0.01, 0.05,0.15 and 0.20%). The average EC50 value of all the 12 tested *Fusarium* isolates was 0.125mg/ml of tested chemical (Picoxystrobin 7.05% + Propiconazole 11.71% w/w SC). Similarly good reduction in mycelial growth was observed in combination product of Azoxystrobin 18.2% + Difenaconazole 11.4% w/w SC. Lowest inhibition was observed in Tricyclazole 70% WP. When all the fungicides tested in net house conditions by seed treatment, the fungicides were effective and were not phytotoxic to seeds or germinated seedlings in two rice varieties i.e., Pooja and PB-1121. 0.1% of above chemicals provides more than 80% control of rice bakanae disease over untreated control. Overall, the results indicated that, the use of combination products provides better control of bakanae disease than individual product. This also solves the problem of resistance development by the fungi.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/8

Evaluation of different organic modules against major insect-pests in local aromatic paddy

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ABSTRACT

One field experiment was conducted at Regional Research and Technology Transfer Station, Coastal Zone, Bhubaneswar, OUAT during *Kharif*, 2019 and 2020 to evaluate different organic modules against major insect-pests in local aromatic paddy; *Leelavati*. The experiment constituted four organic modules compared with existing farmers' practice and untreated control replicated four times in RBD. The results revealed that organic module constituting 'seed treatment with *Pseudomonas fluorescens* @10g/kg + Green Manuring with Dhaincha+ Vermicompost @1.5 t/ha+ Neem cake @2.5q/ha + Jivamrut @250l/ha at 30, 45 and 60 days after transplanting + Pheromone trap + release of *Trichogramma chilonis* 6 times @1lakh/ha + Foliar spray of *Beauveriabassiana* @1.25 l/ha 4 times'resulted in 41.6% reduction in dead heart (DH) and 63.1% in white ear head (WEH) incidence, 62.6% in BPH population and 27% yield improvement over the farmers' practice (recommended dose of fertilizer + foliar spray of Chloro- Cypermethrin @1000ml/ha twice). This module had 70.5, 75.4, 62.6 and 67.4% reduction in DH, WEH, leaf folder damage and BPH population respectively having 67% improvement in paddy grain yield over untreated control plot. Maximum gross income/ha (Rs131600/ha) and incremental net profit (Rs24375/ha) was achieved in the recommended technology compared to gross income of Rs 103600/ha and incremental net profit of Rs19590/ha in the existing technology. The indigenous microbial culture (Jivamrut) was prepared by mixing 100 litres of water with 10kg cow dung, 10 litre cow urine, 2kg jaggery and 200gm gram flour fermented for seven days before each soil application. The Jivamrut was analysed and found to be acidic (P^H-4.76) and it contained 0.23%N, 0.10%P_2O_5, 0.12%K_2O and microbial organism load of 2.5X10^9 Cfu/ml sample. This organic module comprising of Jivamrut and other organic sources of nutrients along with biopesticides was found to be very effective against paddy insect-pests and economical compared to existing farmers' practice.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/9

Effect of essential oils on sheath blight disease severity in rice

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ABSTRACT

Sheath blight caused by *Rhizoctonia solani* Kuhn is one of the most important diseases on the major high yielding rice varieties. Because of lack of resistant donor lines no variety is completely immune to the disease. Till now, chemical control is the most widely used means to manage the disease which may have several adverse effects on the environment. Essential oils are among the most promising compounds for bio rational pest management. As highly volatile compounds are found in essential oils, they therefore cause no residue problems either in crop or in soil and are less subject to resistance. Keeping these factors in view, a field experiment was conducted at All India Coordinated Rice Improvement Project, Chiplima, Sambalpur, Odisha during kharif and rabi seasons of 2019-20 and 2020-21 respectively to assess the effect of different essential oils for the management of sheath blight disease in rice. They were sprayed twice at weekly interval starting from the third day of inoculation. Among all the essential oils, Citronella oil @ 2ml/l was found best to manage the disease during both the years of experiment. It gave 36% disease control compared to check plots. Though the chemical check gave the highest disease control (47.25%) but considering the environmental point of view, Citronella oil @ 2ml/l can be recommended as an alternative to manage sheath blight disease in rice without any toxic effect on the crop.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/10

Correlation of major insect-pests activities and weather parameters in rice

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ABSTRACT

The present investigation was carried out to study the activity of major insect-pests of rice and its correlation with weather parametersat Main Rice Research Station, Anand Agricultural University, Nawagam, Gujarat during *kharif* 2020. The study revealed that the insect-pests activities commenced from 37th Standard Meteorological Week (SMW) and continued to 45th SMW. The incidence of yellow stem borer in terms of per cent white earheads noticed to reaches at peak level of infestation during the 41st SMW with 7.08 per cent. The infestation of leaf folder reaches at peak level during 40th SMW with 10.24 per cent damaged leaves. The white backed plant hopper reaches at peak level during the 45th SMW with 134.0 WBPH per 25 hills. The correlation of yellow stem borer for white earheads shows positive correlation with the maximum temperature (r=0.657) and negative correlation with minimum temperature (r=-0.539), relative humidity (r=-0.385), sunshine hours (r=-0.571) and rainfall (r=-0.371), respectively. Whereas, the correlation of rice leaf folder in terms of per cent damaged leaves shows positive correlation with maximum temperature (r=0.187), while negative correlation was found with minimum temperature (r=-0.507), RH (r=-0.406), sunshine hours (r=-0.441) and rainfall (r=-0.405), respectively. The correlation of WBPH population shows significantly positive correlation with maximum temperature (r=0.414), while negative correlation was found with minimum temperature (r=-0.669), RH (r=-0.630), sunshine hours (r=-0.388) and rainfall (r=-0.304), respectively.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/11

Genetic dissection of brown planthopper, *Nilaparvatalugens* (Stål) resistance from Indian landraces

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ABSTRACT

Brown plant hopper, *Nilaparvata lugens* is a major yield reducer of rice in south-east Asia. Besides being capable of direct damage it also plays a major role in stunted virus transmission. Managing this pest through host plant resistance is the sustainable option for marginal farmers. Hence, an attempt was made to identify new resistant donor against *N. lugens* due to its continuous evolving nature and exhibition of varying degree of resistance. Therefore, 300 traditional rice landraces were screened against *N. lugens* for their level of resistance. Further, 96 landraces were genotyped with 93 gene linked marker for resistant association studies showed 8% variability among the populations. Population structure and cluster analysis results revealed that rice landraces were grouped into three major genetic clusters with a clear genetic difference between resistance and susceptible genotypes. Resistance, moderately resistant and susceptible genotypes occupied separate quarters in principal coordinate analysis (PCoA). Additionally, general linear model and multi linear model showed significant marker trait association of five molecular markers *viz*., RM19291 (*Bph30*), RM28472 (*Bph18*), RM28449 (*Bph17*), RM7 (*Qbph3)* and RM5633 (*Qbph4.4)* with different phenotypic parameters. These identified resistant genes either alone or in combination would be highly helpful to develop a durable resistant rice variety by biotechnological advancements.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/12

Identification of resistant sources for leaf blast in rice

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ABSTRACT

Rice blast caused by *Pyricularia grisea* (Cooke) Sacc, is a major production constraint in rice cultivation. In recent years, this disease has been reported to appear regularly at an alarming state in many areas, which were earlier considered non endemic to this disease and the losses are heavy when the climatic conditions favorable to the disease development. The disease is appearing during *rabi* season in Godavari delta of Andhra Pradesh. Attempts were made to screen the entries using standard protocols (SES, 2014) to identify the resistant sources for leaf blast in rice.

The results revealed that two entries *i.e.,* NLR 3415 and HUR 17-1were identified as resistant entries for four seasons from 2017 to 2020. Seven entries *i.e.*, CR 3996-11-240-3-1, RP 6179-GSR-IR1-8-S9-D2-Y2, OR (T)-31, CR 4112-3-2-1-1-1-1-1, Pusa 1853-12-288, HUR 105 (RP) and CR 4156-506-2-25 were found resistant for three consecutive seasons from 2018 to 2020. While, 17 entries *i.e.*, PNP 55, CSR MAGIC 157, CSR 36 (Alkaline check), KR 15066 (224-4-3-1-1), Pusa 1692-10-20-1-1-1, Pusa 1882-12-111-7, Pusa Basmati -1 (YC & RP), Pusa 1985-15-7-58-190, IR 64 (RP), Co 51 (NC), Pusa 1886-13-91-26-9, RMS-R-10, Zenith, Usen, BE 683, BE 698 and ALSG 317 were found resistant for leaf blast disease and recorded score 1 to 3 in two consecutive years and identified as resistant sources for leaf blast in rice.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/13

Economics and energy analysis of adoption of IPM in Tamil Nadu

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ABSTRACT

Integrated pest management (IPM) has been accepted as the main strategy for managing pests throughout the world. This study estimates economics and energy efficiency of Integrated Pest Management in rice. The study is based on primary data collected for the year 2020-21 from a sample of 155 SCSP beneficiary farmers (trained in IPM) and 40 farmers (non-beneficiaries). A total of 195 sample rice growing farmers were selected by adopting random sampling technique. Based on the energy equivalents of the inputs and outputs, the energy ratio, energy productivity, specific energy and the net energy were calculated. A comparative energy consumption pattern for IPM and Farmers' practice (FP) was estimated. Equivalent energy inputs for all input and output parameters of rice cultivation were determined from the literature. Equivalent energy inputs for biopesticides were not found to be available in the literature and were calculated for the first time on the assumption that they are inferior chemicals and hence, the energy conversion ratio was taken as 10 MJ/Kg. Results showed that the average grain yield obtained was almost similar in both the systems (4.4 t/ha and 4.6 t/ha for FP and IPM respectively). Adoption of IPM saved total energy inputs by 3324 MJ/ha. The B: C ratio for IPM and Farmers' Practice (FP) were 1.99 and 1.69 respectively. IPM method of rice cultivation was energy efficient (8.7) compared to the FP (8.4). The energy productivity is calculated as 0.28 kg/MJ and 0.25 kg/MJ for IPM and FP, respectively. In this study, the specific index for IPM method and FP were 3.62 MJ/kg and 4.05 MJ/kg, respectively implying that each kilogram of paddy produced by IPM method will save approximately 0.43 MJ of energy compared to the Farmers' Practice of rice production.Both the benefit–cost ratio and the energy efficiency in IPM were higher than that of the Farmers' Practice. From the results of the above study, it can be concluded that adoption of IPM in rice cultivation is economical in terms of energy and monetary net returns, in comparison to Farmers' Practice.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/14

Pyramiding of Blast, Bacterial blight, and Brown plant hopper resistance gene for imparting durable resistance using CRISPR/Cas 9 Targeted Mutagenesis in rice (*Oryza sativa L.*).

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ABSTRACT

The adoption of host resistance has been proven to be the most economical and effective approach to control rice blast. In recent years, sequence-specific nucleases (SSNs) have been demonstrated to be powerful tools for the improvement of crops via gene-specific genome editing, and CRISPR/ Cas9 is thought to be the most effective SSN. In plants, sphingolipids, such as long-chain bases (LCBs), act as bioactive molecules in stress responses. Until now, it is still not clear if these lipids are involved in biotic stress responses to herbivore. Researchers reported that a rice LCB gene, OsLCB2a1 encoding a subunit of serine palmitoyl transferase (SPT), a key enzyme responsible for the *de novo* biosynthesis of sphingolipids, plays a critical role in plant defence response to the brown plant hopper (BPH) attack and its up regulation protects plants from herbivore infestation. Transcripts of OsLCB2a1 gene in rice seedlings increases at 4 h but decreases at 8–24 h after BPHattack. Sphingolipid measurement profiling revealed that overexpression of OsLCB2a1 in *Arabidopsis thaliana* increases trihydroxylated LCB phytosphingosine (t18:0) and phytoceramide by 1.7 and 1.3-fold, respectively, compared to that of wild type (WT) plants. Transgenic Arabidopsis plants also exhibited higher callose and wax deposition in leaves than that of WT. Overexpression of OsLCB2a1 gene in *A. thaliana* reduces the population size of green peach aphid (*Myzuspersicae*). The defence response genes related to salicylic acid signaling pathway, remained unregulated in the OsLCB2a1-overexpressing transgenic plants. knockdown expression of the rice ERF gene OsERF922 by RNA interference (RNAi) enhanced rice resistance to *M. oryzae*, indicating that OsERF922 acts as a negative regulator of blast resistance in rice. A total of 22 dominant and 9 recessive BB resistant genes have been identified. Some of which have been widely used in rice production. Among these genes, Xa21 is the best studied for BB resistance. Through phosphorylation and cleavage of its intracellular kinase domain, Xa21—a cell membrane receptor — perceives the presence of Xoo and relays the signal to the nucleus through multi-step signal cascades involving some key proteins such as XA21 Binding Protein 3 (XB3) , mitogen-activated protein kinase 5 (MAPK5), MAPK12, and transcription factors (TFs) including OsWRKY62 and OsWRKY76 in the nucleus. Some Xoo resistant genes,

such as xa5, are transcription factors. Furthermore, many effectors from Xoo belong to the transcription activator-like (TAL) family, which help in injection into rice cells to activate susceptibility genes in the host to exert their functions. The known Xooeffectors include avrxa516, avrXa717, avrXa1018 and avrXa2719, which triggers xa5-, Xa7-, Xa10- and Xa27-mediated resistance, respectively.

Zinc-Finger Nucleases (ZFNs), Transcription Activator-Like Effector Nucleases (TALENs), and Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)-associated (Cas) systems have been successfully used for gene editing in a variety of species. There are two components to the CRISPR system: a nuclear-localized CRISPR-associated (Cas) 9 protein and a guide RNA (gRNA). Cas9 is a large protein containing two nuclease domains, and the most used one is derived from *Streptococcus pyogenes*. The gRNA is a synthetic 100 nucleotide (nt) RNA molecule, of which the first approximately 20 nt are the targeting site, and the 32 end forms a hairpin structure that interacts with the Cas9 protein. Cas9 and the gRNA interact to identify DNA sequences complementary to the gRNA and generate a DNA double-strand break (DSB). These systems generate double-strand breaks (DSBs) at target loci to drive site-specific DNA sequence modifications. The modifications include sequence insertion and deletion and other mutations in the host genomes via the error-prone non-homologous end joining (NHEJ) pathway or sequence correction or replacement through the error-free homologous recombination (HR) pathway.

Both ZFNs and TALENs have tandem repeats in their DNA-binding domains that can be engineered to recognize specific DNA sequences; the resulting chimeric nucleases can thus be guided to the desired target sequences in the genome to generate DSBs. For each target site, a new ZFN or TALEN chimeric protein needs to be engineered to recognize the target. This has been a major hurdle in the wide use of these two gene-editing systems because engineering a new protein is no trivial task. In comparison, the newly developed CRISPR–Cas system uses a short single guide RNA (sgRNA) to direct the Cas9 endonuclease to complementary target DNA, so only a new sgRNA is needed for a new target site. This system thus greatly simplifies the gene-editing process and widens target-site selection. An additional requirement for the Cas9 nuclease activity is the presence of the protospacer-associated motif (PAM) NGG downstream of the target site. This requirement is an important consideration in target-site selection.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/15

Oxidative burst during rice-elicitor/pathogen interaction

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ABSTRACT

One of the earliest detectable characteristic of a plant's defense responses to microbial infection is oxidative burst, which is defined as a rapid, temporary generation of massive levels of reactive oxygen species (ROS), e.g. hydrogen peroxide (H_2O_2). The purpose of this study was to look into the intensity and timing of ROS formation and antioxidant enzyme expression as initial responses of 5 rice cultivars, *viz.*, TN-1, Satabdi, Naveen, Annapurna and Tapaswini against two elicitors (Salicylic acid, SA and Chitosan, CH) and bacterial leaf blight pathogen *Xanthomonas oryzae* pathovar *oryzae* (Xoo). In case of Xoo application, 24 h post-inoculation (hpi), Naveen, Annapurna and Tapaswini had shown significant increase in H_2O_2 production - 2.3, 2.9 and 2 times respectively higher than control, followed by a sharp increase in H_2O_2 generation after 72 hpi, indicating a biphasic oxidative burst. TN-1, Tapaswini had shown highest increase 2.3, 3.2 times respectively in H_2O_2 production at 96hpiin case of CH application. On SA treatment, same trend happened for all varieties, but a gradual decrease in the level of H_2O_2 production was observed at 48 hpi. Catalase activity (CAT) was much higher in pathogen-inoculated TN-1 with a value of 2.4 nkat/mg protein, whereas CAT decreased at later stage in CH-treated Tapaswini plants. In most varieties, a bi-phasic CAT activity was observed in CH-treated plants. CAT activity in SA-treated TN-1 at 72 hpi with a value of 15.9 nkat/mg protein increased 1.4 times the control. Guaiacol peroxidase (GPX) activity was highest at 72 hpi in Xoo/SA/CH-treated plants in TN-1, Tapaswini, Satabdi and Naveen. Annapurna recorded significant increase of GPX activity at 24 hpi, after that activity was gradually slowed down. The Ascorbate peroxidase (APX) activity started increasing sharply in all cultivars at 24 hpi in all treatments. An insignificant fall in APX activity was observed at 48 hpi, whereas highest activity was recorded at 72 hpi. The oxidative burst produced during the interaction of rice with Xoo was host's first line of defense against the invading pathogen. The two elicitors SA and CH acting as mimics of the pathogen could induce ROS generation and antioxidative mechanism.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/16

Effect of date of planting on the incidence of planthopper complex in rice at Tunga Bhadra command area of Karnataka

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ABSTRACT

Field incidence of insect pests is highly dependent on crop stage and prevailing abiotic as well as biotic factors that affect their multiplication and growth. As cropping systems are highly dependent on monsoon rains in the country, a shift in sowing or planting dates have been observed as a strategy to cope up with the climate change impacts. Keeping this in view, to generate knowledge on impact of these changes on Planthoppers (BPH and WBPH) incidence, the trial on Effect of planting dates on BPH and WBPH incidence was conducted.

During *Kharif* 2019, effect of planting dates on planthoppers incidence trial was conducted at ARS, Gangavathi. BPT 5204 was planted at three dates *viz.*, normal planting as per the recommended package of practices, 20 days earlier to normal planting, designated as 'early planting' and 20 days later than the normal planting, designated as 'late planting'. Each time, sowing of the nursery and planting was done separately in 500 sq. m area. WBPH population (0.4 – 193.2 hoppers/5 hills) was higher than that of BPH (0.6 -140.5 hoppers/5 hills) in all the three plantings. WBPH numbers crossed ETL at 60 – 110 DAT in early planting (62.2 – 128.3 hoppers/ 5 hills), at 40 – 110 DAT in normal planting (80.8 – 181.4 hoppers/ 5 hills) and at 30 - 90 DAT in late planting (87.5 – 193.2 hoppers/ 5 hills). Similarly, BPH population crossed ETL in normal planting between 50 DAT – 110 DAT (53.9 – 117.3 hoppers/ 5 hills) and at 40-110 DAT in late planting (76.2 – 140.5 hoppers/ 5 hills). Grain yields of 7190, 6264 and 5068 kg/ha were recorded in early, normal and late plantings, respectively.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/17

Assessment of riceinsects populations using light trap at Tunga Bhadra command area of Karnataka

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ABSTRACT

Insect pests are the key constituents of biotic stresses posing hurdles for sustainable rice production. Globally, in recent times, changing climatic scenario has had a continued impact on shifting crop cultivation practices resulting in altered pest profiles in rice. Socio economic changes and concomitant ecological constraints make it particularly challenging for the farmers to battle the variety of pests infesting rice in our country. The national pests *viz.*, stem borer, gall midge, planthoppers and leaf folder consistently occur and affect rice crop growth across the diverse ecosystems. There are other pests of regional significance like hispa, caseworm, swarming caterpillar, cutworms etc. which also have the potential to cause economic losses to rice farmers under unpredictable situations. Monitoring of insect pest populations through light traps at different locations helps in short- and long-term assessment of pest populations for use in pest forecasting.

During *Kharif* 2019, YSB, LF, CW, GLH, BPH and WBPH were recorded at TBP command area of Karnataka. All the pests were recorded throughout the year and showed near uniform distribution. YSB populations were moderate and sex ratio was highly skewed towards females. The population was higher in 6th SW with 63 females and 20 males. Leaf folder catches also were highest (71) in the same SW. GLH (*N. virescens*and *N. nigropictus*) catches were maximum (170 and 369 respectively) in 47th SW. Among the plant hoppers, WBPH was dominant with a highest population of 400 in 43rd SW. Present study will helps to design any effective location specific pest management strategies, knowledge of population dynamics of insect pests in relation to abiotic and biotic factors becomes vital.

ADJNS/TH-III/LT/18

Determination of the causal organism of rice grain discolouration

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ABSTRACT

The causal organism of grain discolouration of rice was confusing as many researchers reported to be caused by various pathogens like fungi, bacteria, environmental effects etc. Rice grain showing typical brown or black spots was used for isolation of the pathogen using potato dextrose agar media. The mycelia were fast growing, brown to greyish black with a black reverse. The mycelial diameter measured about 11 mm and 82 mm after one day and seven days of inoculation respectively. The width of the fungal hypha measured 4.44 µm. The conidia were septate, brownish in colour and measured 17-21 x 10-12 µm. The conidia were curved (lunate), the sub terminal cell enlarged, pale brown at both ends with 3–5 septa. The DNA amplification of the ITS regions showed product size of S 600 bp. The ITS regions were sequenced and revealed 100% similarity with *Curvularialunata*. Based on the morphological and molecular assays, the pathogen causing grain discolouration was revealed as *Curvularialunata*.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/19

Development of a multi-residue method for pesticide quantification from rice grain

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ABSTRACT

A multi-residue method for pesticide (>100) quantification from rice grain was established as per AOAC, SANTE and FSSAI guidelines. In brief, one kg rice sample was collected and ground. Rice sample (10 g) in was taken in a 50 mL centrifuge tube and 12 mL of distilled water and 10 mL of ethyl acetate were added and vortexed for 1 min followed by addition of 4 g of anhydrous magnesium sulfate ($MgSO_4$) and 1 g of anhydrous sodium chloride (NaCl). The sample mixture was homogenized for 3 min and centrifuged at low temperature. Supernatant was transferred added in centrifuge tube containing 50 mg mL^{-1} PSA and 150 mg mL^{-1} $MgSO_4$. The content was vortexed and centrifuged at 5000 rpm for 5 min at low temperature. The supernatant was filtered through 0.2 micron PTFE membrane filter into sample vial for LCMSMS and GCMSMS injection. Detailed parameters were standardized as per the guidelines. In brief, the LOD of the method was < 10 ppb for most of the pesticides and LOQ was <10 ppb (for 60 pesticides). The recovery of different pesticides was within 80-120% of the fortified quantity with the precision of <20% RSD. We quantified the pesticide residues present in paddy as well as rice samples (300) collected from different district of Odisha. Detailed data will be presented during the symposium.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/20

Sensitivity of rice false smut disease causing pathogen, *Ustilaginoidea virens* to EBI and QoI fungicides in India

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ABSTRACT

Rice false smut (RFS), caused by *Ustilaginoidea virens* (Cooke) Takahashi, is now a major fungal disease of rice in all rice growing areas of the world. The typical symptom of RFS disease is the formation of false smut balls in rice grains and generally visible during harvesting stages. The pathogen affects production as well as overall quality of rice (Bag et.al., 2021) and produces toxic metabolites, including ustilaginoidins and ustiloxins which threaten food and feed safety (Qiu et al, 2019). Till now, RFS is appeared in almost all HYV and hybrid varieties. In absence of RFS resistant variety, application of fungicides is the best and effective way to manage the disease. In particular, Ergosterol biosynthesis inhibiting (EBI) fungicides like propiconazole, tebuconazole, difenconazole and Quinone outside inhibiting (QoI) fungicides like azoxystrobin, tryfloxistrobin are more commonly used in rice fungal disease management. However, due to intensive application of fungicides, resistance has been detected in several important pathogens. Zhou et al. (2019) reported propiconazole-resistant isolates of *U. virens* in China. Thus, our objective is to find out the lethal dose 50 (LD_{50}) of tebuconazole, propiconazole (EBIs) and azoxystrobin (QoI) to Indian isolates of *U. virens* and frequency distribution of sensitivity of isolates of *U. virens* from eastern and north-eastern India. All three fungicides were assayed against the *U. virens* culture of native isolate (NRRI-FS-1) following poisoned food technique under ideal laboratory condition. LD_{50} values of azoxystrobin, propiconazole, and tebuconazole for inhibiting mycelial growth of *U. virens* (Isolate NRRI-FS-1) were calculated as 0.08, 0.05, and 0.035 ìg/ml respectively. Frequency distribution of sensitivity of 63 isolates of *U. virens* from eastern and north-eastern India at 5 different concentrations based on the LD_{50} value (0.034) of tebuconazole standard viz., 0.02, 0.03, 0.034, 0.04, 0.05 & control revealed that 90.5% isolates are sensitive in the ranges 0.019 - 0.035 ìg/ml. Only 6 isolates are sensitive to marginally high concentration of tebuconazole (LD_{50} value ranges 0.036-0.04 ìg/ml), thus less sensitivity to LD_{50} value in compare to NRRI isolate (NRRI-FS-1). This study suggested that *U. virens* in India are highly sensitive to these fungicides.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/21

The complete mitochondrial genome of rice earhead bug, *Leptocorisaoratorius* (Fabricius) (Hemiptera: Alydidae) using next generation sequencing

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ABSTRACT

*Leptocorisaorat orius*is the key pests of rice in India. Till now, *L. oratorius*mitochondrial genome was not sequenced which requires for population genetics, and phylogenetic evolution studies. Hence, an attempt was made to sequence the complete mitochondrial genome of two samples of *L. oratorius*from India for the first time. The mitogenomes of *L. oratorius*are 17,584 and 17,583 bp long with 73.57% and 73.64% of A + T contents, respectively for both the samples. *L. oratorius*mitochondrial genomes include the 37 genes (13 PCGs (*cox1-3, atp6, atp8, nad1-6, nad4l* and *cob*), 22 tRNA genes, and 2 ribosomal RNA (*rrnS*and*rrnL*) subunits genes with typical representation of metazoan mitogenomes. The phylogenetic analysis of 65 mitogenome of pentatomomorpha infraorder based on maximum likelihood resulted that Coreoidae superfamily differentiated from Lygaeoidae, Aradoidae, Pentatomoidae. Further, family level phylogenetic analysis yielded two topologies when rooted with Coreidae, Rhopalidae and Alydidae in one clade; remaining families forms another clade. Further, the conformation of *Leptocorisaoratorius* from the present study form a separate subclade from earlier reported *Leptocorisa Sp.* Bayesian analysis also supported the similar claim of phylogeny. Present study provides the reference mitogenome for *L. oratorius* that may be utilized for population genetics and phylogenetic evolution based future studies of *L. oratorius*.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/22

Activities of defense enzymes in red rice genotypes showing differential response to brown planthopper infestation.

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ABSTRACT

Rices with red bran layer are called red rices, which contains Polyphenols and anthocyanin and also posses antioxidant properties. Red rices are highly nutritive and have medicinal values, curing blood pressure and fever, for treating leucorrhoea and abortion complications in women, promotes blood circulation and used for other stomach problem and a cholesterol lowering product. With the sharp increase in lifestyle-related health issues and diseases such as diabetes, cancer and heart problems, scientists are looking at quality traits other than carbohydrates, protein, and fat in foodstuffs in rice. They not only possess nutritional values, but also have many pest and disease resistance properties. More studies are being undertaken to mine new genes/QTLs in red rice possessing resistance against biotic and abiotic stresses. Keeping all these information in view, a study was undertaken on red rice and its resistance to brown plant hopper as it was a major pest in all rice growing areas of the country. Different defense enzymes *i.e.*, peroxidase, polyphenol oxidase, catalase and super oxide dismutase involved in resistance mechanism were estimated at different time interval after BPH infestation. In all red rice genotypes including control check plants defense enzyme activity was increased upto 48 hours after infestation of BPH but it gradually decreased after that. In case of highly resistant red rice genotypes the percentage increase of enzyme activity was more as compared to resistant and moderately resistant red rice genotypes. The susceptible check TN-1 plants showed less increase in enzyme activity. Resistant check plants *i.e.*Salkathi and PTB-33 showed increased enzyme activity up to 48 hour of infestation which was statistically on par with Mata Meher and Hermonona. The Catalase activity was increasedupto 24 hour of infestation then it decreased gradually in all genotypes. The percent increase of catalase activity was more in highly resistant red rice genotypes followed by resistant and moderately resistant red rice genotypes. Any herbivore damage leads to induction of rapid signals and responses in plants such as oxidative burst, accumulation of secondary metabolites and defensive proteins. This study will be helpful in breeding resistance varieties against brown planthopper.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/23

Molecular phylogeny, pathogenic variability and phytohormone production of *Fusarium fujikuroi*isolatesassociated with bakanae disease of rice

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ABSTRACT

Rice bakanae also called as foolish seedling disease is emerging as major problem in rice cultivation in major rice growing regions of the country. Earlier the disease believed to be prevalent only in basmati growing regions of north India. But, from past few years the disease is emerging as major threat in Eastern states of Odisha, West Bengal, Assam, Bihar and Jharkhand. The disease caused by a highly seed borne fungal pathogen *Fusarium fujikuroi* . The disease may affect rice plants from pre-emergence to the crop maturity stage. The symptoms like abnormal elongation, seedling death, thin and chlorotic leaves, and formation of roots in each internode can be seen. Severely infected seedlings often die at early stages. Based on the phytohormone produced by the pathogen, we can differentiate the symptoms. High production of gibberellic acid (GA_3) causes abnormal elongation, whereas, production of fusaric acid leads to seedling death at the early tillering stage. In the present study, total of 45*Fusarium* isolates were collected from rice plants at different geographical locations andseeds of different rice cultivars. The isolates were evaluated for morphological, biochemical and pathogenic diversity. Theamplification of TEF-1á gene was carried out for exploring the species spectrum associated with the cultivated and prereleasedrice varieties. The production of gibberellin varied from 0.62 to 3.26 ìg/25 ml, while as that of Indole acetic acidvaried from 0.50 to 4.15 ìg/25 ml among the *Fusarium* isolates. The phylogenetic analysis identified 5 different species ofthe genus *Fusarium viz*. *Fusarium fujikuroi*, *F. proliferatum*, *F. equiseti*, *F.sacchari*and *F. verticillides*after nucleotideblasting and sequence analysis in NCBI. Only two *Fusarium* spp. *F. fujikuroi*and *F. proliferatum*were found to be pathogenic under virulence assaysof the isolates. The isolates showed a considerable variation in morphological and pathogenic characters. These results help us to formulate suitable management measures along with detailed study of rice-pathogen interaction.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/24

Current status of sheath rot disease of ricein Konkan region of Maharashtra and it's management

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ABSTRACT

India is the world second largest producer of rice (*Oryza sativa* L.). It is a versatile food crop of the world and it's a staple food of almost one to two billion peoples. More than 70 to 80 percent rice is grown and consumed by the small and marginal farmers. Rice is attacked by several fungal, bacterial and viral diseases, among them blast and bacterial leaf bight was considered to be major diseases. However, during past two to three years Sheath rot, caused by*Sarocladiumoryzae* (Sawada) has recently become a serious disease of rice. It has caused 10-80% yield loss, when infection occurs during or after the booting stage, before the emergence of the panicles. Hence the present study was conducted at RARS, Karjat to know the status of disease its virulence, Pathogencity and management.Sheath rot disease incidence (15-20%) was noticed on varieties viz Ratnagiri 7, Ratnagiri-8, Ratnagiri-24, Karjat-2, Karjat-3,Karjat-6 &Karjat-7, Jordar, YSR, Zinnia, Masuri, Jaya, Rupali, Suvarna, Shubhangi, Daptari, Punam in all the five districts of *Konkan* Region of Maharashtra. The most virulent pathogen was observed on karjat-6. During the management study hexaconazole 5 EC (0.1%)was found to be effective fungicide with disease incidence of 41.38 per cent as compare to controlfollowed by the treatment T_5 -hexaconazole 5 EC (0.05%) andT_3 (chitosan,50%dilution) and at par with each other. Further work on molecular variability among the pathogens is in progress.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/25

Biochemical Characterization of *Scirpophaga Incertulas* Populations of Telangana State, India

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ABSTRACT

Biochemical diversity analysis in rice yellow stemborer populations (*ScirpophagaIncertulas*) is very useful to understand intraspecific variations, required for adopting suitable Integrated Pest Management strategies. Larvae were collected from six different regions of Telangana *viz.*, Rangareddy (RGD), Mahbubnagar (MBR), Nizamabad (NZD), Jagtial (JGL), Warangal (WGL) and Medak(MDK). Based on the importance, five non-enzymatic compounds (total protein, urea, uric acid, glucose and cholesterol) and activity levels of three enzymes (aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP)) were studied in the rice yellow stemborer larvae. The quantitative measurements of all the eight parameters showed significant differences among six populations. The highest amount (1.495 g/dl) of total protein was measured in MDK and lowest amount (0.853 g/dl) in JGL. The maximum values urea and uric acid content were noticed in JGL population whereas the corresponding lowest figures were from WGL and NZD populations, respectively. Glucose content in the larvae varied from 108.825(JGL) to 236.6mg/dl (MBR) across the larval populations. . The amount of cholesterol was maximum in JGL (11 mg/dl) and minimum in MDK (8.175 mg/dl). The activity level of AST ranged from 1405 to 3201 IU/I. The minimum value (1703 IU/I) of ALT was noted in NZD population and maximum value (2716 UI/I) in MBR population. The highest (505.37 IU/I) and the lowest amount (817.75 IU/I) of ALP were noticed in MDK and MBR populations, respectively Hierarchical agglomerative clustering using Ward method produced two clusters for non-enzymatic parameters , with cluster one consists of JGL, NZD and WGL populations and cluster two contains RGD,MBR and MDK populations. In case of enzymatic parameters, hierarchical clustering divided the total populations into two clusters with MBR and JGL populations in cluster one and remaining four populations in cluster two.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/26

Recombinase polymerase amplification (RPA) assay for rapid detection of *Ustilaginoidea virens*: A viable PCR substitute for mass screening of isolates

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ABSTRACT

False smut of rice, caused by *Ustilaginoidea virens* (Cke.) Tak. (Ascomycota, Clavicipitaceae) is a common grain disease in most rice-growing areas of the world. In recent years, it has emerged as the most devastating grain disease in majority of the rice-growing areas of the world including India. The available methods for detecting *U. virens* are time consuming and require expensive equipment, sophisticated laboratory set up and highly skilled personnel. Recombinase polymerase amplification (RPA) is a rapid, isothermal amplification method with high specificity and sensitivity. In this study, we have developed a RPA protocol for rapid and specific detection of *U. virens* directly from mycelial mat. Three oligonucleotide primer pairs were designed from the *U. virens* GTP binding protein beta subunit (UVGbeta-1) gene (GenBank Acc. # GU014921). RPA was performed with all the three primer pairs using the Twist Amp Basic Kit at an isothermal condition (37°C) for 30 min. The developed RPA assay efficiently detected *U. virens* even in crude sap extracted from fungal mycelia. The specificity of the RPA primers were evaluated using DNA from other rice pathogens, as well as, by sequencing the RPA amplicons. Further, the sensitivity of RPA assay was compared with the reported loop-mediated isothermal amplification (LAMP) and nested PCR protocol. Other than RPA, both LAMP and nested PCR assay failed to detect *U. virens* from crude sap. Therefore, the developed assay can be a potential diagnostic tool for rapid and specific screening of *U. virens*, even at a very initial stage of fungal isolation in the laboratory condition.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/27

Characterization of organ specific endophytic microorganisms associated with temperate varieties of rice and their biocontrol activity against blast of rice

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ABSTRACT

The study was conducted to characterize and assess the biocontrol efficacy of endophytic microorganisms against blast disease of paddy caused by *Magnaporthe grisea*. 125 endophytic microorganisms were isolated from roots, stem and leave of four major rice cultivars of paddy (C1039, SR3, SR4 and SR5) grown in temperate region. All the endophytes were tested for antagonistic activities against blast of rice under *in vitro* conditions. 5 fungal (varying from 89%-70%) and 5 bacterial (71- 60 %) endophytes showing highest potential of antagonistic activity were selected for further studies. The selected isolates were studied for the effect of volatile compounds. In case of fungal endophytes highest inhibition was found by f18 (77 %) followed by f11 (68%). In case of bacteria the highest inhibition was found by b18 (65%) followed by b17 (62%). Also f18, b7, b17, b18 and b9 were found effective in producing chitinase enzyme ranging from 3µg/ml to 0.6 µg/ml. All the isolates were able to solubilize the phosphorus. The isolates f18, f13 and f12 and b55, b9 and b18 also showed ammonia production. HCN production was also found by isolates b17 and b9. Isolates f18, f13, f12 and all bacterial isolates were found to produce siderophores ranging from 54 µg /ml to 15 µg/ml. All the endophytes were tested under green house conditions. Among bacterial endophytes highest disease control was shown by isolate b18 with disease incidence of 18 % and intensity of 7%, as compared to control with incidence of 64% and intensity of 36%, while as in case of fungal isolates the isolate f12 was showing highest disease control (15 % incidence, 8 % intensity) followed by f11 (17 % incidence, 10 % intensity) in comparison to control showing incidence and intensity of 61 % and 34 % respectively. All the ten isolates were characterized both by cultural, morphological and molecular means and were identified as F11, f17: *Trichoderma afroharzianum*,F12: *Trichoderma harzianum*, F13: *Penicillium rubens* and F18: *Aspergillus flavus* and b7: *Stenotrophomonas rhizophila*, b9:*Stenotrophomonas maltophilia*, b17: *Bacillus cereus,* b55: *Enterobacter cloacae* and b18: *Bacillus licheniformis*.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/28

Identification of blast resistance genes in rice genotypes

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ABSTRACT

Rice blast caused by *Pyricularia grisea* (Cooke) Sacc, is a major production constraint in rice cultivation. In recent years, this disease has been reported to appear regularly at an alarming state in many areas. The disease is appearing during *rabi* season in Godavari delta of Andhra Pradesh. For effective management of blast use of resistant varieties is the most ideal strategy. So, attempts were made to screen the entries using standard protocols (SES, 2014) to identify the resistant cultures for leaf blast in rice and molecular identification of major blast resistance (R) genes in rice genotypes using gene linked markers during 2017 season.

The results revealed that presence of *Pi1* blast resistance gene was detected in MTU 2077, MTU 1064, Improved samba mahsuri, NLR 28600, MTU 1217, MTU 1239, MTU 1006, MCM 101, Swarna sub1, MTU 1231, MTU 1190, BPT 2231, BPT 1768, NLR 33641, NLR 3041, NLR 40024, NLR 40054, NLR 20084 and NLR 40058 varieties/cultures through SSR marker with primer RM224 (157bp). Similarly, presence of *PiK*^{h} (Pi54) blast resistance gene was detected in NLR 3513, MTU 1231, BPT 2231, BPT 2411, BM 71, NLR 145 and MCM 103 through SSR marker with primer RM206 (147 bp). Attempts to detect the presence of *Pi2* (*Piz-5*) blast resistance gene were made with SSR primer RM 527. It was not found in tested varieties. Presence of *Pi5(t)* blast resistance gene was detected in NLR 28600, MTU 1217, NLR 3513, MTU 1031, BPT 2411, NLR 9672, NLR 9674, NLR 30491, NLR 145, NLR 3041 and NLR 40024 through SSR marker with primer RM21 (157 bp).

Presence of *Pik*^{s}blast resistance gene was detected in MTU 1006, MCM 101, Swarna sub 1 through SSR marker with primer RM1233 (175 bp).Presence of *Pi40(t)* blast resistance gene was detected in MTU 1032, BPT 2231, BPT 2295 BPT 1768, NLR 33641, NLR 30491, NLR 145, NLR 3041 through SSR marker with primer RM3330 (145 bp). Attempts to detect the presence of *Pik*^{s} blast resistance gene were made with SSR primer RM144. An amplified fragment at 254 bp was detected inMTU 2077, MTU 1211, MTU 1232, NLR 3242, MTU 5182 and NLR 3513. Presence of *Pib*blast resistance gene was not detected in tested varieties through SSR marker with primer RM208 (173 bp). Presence of *Pi15* blast resistance gene was detected in NLR 3513, BPT 2411, BM 71, NLR 9672, NLR 33641, NLR 30491, NLR 3041, NLR 40054 and MCM 103 through SSR marker with primer RM316 (192 bp).Presence of *Pi39* blast resistance gene was detected in NLR 28600, MTU 1231, MTU 1190, BPT 2595, BPT 1768, BPT 2411, BM 71, NLR 9672, NLR 9674 through SSR marker with primer RM3843 (100 bp). The results indicated that rice genotypes *viz*., NLR 3513, BPT 2411 and NLR 3041 were having four resistance genes.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/29

Screening of genotypes for stem rot resistance in rice under pot culture conditions

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ABSTRACT

Stem rot disease of rice is caused by *Sclerotium oryzae*has been reported from rice-growing countries of the world. The pathogen has been reported to cause 5-80 per cent losses in grain yield in different parts of the world. The disease was prevalent in all the rice-growing areas of India. This disease affects the stem resulting in rotting and subsequent lodging of the crop. In Andhra Pradesh, this disease is emerging as major disease and appearing in sporadic/regular manner on MTU-3626 (Prabhath) in Godavari delta. Hence, attempts were made to identify the resistant sources for this disease. Studies were carried under pot culture conditions for screening of rice genotypes using artificial inoculation techniques during *kharif* 2019 season. The pathogen was multiplied on rice straw culture media and applied twice to soil in pots. The results revealed that stem rot incidence was found minimum in MTU-1253 (2.27%), MTU 1239 (3.23%), MTU 1078 (4.08%), MTU 1064 (5.41%), MTU 1223 (9.76%), NLR 3041 (2.56%), NLR 20104 (7.02%), NLR 33671 (6.25%), NLR 34449 (6.38%), NLR 40065 (7.32%) and BM-71 (8.82%) entries. MTU 1239 recorded stem rot incidence (3.23%) having bending strength (86.61) and culm strength (8.2).

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/30

Environmental fate of chlorantraniliprole and triflumezopyrim in combinations as compared to their individual applications in rice ecosystem

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ABSTRACT

Chlorantraniliprole and triflumezopyrim are new pesticide molecules applied to manage the crop pests of rice. Chlorantraniliprole (3-bromo-N-[4-chloro-2-methyl-6-[(methylamino) carbonyl]phenyl]-1-(3-chl-oro-2-pyridinyl)-1H-pyrazole-5-carboxamide) (CAP) is an anthranilic diamide insecticide that works by activating insect ryanodine receptors. Triflumezopyrim (TMP) (2,4-dioxo-1-(pyrimidin-5-ylmethyl)-3-[3-(trifluoromethyl)phenyl]-3,4-dihydro-2H-pyrido[1,2-a]pyrimidin-1-ium-3- ide) is a mesoionic insecticide, which acts on nicotinic acetylcholine receptor (nAChR). The behaviour of CAP, TMP and their mixture in terms of residue dissipation is important in determining their possible risks to human health and the non-target toxicity to soil microbes needs to be understood. SANTE guidelines (SANTE/12682/2019)(SANTE 2019) were followed for method validation of TMP and CAP. The dissipation half-lives of CAP were 11.96, 11.05 and 12.17 days, respectively for CAP as individual and CAP in mixtures with 75 and 50% of recommended doses. Similarly, the dissipation half-lives of TMP in plant tissues were 9.20, 9.07 and 8.85 days, respectively for TMP as individual and TMP in mixtures with 75 and 50% of recommended doses. Pesticide applied as mixtures had passing effect on soil enzyme activities. It may be possible because of more amount of pesticide was applied as mixtures. But 14th day onwards, soil microbial activities recovered. There were no detectable residues in paddy straw after application of these mixtures. Moreover, the residues in rice grains was below the prescribed maximum residue limit. In modern day agriculture, where environment safety and pest management run side by side, the mixture of CAP and TMP can play a pivotal role in multi-pest management along with ensuring environmental safety.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/31

Chemical characterization of rice plant volatiles and their behavioural response againstrice gall midge, *Orseolia oryzae* (Wood-Mason)

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ABSTRACT

Rice gall midge, *Orseolia oryzae* is a serious pest of rice, which damages the crop and causes tremendous yield reduction by forming silver shoots. Its management by the use of onlyresistant varieties is not very easy as the pest has a unique potential to evolve and produce newer biotypes rapidly. Therefore its management with some alternativetechnique is of prime interest. In the present investigation, the rice leaf volatiles from the highly resistant (Abhaya, AC-44525, AC-44897) and highly susceptible (TN1, AC-44585, AC-44597) accessions were extracted and characterized using GC-MS. Of the differential volatiles identified from the accessions, four major volatile compounds *viz.*, Heptadecane, Undecane, Tetradecane and Tetracosane were tested to study the behavioral response of adult gall midge using Y-tube olfactometer.The observations on the number of entries and time spent in each volatile treated arm and control arm were recorded. The adults made significantly more entries (P= 0.05) and spent significantly longer time (P=0.008) in the treated arm than in the control arm when exposed to Undecane. In the case of tetracosane, adults spent significantly more time (P=0.02) in the treated arm than the control arm, whereas results were non-significant for the number of entries. Results revealed that there was no significant response for both the number of entriesand time spent when adults were exposed to tetradecane and heptadecane. Our results conclude that volatiles like undecane and tetracosane play a major role in attracting the gall midge and can be utilized in the management of gall midge in the rice ecosystem.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/32

Imidacloprid induced transgenerational hormesis in *Trichogramma chilonis* Ishii

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ABSTRACT

The aftermath of hormesis for the intractable pests can be dreadful, but considering the natural enemies, it is a puissant weapon in optimizing the mass rearing and enhancing the quality of the bio-control agents. In this study, the transgenerational stimulatory effects of imidacloprid on the demographic traits of *Trichogramma chilonis* Ishii were investigated for five continuous generations (F_1 to F_5). The age-stage, two-sex life table analysis was performed using TWOSEX-MSChart computer program. The initial bioassay results showed that imidacloprid exhibited high toxicity against the parasitoid with a median lethal concentration (LC_{50} of 0.002 mg a.i./l) whereas the sublethal (LC_5) and low lethal (LC_{30}) concentrations were 0.00005mg a.i./l and 0.0005mg a.i./l respectively. A reduced adult longevity and fecundity of *T.chilonis* were observed during F_1 generation, but a substantial increase of the same was observed during F_5 generation when exposed to low lethal and sublethal concentrations. Moreover, there was a substantial increase in the population parameters such as intrinsic rate of increase (r), finite rate of increase (ë) and net reproductive rate (R_0) during F_5 generation compared to F_1 generation. These results indicated that although low and sublethal concentrations of imidacloprid have a negative impact on the biological traits of *T.chilonis*at initial generations, but have the ability to induce hormesis effects in the later generations. Overall, our results provide a comprehensive grasp of the imidacloprid-induced hormesis stimulating the development of *T.chilonis.* Taken together,our results would impact the mass rearing of the widely used bio-agent, *T. chilonis*.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/33

Effect of host densities on the quality mass production of *Habrobracon hebetor* (Say) (Hymenoptera: Braconidae)

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ABSTRACT

Biological control with the help of natural enemies is one of the most important aspects of integrated pest management strategies. The parasitoids optimize the reproductive potential by exploiting the host immune system, varying the clutch size, emergence rate with reference to host density. The current study was carried out to determine the efficiency and quality of the wasp, *Habrobracon hebetor* (Say) (Hymenoptera: Braconidae), when reared on different host densities (5, 10, 15, 20 and 25) of the factitious host, *Corcyra cephalonica* (Stainton). Density dependent increase in egg-laying capacity of *H. hebetor* was observed. The larval hatch rate of parasitoid has significantly declined with increasing host density, from 37.00 at a density of 5 to 27.50 at a density of 25 ($P<0.0001$). The non-significant adult emergence rate was observed across different host densities, despite the maximum number of pupae (36.75±4.17) were observed under lower host density ($P<0.0001$). Concerning, sex-wise emergence, the highest female emergence was observed at lower host densities, whereas male emergence rate was maximum at higher host density ($P<0.0001$). Both male and female longevity of *H. hebetor* was longest at higher host densities ($P<0.0001$).Body size has been the most prominent fitness measure in predictive models of clutch size and progeny sex allocation in parasitoids. In the current study, the size (measured through wing length and hind tibia) of the female adult parasitoid was larger at lower host density. Overall, the study thus provides noble information which can be used for interpreting the functional response in parasitoids as well as for the mass rearing of *H. hebetor*.

ADJNS/TH-III/LT/34

Management of Sheath Rot Disease of Rice

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INTRODUCTION

Rice is the Staple food of the people in Eastern, South and South Eastern parts of India .It is grown in various agro-ecological zones in tropical and sub-tropical areas especially Asia , the continent accounting 90% of the world production(IRRI, 2015). Rice in India is important part in National economy. India is world's second largest producer of rice and the largest exporter of rice in the world .Rice production is around 120million tons in 2020-21. It is grown in 43million ha in India. The rice crop is known to suffer wide array of fungal diseases causing considerable yield loss. Sheath rot disease of rice caused by *Sarocladiumoryzae* (Sawada) , 1922 Gams And Hawksw , however hasnot drawn due attention and so far it has been considered to be a minor disease. Sheath rot disease is a major problem in upland rice in west Africa on rice cultivars introduced from Asia(Ou, 1985). Depending upon the conditions, yield losses vary from 20 to 85% . In Taiwan, extent of damage ranged from 3 to 20% and sometimes it goes to 85% (Chen, 1957).

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/35

Elevated atmospheric CO_2 alters the soil arthropod community in the rice ecosystem

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ABSTRACT

The abundance and diversity of soil arthropods can reflect changes in soil quality. However, the extent to which elevated CO_2 will serve to alter soil arthropod communities in rice ecosystem remains elusive. The present study was conducted at ICAR-National Rice Research Institute, Cuttack, Odisha, India to study the effect of elevated carbon dioxide (CO_2) concentration(550 and 700 ppm) in the atmosphere on the abundance of soil arthropod population in the rice field against ambient CO_2(410 ppm) in the environment during the dry season 2017-18. The arthropod population of (30×10×15) cm^3 soil sample were recorded in three phases of January (Before planting), February - May (Cropping season) and July (After harvest) from the rice fields under both the treatment belonged to the orders namely Collembola, Acari, and other groups (Coleoptera, Diptera, Hymenoptera, Millipede, Orthoptera, Dermaptera).The maximum temperature and minimum moisture content of soil samples were noticedunder elevated CO_2 than ambient condition.The significant population densities of Collembola and other groups were fluctuated under ambient condition whereas constantly decreased due to high temperature and low moisture content of soil under elevated CO_2. But the increase in the population density of acari was non-significant under elevated CO_2. The soil sample analysis data showed that the lowest mean population densities of Collembola (4.10) and other groups (7.10) were recorded in the month of May under 410 ppm CO_2 and in the month of July i.e. 1.90 and 2.30 respectively under 700 ppm CO_2 followed by 2.20 and 3.50 respectively under 550 ppm CO_2. Similarly, the highest Acari population was found in the month of June and July under ambient and elevated CO_2 respectively. Elevated CO_2 showed lower relative abundance of collembola (30.7%) and other groups (43.9%) under 700 ppm CO_2 followed by 31.3% and 49.8% respectively under 550 ppm CO_2 compared to 410 ppm CO_2 (34.9% and 55.2% respectively). The maximum Simpson's diversity of index (D) values 0.73 and 0.69 of soil arthropod were recorded under 700 ppm and 550 ppm CO_2 respectively against 410ppm CO_2 0.61.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/36

Use of Ground-based Hyperspectral Radiometryfor Detection of Stress in RiceCaused by Yellow Stem Borer

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ABSTRACT

Spectral mixture analysis and hyperspectral remote sensing are analytical and hardware tools which are new to precision agriculture. This will allow detection and identiûcation of various crop stresses and other plant and canopy characteristics through analysis of the spectral signatures. Based on this concept, the field experiments were conducted to characterize the Yellow stem borer (YSB) infestation at different damage levels on rice through hyperspectral remote sensing. Damages are categorized into two based on damage severities i.e 50% and 100% affected samples. The YSB damaged leaf had higher spectral reflectance in the visible region (400-700nm) and in the SWIR region (1100-2500nm) due to presence of stress. The spectra reach its peak value at 882nm for both affected and heathy samples on the original spectra. Atmospheric perturbations from 1350-1450, 1780-2000 and from 2350-2500nm were removed to get a smoothened spectrum. There was a greater variation in the NIR region (700-1100 nm) which shows the healthy sample has more reflectance value than affected YSB samples. A sharp peak was seen at 550nm indicating the presence of anthocyanins. Reduction of chlorophyll content occurs at 684nm and at 691nm the inclination in the spectra indicates the presence of red edge. Derivative analysis depicted sensitive bands such as 717, 724, 732, 761, 766, 814 and 895nm which showed major deviation in the NIR range and were marked as sensitive bands. Absorption features after doing continuum removal at various band depths are located at 504, 680, 789, 802, 816, 898 and 1267nm which were also considered as significant bands. Band Depth, Band Area and Normalized Band Depth were also calculated for different band widths at different intervals of 5,10, 15 and 20nm and was found that the value of Normalized Band Depth did not change irrespective of the change in the band widths and their respective intervals. T-test was applied on the bands marked from derivative analysis and continuum removal to check their sensitivity. The bio-chemical analysis results showed that the value of phenol content of infested samples was more as compared to healthy samples but all other content such as chlorophyll, reducing sugar, non-reducing sugar and carbohydrate was were more for healthy as compared to YSB samples.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/37

Spectral Vegetation Indices as Indicators of damage by Rice Leaf Folder

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ABSTRACT

Rice leaf folders (RLF), *Cnaphalocrocis medinalis* (Guen.)once regarded as minor pest has become major pest in several parts of India including Odisha. The insect causes significant damage to the rice crop by folding leaves and scraping off the green mesophyll tissue. Remote sensing can be used to track spatial-temporal changes in crop morphology and physiological status as well as to improve precision farming techniques. The use of hyperspectral remote sensing for diagnosis of insect pest infestations can speed up detection time and allow for non-destructive sampling. Furthermore, with India's launch of new hyperspectral remote sensing satellites, the focus of current research has switched to maximizing the benefits of the new technology for the Indian farming community. In order to develop an RLF monitoring method based on hyperspectral data, the reflectance of rice leaves at different levels of infestation (5 grades) caused by the rice leaf folder were recorded at the booting stage with different infestation scales. The reflectance for healthy sample in the green region (540-560 nm), blue region (450-520 nm), red (580-700nm) and NIR region (700-1000nm) increased significantly after the visible range as compared to leaf folder infested samples. Normalized Difference Vegetation Index (NDVI), Leaf Area Index (LAI), Red Edge Position Index (REPI), Photochemical Reflectance Index (PRI), Plant Senescence Reflectance Index (PSRI) calculated to know the difference between healthy and Leaf folder infested samples. In our experiment, the NDVI value ranged from 0.51 (leaf folder grade 5) to 0.77 (Healthy). LAI value ranged from 1.44 (Leaf folder grade 5) to 3.2 (healthy). REPI was found at 722, 721, 719, 718, 712 and 707 nm for healthy, leaf folder grade 1, 2, 3, 4 and 5 respectively. PSRI values were 0.03, 0.07, 0.125, 0.129, 0.14 and 0.18 nm for healthy, leaf folder grade 1, 2, 3, 4 and 5 respectively.Deriving the spectral vegetation indices by analysing the hyperspectral signatures will assist the researchers/ young entrepreneurs for site specific pesticide application for management of a particular pest.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/38

Behavioural response of the ectoparasitoid, *Habrobracon hebetor* Say on sub-lethal phosphine treated factitious host, *Corcyra cephalonica* Stainton

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ABSTRACT

The rice moth, *Corcyra cephalonica* Stainton is one of the most destructive stored grain pests worldwide. Besides being a pest, itis also a factitious host for the mass production of several natural enemies. Insects and their natural enemies get exposed to insecticides both at lethal and sub-lethal concentrations which affect their physiology and behaviour. In this study, we assessed the effect of sub-lethal concentration of phosphine on the larval body volatiles of *C.cephalonica* followed by the behavioural response of *H. hebetor.* For *C.cephalonica*, the lethal (LC_{50}), low-lethal (LC_{25}) and sub-lethal (LC_5) concentrations of phosphine were found to be 67.975 ppm, 32.875 ppm and 11.893 ppm respectively. The 5th instar larvae of *C.cephalonica* were exposedto these concentrations of phosphine and rearedfor two consecutive generations (G1 & G2). GC-MS analysis revealedthe presence of differential volatile chemicals in LC_5, LC_{25}, and LC_{50}treated and untreated larvae.The chemicals showing higher peaks in the chromatogram *viz.,*eicosane, tetrapentacontane, C_7-C_{40} alkane chain along with the crude extracts of both treated and untreated larval body wash were selected for Y-tube olfactometer assay. Observations on time spent and number of entries were recorded.The adult female parasitoids spent significantly higher time in the treated arm than control arm for C_7-C_{40} alkane chain (P=0.006), crude extracts from LC_5(P=0.004), LC_{25}(P=0.008), LC_{50} (P=0.046) and untreated larvae (P=0.001) while for eicosane and tetrapentacontane the results were non-significant. Similarly for mean number of entries into the treated arm significant results were obtained for LC_5, LC_{25}, LC_{50} treated and untreated crude larval body wash extracts (P=0.003, P=0.037, P=0.011 and P=0.041) and eicosane (P<0.001) while it was non-significant for tetrapentacontane and C_7-C_{40} alkane chain. The study concludes that sub-lethal phosphine treated host may improve the behavioural response of the parasitoids and could be a possible case of behavioural hormesis.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/39

UAV Remote sensing tool for detection and management of Rice diseases

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ABSTRACT

Unmanned aerial vehicles (UAVs) remote sensing is a new alternative to traditional rice disease diagnosis and detection based on visual symptoms, allowing quick, accurate, and large-area disease detection. UAV remote sensing provides remarkable spectral, geographical, and temporal resolution, allowing damaged plant tissue to be distinguished from healthy tissue based on disease symptoms. UAV spraying can operate at low altitudes and at varying speeds, making it ideal for situations where aerial and ground applications are infeasible, and precision applications are required. This technology will become a core element in a farmer's precision equipment mix in the future, together with developments in digitalization and artificial intelligence for precision application across fertiliser, pest, and crop management demands. RGB sensor, multispectral sensor, and hyperspectral sensor have been successfully used to detect sheath blight; multispectral sensor has been used to detect and quantify NBLS; and infrared thermal sensor can be used to detect the occurrence of rice blast, among the five remote sensors commonly used for assessing abiotic and biotic stresses of crops. There have been no reports of fluorescence imaging being used to identify rice illness so far. UAVs used for crop phenotyping and disease detection include multirotors, helicopters, fixed wings, blimps, and flying wings. It's critical to pick the right unmanned aerial system to get the greatest imaging data that can be processed and modelled for crop disease diagnosis and quantification. Each UAV has its own set of advantages and disadvantages in terms of cost, flight capability, and payload capacity, just as each sensor has its own set of advantages and limits when it comes to obtaining spectrum data. Furthermore, UAVs can be employed as a novel aerial fungicide sprayer for disease control.UAV sprayers can fly at low altitudes, at different speeds, and with low fungicide volumes, making them more suitable for situations where precision fungicide applications are required for more cost-effective and environmentally friendly control of diseases like rice sheath blight with cluster occurrence.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/40

Agri –Robo: Autonomous Farming Robot with Plant Disease Detection in Rice

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ABSTRACT

Farmers in India have numerous obstacles, despite the fact that it is an agricultural country. These losses are primarily due to lack of agricultural monitoring, different crop diseases, and poor pesticide management which necessitates early detection, identification of diseased plants and also ongoing farm monitoring. A brief suggestion is presented to overcome these problems by continually monitoring crops using "Agri-Robo" and image processing techniques in this study. Image processing provides an answer to the aforementioned problem. It provides a quick, automatic, and accurate answer. It monitors crops, identifies and tracks illnesses and chemicals. It not only detects sickness, but also sprays pesticides as per the need. It decreases farmers' effort while also boosting the pace and accuracy of their work. It performs variety of spraying-related tasks and promotes agricultural output to increase production, improve application precision, and worker safety. In this system, collected images from the camera are processed using image processing techniques, and the processed results are transformed into binary codes and sent to microcontroller unit via RF module. DC motors are utilised to mix pest in the tank and to apply insecticide with a sprayer. The microcontroller unit is in charge of controlling the spraying mechanism. A tank containing pesticides, a sprayer, and a DC motor guide the robot to spray the pesticides in specified spray area make up the spraying system. The DC motors are controlled electronically by microcontroller via L293D driver, which gets input signals from RF module on the robot's underbelly. The DC motor is turned on and off in response to signal, allowing for selective pesticide spraying on plants. Injection mechanism contains three pests that are driven into the tank by DC motor for pesticide mixing. Some DC motors apply pesticides to a specific illness that is detected using image processing techniques. This Aigamo robot has two revolving rubber brushes on its underside that oxygenate the air and prevent weeds from growing. It's a robot system to manage crops, as well as to identify and monitor crop diseases and herbicides.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/41

Droplet distribution and phytotoxicity of commonly used pesticides in rice using Unmanned Aerial Vehicle (UAV)

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ABSTRACT

The application of the pesticides is inevitable for pest management. In India, the pesticides are generally sprayed using the manual which is both difficult and detrimental to one's health due to direct exposure. Manual spraying also results in non-uniform spraying and below par pest control performance. Rice receives 26-28 % total pesticides sprayed in India (highest on any crop). Pesticide spraying operation in the rice crop is most tedious. In order to meet labor shortage and to avoid pesticide exposure, the future of rice crop management including pesticide spraying has to be standardized with mechanization/advanced equipment like UAV or Drone. Also, there is no crop-specific SOP for rice, hence, we have undertaken a study on droplet distribution and phytotoxicity for commonly used pesticides in rice using Unmanned Aerial Vehicle (UAV). Droplet distribution parameters were studied using water sensitive papers (WSP) by placing top and bottom of crop canopy. For phytotoxicity, rating scale of 0-10 was used based on crop response or injury. UAV model GA-03-CA-02 was used for pesticide spraying. Total five pesticides belonging to WG, SC and SG formulations were used. In case of manual sprayer, higher coverage (17.84%) and deposition (1.88 µL/cm^2), number of deposits (50.90/cm^2) were observed on top of the canopy than the bottom (1.11%, 0.26 µL/cm^{2}and 6.21 /cm^2). The bottom of the canopy were better exposed to spray liquid (3.53 to 6.73% coverage; 15.03-132.33/cm^2 and 0.24-0.91µL/cm^2) when pesticides are applied through UAV compared to manual spraying because of the thrust that was generated during the operation. For all the pesticides tested, no phytotoxicity symptoms were recorded. Hence, in order to have better spray coverage and deposits per unit area with least spray liquid, UAV's are better suitable. The research results would provide some technical supports for pesticide spraying in rice.

Theme - III : GenNext technologies for pest management

ADJNS/TH-III/LT/42

T3SS effectors of *Xanthomonas oryzae* pv. *oryzae* vs rice: Understanding for bacterial blight management

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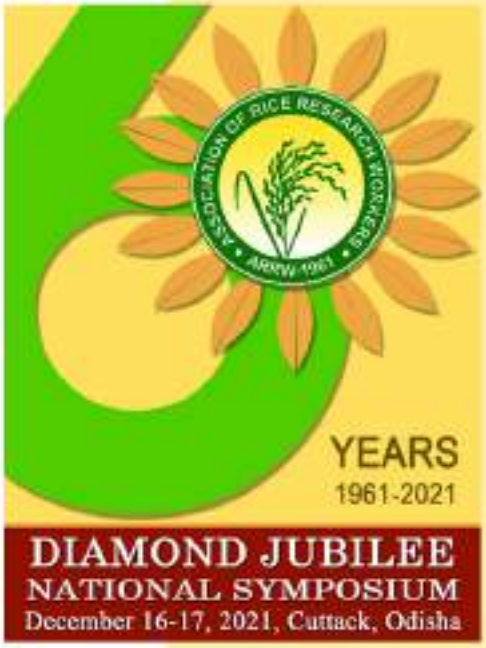
ABSTRACT

The rice bacterial blight (BB) pathogen *Xanthomonas oryzae*pv. *oryzae* (Xoo) employs T3SS-effectors to subvert rice PTI for its unlimited proliferation inside the host plants during disease development. We screened T3SS-effectors repertoire of a virulent Indian strain Xoo race 4 and found that race 4 contains 21 Xopand 18 TALE effectors. Among TALEs, both complete (tTALEs) as well as incomplete/pseudo/iTALEs are identified. The functional analysis based on loss-and-gain of effector revealed that two namely,XopF and XopR contribute immensely during BB development. Xoo mutants(XooΔ*xopF*orXooΔ*xopR*) showed significantly reduced ability for *in planta* colonization, BB intensity but induced more callose deposition. Xoo mutants caused significant fold increase in rice PTI marker transcripts. The both the effectors localize to plasma membrane. We identified two rice interactors for XopF, namely photosystem-I reaction subunit V (PSI-G) and cyclophilin II. PSI-G interacts with many proteins of photosystem I,while cyclophilin II associates with proteins involved in protein-folding, signal transduction and ubiquitination. This suggests that XopF interacts with the two interactors to fulfil its common goal of subverting the plant immunity, either through interfering photosystem I or through destabilising plant immune protection system like cyclophilin. Altogether, this insight into the Xoo-effectors vs rice exposes novel target gene(s) in rice for their sensible exploitation in BB resistance programme.



Theme IV

Rice for Livelihood Security, Equity and Profitability

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/1

A Study on Sustainable Agribusiness of Rice through Co-operative Marketing.

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ABSTRACT

The rice production in India has been significantly increased from 1024.86 LMT in the year 2015-16 to 1146.38 LMT in 2019-20. As per data given by Union Minister of State for Consumer affairs, food and public distribution (www.pib.gov.in) dated 12th February 2021. It is also observed that only 519.97 LMT was procured for central pull for public distribution. This clearly shows that there is ample scope of agri-business of the sustainable crop rice through other agri-marketing channels. In this regard this study is an attempt to explore the potential profitability of rice through cooperative marketing. The study is important as it is facing the challenge of the constraints regarding market functions such as procurement, primary processing(mostly in case of per boiled rice), the distributions with respect to primary market, intermediate market and retail market. On the other hand it is observed that in some areas of the state West Bengal where the Primary Agricultural Marketing Societies(PAMs) are well developed and the cooperative market is also established, the transport and other essential contacts are also increased. The state West Bengal is purposively selected for this study since this state is the second highest producer of rice. This study also aims at the export possibility of agri-business of rice by demand forecasting. The study is based on both secondary data from government sources and primary data collected from selected sample PAMs. Data collection from primary sources is done by using Delphie method from the selected stake holders. The various activities of different market functionaries were also studied. Cooperative storage facility at an affordable rate to the producer is a prime consideration of the agri-business to be successful. This reduces the cost of storage significantly. Realizing this, the National Cooperative Development Corporation (NCDC) encouraged cooperatives to construct more storage facilities since 2000-2001. This was conducted both in rural level and market level.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/2

Effects of changes in paddy procurement policy in West Bengal - some preliminary insights

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ABSTRACT

West Bengal is the topmost rice producing state in India. West Bengal Government procures paddy under Decentralized Procurement System (DCP). A policy of one farmer, one registration and one bank account is in force under DCP for procuring paddy from farmers. As per the initial notification in 2019-20Kharif Marketing Season (KMS), one farmer was eligible to sell upto 45 quintals per hectare of paddy. But as per later notification dated 27-4-2020, irrespective of land records, a farmer was eligibleto sell up to 90 quintals of paddy onlyfor the entire KMS. The same policy i.e a maximum of 90 quintals per farmer was implemented in 2020-21 KMS also.It was anticipated that this policy change will increase opportunity to large number of farmers for participating in DCP program. Accordingly 22.68 lakh farmers benefitted from the DCP operations in 2020-21 compared to 14.21 lakh in 2019-20 KMS. However the quantity of paddy procured in 2020-21 declined to 453.61lakh quintals compared to 485.83 lakh quintalsin 2019-20 KMS, despite of 2.92 percent increase in Minimum Support Price of paddy. Consequently average quantity of paddy procured per registered farmer declined to 20 quintals in 2020-21 KMS compared to 34.18 quintals in 2019-20 KMS. In 2020-21 KMS, 81 FPO/FPCs were registered under DCP. Under the DCP system, rice mills needs to get empanelled for participating in Custom Milled Rice (CMR) program and has to enter into a contractual agreement with Food and Supplies Department by furnishing bank guarantee.In 2020-21 KMSnumber of slabs for bank guarantee in the case of millers for getting empanelled under Government paddy procurement program (based on processing and holding capacity of rice mills), increased to eight (compared to four in 2019-20). Further in 2020-21 marketing season, incentives in terms of higher paddy quantity allotment were announced for the millers submitting bank guarantee early. However only 608 mills participated in DCP in 2020-21 KMS compared to 649 in 2019-20 KMS.Thus policy changes coupled with Covid-19 situation led to more participation of farmers, less participation of rice mills and 6.63 percent decline in total paddy procurement under DCP in KMS 2020-21 compared to KMS 2019-20.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/3

Rice Based Integrated Farming Systems: Profitable Entrepreneurship for Livelihood Security under Konkan Region

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ABSTRACT

Agriculture in India has been, and will continue to be so, in near future, the back bone of Indian economy.With the help of minimum resources, India has achieved the food security goal by increasing the production of agriculture and allied sectors. However, the strategy did not explicitly recognise the need to raise farmers' income, nutritional security and to promote farmers' welfare. The efforts in production in agriculture could be converted into income only if the reasonable price is realized. This might be happen by considering agriculture as a business. In this context, integrated farming system (IFS) is most important to convert sustenance/ traditional farming into sustainable and profitable entrepreneurship mode by incorporation of various modules specially small and marginal farmers. IFS is a powerful tool; it holds the key for ensuring income, employment, livelihood and nutritional security in a sustainable mode Konkan region of Maharashtra is distinguished by virtue of its distinct agro-climatic conditions, soil types, topography, crops and cropping systems, food habits, livelihood and socio-economic conditions etc. from rest of Maharashtra. This region comes under high rainfall zone; rice is major staple food crop during *kharif* season. There is limited scope during*kharif* however, substantial scope to other crops during *rabi* season. Besides agriculture, horticulture, nursery, fisheries, livestock sector is equally important enterprises supporting as income source and employment generation to the farming community. Integration of all the enterprises along with the natural resources is the growth engines for Konkan agriculture. Considering all these parameters and farmer's needs, study has been takenfor development of an ideal integrated rice basedfarming system model for small and marginal farmers on an area of 1.00 ha for 6 family members at Regional Agricultural Research Station, Karjat, Dist. Raigad under All India Co-ordinated Research Project on Integrated Farming Systems. The average of six years data showed that the total production of 47.09 t REY. In terms of economic returns, the gross and net returns were Rs. 7,15,957/- and Rs. 2,10,553/-, respectively withbenefit : cost ratio 1.42 and employment generation of 1085 man days which contributed 40.53 % in the total cost of production. This model gave year round income to farmers. The annual production of this IFS model was surplus for cereals, oilseeds, milk, fruits and vegetables commodities. This recommended model would turn into profitable entrepreneurship for income generation, livelihood and nutritional security to farmers of Konkan region of Maharashtra.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/4

Management of combined harvested straw by development of a tractor operated straw chopper cum seeder

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ABSTRACT

In Odisha, 12 lakh hectares area fall under Rice-fallow system which offers huge scope for pulse cultivation provided effective technology is made available. Introduction of tractor operated zero till drill for line sowing pulses under residual moisture in Rabi season following Kharif paddy has been successful but for the combined harvested fields due to clogging of straws in tynes in an estimated total combine harvested area of 7.54 lakh ha in the state.Straw burning being the easier option at this instant for the farmers to get their field free for land preparation and sowing pulse seeds thereafter, the environmental pollution has been the major concern apart from degradation of soil, and destruction of micro-organisms in the soil due to rise in soil temperature. Delay in land preparation also hampers sowing and prohibits pulse crop production; thus, the rice-fallow area increases adding further problems. A Tractor operated Straw Chopper cum Seeder was designed and developed with fluted roller metering mechanism for metering of pulse seeds, Y shaped flails arranged on periphery of a hollow shaft for chopping straws and zero till tynes for opening furrows simultaneously by which chopping of combine harvested left over straws and line sowing of pulse seed in furrows made by inverted 'T' type zero till tynes are accomplished simultaneously.The designed straw chopper cum pulse seeder with a hopper of 30 kg capacity (green gram) was attached with inverted-T type furrow openers (5 nos.) to place seed at desired depth and spacing (30 cm). The chopping unit was developed to chop and shred both standing and loose straw using inverted-Y type flails and could handle a peak straw load of 10.25 t ha^{-1} and a forward speed of 2.50 km h^{-1}. The total power required (drawbar and PTO) to operate the machine is around 42.3 hp. The average field capacity of the implement was 0.286 ha h^{-1} at 2.25 km h^{-1}. The cost of operation of machine was 919 Rs h^{-1} and Rs. 3064 per ha and was lower than conventional methods (rotavator + seed drill and Cultivator+ broadcasting + rotavator) by 18.41 and 16.13%.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/5

Economic Viability of Paddy Farming in Major Indian States

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ABSTRACT

The objectives of the study is to analyse the component wise input intensity, the value of output& profitability among the major paddy growing states like, Andhra Pradesh, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal; collecting information for the year of 2004-05 to 20015-16 crop years from the portal of Ministry of Agriculture, Cooperation and Social Welfare, GoI. Deflating both the farm harvest prices (FHP) and minimum support prices (MSP) at 8 Per cent opportunity coat of capital, a comparison have also done over 12 years period of above mentioned states to get a picture of real increments over the base year of 2004-05. The application of fertilizers are increasing and for other major inputs are decreasing over time but the animal & human labour are decreasing with higher rates; on the other hand the cost incurred for the inputs are increasing except animal labour. Only in UP, the cost of animal labourare still increasing. The paddy growers of Punjab and Andhra Prodesh received positive net returns and in West Bengal farmers received negative returns over total cost basis throughout the study period. The return cost ratio over total cost were greater than one from 2007-08 to 2015-16 almost all the states except in West Bengal. An attempt had also been made from the primary data to judge the economic viability of seed agripreneurship development with processing unit at village level, where the B-C ratio(2.41) @ 10 per cent opportunity cost and FRR(41 Per cent) discerned higher amount to repay the credit& sufficient margin for borrowed fund by the rural youths in seed village scheme for seed replacement and to mitigate the problems of high volume low cost quality seeds in time. The coordination among different organistions, like the state agriculture department, financial institutions, RRS of Universities &KVKs may play better role to judge the efficacy of existing HYVs and supply of foundation seeds to the potential growers for the reduction of cost of cultivation as reveled from the perceptions of growers.

ADJNS/TH-IV/LT/6

Genetic Variability and yield analysis in rice

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ABSTRACT

By 2050, to feed the growing human population the food production requires to be doubled. Land resources are decreasing due to salinity, drought and many other abiotic stresses. Capricious behavior of climate leads to evolution of new pathotypes, and insect-pest activities, and is changing the physiological rhythm of crop plants. Under such situation breeding of rice, a major food staple, will continue to play a major role to overcome this enormous challenge. Presence of Genetic variability is one of the main prerequisite of any breeding programme. Studies were conducted in a population of rice comprising 45 diverse genotypes for thirteen morphological characters. Characters with high genotypic and phenotypic coefficients of variation (GCV and PCV) with high heritability along with high to moderate genetic advance for flag leaf area, plant height, panicle number, secondary branches, spikelet number, and filled grains per panicle, and straw and grain yield per plant indicated the predominance of additive gene action for the expression of these characters. Grain yield was found to be positively and significantly correlated with flag leaf area, primary and secondary branches, spikelet number, and filled grains per panicle, test weight, and straw yield at both genotypic and phenotypic levels indicating these characters are important for improvement of grain yield. The results of phenotypic and genotypic path coefficient analyses indicated that selection of higher flag leaf area, straw yield, primary branch, and filled grains per panicle and with a reasonable balance for moderate tiller number, test weight, and panicle length would increase grain yield in this population**.** Genetic divergence following Mahalanobis' D^2 analysis grouped these 45 genotypes into seven clusters. Test weight (37.98%) and days to 50% flowering (32.22%) contributed maximum towards divergence. Selection of parents from within and between clusters for initiating cross-breeding programme has been suggested.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/7

Rice based food entrepreneurship development of women farmers

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ABSTRACT

The promotion of women's entrepreneurship through women's collective action (cooperatives, SHGs, FPOs) offers a unique opportunity for their economic, social and technological empowerment. Micro, small and medium-sized enterprises have been recognized as a crucial way to promote women's economic empowerment. In order to transform women farmers' into entrepreneurs, it is imperative to provide them access to credit, technology, skills in enterprise management and product and market information. Women farmers can be provided technical knowledge and skills for taking up entrepreneurship in the production of nutritionally enriched rice varieties(high zinc, protein, low GI).Value added products from nutritionally enriched rice varieties(infant foods, snacks, energy bar) can be prepared and marketed as health products by the women's SHGs. These products can be incorporated in the supplementary feeding programs and mid-day meals for school children. Gluten free foods are gaining traction in our country and with appropriate training women can prepare ready to eat/ ready to cook products from popular rice varieties. The consumers' willingness to pay a premium for biofortified rice variety and high sensory acceptability (DRR DHAN45) indicates the readiness of consumers' to accept these rice varieties (Amtul et al. 2019 and2021).The rice byproducts have multifold contribution to food sustainability asbioactive compounds and nutrients can be extracted from rice bran and husk for use in health foods and are a source of indirect income generation (Iriondo-DeHond et al., 2018). Brown rice is being included in the daily diets by health conscious consumers but faces some resistance due to longer cooking time and hard texture. Germinated brown rice products are an alternative to brown rice and are also nutritionally superior due to higher concentration of bioactive compounds .Therefore, women's entrepreneurship based on product development from these rice varieties and rice by products offers a great potential as highly complex skills and infrastructure set-up is not necessarily required to set up a rice based food enterprise.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/8

On farm testing of Drought tolerant paddy varieties in Tiruvallur district

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ABSTRACT

Drought is the major yield limiting factor for rainfed direct sown paddy cultivated in about 1500 ha in Tiruvallur district.Paddy crop raised in dry direct sown condition is rain fed in the initial stages and is tank fed in the later stages with the availability of monsoon rains. Early season drought is more prevalent in these areas though mid and late season drought is also occasional. Majority of the farmers cultivate BPT 5204 and ADT 37 which are susceptible to water stress, pest and diseases and experience severe yield losses. Paddy varieties with drought tolerance and high yield with resistance to major pest and diseases and also have good acceptability in the market need to be assessed. Hence the present study was undertaken to assess suitable drought tolerant varieties for Tiruvallur District. The paddy varieties CO 53 (TNAU, 2020) and CR Dhan 205 (CRRI,Cuttack,2014) were assessed by KVK, Tiruvallur under rainfed direct sown conditions in Thadur and Agoor villages of Tiruttani block during Rabi, 2020. CO 53 was earlier in duration (105 days) compared to CR Dhan 205 (112 days). Both the varieties show drought tolerance capacity and withstand drought upto 15 days during vegetative stage. CO 53 also has short bold grains similar to the check variety ADT 37 and hence both the varieties fetch same market price, while CR Dhan 205 has medium slender grains and hence fetches better market price compared to CO 53. While comparing the yield potential of both the varieties, CR Dhan 205 gave higher grain yield of 51.7 quintals/ha and CO 53 yielded 49.4 quintals/ha which was 11 per cent and 7 per cent higher than the check variety ADT 37 respectively. CR Dhan 205 gave higher Net income of Rs. 37650/ha with BC ratio of 2.12 in comparison to CO 53 which gave Net income of Rs. 23375/ha and BC ratio of 1.73. Hence CR Dhan 205 was found to be suitable for rainfed direct sown conditions of Tiruvallur district.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/9

Laying experiments in rice using structurally incomplete Generalized Row-Column Designs (GRCD) through web based system

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ABSTRACT

The rapid advancement of the internet technology has expanded the use of statistical packages for the analysis of data and sharing the findings with researchers quickly and conveniently. Designing an experiment is an important to draw valid inferences from the data generated from experiments keeping in view the objectives of study and hypothesis to be tested. Block designs are used when the heterogeneity present in the experimental material in one-direction. However, when the heterogeneity present in the experimental material in two directions, then row-column designs are used. Designs used for the above situations are termed as Row-Column Designs (RCD) or designs for two-way elimination of heterogeneity.However, there may be instances when the number of treatments is substantially large with limited number of replicate then two-dimensional designs called generalized row column designs(GRCDs) with multiple units per cell are used. There are two types of GRCDs,one is structurally complete (SC) GRCD and other one is structurally incompleteGRCD. There are some software available for generation of structurally complete GRCD,but no information regarding any existing standard software either stand alone or web based could be found for generation of structurally incomplete GRCD.Due to their wide use in agricultural experiments and various other fields, web based software for generation of structurally incomplete GRC designs has been developed. It has been developed on .NET framework using C#. Four different series of SIGRC designs can be generated by entering the number of treatments. These designs can be used in rice variety trial for yield assessment in response to other factors associated with the yield parameter. Before experiment, researchers can design their layout of treatments with the help of this web solution for calculation of two wayheterogeneity for multiple treatmentsin research plots. If some treatments are missing for biological experiments in lab conditions these structurally incomplete GRCD designs can be used for planning of laying out of the experiments without losing variability component in the plots.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/10

System of Rice Intensification (SRI) for higher production and releasing unsuitable areas in Tripura state

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ABSTRACT

System of Rice Intensification (SRI) was introduced with an intention to find sustainable agricultural practices that can lead to higher productivity, optimum use of capital, labour, lower requirement of material inputs and less consumption of water. A rapid increase in rice productivity throughadoption of SRI in Tripura, more rice can be grown from the same area and there is a scope too for shifting unsuitable areas to other crops. Variety wise analysis of yield data collected through primary survey indicated that the new hybrids like Arize 6444, Rajalaxmi, PHB 71, KRH-4and VNR-2111 have shown promising results under SRI method of cultivation. Trend of growth in area (79.82***), production (82.48***) and yield (1.66***) under SRI since 2002-03 to 2015-16 using 3 years moving averages were significant, however, there was a slight reduction in the percentage coverage of SRI to total rice area for last five years, which might be due to the reasons that farmers' were shifting their areas to grow high value crops to meet their higher income expectations.SRI is found to be an integrated agro-ecologically sound approach in case of irrigated rice, which reduces the costs of production and at the same time, raised the output. There is increasing evidence that SRI principles and practices can offer an environment–friendly strategy for sustainable agriculture, with appropriate modifications as per local conditions. Therefore, more incentives and subsidies can be provided to farmers' for continuance of the SRI practice for sustaining their livelihoods.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/11

Participatory, equitable and market targeted transfer of technology- A study on Varietal Cafeteria and its widespread reach for impact in strengthening seed system and adoption of new varieties in Eastern India

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ABSTRACT

Role of improved crop varieties in ushering productivity is very well recognized since the green revolution era. However, acceptance of improved crop varieties along with better agro-techniques through different extension and training programmes has been rigorously advocated, yet the large-scale adoption and operative visibility remain an existing gap. One factor of this slow adoption rate is that farmers do not directly visualize the significant advantages and benefits over existing one which correspond to 'seeing is believing' leading to secure livelihood and enhanced profitability. Apart from that, a varietyneedsa robust positioning in the seed chain calling for acceptance by not only farmers but other key influencers from market and policy domain. Again, the farmer perception, preference remains diverse based on their ecosystem, gender, socio economic background which must be captured and catered to, in an equitable and inclusive manner. Therefore, for disseminating the significance of improved technology as new varieties with best bet crop management practices among the farming community a concept of Client Oriented Rice Varietal Cafeteria is idealized and implemented. This market inclusive concept showcases diverse improved varieties (abiotic/ biotic stress tolerant; Premium Quality; Biofortified; Traditional etc.) along local grown cultivars laid with scientifically valid replicated trial design. Crop cafeteria designed by IRRI provides an opportunity to witness relative performances of diverse rice varieties, having different maturity period, performance dependent traits and ecological fitment. The VC engage private and public seed sector players, and their market channels actors like distributors, dealers, FPOs, associated agro-vets/extension agents and the farmers through participatory evaluation process at the time of synchronous maturity time. This study analyzes how these platforms are creating sex disaggregated data on trait preferences, rankings, stakeholder trait preferences, varietal visibility/awareness, institutional and multi actor linkages for scaling. Meticulous management, analysis and plotting of Big Data harvested as qualitative (from wide stakeholder) and quantitative (data enumerators) on trait performances indicate the best fit and preferred rice varieties of a specific geography. This helps in establishing linkages between formal and informal seed systems and stabilizes seed supply chain management through mapping and managing varietal demand and supply. The evidence-based participatory evaluation from key stakeholder also provides breeders with helpful information on trait preferences for further varietal improvement. Rice varietal cafeteria findings also provide insightful guidance for policymakers to advocate for seed and varietal replacement. The steady increase in procurement of breeder seed and multiplication of many climate resilient varieties, such as Sahbhagi Dhan, BINA Dhan 11, CR 1009 Sub-1, DRR Dhan 44 by both public and private seed agencies of the targeted geography marks the significant and strategic success which is the result of such efforts and consequential linkages.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/12

Promoting vegetablecultivation and empowered marketing:A focus on entrepreneurial competences

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ABSTRACT

Entrepreneurship abilities are one of those competencies that is necessary to achieve desired goals and accomplishments associated to the farm business. Recently, there has been a substantial highlighting on diversification of farm enterprises towards horticulture (vegetables, fruits, medicinal & aromatic plants, ornamental crops, and spices), plantation crops (cashew nuts, coconut and cocoa) and allied activities. Establishment of critical infrastructural facilities like cold chain, quick transit, grading, processing, packaging and quality control methods provided prospects to invest. A project on ''Leveraging Institutional Innovations for Inclusive and Market led Agricultural Growth in Eastern India'' was conceived and launched during December 2019 at Kandha village of Badamba block, Cuttack district, Odisha with the major aim of identifying and executing critical intervention points for the improvement of farmers'-based institutions for enhancing income of farmers.

During the 1st year, a mini-cold storage structure created with the storing capacity of around 10 tons along with weigh balance, to provide an edge to the vegetable farmers to hold up the produce, if the market is unfavourable. To start with field interventions, eleven farmers have been provided with sweet potato vines (12000 cuttings) of high yielding 'Bhukrishna' variety developed by ICAR-CTCRI, Bhubaneswar. Seed-kits of improved variety vegetables like brinjal, chilli, beans, pumpkin, onion, okra, etc. were also distributed among the interested farmers and bio fertilizers viz. Mycorrhiza, phosphorous solubilizing bacteria, Azotobactor, Azospiriulum and Microphos have been distributed among 20 farmers for using in existing vegetable crops. By experiencing the success during 1st year, farmers demanded further support and vegetable seeds of improved varieties like Toco

Theme - IV : Livelihood security, equity and profitability

Hodge1195 and Toco To-017 of tomato, Beco Serengeti variety of beans, Little champ variety of bitter gourd, Cuco clara variety of cucumber, etc. were distributed to 30 farmers.

Earlier farmers were selling their produce mostly to the middlemen compromising price and even quantity rebate. Anticipating that knowledge-based institutions can put right the marketing pattern and create awareness, a Village Agricultural Knowledge Centre (VAKC) has been formed on a rented room and equipped with Computer and audio-visual facilities. The VAKC provided latest information on prices of agriculture produce to farmers as well as awareness about different *yojanas* and schemes of central and state government. Farmers are meeting together frequently to discuss emerging issues, to get updated knowledge online as well as from various institutional sources. Many training programmes were conducted at the project village covering the cultivation of summer vegetables and gave detailed account on varieties, sowing/ transplanting, plant protection, soil type, essential nutrients for soil, optimum soil management, soil health testing and many more important aspects, which are essentials for vegetable cultivation. Marketing insights were provided through discussion on training on aggregation, storing, standardization, grading, etc.

Using time-series data, the price of onion forecasted using the models ARIMA and ARIMA-GARCH. Further, real time data collected from authorized sources, validated with forecasted prices and disseminated through VAKC at the village and through social media. As the farmers were organized earlier with a Farmer Producer Company (FPC) for paddy seed production, adding vegetable farming helped them in raising their income further due to aggregation of operations.Collection of feedback from beneficiary farmers indicated that they have shifted to practice of using improved cultivars instead of local varieties of vegetables. However, they seek support for large-scale cultivation, infrastructure for storage, standardization, grading and transport to market with higher margin of profit.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/13

Leveraging Village Agri-Knowledge Centre for Market Empowerment of Small Farmers: A Case Study

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ABSTRACT

Agricultural markets serve as the first point of contact between the farmers and traders and/or farmers and consumers. Agricultural marketing system in Eastern and North-Eastern states is distinctly different from that of other states in terms of size, infrastructure and the major problems encountered by the farmers of this region are absence of organized marketing institutions and infrastructure, lack of wholesale markets, lack of access to market information, lack of storage place, lack of knowledge on standardization/grading, lack of institutional credit availability, lower price realization, etc. Anticipating that knowledge-based institutions can mendthe marketing organization,a Village Agricultural Knowledge Centre (VAKC) has been formed for dissemination of weather data as well as providing timely information on agro-climatic conditions and market details. The VAKC provided latest information on prices of agriculture produce to farmers. It has also been proved as a beneficial structure for creating knowledge and awareness about different *yojanas* and schemes of central and state government. As the farmers were organized earlier with a Farmer Producer Company (FPC) for paddy seed production, adding vegetable farming helped them in raising their income further due to aggregation of operations. Demonstration has been conducted to encourage organic farming, sustainable agriculture, vermicomposting etc. and about 300 farmers received farm inputs (seed, seedlings, vine cuttings, bio-fertilizer, etc.) from ICAR-NRRI, Cuttack regularly. Collection of feedback from beneficiary farmers indicated that they have shifted to practice of using improved cultivars instead of local varieties of vegetables. Further, discussion, training and providing information through social media and other means, they become empowered and attained with bargaining capacity in transaction of inputs and produce.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/14

Income and employment generation through eco-friendly utilisation of rice straw for production of mushrooms and vermicompost

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ABSTRACT

In order to make the rice production system viable and increase the income and profit in rice cultivation, the by-products of rice crop are to be reused and recycled efficiently. In India, rice straw which is the major by-product of production is to be around 220 million tons. Lack of feasible options of utilisation of rice straws, the rice straws were subjected to burn on field. This open field straw burning has negative environmental effects including greenhousegasemission and air pollution. Economically utilization of paddy straw will add additional income and scope for employment generation to rice farmers.So, the available paddy straw can be used as a substrate for production of different species of mushroomwhich is called as a nutritional food for the poor people and can be considered as one of the cheapest and economically viable biological processes to convert the organic residues as human food.

By considering the fact, training cum demonstrations of paddy straw mushroom were conducted in four adopted villages namely Biswanathpur, Satyanarayanpur, Laxminarayanpur and Ganeswarpur of Salipur block, Cuttack District during 2019-21 under the project 'Increasing productivity and sustaining the rice-based production system through Farmer FIRST approach'.Mushroom intervention was targeted to educated rural youth and farm women. Critical inputs like mushroom spawn, gram floor, and polyethylene were provided to about 100 farmers. Farmers got an average yield of 0.6 kg to 1.5kg per bed in just 12-14 days. The yield and profits from mushroom cultivation encouraged the unemployed youths to undertake mushroom cultivation as commercial basis.Five numbers of youths/farmers developed their own mushroom units taking technical and inputs supports from the project. Among them a farmer, named Shri Ranjan Kumar Behera from villageBiswanathpur has successfully established as entrepreneur in mushroom production. He has growntotal 4000 beds of paddy straw mushroom per annum by taking 25 beds per day for 160 days in a year. He has produced about 20-22 kg of mushrooms and got net income of Rs 1500-1660/ day with a Benefit: Cost (B:C) ratio of 1: 2.26. Through mushroom production, he has generated 150-160 Man days/annum. Besides, he has utilised the mushroom spent for vermicompost production and produced 15ton of vermicompost per annum which helped him for gainful management residues to valuable farm inputs.The learnt lesson is that a mushroom farmer can earn a net additional income of Rs. 28,000-30,000 per month by growing 25 beds /day for 160days and vermicomposting 2 beds for 3 cycles/ annum and more importantly can contribute to massive reduction in environmental pollution caused due to straw burning.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/15

Consumers' Preference on Rice Quality Parameters: A Review Analysis of Researches conducted across the Globe

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ABSTRACT

This review paper is based on the consumer preferences for different varieties of rice across the globe. The research was done on a large scale regarding both intrinsic and extrinsic qualities of rice like grain colour, size, aroma, shape, stickiness, appearance, nutrition, source and price etc in relation to various parameters like socio-economic status, age, gender, location, education and lifestyle etc. It was found that the preference of consumers varied on a wide range. In Asia, where rice is the staple food in most of the countries, the consumers preferred more for 'long slender basmati rice and partially milled red colour raw rice' like in Sri Lanka, while consumers of Thai countries were more concerned about rice aroma (jasminization) and stickiness etc. In most of the African countries, the preferred attributes were taste, cooking quality, cooking time and aroma. The attributes which are least preferred by consumers were price, impurities and source of rice. In European countries, where rice is not the staple food, but traditional European rice, which is distinguished for its aroma, stickiness, texture, nutrition and flavour,was most preferred among the rice consuming European countries like Italy. In India, rice is preferred by consumers on different parameters, like consumers of North Eastern states gave more preference to nutritional value and non-toxic environment-friendly rice varieties overtheircolour and shape, while consumers of Southern states preferred polished rice over brown or unmilled rice and gave more choice to grain appearance and cooking quality.

Analysis of researches conducted in Odisha revealed, high income group of urban population changed their perception about health and lifestyle and more tilted towards Traditional Aromatic Rice Varieties (TARV) which is healthier and chemical free. From the analysis of various research studies on consumers' preference, it can be concluded that rice physical attributes are considered more by major segment of people over its nutrition due to lack of awareness on rice bio-fortification, high price of fortified or organic rice and its long cooking time. Urban people and high-income group prefer traditional or organic rice over extrinsic traitsof grains. So, futurerice breeding strategy, crop improvement programmes and market segmentation should be done based on the consumers' preference criteria.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/16

Estimation of Growth Rate and Decomposition Analysis of Area, Production and Yield of Rice in West Bengal

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ABSTRACT

West Bengal is the highest rice producing state in India with production of 15.8 thousand tons of rice in 5.4 thousand hectare area with the yield of 2.9 tons/ha during 2019-20. In West Bengal, the rice area was increases 1.2 times, production was increased 2.9 times and yield was increased 2.5 times during last sixty years. Hence, it is vital to study the growth rate and contribution of factors in the production of rice for different district of West Bengal. Therefore the study has been planned with the objective of estimation of growth rate and decomposition analysis of rice area, production and yield of rice in different districts of West Bengal. The district wise data on area, production and yield of rice of West Bengal from 1983-84 to 2016-17 collected from Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India has been used in the present study. The data has been divided into four decades and decade wise growth rate and decomposition has been estimated. Its' highest positive growth ratefor area was observed in Purulia district during 2010-11 to 2016-17 and most negativegrowth was observed for Darjeeling during 1990-91 to 1999-2000. For rice production, the highest positive growth ratewas observed in Nadia district during 1983-84 to 1989-90 and lowest growth ratewas observed in Darjeeling during 1999-2000. For rice yield, the highest growth rate was observed in Midnapore (West) and lowest growth rate was observed in Darjeeling during 1983-84 to 1989-90. The contribution of area and yield in the production has been computed using decomposition analysis.It was observed that during first decade (1983-84 to 1989-90), highest contribution was observed for Darjeeling for area and lowest contribution was observed in the same district for yield. During second decade(1990-91 to 1999-2000), highest contribution was observed in Malda for yield and lowest for area in the same district. During third decade(2000-01 to 2009-10), highest and lowest contribution was observed in Dinajpur (South) for area and yield, respectively. During the fourth decade (2010-11 to 2016-17), highest and lowest contribution was observed for area and yield, respectively in Burdwan district. The growth rate of area, production and yield was positive for most of the districts.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/17

Up-scaling of Water Saving Technologies in Rice Cultivation to Reach the Unreached sector in Rural Areas.

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ABSTRACT

The most staple and principle food crop of Tamilnadu state is Rice and the crop consume large amount of water during its growth and the water use efficiency is low in comparison to other field crops. The promising techniques were on water saving in rice advocated and popularised among poor land holding farmers in rice growing locations and awareness created among rural farmers through IOCL funded project titled 'Implementing Water Saving Technologies for Sustaining Rice Production in Villupuram District of Tamil Nadu'with key objective of reaching the unreached and to improve the water usage efficiency, grain yield and livelihood by implementing water saving technologies for sustaining rice production in the villages through conduct of field demonstrations and dissemination of water saving technologies in System of Rice Intensification (SRI), Alternate Wetting and Drying Irrigation (AWDI) and Direct Seeded Rice (DSR) in rice crop cultivation.

Increase in the grain yields obtained with water saving technologies in rice crop made the farmers confident and paved way for its adoption in rice cultivation in theDistrict through demonstrations and capacity building programmes.The results from the demonstrations conducted, revealed that the conventional planting system recorded water requirement of 1200 - 1390 mm, 940 mm -1050 mm in SRI, AWDI recorded 850 mm -1150 mm and Direct Seeded Rice (DSR) 950-1100 mm 75 demonstrations in System of Rice Intensification (SRI), 75 demonstrations in Alternate Wetting & Drying Irrigation (AWDI) and 50 demonstrations in Direct Seeded Rice under puddle condition (DSR) conducted with impact area of 145 hectares and 1000 beneficiaries.Demonstration on SRI with target area of 125 acres and impact area of 270 acres;AWDI with target area of 125 acres and impact area of 286 acres and in DSR it had target area of 60 acres and impact area of 124 acres being achieved through this project.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/18

Morphological and Physicochemical Characterization of temperate Rice (*Oryza sativa* L.) Germplasm

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ABSTRACT

Morphological and physicochemical characterization of rice (*Oryza sativa* L.) germplasm is fundamental in order to provide information for trait based breeding programmes. Present study was conducted during *Kharif* 2019 with the objective to characterize51 elite germplasm lines representing different sub-species of rice with respect to morphological and physicochemical traits. The data was analyzed to estimate various descriptive statistics, variability and diversity analysis. All morphological and quality descriptors showed remarkable differences in their distribution and amount of variations within them. The analysis of variance indicated existence of considerable amount of variability for all observed characters. The high amount of genotypic and phenotypic coefficient of variation was observed for grain yield, biological yield and kernel length breadth ratio before cooking. Similarly, for physicochemical traits high amount of genotypic and phenotypic coefficient of variation was observed for gel consistency followed by alkali spreading value. High estimate of broad sense heritability along with high genetic advance was observed for grain yield and biological yield viz-a-viz for kernel length breadth ratio after cooking. Likewise, for quality traits, high estimate of broad sense heritability along with high genetic advance was observed for alkali spreading value and gel consistency. Further, the clustering of genotypes on the basis of 28 traits using Mahalanobis D^2 statistics grouped the genotypes in ten clusters. These results reflect the high genetic differentiation existing in the rice germplasm set. In addition the association analysis revealed that the grain yield was positively and significantly correlated with days to 50 % flowering, days to maturity, number of effective tillers per plant, plant height, biological yield, indicating their strong association with grain yield andthus selection for these traits could prove quite useful in improving grain yield.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/19

High spikelet numbers, a valued parameter for varietal popularity among farmers in Odisha

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ABSTRACT

Factors deciding the popularity of rice varieties among the farmers is crucial for rice improvement programs. In Odisha, understanding the yield and related traits relation with varietal popularity would assist in development of farmers preferred new varieties. This analysis requires comparison of popular rice varieties grown by the farmers to that of other released varieties. In this analysis, farmers valued varieties (preferred) of Biridhi block, Jagatsinghpur district of Odisha was collected and analysed with other released varieties for the traits namely number of panicles per plant, total number of spikeletsper panicle and single plant yield. It was found that in varieties preferred by farmers, no of panicles per plant are 21.68% lesser than other released varieties whereas no of spikelets was 24.83% higher in farmers' varieties. Further regression analysis between number of spikelets per panicle and yield of farmers valued varieties also showed positive association indicating number of spikelets per panicle is the major yield related parameter determining the yield of the farmers valued varieties in Odisha, India. Further, favourable alleles of spikelets per panicle in farmers valued varieties could be exploited for rice improvement.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/20

Studies of foliar nutrient application on Productivity and uptake of rabi blackgram

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ABSTRACT

A field experiment carried out at Agricultural Research Station, Brinjhagiri, Chatabar of Faculty of Agricultural Sciences, Siksha 'O' Anusandaha (Deemed to be University), Bhubbaneswar, Odisha during rabi season of 2019 and 2020. The experiment was laid out in randomised block design with eight treatments viz. T1: Control, T2: RDF (20: 40: 20 kg N, P_2O_5 and K_2O ha^{-1}), T3: RDF + 2% Urea spray; T4: RDF + 2% MOP spray; T5: RDF + 2% DAP spray, T6: RDF + 2% NPK 19:19:19 spray; T7: RDF + 40 ppm spray; T8: RDF + 1% Salicylic spray, replicated 3 times. The test variety was Mahuri (OBG 31). The result revelled that foliar application of urea, DAP, MOP, NPK 19:19: 19, NAA and salicylic acid have positive increment over sole RDF. With 2% spray of NPK 19:19: 19 in addition to RDF (20: 40: 20 kg N, P_2O_5 and K_2O ha^{-1}) higher growth attributes were recorded. This treatment also produced the highest yield of 988.4 kg and 1053.3 kg per ha in 2019 and 2020 respectively. The highest NPK uptake was also calculated in the same treatment for both the years. Economically 2% foliar application of DAP along with RDF (20 kg N, 40 kg P_2O_5 and 20 kg K_2O kg ha^{-1}) found to be the best, with a return of Rs 1.85 and Rs 2.02 by investing a rupee for the respective year.

Theme - IV : Livelihood security, equity and profitability

ADJNS/TH-IV/LT/21

Grain size in relation with varietal popularity in Odisha, India

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ABSTRACT

Regression analysis is a statistical approach used to determine the strength and character of the relationship between dependant variables and independent variables. The grain size is the major factor determining the yield and popularity of rice varieties. In this work, rice varieties popularly grown by the farmers in Biridhi block, Jagatsinghpur district, Odisha was compared with other released rice varieties for the parameters namely grain size and single plant yield to understand the relationship of grain size with popularity of the variety. It was found that grain length in farmer's preferred or valued varieties is less than other released varieties by 19%. Further, grain width of farmer's varieties is more than other released rice varieties by 12.8%. Besides, it was found that grain length contributes to 16% and grain width contributes 5% to single plant yield of farmers valued varieties. However, grain length contributes to only 2% and grain width to 0.13% to single plant yield in other released rice varieties. Hence, grain length of released varieties could be increased to enhance the single plant yield.

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