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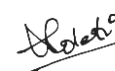
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PREFACE

Under the All India Coordinated Rice Improvement Project (AICRIP) evaluation of varietal improvement, crop production and crop protection technologies across locations has been continuing to contribute towards strategies strengthening rice farmers' efforts towards sustainable rice production. About 400 scientists, belonging to ICAR - Indian Institute of Rice Research, 45 funded and more than hundred voluntary centres of State Agricultural Universities, Departments of Agriculture, ICAR Institutes and Private Undertakings work towards progress of rice research under the umbrella of AICRIP.

This volume reports the salient findings of experimental trials in Entomology and Plant Pathology during 2019. The major goal of Crop Protection programme of AICRIP is to develop a broad based, eco-friendly and cost effective IPM technology which can help in alleviating socio-economic constraints through providing gainful benefits for rice farmers. Emphasis is on ecologically conducive and cost optimizing IPM components such as host plant resistance, ecological engineering and biodiversity, utilization as well as need based application of only safe chemicals. Efforts are underway to build decision support systems for assistance in farmers' decision making.

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



(S.R. Voleti)

Director (A)

March 2020

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TRIALS
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2 Entomology Kharif 2019

SUMMARY

All India Coordinated Entomology Programme was organized and conducted during *kharif* 2019 with seven major trials encompassing various aspects of rice Entomology involving 234 experiments (90.0%) that were conducted at 42 locations (IIRR, 32 funded & 9 voluntary centres) in 22 states and one Union territory. Details of scientists involved in the program at headquarters, cooperating centres and the performance of centres is provided in Appendices I and II.

2.1. Host plant resistance studies comprised of seven screening trials involving 1652 entries evaluated at 42 locations against 11 insect pests. 64 entries (3.87%) were identified as promising.

Planthopper screening trial (PHS) - Planthopper screening trial (PHS) - Evaluation of 120 entries against the two planthoppers BPH and WBPH in 10 greenhouse and 8 field tests indicated 16 entries (including 7 breeding lines *viz.*, KNM 7629, MTU 1305, MTU 1306, MTU 1308, RMS-ISM-Bph33-1, RP 221-3-5-2, RP 179-3-9-1, 4 germplasm lines from IIRR *viz.*, IC 216735, IC 76013, IC 75975 and IC 76057, 2 germplasm lines from NRRI *viz.*, CRCPT 7 and CRCPT 8 and three checks) as promising in 7 to 14 tests. Of these, 6 are in the second year of retesting.

Gall midge screening trial (GMS) - Evaluation of 40 entries in one greenhouse and 5 field tests against 6 populations of gall midge (five identified biotypes) helped in identification of one retested entry, SKL-07-8-720-63-147-182-276 as promising in 3 tests of the 6 valid tests across all the populations. Aganni was promising in 4 tests.

Gall midge special Screening trial (GMSS) - Evaluation of 85 donors against 5 gall midge biotypes in one greenhouse and 6 field tests identified 16 lines as promising in 4 to 6 tests. IIRR-ENT-2019-17 was promising in 6 tests, while 14 pyramided lines (MTU1010 with gm3+Gm4 +Gm8) along with Aganni were promising in 4 tests. Of these promising pyramided lines, six were in the second year of retesting.

Leaf folder Screening Trial (LFST) - Field evaluation of 20 entries replicated thrice in a randomised block design at 16 locations revealed that 4 entries as promising in 3-4 tests out of 9 valid field tests. Two mutant cultures of PTB, Cul M8 and Cul M9 were found promising in 4 of the 9 valid tests while another mutant culture, Cul M6-2 and a selection from landrace Kalluruli were found promising in 3 of the 9 valid field tests conducted at different locations.

Stem borer screening trial (SBST) - Evaluation of entries in 19 valid field tests identified 12 entries as promising in 4 to 6 of the 19 tests in terms of low dead hearts ($\leq 10\%$), white ear damage ($\leq 5\%$) and high grain yield ($\geq 15\text{g/hill}$) suggesting that recovery resistance and tolerance could be the mechanism in these entries as they have good grain yield despite damage. The mean no. of larvae in the stubbles in these entries varied from ranged from 0.13-1.68/hill. Four of these promising entries *viz.*, KAUPB 0627-2-11, JGL 33440, BK 49-76 and JGL 33080 were in the second year of testing.

Multiple resistance screening trial (MRST) - Evaluation of 25 entries in 6 greenhouse and 43 field tests against 9 insect pests revealed three entries *viz.*, Sinnasivappu, JS5 (selection from Jaya) and SKL -07-11-177-50-65-60-267 as most promising in 4-6 tests with a PPR of 2.7 to 4.8 against 3 pests. The check lines PTB 33, Suraksha and W1263 were promising in 9, 8 and 5 tests, respectively with a PPR of 3.4 to 7.3 against 3 to 4 pests

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

NSN1: Evaluation of 367 entries at 18 locations in 5 greenhouse and 26 field tests against 7 insect pests identified three entries *viz.*, IET nos 27632, 26948 and 28793 as promising in 4 to 5 tests of the 31 valid tests against one to three pests. Aganni and PTB 33 were promising in 4 and 3 tests, respectively.

NSN2: Evaluation of 682 entries in 5 greenhouse and 18 field tests against 7 pests in 23 valid tests identified six entries along with PTB 33, RP 2068-18-3-5 and Aganni as promising in 3 to 4 tests of the 23 valid tests against one or two pests.

NHSN: Evaluation of 94 hybrids along with checks in 5 greenhouse and 17 field tests against 6 insect pests identified IET Nos 28125, JKRH-3333 (NCH-1) and CH 45 as promising in 3 tests of the 22 valid tests. Abhaya, PTB 33 and RP 2068-18-3-5 were promising in 3 to 4 tests

2.2. INSECT BIOTYPE STUDIES comprising of three trials 1) Gall midge biotype monitoring trial (**GMBT**), 2) Gall midge population monitoring (**GMPM**) and 3) Plant hopper special screening trial (**PHSS**) were conducted to monitor the virulence pattern of gall midge and brown planthopper populations.

Gall midge biotype monitoring trial (GMBT) - Evaluation of the gene differentials in one greenhouse and 9 field tests against 5 different biotypes identified Aganni (*Gm8*) as promising in 8 of the 10 valid tests. INRC 3021(*Gm8*), RP5925 (*Gm8*), W1263 (*Gm1*) and Kavya were promising in 5 of

the valid 10 tests. The results suggest that *Gm8* and *Gm1* hold promise across locations.

Gall midge population monitoring (GMPM) - Evaluation of the gene differentials through single female progeny testing revealed that populations at Jagtial and Warangal were less virulent on Aganni (*Gm8*) as compared to populations at Pattambi whereas there was increase in virulence on RP 2068-18-3-5 (*gm3*). This is a matter of concern as this trend has also been evident in GMBT trial in the past few years.

Planthopper special screening trial (PHSS) - Among the 16 gene differentials evaluated, two differentials viz., PTB 33 (with *bph2+Bph3*+unknown factors) was promising at 8 locations and RP 2068-18-3-5 (with *Bph33(t)* gene) was promising in 9 out of 11 locations. T12 (with *bph7* gene) performed better at 4 centres, while Rathu Heenati (with *Bph3+Bph17* genes), Swarnalatha with *Bph 6* gene and Babawee with *bph 4* gene performed consistently at 3 centres, each. Three other gene differentials viz., ASD 7 with *bph2*, Chinsaba with *bph 8* gene and IR 65482-7-216-1-2-B with *Bph 18* gene showed low damage at two locations only. Except for PTB 33 (DS 4.3), none of the above differentials showed promise against WBPH. RP 2068-18-3-5 showed superiority through low honeydew excretion, nymphal survival and egg hatching in tests conducted at Pantnagar.

2.3. Insecticide Botanicals Evaluation Trial (IBET) was carried out at 28 locations across the country to evaluate performance of various treatments having combinations of commercially available neem formulation, effective plant oils along with recommended insecticides against major insect pests of rice and consequent impact on natural enemies and grain yield during kharif, 2019. Based on the performance of the various treatment combinations in controlling the pest damage at various locations, all insecticides module was found to be superior in reducing stem borer damage compared to other insecticide-botanical modules and was the most effective treatment at both vegetative and reproductive phases. Lowest silver shoot damage was recorded in neem formulations and triflumezopyrim module on par with all insecticides treatment. All insecticides combination was found to be the most effective treatment against plant and leafhoppers. Against leaf folder also, insecticides module was effective in reducing leaf damage. Insecticide and botanical combination treatments were found moderately effective in reducing damage by hispa, whorl maggot and grasshopper pests. Botanical combination treatments however showed relatively higher natural enemy (mirid, spider and coccinellid) populations compared to all insecticides treatment signifying that botanicals are relatively safe to predators. Among various treatments, all insecticides treatment recorded highest yield of 4781.2 kg/ha with 32.3% increase over control followed by treatment with applications of neemazal, neem oil and triflumezopyrim showing yield of 4393.0 kg/ha (21.6% IOC).

2.4. Ecological studies consisted of trials on Effect of planting dates on insect pest incidence (**EPDP**), Effect of iron seed coating on insect pest incidence (**ESCP**), Influence of crop establishment methods on pest incidence (**IEMP**), Cropping systems influence on pest incidence (**CSIP**) and Evaluation of pheromone blends for insect pests of rice (**EPBI**)

Effect of planting dates on insect pest incidence (EPDP) trial was conducted at 22 locations. Incidence of stem borer was reported from 16 locations with maximum damage in late planting. Highest damage was observed in late planting at Titabar (43.33% DH & 54.26% WE) followed by Pusa (19.38% DH) and late planting at Nawagam (32.16% WE). Gall midge incidence was noticed at 6 locations with maximum damage in late planting at Titabar (23.85% SS) followed by Sakoli (23.29% SS). Among the foliage feeding insects, leaf folder incidence was observed at 21 locations with maximum damage in late planting at Titabar (50.44% DL) followed by Nawagam in late planting (32.47% DL) and normal planting (24.90% DL). Whorl maggot incidence was recorded at 6 locations and late planting resulted in higher incidence as compared to early and normal plantings. Hispa damage was reported from 3 locations and Malan centre recorded highest damage of 68.85% in late planting. Case worm incidence was observed at 2 locations with maximum damage (67.52%) in late planting at Titabar. Among the sap sucking insects, WBPH incidence was more as compared to BPH incidence across locations and plantings. BPH incidence was observed at 10 locations with maximum numbers at Gangavathi in late planting (79.10 hoppers/5 hills) and normal planting (60.02 hoppers/5 hills). WBPH incidence was recorded from 9 locations with maximum population in late planting at Nawagam (105.70 hoppers/5hills) followed by late planting (94.03 hoppers/5 hills) and normal planting (89.53 hoppers/5hills) at Gangavathi. GLH incidence was reported from 10 locations and was less than 10 hoppers/5 hills in different plantings at all the locations in all the three plantings, except at Ranchi (26.35 - 45.60 hoppers/5 hills). Low incidence of grasshopper was observed at Chatha and Khudwani (<10 hoppers/5 hills), that of horned caterpillar at Navasari and rice skipper at Khudwani.

Effect of iron seed coating on insect pest incidence (ESCP), initiated this year in collaboration with Agronomy revealed, low pest incidence across the locations in different treatments. Stem borer incidence was at par in different seed coated treatments (0.5 – 10.6% DH & 3.9 – 16.6% WE) and also in different sowings (0.1 – 10.8% DH & 4.1 - 16.4% WE). However, gall midge (9.2 – 13.9% SS) and BPH incidence (11-19 hoppers/hill) was low in seed coated treatments compared to normal transplanting (24.6% SS & 33/hill) and T3 treatment with uncoated seed (22.6% SS & 32 hoppers/hill).

Influence of crop establishment methods on pest incidence (IEMP) trial, initiated this year in collaboration with Agronomy, revealed that dry direct seeding recorded relatively high stem borer (12.65% WE), leaf folder (9.42% DL) and whorl maggot (9.12% DL) damage followed by normal transplanting method (10.86% WE; 9.38% LFDL). BPH numbers were found high in

normal transplanting (6.5 hoppers/hill) method as compared to dry direct seeding, puddled direct seeding and mechanised transplanting methods. Since this was the first year of this trial the findings need further years of observation, testing and validation.

Cropping systems influence on pest incidence (CSIP) was initiated this year to evaluate the influence of different rice crop establishment methods under different residue management strategies with the overall objective of realising the potential of the sequence crop to improve the overall productivity of the rice based cropping system. The trial was conducted at Karjat and Jagdalpur. At both these locations, incidence of stem borer, leaf folder, whorl maggot and GLH was too low to draw valid conclusions.

Evaluation of pheromone blends for insect pests of rice (EPBI) was a new trial initiated with an objective to evaluate pheromone blends and doses against rice leaf folder and pink stem borer. The trial was conducted at 12 locations for both pests. Rice leaf folder catches were high in RLF blend at Ludhiana (26 moths/trap) followed by Titabar (7 moths/trap). However, at other locations, catches were low in pheromone traps in spite of the presence of adult population in the field, which needs further evaluation. Multispecies blend attracted both rice leaf folder and yellow stem borer, however it needs further investigation.

2.5. BIOCONTROL AND BIODIVERSITY STUDIES These studies covered i) Ecological Engineering for Planthopper Management (**EEPM**) and ii) Bio-intensive Integrated pest management (**BIPM**).

Ecological engineering for pest management (EEPM) trial was carried out in eight locations with a combination of interventions such as organic manuring, alleyways, spacing management, water management and growing of flowering plants on bunds. The results also indicated that water management along with ecological engineering significantly reduced hopper population at Warangal (18.93 hoppers/hill) when compared to farmers practice (127.47 hoppers/hill) while increasing yields. Stem borer damage was significantly lower in ecological engineering treatments with various bund crops at New Delhi. Such interventions increased the natural enemy populations like mirids, spiders and coccinellids. Increased egg parasitisation of hoppers was observed at Gangavathi with a mean parasitisation of 15.91% with ecological engineering as compared to 4.96 % in farmer's practices. At Warangal, the benefit cost was also significantly higher with ecological engineering (1.94) compared to Farmers practice (1.29).

Bio intensive pest management trial (BIPM) was initiated to explore the feasibility of bio-intensive approaches for managing pests for organic rice cultivation. The trial was conducted in 10 locations this year. The stem borer incidence was reduced in BIPM plots at Chinsurah (5.47%), Jagdalpur (6.00%), Raipur (13.26%) and Titabar (1.38 %) as compared to farmers practice where it was 19.35%, 8.91%, 17.50% and 29.92 % respectively. In Ludhiana and Ranchi, the pest incidence was on par with that of Farmers'

practice. The results indicated an increase in natural enemy population in the organic BIPM plots.

2.6. Integrated Pest Management special (IPMs) trial was conducted at 13 locations involving 28 farmers' in a participatory mode across the Country with an objective of managing insects, diseases and weeds in a holistic way by providing a basket of options to the farmers. The insect pest incidence exceeded ETL at 8 locations and was observed high in farmer practices plots as compared to IPM plots. Stem borer damage was low in IPM plots than FP plots at 4 locations while dead heart damage was very high in FP plots at Titabar (49.8%), Pusa, Karjat and Sakoli. Gall midge incidence was low in IPM plots (<2% SS) compared to FP plots (10.2 – 36.1% SS) at Titabar while the incidence was high in both IPM and FP plots at Sakoli. Leaf folder incidence was low in IPM at Titabar (<2% LFDL) compared to FP plots (23.8 – 38.9% LFDL). Hispa incidence was low in IPM (8.81-24.8% HDL) compared to FP plots (33.3 – 96.6% HDL) throughout the crop growth period at Malan. Though the populations of planthoppers was high initially in IPM plots (177-391/ 5 hills), they got reduced later with the adoption of IPM practices (< 50/5 hills) at Gangavathi and Raipur. Yield was high in IPM plots compared to FP plots at all the locations with maximum yield at Ludhiana in IPM field (7352 kg/ ha). Similarly, BC ratio varied from 0.88 to 4.71 at various locations in both IPM and FP plots.

2.7. Assessment of insect populations throughout the year using light traps revealed that, yellow stem borer, leaf folder, and hoppers continued to be the most important pests in terms of numbers as well as spread across the locations. Gall midge continues to be an endemic pest. However, case worm, white stem borer, pink stem borer, black bug, gundhi bug, and zigzag leaf hopper showed an increase in the spread and intensity of incidence posing concern for future. Patterns in seasonal incidence and population build up on the basis of light trap data indicates that the key pests are reaching their peak levels in the months of October and November in the kharif season. Therefore, strategies are to be timed accordingly for the effective management of insect pests in rice.

ENTOMOLOGY

INTRODUCTION

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.

Under All India Coordinated Rice Improvement Project (AICRIP) Entomology programme, our research focus is to develop and strengthen the all-inclusive theme of integrated rice pest management to achieve the sustainable goal of ensuring social, economic and ecological benefits for the rice farmers. Pest surveillance is the key initial step in any pest management programme. Under AICRIP, Pest Survey Reports (PSR) are generated at fortnightly interval by each cooperating centre that includes real time information on insect pest incidence in farmers' fields. In 2019, rice varieties and hybrids cultivated in Kangra district, Himachal Pradesh were severely affected by rice hispa and white stem borer, while in Sirmaur district hopper burn was seen in a few pockets. In Karnal district of Haryana, yellow stem borer, pink stem borer, BPH and WBPH were found damaging the crop. Hopper burn was reported from Balbera village on variety Pusa44 in Patiala district of Punjab. BPH and leaf folder inflicted damage at flowering stage in Navasari, Gujarat. At reproductive stage, panicle mite and gundhi bug caused considerable damage. In Maharashtra, Bhandara District, stem borer attained severe form at grain filling stage. In various parts of Pattambi, Kerala low incidence of ash weevil, mealy bugs and leaf mites were noticed, while in certain pockets BPH population attained alarming proportion. Moderate incidence of leaf mite was observed at Aduthurai, Tamil Nadu in the months of May and June. Mealy bug was also a pest of concern. At Karaikal, Puducherry, stem borer, gall midge and leaf folder were found damaging the crop. BPH was found in severe form in direct sown crop, whereas the caseworm damage was observed in transplanted paddy. In Mysore, Mandya, and Chamarajanagara districts of Karnataka, yellow stem borer, BPH, leaf folder and ear head bug were in severe form at reproductive stage. In Telangana, hispa incidence was severe in Maheshwaram mandal of Ranga Reddy district. BPH caused extensive damage in certain pockets, while in Warangal district leaf folder was observed in severe form in the *Rabi* season.

Development of multiple pest resistant varieties and strengthening all our efforts to consistently maintain a robust Host plant resistance programme is the prime activity at different centres and target pests include mainly -

planthoppers, gall midge, stem borer and leaf folder. Germplasm accessions of both indigenous and exotic origin, landraces, wild rice resources and advanced breeding lines at different stages get screened against not only insect pests but also diseases at different centres, particularly hot spots for specific pests. Promising lines with desirable resistance traits are identified for use in advanced breeding programme.

In view of the importance of all-round plant health, insecticides with their curative action and botanicals with their environment friendliness need to be integrated into pest management programmes to protect the interests of rice farmers. Hence, efforts are made not only to screen newer insecticide molecules for bio efficacy and safety but also investigate the possibility of alternating their use with botanicals possessing green chemistry and supplementary benefits as components of organic means of managing insect pests.

Investigations are also being made to study the underlying impact of climate change scenario on shift in cropping patterns and resultant alterations in pest profile dynamics. Few collaborative trials involve cooperation from agronomists at different cooperating centres.

Ecological engineering and biointensive pest management efforts aim to understand the ways of intelligently exploiting the rice ecosystem rich with natural enemy diversity for eco-friendly and economically gainful rice IPM.

Adoption of integrated pest management by farmers depends on the effectiveness of holistic solution provided to alleviate their multiple pest problems. In addition to enhanced yields farmers need to be convinced about economic gains from IPM implementation. Under AICRIP, farmer participatory multidisciplinary approach through involvement of Entomology, Plant Pathology and Agronomy researchers is being advocated to validate location specific IPM practices across the country.

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.

The following report highlights the significant findings from the green house evaluations and field trials carried out at IIRR and its cooperating centres under AICRIP during 2019.

2.1. HOST PLANT RESISTANCE STUDIES

The prime objective of host plant resistance studies is identification and delineation of new sources of resistance to major insect pests, and multilocal evaluation of breeding lines from various National Screening Nurseries against insect pests to identify lines with tolerance/resistance. These include multi-location evaluations under both greenhouse and field conditions to evaluate the performance of germplasm accessions, breeding lines as well as characterization of insect pest populations from various hot spots. Seven trials *viz.*, i) Planthopper Screening trial (PHS), ii) Gall Midge Screening trial (GMS), iii) Gall Midge Special Screening trial (GMSS), iv) Leaf Folder Screening Trial (LFST), v) Stem Borer Screening Trial (SBST) vi) Multiple Resistance Screening Trial (MRST) and vii) National Screening Nurseries (NSN) were constituted and conducted during *Kharif* 2019. In all, 1652 entries were evaluated at 42 locations against 11 insect pests and 64 entries (3.87%) were identified as promising. **The detailed pest reaction of all the entries in each trial is presented in a separate volume “Screening Nurseries: – Diseases & Insect Pests”.**

i) Planthopper screening trial (PHS)

The planthopper screening trial was constituted with 120 entries comprising of 11 breeding lines developed at RRU, ANGRAU, Bapatla; 8 breeding lines developed at TNAU, Coimbatore; 10 breeding lines developed at RARS, PJTSAU, Jagtiyal; 10 breeding lines developed at Kunaram, PJTSAU; 5 breeding lines developed at APRRI, ANGRAU, Maruteru; 14 breeding lines developed at ARI, PJTSAU; Rajendranagar, 3 breeding lines developed at RARS, PJTSAU, Warangal; 5 breeding lines and 4 germplasm accessions developed at NRRI, Cuttack, 29 breeding lines, 4 germplasm accessions and improved Samba Mahshuri parent developed at IIRR, Hyderabad along with three resistant checks PTB 33, RP 2068-18-3-5 (BPH) and MO1 (WBPH) as well as one susceptible check TN1. Of these, sixteen entries were under retesting. The entries were evaluated at 14 locations in 18 tests against brown planthopper (BPH), whitebacked planthopper (WBPH) and mixed populations of planthoppers under both field and greenhouse conditions.

Evaluation of entries in 8 greenhouse and 2 field tests against brown planthopper, 2 greenhouse and 1 field test against whitebacked planthopper and 5 field tests against mixed populations of planthoppers revealed 7 breeding lines *viz.*, KNM 7629, MTU 1305, MTU 1306, MTU 1308, RMS-ISM-Bph33-1, RP 221-3-5-2, RP 179-3-9-1 as promising in 7-10 tests (**Table 2.1**). Four germplasm accessions *viz.*, IC 216735, IC 76013, IC 75975 and IC 76057 from IIRR performed consistently better in 10 to 14 tests in the second year of retesting and two germplasm accessions *viz.*, CRCPT 7 and CRCPT 8 from NRRI performed better in 7 to 9 tests. Three breeding lines *viz.*, MTU 1305, MTU 1306 and MTU 1308 performed better in the second year of retesting. The susceptible check TN1 recorded damage score in the range of 8.2 to 9.0 in these valid tests. The universal checks - PTB 33 and MO1 performed well in 10 and 9 tests respectively. The breeding line, RP

2068-18-3-5 carrying BPH resistant Bph33t gene and gall midge resistant gm3 gene and identified as a donor check line for BPH performed better in 11 tests.

Mixed populations of brown planthopper and whitebacked planthopper were present in Gangavathi, Maruteru, Pantnagar, Sakoli and Warangal. Data on BPH and WBPH populations during the field evaluation at Gangavathi (WBPH: BPH in 1.5:1.0 ratio) revealed predominance of WBPH over BPH. In Nawagam only WBPH was present. BPH was predominant throughout the crop season at Pantnagar (BPH 5-26 times more), Maruteru (BPH 13.7 times more than WBPH) while at Warangal, BPH and WBPH were in 1:3 ratio in the beginning of the crop and there was a gradual decline in WBPH population. At Aduthurai, Jagtial and Rajendranagar, only BPH population was present.

Evaluation of the entries against the two planthoppers BPH and WBPH in 10 greenhouse and 8 field tests indicated 16 entries (including 7 breeding lines, 6 germplasm and three checks) as promising in 7 to 14 tests. Four germplasm accessions viz., IC 216735, IC 76013, IC 75975 and IC 76057 from IIRR and three breeding lines viz., MTU 1305, MTU 1306 and MTU 1308 performed better in the second year of retesting.

ii) Gall midge screening trial (GMS)

The objective of this trial was to evaluate the performance of the breeding lines developed from known sources of gall midge resistance against various populations of gall midge. The trial was constituted with 40 entries (36 breeding lines along with 3 resistant checks and one susceptible check). The nominations included material developed from 18 crosses bred at 5 locations viz IIRR, Jagtial, Kunaram, Pattambi and Sindewahi and were evaluated at 11 locations across the country against 5 identified biotypes of gall midge. The valid data from 6 locations for various biotypes/populations were considered for analysis and the salient findings are discussed as under:

JGL 33126, JGL 33138, SKL-07-11-177-50-65-143-89 and W1263 recorded nil damage at IIRR and CHP for GMB1. SKL-07-8-720-63-147-182-276* and Aganni had nil damage for biotype 3 at JGL. Only Aganni had nil damage at both Warangal and Sakoli. All the entries were susceptible at Pattambi.

Evaluation of 40 entries in one greenhouse and 5 field tests against 6 populations of gall midge (five identified biotypes) helped in identification of one line, SKL-07-8-720-63-147-182-276 an entry under retesting as promising in 3 tests of the 6 valid tests across all the populations (**Table 2. 2**). Aganni was promising in 4 tests.*

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Table: 2.1 Performance of the most promising entries against planthoppers, PHS, kharif 2019

Entry No.	Designation	Cross	Brown planthopper										Whitebacked planthopper			Planthoppers					No. of Promising Tests (NPT)					TOTAL																				
			IIRR	ADT	CBT	CTC	LDN	MND	PNT	WGL	JGT	RNR	IIRR	CBT	NWG	MTU	GNV	PNT	SKL	WGL	BPH		WBPH		PH																					
																					Greenhouse reaction										110DT	78DT	GH	GH	74DT		81DT	60DT	90DT	68DT	GH (8)	FR (2)	GH (2)	FR (1)	FR (5)	
																					Damage Score										%DT	No/10h.	DS		No/10h.	DS	No/10h.									
5	IC 216735*	Germplasm acc.	1.6	3.0	8.3	5.0	3.0	3.0	0.9	2.9	9.9	315	9	7.5	104	3	187	57	140	119	7	2	0	1	4	14																				
12	IC 76013*	Germplasm acc.	0.9	7.0	6.8	7.0	2.4	3.0	0.7	2.7	14.8	348	9	6.2	198	3	237	78	106	90	5	1	0	1	3	10																				
24	IC 75975*	Germplasm acc.	0.9	1.0	5.4	9.0	3.6	3.0	0.9	5.8	8.1	71	9	6.1	226	3	206	64	174	74	6	2	0	0	4	12																				
29	IC 76057*	Germplasm acc.	2.2	9.0	5.8	9.0	3.0	3.0	1.0	6.8	4.3	371	8.7	6.5	258	3	159	75	151	72	4	1	0	0	5	10																				
37	KNM 7629	MTU1156/KNM118	2.5	9.0	7.0	9.0	8.1	9.0	1.0	7.8	8.9	410	8.5	8.5	190	9	178	75	184	47	2	1	0	1	3	7																				
49	MTU 1305*	(MTU 1075/MTU 1081)/MTU 1121	6.9	3.0	7.6	9.0	3.2	5.0	0.6	2.1	21.6	240	7.5	8.8	199	3	200	73	164	175	5	1	0	1	3	10																				
51	MTU 1306*	MTU 1121/MTU 1010	9.0	5.0	8.3	9.0	9.0	5.0	3.8	5.9	18.3	753	9	8.2	160	5	144	77	145	69	2	0	0	1	4	7																				
53	MTU 1308*	(MTU1010/MTU1081)/MTU 1121/JGL18047	9.0	5.0	8.3	1.0	4.7	7.0	5.6	6.3	19.3	244	9	7.5	234	3	211	80	132	71	3	1	0	0	3	7																				
75	RMS-ISM-Bph33-1	ISM/RP2068	6.1	9.0	6.4	9.0	3.5	3.0	5.3	6.8	19.2	85	9	9	274	5	156	75	134	195	2	1	0	0	4	7																				
99	CRCPT 7	CR AC 35003	6.1	9.0	7.4	3.0	9.0	9.0	6.5	8.2	6.0	187	6.3	8.2	238	5	160	73	171	59	1	2	0	0	4	7																				
101	CRCPT 8	CR AC 34997	7.9		8.7	5.0	9.0	9.0	2.8	4.0	3.1	194	9	8.2	239	7	168	70	158	51	3	2	0	0	4	9																				
108	RP 221-3-5-2	MTU1121/Vijetha	8.7	3.0	8.3	3.0	4.6	7.0	6.3	4.5	10.2	390	9	8.2	240	3	200	75	197	124	4	0	0	0	3	7																				
109	RP 179-3-9-1	MTU1121/Vijetha	6.1	3.0	7.0	3.0	3.0	7.0	5.2	5.0	7.7	525	9	8.3	311	3	194	78	181	74	4	1	0	0	3	8																				
117	PTB 33	R. check	0.3		7.0	1.0	2.8	1.0			0.0	129	3.5		288	9	149	89	140	59	4	2	1	0	3	10																				
40	RP2068-18-3-5	R. check	1.5	1.0	4.4	7.0	2.9	3.0	0.7	3.8	20.0	281	8.8	7.2	205	5	177	81	162	38	7	1	0	0	3	11																				
120	MO1	R. check	5.5			3.0	8.0	5.0	7.6		0.0	222	1.3		208	3	196	85	155	33	2	2	1	0	4	9																				
Promising level			5	5	5	5	5	5	3	5	10	350	5	5	200	5	200	75	160	75																										
No. of promising entries			19	28	4	33	27	27	22	15	40	48	5	0	38	22	60	52	50	44																										

*-Entries under retesting.

Table 2. 2 Reaction of promising breeding lines against gall midge populations in GMS, *kharif* 2019
Per cent plant damage

Entry No.	Designation	GMB1		NPT	GMB3	NPT	GMB4	NPT	GMB4M	NPT	GMB5	NPT	Overall NPT
		IIRR	CHP		JGT		SKL				PTB		
		GH	50DT	2	50DT	1	50DT	1	50DT	1	50DT	1	6
24	SKL-07-8-720-63-147-182-276*	0	20	1	0	1	10	0	0	1	93.3	0	3
30	Aganni	NT	0	1	0	1	0	1	0	1	100	0	4
Total Tested		38	39		39		39		39		40		
Average damage in the trial		56.1	34.4		73.8		69.5		71.3		90.9		
Ave. damage in TN1		100	80		100		100		90		95.2		
Promising level		0	0		0		0		0		0		
No.promising		15	7		2		1		2		0		

*- Entry under retesting. Data from Nellore and Cuttack not received. Data from JDP, MNC, RNC, RGL and MTU were not considered for analysis due to low pest pressure

iii) Gall midge special screening trial (GMSS)

This trial constituted with 85 entries (39 germplasm accessions and 40 gene pyramided lines nominated from IBT, PJTSAU along with check varieties) was carried out in 10 locations to identify new sources of resistance to gall midge biotypes/populations. Of these, 28 lines were under retesting. The valid data from seven locations which had >50% DP in TN1 were analysed and discussed biotype/population wise as under:

Evaluation of the entries for GMB1 identified Aganni, IIRR-ENT-2019-17 and 13 gene pyramided lines (MTU1010 with *Gm4* and *Gm8*) (IBT GM 4, IBT GM 5, IBT GM 3, IBT GM 6, IBT GM 7, IBT GM 9, IBT GM 12, IBT GM 17, and IBT GM 23, IBT GM 30, IBT GM 32, IBT GM 36, IBT GM 39) as promising with nil damage at IIRR and CHP.

Against biotype 3, IIRR-ENT-2019-17 and Aganni showed nil damage at both Jagtial and Ranchi. IIRR-ENT-2019-17, INRC 17470, RMSGM3, Aganni, 19 lines from IBT WGL series and 16 from IBT GM series recorded nil damage at Sakoli for biotype 4. ARC 5906*, INRC 17470*, IIRR-ENT-2019-15, IIRR-ENT-2019-17, IBT WGL3, IBT WGL5, IBT WGL31, IBT GM 1*, IBT GM 2*, IBT GM 3* and IBT GM5, recorded nil damage against biotype 4 M at Warangal.

None of the entries recorded nil damage for biotype 5, at Pattambi.

*Evaluation of 85 donors against 5 gall midge biotypes in one greenhouse and 6 field tests identified 16 lines as promising in 4 to 6 tests. IIRR-ENT-2019-17 was promising in 6 tests and 14 pyramided lines (MTU1010 with *gm3*+*Gm4*+*Gm8*) along with Aganni were promising in 4 tests (Table 2.3). Of these 6 lines were promising in the second year of retesting.*

Table 2.3 Reaction of donors against gall midge populations in GMSS, *kharif* 2019

Entry No.	Designation	GMB 1	GMB 1	NPT	GMB 3	GMB 3	NPT	GMB 4	GMB4 M	GMB 5	Overall NPT
		IIRR	CHP		JGT	RCI		SKL	WGL	PTB	
		GH	50DT		50DT	50DT		50DT	53DT	50DT	
2	IIRR-ENT-2019-17	0.00	0.00	2	0.00	0.00	2	0.0	0.0	100.0	6
66	IBT GM3*	0.0	0.0	2	0.0	35.0	1	0.0	0.0	100.0	5
68	IBT GM5	0.0	0.0	2	0.0	30.0	1	0.0	0.0	100.0	5
58	IBT WGL31	NT	0.0	1	0.0	25.0	1	0.0	0.0	100.0	4
64	IBT GM1*	0.0	30.0	1	0.0	35.0	1	0.0	0.0	100.0	4
65	IBT GM2*	0.0	20.0	1	0.0	35.0	1	0.0	0.0	100.0	4
67	IBT GM4	0.0	0.0	2	0.0	35.0	1	0.0	20.0	100.0	4
69	IBT GM6	0.0	0.0	2	0.0	30.0	1	0.0	5.0	100.0	4
70	IBT GM7*	0.0	0.0	2	0.0	25.0	1	0.0	15.0	100.0	4
72	IBT GM12*	0.0	0.0	2	0.0	30.0	1	0.0	5.0	100.0	4
74	IBT GM17*	0.0	0.0	2	0.0	25.0	1	0.0	5.0	100.0	4
77	IBT GM23	0.0	0.0	2	0.0	30.0	1	0.0	10.0	100.0	4
79	IBT GM30	0.0	0.0	2	0.0	35.0	1	0.0	5.0	100.0	4
81	IBT GM36	0.0	0.0	2	35.0	0.0	1	0.0	100.0	100.0	4
82	IBT GM39	0.0	0.0	2	30.0	0.0	1	0.0	100.0	100.0	4
40	Aganni	12.5	0.0	1	0.0	0.0	2	0.0	5.0	100.0	4
Total Tested		65.0	84.0		85.0	85.0		85.0	85.0	85.0	
Average damage in the trial		20.0	23.2		27.1	22.3		41.2	37.4	99.4	
Average damage in TN1		86.7	70.0		92.5	65.0		100.0	80.0	100.0	
Promising level		0	0		0	0		0	0	0	
No.promising		33	35		43	21		39	11	0	

*- Entry under retesting. Data from Moncompu, Ragolu and Jagdalpur was not considered due to low pest pressure.

iv) **Leaffolder screening trial (LFST)**

The main objective of Leaf folder screening trial (LFST) is to identify new sources of resistance against leaf folder, *Cnaphalocrocis medinalis* Guenee by field screening through augmented releases. The trial comprised of 20 entries with 13 nominations from Regional Agricultural Research Station, Pattambi, Kerala; two nominations from Rice & Wheat Research station, CSK HP Agricultural University, Malan, Himachal Pradesh and three nominations from Main Rice Research Station, Anand Agricultural University, Nawagam, Gujarat together with a susceptible check (TN1) and resistant check (W1263). During *Kharif* 2019, the trial was conducted at 16 locations with 20 entries replicated thrice in a randomised block design. In the first year of testing, data analysis revealed four entries as promising in 3-4 tests of 9 valid field tests (**Table 2.4**). Average damage in the trial varied from 7.7 to 78.2% while the maximum damage ranged between 14.7 and 92.8% across locations. The average damage by leaf folder in susceptible check varied from 13.8 to 82.1%. Two mutant cultures, Cul M8 and Cul M9 were found promising in 4 out of 9 valid field tests. Another mutant culture, Cul M6-2 and a selection from landrace Kalluruli were found promising in 3 of the 9 valid field tests and were found at par with resistant check, W 1263.

Table 2.4 Performance of entries against leaf folder in LFST, Kharif 2019

Designation	Parentage	CHT	KRK	LDN	MLN	NVS	NWG	PTB	ADT	RNR	NPT (9)
		60DT	60DT	80DT	114DT	80DT	60DT	50DT	80DT	83DT	
Cul M8*	Mutant 170 GY of PTB 21	23.7	4.4	14.1	35.4	3.2	32.3	49.3	22.8	3.9	4
Cul M9*	Mutant 220 GY of PTB 18	22.9	11.3	19.8	29.4	9.4	34.1	81.9	31.6	10.4	4
Cul M6-2*	Mutant 170 GY of PTB 18	19.7	24.4	27.3	28.5	13.4	71.5	85.2	28.4	6	3
Kalluruli*	Selection from landrace Kalluruli	25	14.6	16.5	31.7	7.9	29	74	31.8	11	3
JS 3	Pureline selection from Jaya	27.1	27.7	30.3	32.1	8	26	86	32.2	1.4	2
JS 4	Pureline selection from Jaya	22.4	22.5	31.5	42.9	9.5	26.6	85.8	31.1	7.4	2
JS 5	Pureline selection from Jaya	22.8	34	31.1	32.8	6.6	32.6	81.8	30.8	2.2	2
Cul 3	Swetha x Kuruka	25.4	33.5	27.5	36.9	13.6	24.4	84.5	27.8	7.7	2
Cul M4	Mutant of PTB 18	22.1	17.1	34.3	32.9	9.9	38.2	61.4	22	2.8	2
Matali	Local red rice from Kullu valley in HP	24.2	16.7	20.9	26.6	13.8	43.2	66.5	19.6	12.4	2
NWGR 16041	NWGR 2006/ Mahi-sugandha/47-1-1-1-1-1-1	23.4	42.3	28.8	29.6	8.5	31.4	87.1	31.4	12	2
JS 1	Pureline selection from Jaya	24	23.6	33.3	37.8	15.6	34	88	28.1	8	1
JS 6	Pureline selection from Jaya	22.8	28.8	26.3	30.8	13.3	25.3	86.1	29.3	7.7	1
Cul 7	Pureline selection from Jaya	22.2	32.5	31.7	34.9	11	41.7	89.4	22.6	3.9	1
Chohartu	Local red rice from Rohru in Shimla region	27.1	27.8	28.8	41.5	10.6	32.8	85.5	22.3	4.8	1
NWGR 9078	GR 7/NWGR 99038/1-1-1-1	24.9	36.9	23.1	30.4	19.6	50.4	82	20.8	6.6	1
NWGR 13052	Gurjari/IET17126/1-4-1-1-1-1	26	33.2	31.8	30.9	19.9	36.3	82	19.9	14.7	1
JS 7	Pureline selection from Jaya	23.5	30.3	31.9	34	18.2	29.7	92.8	31.4	11.4	0
W 1263	Resistant check	22.8	27.6	18.7	34.2	0.2	43.5	36.3	9.2	11.9	3
TN 1	Susceptible check	24	30.1	40.9	37.6	32.6	47	82.1	32.5	13.8	0
Minimum damage		19.7	4.4	14.1	26.6	0.2	24.4	36.3	9.2	1.4	
Maximum damage		27.1	42.3	34.3	42.9	36.7	71.5	92.8	32.2	14.7	
Average damage in trial		23.8	25.7	26.7	33.3	12.4	35.9	78.2	25.9	7.7	
Promising level		20	15	20	30	10	25	30	20	10	
No. Promising		1	3	4	4	9	1	0	3	12	
Total entries tested		20	20	20	20	20	20	20	20	20	

* promising

Data from Bapatla, Chinsurah, Gerua, Gangavathi, Jagdalpur, Karjat and Khudwani were not included in the analysis due to low pest pressure

In Leaf Folder Screening Trial (LFST), field evaluation of 20 entries replicated thrice in a randomised block design at 16 locations, during Kharif 2019, revealed that 4 entries were promising in 3-4 tests out of 9 valid field tests. Two mutant cultures of PTB, Cul M8 and Cul M9 were found promising in 4 of the 9 valid tests while another mutant culture, Cul M6-2 and a selection from landrace Kalluruli were found promising in 3 of the 9 valid field tests conducted at different locations.

v) Stem borer screening trial (SBST)

Stem borer Screening trial (SBST) initiated in 2015 was continued during *kharif* 2019 with 65 entries including nominations from IIRR, Cuttack, Jagtial, Warangal and Pattambi, which were specifically bred for stem borer tolerance. The entries were evaluated at 13 locations and at each location observations were recorded on dead heart at vegetative phase and white ear damage, grain yield in the infested plant and the larval survival in the stubbles at harvest. For effective screening two staggered sowings were

taken up in most of the locations. Two locations; Pattambi and Malan reported the damage for white stem borer, *S.fusciiflua*, while in other locations yellow stem borer damage was recorded. The results of the evaluation from the valid tests are discussed below (**Table 2.5**).

Dead heart damage: The dead heart damage in the trial varied from 3.0 to 42.1% with an average damage of 19.9% DH across 5 locations in 9 valid tests. Evaluation of entries for dead heart damage at 30 and 50 DAT in two staggered sowings helped in identification of four retested entries - WGL 1083*, JGL 33440*, KAUPTB 0627-2-11*, BK 49-76* and a new entry, NND 2 as promising in 2 of the 9 tests with $\leq 10\%$ DH (DS3.0).

White ear damage: The white ear damage across 5 locations in 6 valid tests varied from 0.0 to 78.8% with a mean of 21.1%WE. Evaluation of entries identified, CRCPT 7, JGL 32994, JGL 33440, KMR3, WGL 1062, IET28068*, NND2 and NND5 as promising in 2 tests of the 6 valid tests with $\leq 5\%$ WE (DS1.0). The larval survival per entry across 9 locations in 12 tests varied from 0 to 12 larvae/hill in the stubbles with a mean of one larvae/hill. At Rajendranagar, traces of pink stem borer larvae were observed in very few entries.

Grain yield: JGL 33145*, KAUPTB 0627-2-11, RP 5587-B-B-B-273-1* and TKM 6 were promising in 3 of the 4 tests with $\geq 15\text{g/hill}$ in 3 of the 4 valid tests for grain yield /hill despite stem borer damage in the valid tests. However, JGL 33440*, NND 2, JGL 34452*, JGL 32994*, KMR3*, CRCPT 7, JGL 33080*, BK 49-76*, RP bio 4919-385 and IET 27049* which were promising 2-3 tests for stem borer damage were also promising in one to two tests for grain yield of the 4 valid tests.

.Table 2.5 Reaction of cultures to stem borer in SBST, kharif 2019.

S.No.	Designation	No. of promising tests (NPT)					
		SBDH	SBWE	SBDH+SBWE	GY/hill (g)	Overall	Larvae/per hill
		9	6	15	4	19	12
32	KAUPTB 0627-2-11*	2	1	3	3	6	0.61
17	JGL 34452	2	1	3	2	5	1.18
31	JGL 33440*	2	2	4	1	5	0.91
61	NND 2	2	2	4	1	5	0.84
9	JGL 32994	1	2	3	1	4	0.71
29	JGL 33080*	1	1	2	2	4	1.1
52	BK 49-76*	2	0	2	2	4	0.93
54	RP bio 4919-385	1	1	2	2	4	1.31
55	KMR3	1	2	3	1	4	1.68
58	IET 27049	1	1	2	2	4	0.88
5	CRCPT 7	1	2	3	1	4	0.66
30	TKM 6	0	1	1	3	4	0.9

- Data not received from NRTI, CTC. Data from CBT,PTB,GGT,CHN,MLN,RNR for DH;CBT,PTB,GGT, CHN,MLN, RNR,NVS , for WE; was not considered due to insufficient pest pressure for screening.

Evaluation of entries in 19 valid field tests identified 12 entries as promising in 4 to 6 of the 19 tests in terms of low dead hearts, white ear damage and high grain

yield suggesting that recovery resistance and tolerance could be the mechanism in these entries as they have good grain yield despite damage. The mean no. of larvae in the stubbles in these entries varied from 0.13-1.68/hill. Four of these entries viz., KAUPTB 0627-2-11, JGL 33440, BK 49-76 and JGL 33080 are promising in the second year of testing

vi) Multiple resistance screening trial (MRST)

This trial was constituted with a view to identify the reaction of entries found promising in pest specific trials to other pests and to evaluate the reaction of advanced breeding lines to insect pests. The trial included evaluation of 25 entries consisting of three each of the promising entries from PHS and GMS trials, 5 from SBST trial, 3 nominations from Kerala and 6 nominations from Cuttack along with four resistant checks and one susceptible check, against 9 insect pests, at 28 locations. **The details of the reaction of entries is available in Screening Nurseries-Diseases and Insect pests Vol II. The valid data from various locations are discussed pest wise (Table 2. 6).**

BPH: IR 73382-80-9-3-13-2-2-1-3-B (HWR-16) and RP 5995 Bphk17-5 were promising in 2 of the 4 valid greenhouse tests with a DS \leq 3.0. PTB 33 was promising in 3 tests.

WBPH: None of the entries was found promising.

Mixed population of planthoppers: Cul M9 (Mutant 220 Gy of PTB 18) and PTB33 exhibited field tolerance with a DS \leq 3.0 in 2 valid tests at GGV and MTU for mixed population of planthoppers though BPH was predominant at MTU and WBPH at GGV.

Gall midge: Sinnasivappu and W1263 had nil damage in 4 and 2 tests, respectively of the 6 valid tests for gall midge.

Stem borer: Evaluation of entries against stem borer at vegetative phase for dead heart damage in 7 valid tests identified JS1 (a pure line selection from Jaya) with nil damage. Cul 7, Cul M9, JS 3, RP 5690-20-6-3-2-1, RP 5587-B-B-B-262, BK 39-179, PTB33 and Suraksha were identified as promising in 2 of the 14 valid tests at reproductive phase for white ear damage.

Foliage feeders: Incidence of leaf folder, whorl maggot, case worm and rice hispa were observed at various locations. RP 5995, Bphk17-5 and Suraksha were promising for leaf folder damage in 2 of the 8 valid tests. Suraksha was the only entry promising against whorl maggot in 2 of the 5 valid tests with \leq 5.0% DL. None of the entries were found promising for rice hispa (net house screening at Malan for adult damage) and case worm, in one test each.

Evaluation of 25 entries in 6 greenhouse and 43 field tests against 9 insect pests revealed three entries viz., Sinnasivappu, JS5 (selection from Jaya) and SKL -07-11-177-50-65-60- and Cul7, as most promising in 4-6 tests with a PPR of 2.7 to 4.8 against 3 pests. The check lines PTB 33, Suraksha and W1263 were promising in 9, 8 and 5 tests, respectively with a PPR of 3.4 to 7.3 against 3 to 4 pests

Table 2.6 Performance of the most promising cultures against insect pests in MRST, kharif 2019

Sl. No	Designation	No. of promising tests (NPT)											No of promising		MRI	PPR
		BPH	WBPH	PH	GMB	SBDH	SBWE	LF	WM	RH	CW	PM	Tests (T)	Pests (P)		
		4	1	2	5	7	14	8	5	1	1	1				
25	Sinna sivappu	0	0	1	3	0	0	1	1	0	0	0	6	3	18	4.8
9	JS 5	0	0	1	0	1	1	1	0	0	0	0	4	3	12	2.7
16	SKL -07-11-177-50- 65-60-267	0	0	1	0	1	1	0	1	0	0	0	4	3	12	2.7
	Checks															
10	PTB33	3	0	2	0	1	2	0	0	0	0	1	9	3	27	6.1
20	Suraksha	0	0	1	0	1	2	2	2	0	0	0	8	4	32	7.3
15	W1263	0	0	1	2	0	0	1	1	0	0	0	5	3	15	3.4

PPR-Percent Promising reaction:MRI of test entryX100/total MRI, Data from IIRR for BPH and WBPH and NRRI were not received. FR from PNT, WGL, CBT, for planthoppers; JDP,RGL, MTU for GM RGL,RNR,RPR, LDN,CHP,GNV for SBDH; CHP, RGL, GNV for SBWE;JDP, MTU, GNV for LF; RPR for CW not considered for analysis.

Vii. National Screening Nurseries

National Screening Nurseries (NSN) comprised of 4 trials, National Screening Nursery 1(NSN1), National Screening Nursery 2(NSN2), National Screening Nursery–Hills (NSN hills) and National Hybrid Screening Nursery (NHSN). NSN1was constituted with 367 entries (339AVT entries along with 10 insect checks and 14 disease checks) was evaluated at 18 locations. NSN 2 trial comprised of 682 entries (658 entries from IVT trials, 10 insect and 14 disease checks) was evaluated at 14 locations against 7 insect pests. NSN-Hills trial consisting of 130 entries (106 hill entries + 10 insect check lines and 14 disease checks) was evaluated at 8 locations in 13 valid tests (4 greenhouse and 9 field tests) against 9 insect pests. NHSN trial constituted with 118 entries (94 hybrids + 10 insect checks+14 disease checks) was evaluated at 14 locations against 7 insect pests. The valid data in each trial are discussed pest wise:

Brown planthopper:

NSN1: PTB 33 was resistant in 2of the 3 tests, while 14 more entries recorded a DS of ≤ 3.0 in one of the tests.

NSN2: Though evaluation was carried out at 3 locations in green house tests these was no consistency in the reaction of test entries at any two locations except for PTB33 and RP 2068-18-3-5.

NSN hills: IET Nos.26565 and 28194 recorded < DS 4.0 at both IIRR and LDN for BPH.

NHSN: IET Nos 28121, 28123, Gontra Bidhan-3, 28132, 28158 and 28160 were promising in one of the 3 greenhouse tests with a $DS \leq 3.0$. PTB 33 and RP 2068-18-3-5 also showed similar trend.

Whitebacked planthopper:

NSN1: None of the test entries were observed to be promising for WBPH except MO1.

NSN2: All the entries were susceptible to WBPH.

NSN hills: All the entries were found susceptible.

NHSN: All the entries were susceptible, while MO1 was promising in greenhouse test at IIRR with a DS of ≤ 3.0 .

Planthoppers (Mixed population):

NSN1: Field tolerance for mixed populations of planthoppers was exhibited by IET Nos 27117, 27583, 27360, 26744, 28790, 27939, 27927, 27880, 26763 (R), NSN1-159 and PTB33 at Maruteru with a DS ≤ 3.0 . The ratio of BPH to WBPH was 19:1 at Maruteru, while WBPH was predominant at Gangavathi.

NSN2: Twelve entries viz., IET Nos 28344, 28346, 28676, 28511, 28512, 28520, 28263, 28264, 28287, 28071, 27641, 28075 showed field tolerance at Maruteru with a DS of 3.0 (visual score). IET 28071 was promising for BPH at one location in GR test and in field reaction at MTU also.

NSN hills: All the entries were susceptible. PTB33, RP 2068-18-3-5 and Suraksha had DS3.0.

NHSN: None of the entries were found promising.

Gall midge:

NSN1: IET Nos 27632 recorded nil damage against gall midge in 2 of the 4 tests. W1263 and Aganni were promising in 2 and 3 tests, respectively.

NSN2: IET 28334 had nil damage at IIRR and CHP for GMB 1 but it recorded 10.3% SS at Moncompu.

NSN hills: Eighteen entries, viz., IET Nos 27491, 27496, 28210, 28215, 27501, 27498, HR-12, Nidhi, Co-39, RP-Bio-226, Abhaya entries along with NC (Vivekdhan 62, Sukaradhan -1) recorded nil damage against GMB1 apart from Aganni, Kavya, RP 2068-18-3-5, Suraksha and W-1263.

NHSN: IET Nos 28115, 28118, 28125, 28157 and 28178 recorded nil damage for gall midge in green house reaction at IIRR apart from Aganni, RP2068-18-3-5, W1263, and Suraksha. This year the field incidence of gall midge was very high. At Pattambi, the incidence was as high as 195.8 % SS with an average damage in the trial of 73.1% SS but IET Nos 28182, 28183, JKRH-3333 (NCH-1) and Benibhog recorded nil damage.

Stem borer:

NSN1: IET nos. 27512 and 27353 recorded nil damage in 2 (MNC and CHP) of the 6 tests at vegetative phase for dead heart damage. IET Nos 26927 and 26948 recorded nil white ears in 3 of the 9 tests at reproductive phase. The low damage could be due to escape in the critical stages.

NSN2: IET No 28512 had nil damage for dead heart at MNC of the 4 locations tested and for white ear damage at MNC and CHP.

NSN hills: Vivek dhan 62 (NC) at dead heart stage and IET 28227 and Vivek Dhan 154 had 5 % WE.

NHSN: US-314 (NCH) 28125, 28137, 28141, 28169, 28174, 28181, JKRH-3333 (NCH-1), ADT-49 (RCV), 28187 and CH 45 recorded nil white ear damage in two of the eight locations tested.

However, these lines need to be further tested under greenhouse conditions for validation of the reactions and to rule out any damage escape.

Leaf folder:

NSN1: IET No28793 was the only entry with nil damage in one of the 3 valid tests.

NSN2: Eight entries *viz.*, IET Nos 28332, 28365, 28736, 28754, 28288, 28602, 28070 and 28074 had nil damage in one of the 3 valid tests.

NSN hills: All the entries were susceptible at Chatha.

NHSN: IET 28112 had nil damage at 58 DAT at RNR of the 4 locations tested.

Whorl maggot:

NSN2: IET Nos 28406, 28752, 28532, 28550, 28696, 28074 had nil damage at Jagdalpur (77 DAT) of the 3 valid tests.

NSN hills: All the test entries were susceptible at Malan.

NHSN: None of the entries were promising.

Rice hispa:

At Malan, standard facility with technique has been developed for screening against hispa.

NSN 2: None of the entries were promising

NSN Hills: All the entries were found susceptible.

Other pests

Gundhi bug and Grasshopper

NSN Hills: The mean grain damage by gundhi bug at Chatha was 26.4% and the leaf damage by grasshoppers at Khudwani was 11.9% DL. None of the entries were promising at a level of 10% DG and 5 % DL, respectively.

Case worm and whorl maggot *NSN1:* All the entries were susceptible to case worm at TTB and WM at JDP.

Overall reaction

NSN1: Evaluation of 367 entries at 18 locations in 5 greenhouse and 26 field tests against 7 insect pests identified three entries *viz.*, IET nos 27632, 26948 and 28793 as promising in 4 to 5 tests of the 31 valid tests against

one to three pests. Aganni and PTB 33 were promising in 4 and 3 tests, respectively (**Table 2.7**).

NSN2: Evaluation of 682 entries in 5 greenhouse and 18 field tests against 7 pests in 23 valid tests identified six entries along with PTB-33, RP 2068-18-3-5 and Aganni as promising in 3 to 4 tests of the 23 valid tests against one or two pests (**Table 2.8**).

NHSN: Evaluation of 94 hybrids along with checks in 5 greenhouse and 17 field tests against 6 insect pests identified IET Nos 28125, JKRH-3333 (NCH-1) and CH 45 as promising in 3 tests of the 22 valid tests. Abhaya, PTB33 and RP 2068-18-3-5 were promising in 3 to 4 tests (**Table 2.9**).

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

Table 2.7 Performance of the most promising cultures against insect pests in NSN1, kharif 2019

Entry No	IET No.	Cross combination	No. of promising tests (NPT)									Overall NPT
			BPH	WBPH	PH	GM	SBDH	SBWE	LF	CW	WM	
			3	1	2	4	6	9	4	1	1	
232	27632	MTU 1297(MTU 2036-1-1-1-1)	0	0	0	2	0	2	0	0	0	4
246	26948	PRNP-48	0	0	0	0	1	3	0	0	0	4
250	28793	120-11-RM-Sub-1	0	0	0	1	1	1	2	0	0	5
355	AGANNI		0	0	0	3	1	0	0	0	0	4
358	PTB 33		2	0	1	0	0	0	0	0	0	3

Data from JDP, WGL, PNT,GGV,CBT for BPH; PNT, CBT,WGL for WBPH; MNC,JDP,RGL,CBT for GM; WGL,CBT ,RGL, RNR, JDP, RPR,SKL,GNV, MSD, LDN ,NWG for SBDH; CHP,GNV,RNR, SKL, WGL, for SBWE; CBT,WGL , RPR,GNV, MSD, JDP, RGL for LF; JDP for GLH; CBT for WM; RPR for CW - not considered for analysis due to low pest pressure.

Table 2.8 Performance of most promising cultures against insect pests in NSN2, kharif 2019

Entry No.	IET No.	No. of promising tests (NPT)									Overall NPT
		BPH	WBPH	PH	GM	SBDH	SBWE	LF	WM	RH	
		3	1	1	2	4	5	3	3	1	
351	28512	0	0	1	0	1	2	0	0	0	4
604	28071	1	0	1	0	0	2	0	0	0	4
10	28331	1	0	0	0	1	1	0	0	0	3
13	28334	0	0	0	2	0	1	0	0	0	3
350	28511	0	0	1	0	1	1	0	0	0	3
357	28517	0	0	0	1	0	2	0	0	0	3
	Checks										
674	AGANNI	0	0	0	2	1	0	0	0	0	3
677	PTB 33	2	0	0	0	1	1	0	0	0	4
679	RP 2068-18-3-5	2	0	0	1	0	0	0	0	0	3

Data from JDP, PNT, CBT for BPH; JDP for GLH;CBT,PNT for WBPH; CBT,JDP,MNC for GM; CBT,JDP,NVS,GGT,GNV, for SBDH;CBT, GGT for SBWE;CBT,NVS for LF; CBT for WM not considered for analysis due to insufficient pest pressure.

Table 2.9 Performance of the most promising hybrids against insect pests in NHSN, Kharif 2019

Entry No	IET No.	No.of promising tests								Overall NPT
		BPH	WBPH	PH@	GM NPT	SBDH	SBWE	LF	WM	
		3	1	1	2	2	8	4	1	
19	28125	0	0	0	1	0	2	0	0	3
88	JKRH-3333 (NCH-1)	0	0	0	1	0	2	0	0	3
100	CH 45	0	0	0	0	0	2	0	1	3
109	Abhaya	0	0	0	1	0	2	0	0	3
113	PTB 33	1	0	0	0	0	2	0	0	3
115	RP 2068-18-3-5	1	0	1	1	0	1	0	0	4

@-Mixed population of planthoppers

Data from PNT for BPH& WBPH; CBT for GM; GGT, LDN, NWG, RNR, RPR for SBDH; CHN for SBWE; RPR,GGT for LF; PTB and RNR for WM;RPR for CW; not considered for analysis due to low pest pressure

2.2. INSECT BIOTYPE STUDIES

Variation in the response of host plant/ gene differentials to different pest populations in endemic areas are monitored for two major pests viz., planthoppers and gall midge through Insect biotype studies comprising of three trials 1) Gall midge biotype monitoring trial (GMBT), 2) Gall midge population monitoring (GMPM) trial and 3) Planthopper screening trial (PHSS). The results of the observed virulence pattern of gall midge populations during *kharif* 2019 are discussed below:

a) Gall midge biotype monitoring trial (GMBT)

Gall midge biotype trial was constituted with a set of 15 gene differentials categorized into 5 groups and two gene pyramided lines and carried out at 13 locations. The results of the evaluation from the valid data of 9 locations in 10 tests are summarized in **(Table 2.10)** and discussed as under.

Biotype 1: This biotype is characterized by the reaction pattern R-R-R-R-S. The populations at IIRR, Chiplima and Ambikapur (near Raipur) were grouped under this category. All differentials showed susceptibility except Kavya, W1263 (*Gm1*); Aganni, INRC 15888, and RP5925 (*Gm8*) which had <10 % plant damage at all the three locations tested. Variation in the reaction of the other donors was observed

Biotype 3: The reaction of the gall midge populations at Ranchi conformed to the typical pattern of R-S-R-R-S for biotype 3 except for susceptibility of RP 2068-18-3-5 and Phalguna, ARC 5984. At Jagtial, only differentials with *Gm8* gene (Aganni, INRC 3021 and RP5925) were promising.

Biotype 4: Gall midge populations from Sakoli were designated as biotype 4 from earlier studies. But this year only Aganni and INRC 3021 (both with *Gm8*) showed promise, while Kavya, W1263 and RP5925 recorded 0-5 % DP at this location.

Biotype 4M: Aganni (with *Gm8*) and INRC 3021(with *Gm8*) exhibited nil damage whereas RP5925 had 15% DP when evaluated at Warangal. But in farmer's field 30 km from research farm, Aganni recorded 5 % DP, while INRC 3021 showed no damage.

Biotype5: At Pattambi, this year the infestation level was so high that all the donors exhibited susceptibility, though W1263 (with *Gm1*) recorded lowest damage of 23.8 % DP. At Moncompu, both Kavya and W1263 with *Gm1* gene had nil damage.

*Evaluation of the gene differentials in one greenhouse and 9 field tests against 5 different biotypes identified Aganni (*Gm8*) as promising in 8 of the 10 valid tests. INRC 3021(*Gm8*), RP5925 (*Gm8*), W1263 (*Gm1*) and Kavya were promising in 5 of the valid 10 tests. The results suggest that *Gm8* and *Gm1* hold promise across locations.*

Table 2.10 Reaction of gene differentials to gall midge populations in GMBT, kharif 2019

Group	Entry No.	Differential	Gene	GMB1			GMB3		GMB 4	GMB 4M	GMB 4M \$	GMB 5		Overall NPT
				IIRR	CHP	ABP (RPR)	JGT	RCI	SKL	WGL1	WGL2	PTB	MNC	
				GH	50DT	60DT	50DT	50DT	50DT	54DT	59DT	50DT	50DT	
				%DP	%DP	%DP	%DP	%DP	%DP	%DP	%DP	%DP	%DP	
I	1	KAVYA	Gm 1	0	10	0	35	0	0	65	85	47.6	0	5
	2	W 1263	Gm 1	0	0	0	20	0	5	65	100	23.8	0	5
	3	ARC 6605	(?)	0	60	60	95	0	95	80	75	100	20	2
II	4	PHALGUNA	Gm 2	5.9	80	50	100	30	100	85	89.5	100	26.7	0
	5	ARC 5984	Gm 5	15.4	50	60	75	40	100	75	95	100	26.7	0
	6	DUKONG 1	Gm 6	0	50	50	95	0	100	85	95	100	33.3	2
	7	RP 2333-156-8	Gm 7	0	50	70	70	40	95	70	95	100	26.7	1
	8	MADHURI L 9	Gm 9	0	20	30	30	0	63.2	95	80	90.5	26.7	2
	9	BG 380-2	Gm10	27.3	50	100	90	0	100	90	95	100	33.3	1
III	10	MR 1523	Gm11	0	60	0	10	0	95	55	77.8	100	33.3	3
IV	11	RP 2068-18-3-5	gm 3	0	40	20	45	30	45	30	47.4	100	6.7	1
	12	ABHAYA	Gm 4	0	50	30	35	0	85	45	80	100	40	2
	13	INRC 3021	Gm 8	16.7	20	20	0	0	0	0	5	100	20	5
	14	AGANNI	Gm 8	0	0	5	0	0	0	0	0	100	26.7	8
	15	INRC 15888	Gm 8	0	10	10	30	20	30	60	100	100	13.3	3
	16	B 95-1	none	100	40	80	100	35	100	95	100	100	46.7	0
V	17	TN1	none	100	70	100	95	60	100	90	100	100	33.3	0
	18	RP 5925	Gm 8	0	0	0	0	30	5	15	30	100	26.7	5
	19	RP 5921	Gm 1	P.D.I	0	50	70	35	75	NP	100	100	20	1
	20	S. Check	none	100	40	90	100	50	100	95	100	100	26.7	0
Total Tested				20	20	20	20	20	20	20	20	20	20	
Ave.damage in the trial				19.2	35	41.3	54.8	18.5	64.7	62.9	77.5	93.1	24.3	
Average damage in S. checks				100	50	90	98.3	48.3	100	93.3	100	100	35.6	
Promising level				0	10	10	0	0	10	0	10	0	0	
No. promising				12	6	6	3	10	5	2	2	0	2	

* NP-no plants, \$- farmers field Pest incidence was low at JDP, MND,MTU and RGL. Data not received from Cuttack and Nellore

b) Gall midge population monitoring (GMPM)

The virulence pattern of the gall midge populations is monitored through progeny testing of a single gall midge female in GMPM trial. This year the trial was conducted on three differentials, W1263 (*Gm1*), RP2068-18-3-5 (*gm3*) and Aganni (*Gm8*) along with Purple variety at Warangal, Pattambi and Jagtial. The differentials were grown in a single pot with 5-10 seedlings each and labeled appropriately. Each pot was infested with a single mated female collected from light source and covered by a plastic bag placed tightly over the pot. The pots were observed for the gall development and emergence of insects from the gall. Number and sex of the emerging adults was also recorded from each pot. Based on these observations, virulence status was assigned to the parent insect. The results of this year's trial are summarized in **(Table 2. 11)** and discussed below.

Pattambi: Of the 128 females tested, 91 females were virulent. Of these, 68% were virulent on purple, 39.1% on W1263, 17.97% on RP 2068-18-3-5 and 71.1% on Aganni but the damage was low (only 12.9% SS) on W1263. The sex ratio was highly favourable on all the lines and 1M:1.1F on W 1263. This corroborates with the low damage observed in W1263 (*Gm1*) in the other gall midge trials at this location

Warangal: At this location, 250 females were tested, however, the number of infested pots as well as galls were low. Aganni showed the lowest incidence followed by RP 2068-18-3-5 and sex ratio was also in favour of males in Aganni.

Jagtial: Hundred females were tested and Aganni showed nil virulence and damage. The percent virulence was 36% was on purple variety, 20% on W1263 and 28% on RP 2068-18-3-5, while. the percent male progeny varied from 30.0 to 38.9 %.

Evaluation of the gene differentials through single female progeny testing revealed that populations at Jagtial and Warangal were less virulent on Aganni (Gm8) as compared to populations at Pattambi whereas there was increase in virulence on RP 2068-18-3-5 (gm3). This is a matter of concern as this trend has also been evident in GMBT trial in the past few years.

Table 2.11 Virulence composition of gall midge populations in GMPM, kharif 2019

	Locations											
Parameters	Pattambi				Warangal				Jagtial			
No of females tested	128				250				100			
	AGA-NNI	RP 2068-18-3-5	W 1263	PUR-PLE	AGA-NNI	RP 2068-18-3-5	W 1263	PUR-PLE	AGA-NNI	RP 2068-18-3-5	W 1263	PUR-PLE
Pots with Infested plants	91	50	33	87	1	5	14	24	0	28	20	36
% of virulent females	71.1	39.1	17.97	68	0.4	2	5.6	9.6	0	28	20	36
No of plants damaged	287	259	51	337	6	25	50	89	0	188	154	170
% DP	84.4	73.6	17.8	99.4	0.4	2.13	6	8.23	0	27.4	13	21.2
SS(%)	60	63.1	12.9	56.6	0.17	28	36	35.96	0	14.9	13	21.2
Sex ratio (M:F)	1:4.1	1:3.4	1:1.1	1:1.25	1:0	1:1.5	1:5	1:0.78	0	1:1.8	1:2.33	1:1.6
% male progeny	19.7	15.9	47.4	28.3	100	40	16.7	56.3	0	35.7	30	38.9

No data was received from Ragolu, Sakoli and Moncompu

C. Planthopper Special Screening Trial (PHSS)

A set of 16 primary sources of BPH resistance with some sources having known resistance gene(s) was evaluated at eleven locations viz., IIRR, Aduthurai, Coimbatore, Gangavathi, Ludhiana, Mandya, Maruteru, New Delhi, Pantnagar, Rajendranagar and Warangal in the greenhouse in standard seedbox screening test (SSST) with 2 to 3 replications. The special screening tests such as days to wilt to know the tolerance mechanism,

feeding preference test by measuring honeydew excretion, nymphal survival and egg hatching tests were conducted at Pantnagar.

Based on SSST results presented in **(Table 2.12)** showed that two gene differentials *viz.*, PTB 33 (with *bph2+Bph3*+unknown factors) was promising at 8 locations and RP 2068-18-3-5 (with *Bph33(t)* gene) was promising in 9 out of 11 locations. T12 (with *bph7* gene) performed better at 4 centres, while Rathu Heenati (with *Bph3+Bph17* genes), Swarnalatha with *Bph 6* gene and Babawee with *bph 4* gene performed consistently at 3 centres, each. Three other gene differentials *viz.*, ASD 7 with *bph2*, Chinsaba with *bph 8* gene and IR 65482-7-216-1-2-B with *Bph 18* gene showed low damage at two locations only. Four differentials *viz.*, IR 64 (with *Bph1* gene +), IR 36 with (*bph2* gene) at, MUT NS 1 with unknown genetics and Pokkali with *bph9* gene, performed better at one location. Three gene differentials *viz.*, IR71033-121-15 with *Bph 20/21* gene, Milyang 63 and OM 4498 with unknown genetics showed susceptible reaction at all the test locations.

Except for PTB 33 (DS 4.3), none of the above differentials showed promise against WBPH when evaluated at CBT.

At Pantnagar, lowest nymphal survival was observed in RP 2068-18-3-5 followed by Babawee and highest nymphal survival was *observed* in IR 36. RP 2068-18-3-5 did not wilt. Honeydew excretion was lowest in RP 2068-18-3-5 followed by Rathu Heenati and Babawee. RP 2068-18-3-5 showed superiority in all the three tests compared to other donors.

Among the 16 gene differentials evaluated, two differentials viz., PTB 33 (with bph2+Bph3+unknown factors) was promising at 8 locations and RP 2068-18-3-5 (with Bph33(t) gene) was promising in 9 out of 11 locations. T12 (with bph7 gene) performed better at 4 centres, while Rathu Heenati (with Bph3+Bph17 genes), Swarnalatha with Bph 6 gene and Babawee with bph 4 gene performed consistently at 3 centres, each. Three other gene differentials viz., ASD 7 with bph2, Chinsaba with bph 8 gene and IR 65482-7-216-1-2-B with Bph 18 gene showed low damage at two locations only. Except for PTB 33 (DS 4.3), none of the above differentials showed promise against WBPH. RP 2068-18-3-5 showed superiority through low honeydew excretion, nymphal survival and egg hatching in tests conducted at Pantnagar.

Table: 2.12 Reaction of most promising gene differentials against BPH in PHSS, kharif 2019

Entry No.	Designation	Gene	Reaction of Differentials (DS)											
			IIRR	ADT	CBT BPH	GNV	LDN	MND	MTU	NDL	PNT	RNR	WGL	NPT (11)
1	ASD 7 (ACC 6303)	<i>bph2</i>	9.0	8.6	6.5	3.0	6.9	9.0	1.0	7.3	8.4	9.0	8.8	2
2	Babawee (ACC 8978)	<i>bph4</i>	9.0	8.4	7.3	1.0	6.2	7.0	3.0	6.8	2.1	9.0	6.2	3
3	Chinsaba (ACC 33016)	<i>bph8</i>	9.0	8.6	6.4	3.0	6.7	9.0	3.0	7.3	9.0	7.3	8.1	2
7	IR 65482-7-216-1-2-B	<i>Bph18</i>	7.3	8.8	7.1	1.0	5.8	7.0	7.0	7.0	3.5	5.7	8.2	2
14	Ptb33	<i>bph2+</i> <i>Bph3+</i>	1.4	???	4.3	3.0	2.0	NG	9.0	5.0	NG	3.3	3.3	8
16	Rathu Heenati (ACC 11730)	<i>Bph3+</i> <i>Bph17</i>	8.4	7.7	7.6	3.0	4.9	5.0	7.0	6.6	5.1	6.8	8.2	3
17	RP 2068-18-3-5	<i>Bpt33</i>	1.1	1.0	7.8	3.0	2.1	3.0	1.0	4.0	1.2	5.9	1.9	9
18	Swarnalatha (ACC 33964)	<i>Bph6</i>	8.5	3.0	7.1	9.0	5.5	7.0	3.0	7.7	5.6	4.7	6.0	3
19	T 12 (ACC 56989)	<i>bph7</i>	8.5	3.5	7.5	9.0	4.4	7.0	1.0	4.8	8.8	8.1	5.3	4

2.2. CHEMICAL CONTROL STUDIES

Insecticide-Botanicals Evaluation Trial (IBET)

Use of plant extracts or botanicals is one of the earliest and traditional practices in control of insect pests of crops. Botanicals can play a key role in management of rice pests as they are environment-friendly, safe to non-target organisms, renewable and cost effective. Integration of botanicals in rice IPM will reduce pesticide load in environment, prevent insecticide resistance and help in conserving natural enemy populations. Earlier efforts under AICRIP were mainly focussed on evaluation of efficacy of various commercial botanical formulations *vis-a-vis* insecticides against insect pests. Hence, it was felt necessary to test combination of insecticide and botanical modules against major pests of rice in order to identify the effective combination and strategically integrate use of botanicals for ideal rice IPM. So, a trial consisting of various treatments having combinations of effective and commercially available oils with recommended insecticides was initiated last year during *kharif* 2019 to evaluate their performance against major insect pests at 28 locations.

Sl. No.	Location	Date of sowing	Date of planting	Date of harvesting	No of applications	Times of application (DAT)
1	Arundhutinagar	-	-	-	1	45
2	Bapatla	13-08-2019	04-09-2019	04-01-2020	3	60, 70 & 91
3	Coimbatore	03-06-2019	24-06-2019	17-10-2019	3	32, 51 & 67
4	Chiplima	28-06-2019	24-07-2019	23-11-2019	3	25, 50 & 65
5	Chinsurah	26-06-2019	17-07-2019	05-11-2019	3	15, 30 & 50
6.	Cuttack	04-07-2019	04-08-2019	30-11-2019	3	25, 50 & 65
7.	Gangavathi	26-07-2019	12-09-2019	16-01-2020	3	24, 48 & 61
8	Jagdulpur	26-06-2019	06-08-2019	10-12-2019	3	33, 53 & 73
9	Khudwani	16-05-2019	13-06-2019	11-10-2019	3	30, 50 & 65
10	Karjat	13-06-2019	07-07-2019	11-11-2019	2	31 & 51
11	Karikal	08-08-2019	04-09-2019	17-12-2019	3	36, 51 & 70
12	Ludhiana	24-05-2019	24-06-2019	30-10-2019	3	42, 57 & 78
13	Malan	23-06-2019	19-07-2019	07-11-2019	3	36, 42 & 57
14	Mandya	14-08-2019	11-09-2019	06-01-2020	3	31, 50 & 65
15	Masodha	12-06-2019	10-07-2019	15-10-2019	2	29, 46 & 64
16	Maruteru	06-07-2019	06-08-2019	23-11-2019	3	32, 52 & 69
17	Navsari	03-07-2019	05-08-2019	02-12-2019	4	20, 30, 50 & 60
18	Nawagam	18-07-2019	16-08-2019	25-11-2019	3	26, 40 & 60
19	New Delhi	27-06-2019	22-07-2019	18-11-2019	5	35, 57, 66, 71 & 78
20	Pattambi	07-07-2019	26-07-2019	18-11-2019	3	15, 45 & 75
21	Pusa	23-06-2019	18-07-2019	22-11-2019	3	24, 44 & 59
22	Raipur	10-07-2019	16-08-2019	02-12-2019	3	45, 59 & 81
23	Ragolu	30-07-2019	30-08-2019	11-12-2019	2	28 & 51
24	Rajendranagar	05-07-2019	04-08-2019	28-11-2019	4	27, 34, 53 & 70
25	Ranchi	09-07-2019	30-07-2019	04-11-2019	3	30, 50 & 65
26	Sakoli	27-06-2019	24-07-2019	20-11-2019	3	17, 35 & 58
27	Warangal	20-06-2019	18-07-2019	01-12-2019	2	33, 60 & 74
28	Titabar	09-07-2019	10-08-2019	10-12-2019	1	21

Treatments:

Four combination modules/treatments consisting of three insecticides- Chlorantraniliprole 20% SC, Cartap hydrochloride 50% SC and Triflumezopyrim 10% SC, one commercial neem formulation - Neemazal and two oils - Neem and Eucalyptus oil procured from local market, Hyderabad (Telangana) were compared along with untreated control (only water spray). There were five treatments (**Table 2.13**) replicated four times and laid out in Randomized Complete Block Design (RCBD). Spray applications of the treatments were done based on pest incidence exceeding the economic threshold level guidelines at 10-15 days interval. All the treatments were applied as high-volume sprays @ 500 litres of spray fluid/ha.

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

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

Results

Pest Infestation (Table 2.13)

Stem borer infestation was observed in 20 locations and damage during vegetative stage ranged from 0.8 to 13.0% dead hearts (DH) in all insecticide treatments and 1.1 to 19.5% in other combination treatments compared to 1.5 to 32.8% in untreated control, during 30 to 77 DAT. There were significant differences in dead heart damage among the treatments at 12 locations. All insecticides treatment module recorded the lowest mean damage of 3.7% when compared to 10.5% in untreated control. Among other treatments, neemazal, eucalyptus oil and cartap hydrochloride combination showed lowest mean infestation of 5.4% DH. White ears (WE) damage at heading stage in various treatments ranged from 0.5 to 59.3% compared to 1.3 to 79.4% in control across 23 centres. There were significant differences among treatments in white ear damage at 14 locations. Highest white ear damage was reported from Arundhatinagar which ranged from 34.1 to

59.3% while Ragolu reported the lowest (0.7-1.5%) in treatments compared to a maximum of 79.4% in untreated control. Mean WE infestation ranged from 5.9 to 10.6% in treatments as compared to 17.0% in control. Among modules, all insecticides module was found to be the best with 5.9% mean white ear damage followed by neemazal, eucalyptus oil and cartap hydrochloride module with 7.6% WE.

Overall, all insecticides module was found to be superior in reducing stem borer damage compared to other insecticide-botanical modules and was the most effective treatment at both vegetative and reproductive phases.

Gall midge occurrence was reported from 7 centres of which Chiplima recorded highest damage ranging from 8.1 to 16.7% SS across treatments and 22.4 to 23.9% SS in control at 56 and 75 DAT. At other locations, the SS damage varied from 0.8 to 14.2% in treatments and 1.1 to 19.7% in control. There were significant differences in the efficacy among the treatments at Chiplima, Ranchi and Titabar. Lowest mean infestation was recorded in Neem formulations and triflumezopyrim combination (5.8%) on par with all insecticides treatment (6.2%) and significantly superior to control (12.0%).

Brown planthopper incidence was very high at Maruteru (129.5-232.8 hoppers/10 hills) at 50 DAT followed by New Delhi with population of 30.0 to 129.3 hoppers/10 hills at 90 DAT. Across 11 locations, all insecticides treatment was found to be the most effective one (31.2 hoppers/10 hills) followed by insecticide-botanical treatments in reducing BPH populations (31.4-38.8 hoppers/10 hills) and they were significantly superior to control (48.2 hoppers/10 hills).

White backed planthopper populations were observed at 11 locations and Gangavathi recorded the highest populations ranging from 163.3 to 194.3 hoppers/10 hills across the treatments at 55 DAT followed by Nawagam centre (57.5-173.5 hoppers/10 hills). Treatment consisting of all insecticides was the most effective in reducing WBPH populations (27.5 hoppers/10 hills). Botanical-insecticide combination treatments also showed significant efficacy against the hoppers (34.0 to 35.4 hoppers/10 hills) compared to that of control (49.6 hoppers/10 hills).

Green leafhopper incidence was high at Masodha (23.8-248.5 hoppers/10 hills) among the 10 centres. All insecticides combination was the most effective treatment showing population of 13.5 hoppers/10 hills and superior to control (33.9 hoppers/10 hills). There were significant differences in hopper populations among the treatments at 6 locations as well as in populations recorded at 92 and 98 DAT at Bapatla, 30 and 50 DAT at Jagdalpur, 63 and 83 DAT at Navsari and 50 DAT at Ragolu. All the treatments showed significant efficacy (13.5-22.8 hoppers/10 hills) when compared to control (33.9).

Leaf folder damage was recorded from 19 locations and highest leaf damage was recorded in Ranchi centre (17.0-59.3%) during 63 to 67 DAT followed by

Malan with 25.6 to 56.5% at 79 DAT. There were significant differences in leaf damage among the treatments at 13 locations. All insecticides module was the most effective treatment showing mean leaf damage of 4.9% DL followed by treatment with neem formulations and triflumezopyrim (6.6% DL) when compared to other treatments and untreated control (11.4% DL). All botanicals combination treatment also significantly reduced leaf folder damage (7.6% DL) when compared to control.

Whorl maggot infestation was recorded at 8 centres and higher foliage damage was noticed in New Delhi ranging from 11.6-17.5% in treatments followed by Jagdalpur (12.1-14.8%) compared to highest damage in control (24.4%) observed at Titabar . The lowest mean damage was recorded in insecticides treatment (5.1% DL). A damage range of 5.6-7.4% DL was recorded in botanical treatments compared to control (9.0% DL).

Hispa damage was recorded at 4 centres *viz.*, Malan, Maruteru, Ranchi and Ragolu. Highest damage of 47.8 to 92.1% DL was observed in Malan at 77 DAT followed by Ranchi (14.5-65.3% DL at 25 and 33 DAT). Treatment consisting of all insecticides was the most effective one with 26.1% mean leaf damage. Other treatments were also found effective showing 29.2 to 30.7% leaf damage compared to 44.6% in control.

Grasshopper infestation was reported only from Khudwani centre during 30 to 77 DAT with damage range of 0.2 to 8.2% in treatments and 2.0 to 9.9% DL in control. All insecticides module recorded the lowest mean damage of 3.2% compared to 4.9% DL in control.

Natural enemies: The populations of **mirid bug**, an important natural enemy of BPH, were recorded in 7 centres. High populations of 6.8 to 45.0 mirid bugs/10 hills were observed in Gangavathi, followed by Maruteru with 17.8 to 38.0 bugs/10 hills in treatments as against 25.5 to 49.0 bugs/10 hills in control. There were no significant differences in mirid populations among treatments at Bapatla (except at 92 DAT) and Sakoli . Low mean population of mirid bugs was recorded in all insecticides treatment (12.9/10 hills) indicating that the adverse effect of insecticide on predators. Botanical combination treatments showed relatively higher mirid populations (17.8/10 hills) at par with control (19.7 bugs/10 hills) signifying that botanicals are relatively safe to mirid bug. **Spider** populations were recorded in 8 locations, of which Gangavathi reported more spider numbers (14.0-37.3/10hills) during 40 to 100 DAT followed by New Delhi (27.0-31.8/10 hills at 100 DAT) and Maruteru (20.8-28.8/10 hills at 50 DAT). Mean spider population in botanical treatments ranged from 13.2 to 15.1/10 hills as compared to 16.3 in control indicating the relative safety of these treatments to spiders. Comparatively lower spider numbers were recorded in all insecticide treatment (12.1/10 hills). **Coccinellid** populations were reported from 3 centres-Bapatla, Sakoli and Warangal. There were no significant differences in populations among the treatments and control across centres. However, the lowest mean numbers 3.58 per10 hills were recorded in botanicals and cartap hydrochloride treatment compared to 4.54 per 10 hills in control.

Grain Yield (Table 2.14):

There were significant differences in grain yield among the treatments including control at all locations except Bapatla, Chatha, Gangavati, Karaikal and New Delhi. Based on mean yield of these locations, all insecticides- Chlorantraniliprole, Cartap hydrochloride, Triflumezopyrim treatment recorded the highest grain yield of 4781.2 kg/ha with 32.3% increase over control (IOC) followed by neemazal, neem oil and triflumezopyrim with 4393.0 kg/ha (21.6% IOC). All the treatments were significantly superior to control plot which showed an yield of 3613.0 kg/ha.

Insecticide Botanicals Evaluation Trial (IBET) was carried out at 28 locations across the country to evaluate performance of various treatments having combinations of commercially available neem formulation, effective plant oils along with recommended insecticides against major insect pests of rice and consequent impact on natural enemies and grain yield during kharif, 2019. Based on the performance of the various treatment combinations in controlling the pest damage at various locations, all insecticides module was found to be superior in reducing stem borer damage compared to other insecticide-botanical modules and was the most effective treatment at both vegetative and reproductive phases. Lowest silver shoot damage was recorded in neem formulations and triflumezopyrim module on par with all insecticides treatment. All insecticides combination was found to be the most effective treatment against plant and leafhoppers. Against leaf folder also insecticides module was effective in reducing leaf damage. Insecticide and botanical combination treatments were found moderately effective in reducing damage by hispa, whorl maggot and grasshopper pests. Botanical combination treatments however showed relatively higher natural enemy (mirid, spider and coccinellid) populations compared to all insecticides treatment signifying that botanicals are relatively safe to predators. Among various treatments, all insecticides treatment recorded highest yield of 4781.2 kg/ha with 32.3% increase over control followed by treatment with applications of neemazal, neem oil and triflumezopyrim showing yield of 4393.0 kg/ha (21.6% IOC). All the treatments were superior to untreated control.

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Table: 2. 13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No	Treatment details	Stem borer damage (% Dead Hearts)																
		ARD		CBT		CHN		CHP		CTC		GNV	JDP					
		30DT	50DT	30DT	50DT	30DT	50DT	56DT	75DT	30DT	60DT	50DT	30DT	30DT	50DT	50DT	70DT	70DT
1	Botanical-Insecticide 1	1.7b	5.2b	9.0a	4.4a	10.2b	7.6c	2.3c	2.0c	4.0bc	3.2c	3.0a	5.1a	2.7bc	2.8a	1.5b	1.8ab	1.5b
2	Botanical-Insecticide 2	1.4b	4.8b	9.2a	4.2a	11.5b	9.3bc	3.5b	3.2b	4.3b	3.8c	2.0b	3.2a	2.2bc	5.0a	1.8ab	1.2b	1.2b
3	All Botanical	2.2ab	5.9ab	10.9a	4.9a	11.8b	10.7b	3.0bc	3.5b	6.4a	5.9b	3.4a	3.7a	5.3ab	2.3a	1.5b	1.5ab	1.5b
4	All Insecticide	2.3ab	7.0ab	8.9a	3.2a	5.5c	3.7d	1.9c	1.5c	3.2c	2.2d	1.5b	1.6a	1.6c	2.0a	1.1b	1.0b	1.0b
5	Control (Water Spray)	3.0a	9.1a	12.0a	6.6a	18.5a	16.6a	5.7a	7.0a	7.4a	8.1a	3.7a	6.1a	6.9a	4.1a	3.4a	2.2a	3.7a

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No.	Treatment details	Stem borer Damage (%Dead Hearts)																
		KJT		KRK		LDN							MND		MSD		NVS	
		30DT	50DT	30DT	50DT	41DT	45DT	50DT	56DT	61DT	66DT	71DT	30DT	50DT	30DT	50DT	30DT	50DT
1	Botanical-Insecticide 1	19.5a	12.3a	7.3a	1.9a	4.2a	2.9b	2.9b	3.0b	2.8b	1.9bc	2.0c	3.8b	6.4bc	8.9c	8.5c	9.4c	12.5c
2	Botanical-Insecticide 2	15.6a	9.4ab	7.2a	1.4a	4.2a	2.9b	2.9b	2.9b	2.8b	2.8b	3.0b	3.6b	9.2ab	3.9d	3.6d	11.1bc	14.5b
3	All Botanical	17.5a	7.9d	10.3a	2.7a	4.2a	2.8b	2.9b	3.1b	2.9b	2.7b	3.0b	2.2b	5.0bc	16.6b	13.9b	13.1b	15.0b
4	All Insecticide	13.0a	7.7b	9.4a	1.9a	4.1a	1.5c	1.6b	1.5c	1.5c	1.8c	1.9c	1.3b	1.7c	1.7d	0.8d	8.7c	10.8c
5	Control (Water Spray)	11.8a	12.8a	6.4a	3.3a	4.2a	4.6a	5.6a	6.1a	7.1a	7.9a	7.9a	9.1a	12.7a	29.4a	26.3a	20.8a	22.5a

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Stem borer Damage (% Dead hearts)														Mean
		NWG		PUS		RCI		RPR		SKL		TTB		WGL		
		30DT	50DT	30DT	50DT	30DT	50DT	30DT	50DT	65DT	80DT	30DT	50DT	75DT	77DT	
1	Botanical-Insecticide 1	2.6a	5.2c	10.1b	12.2bc	6.7b	5.0b	14.0b	12.3b	2.3a	1.8c	4.7d	5.5d	1.1a	1.4a	5.4
2	Botanical-Insecticide 2	2.1a	8.4b	10.0b	10.5c	7.4b	3.8c	14.3b	12.3b	2.0a	2.7bc	7.4c	8.5c	1.2a	1.7a	5.5
3	All Botanical	2.1a	10.2b	11.2b	13.2d	6.6b	5.1b	13.9b	12.4b	2.0a	4.4ab	17.7b	15.6b	1.2a	2.3a	6.8
4	All Insecticide	2.1a	2.8d	5.8c	3.9d	4.5c	2.0d	12.1b	12.0b	2.4a	3.3abc	3.1d	2.6e	1.1a	1.1a	3.7
5	Control (Water Spray)	2.8a	13.2a	16.1a	18.3a	11.7a	13.6a	18.4a	17.4a	2.0a	5.1a	32.8a	27.9a	1.5a	2.8a	10.5

Botanical-Insecticide 1:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT), Cartap hydrochloride 50% SC 2g/l (60-65 DAT)
Botanical-Insecticide 2:	Neemazal 1% EC 2ml/l (25-30 DAT), Neemoil 10 ml/l (45-50 DAT), Triflumezopyrim 10% SC 0.48ml/l (60-60 DAT)
All Botanical:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT) , Neem oil 10ml/l (60-65 DAT)
All Insecticide:	Chlorantraniliprole 20% SC 0.2ml/l (25-30 DAT), Cartap hydrochloride 50% SC 2g/l (50-55 DAT), Triflumezopyrim 10% SC 0.48ml/l (65-70 DAT)

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No.	Treatment details	Stem borer Damage (% White Ears)											
		ARD	CBT	CHN	CHP	CTC	GVT	KJT	KRK	LDN	MND	MSD	MTU
		Pre-harvest											
1	Botanical-Insecticide 1	34.1c	17.8a	7.3c	3.2c	4.4d	2.8b	4.4b	1.1a	2.5c	2.8d	6.1c	9.0a
2	Botanical-Insecticide 2	59.3ab	17.3a	13.2b	5.2b	7.0c	2.3bc	1.9cd	1.8a	3.5b	6.5c	3.0d	7.9ab
3	All Botanical	47.2bc	17.7a	9.6bc	5.0b	10.9b	3.1ab	4.0bc	1.6a	3.5b	9.6b	9.8b	8.4a
4	All Insecticide	44.4bc	16.0a	7.5c	2.2c	2.6d	1.6c	1.5d	1.8a	2.1c	2.0d	1.0d	4.6b
5	Control (Water Spray)	79.4a	18.9a	9.6a	7.8a	13.7a	4.2a	15.0a	1.3a	8.7a	15.2a	29.6a	6.8ab

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No.	Treatment details	Stem borer Damage (% White Ears)											Mean
		NDL	NVS	NWG	PUS	RCI	RGL	RNR	RPR	SKL	TTB	WGL	
		Pre-harvest											
1	Botanical-Insecticide 1	1.6b	7.0cd	23.1d	10.4c	4.0c	0.8b	0.9c	18.7bc	6.5a	3.9d	1.1a	7.6
2	Botanical-Insecticide 2	2.9a	9.2bc	32.3c	8.3d	5.0c	1.1b	2.4b	19.6b	6.5a	6.2c	2.3a	9.8
3	All Botanical	2.9a	10.6ab	41.2d	14.0b	7.1b	1.5b	1.4bc	17.7bc	7.9a	13.2b	2.4a	10.9
4	All Insecticide	1.6b	4.8d	5.6e	3.1e	2.7d	0.7b	0.5c	16.5c	7.4a	4.0d	1.4a	5.9
5	Control (Water Spray)	2.8a	13.2a	51.6a	23.1a	10.4a	5.0a	6.2a	27.1a	9.1a	20.9a	2.4a	17.0

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No.	Treatment details	Gall midge Damage (% Silver Shoots)											Mean
		CHP	CHP	KRK	MTU	RCI	SKL	SKL	TTB	WGL	WGL	WGL	
		56 DT	75 DT	50 DT	50 DT	30 DT	45 DT	65 DT	50 DT	70 DT	77 DT	93 DT	
1	Botanical-Insecticide1	15.6bc	14.2b	1.3a	1.3a	6.3b	9.7a	18.1a	5.5cd	1.6a	1.3a	0.9a	6.9
2	Botanical-Insecticide 2	9.1d	8.1c	1.3a	2.6a	7.0b	8.4a	14.5a	8.6c	1.5a	1.8a	1.3a	5.8
3	All Botanical	13.7c	13.3b	0.8a	2.2a	6.7b	8.2a	15.2a	15.2b	1.0a	2.1a	1.1a	7.2
4	All Insecticide	16.7b	14.7b	1.8a	1.6a	3.1c	10.6a	14.2a	2.0d	1.0a	2.4a	1.0a	6.2
5	Control (Water Spray)	23.9a	22.4a	1.8a	1.6a	13.1a	12.6a	19.7a	31.2a	1.4a	2.7a	1.1a	12.0

Botanical-Insecticide 1:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT), Cartap hydrochloride 50% SC 2g/l (60-65 DAT)
Botanical-Insecticide 2:	Neemazal 1% EC 2ml/l (25-30 DAT), Neemoil 10 ml/l (45-50 DAT), Triflumezopyrim 10% SC 0.48ml/l (60-60 DAT)
All Botanical:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT) , Neem oil 10ml/l (60-65 DAT)
All Insecticide:	Chlorantraniliprole 20% SC 0.2ml/l (25-30 DAT), Cartap hydrochloride 50% SC 2g/l (50-55 DAT), Triflumezopyrim 10% SC 0.48ml/l (65-70 DAT)

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No.	Treatment details	Brown Planthopper(No./10 hills)													
		BPT						GNV				LDN			MND
		55DT	63DT	92DT	98DT	115DT	122DT	40DT	60DT	80DT	100DT	60DT	70DT	75DT	65DT
1	Botanical-Insecticide 1	79.3a	43.8bc	16.8a	10.0a	7.0a	2.8cd	40.0b	39.5b	33.0c	28.0cd	1.8b	2.5bc	5.5c	10.8a
2	Botanical-Insecticide 2	87.0a	42.5c	20.3a	9.3a	7.3a	2.5d	40.5b	41.0b	37.0bc	30.5c	2.0b	2.0bc	2.3d	9.5a
3	All Botanical	87.7a	58.3bc	18.8a	9.3a	6.3a	3.5ab	42.5b	41.0b	41.3b	39.0b	2.0b	3.0b	7.0b	12.3a
4	All Insecticide	105.3a	61.5b	21.0a	7.8a	6.0a	3.3bc	37.0b	30.8c	25.0d	20.5d	1.5b	1.3c	1.5d	14.0a
5	Control (Water Spray)	105.3a	125.3a	19.8a	10.8a	7.3a	4.0a	49.0a	61.8a	70.3a	76.5a	4.0a	8.8a	12.8a	11.0a

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No.	Treatment details	Brown Planthopper(No./10 hills)														
		MTU		NDL						NVS				RGL		
		30DT	50DT	50DT	60DT	70DT	80DT	90DT	100DT	60DT	63DT	80DT	83DT	30DT	50DT	75DT
1	Botanical-Insecticide 1	33.0a	232.8a	3.3a	12.0a	55.3ab	30.3bc	96.3a	77.8a	7.3a	6.5b	11.3a	9.0b	40.8b	55.5c	41.0b
2	Botanical-Insecticide 2	29.7a	131.5a	4.3a	17.0a	38.3b	11.8c	30.0b	62.0a	7.0a	4.5c	11.0a	6.3d	37.5b	59.3bc	42.5ab
3	All Botanical	37.5a	173.0a	6.5a	15.3a	87.0a	49.0ab	124.3a	90.8a	7.3a	4.8c	11.8a	7.5c	39.0b	62.3b	45.0ab
4	All Insecticide	34.3a	129.5a	4.0a	18.5a	74.3ab	21.5bc	35.8b	70.8a	7.0a	2.3d	11.5a	4.5e	32.5c	40.3d	40.8b
5	Control (Water Spray)	33.3a	224.8a	4.3a	17.3a	68.0ab	72.8a	129.3a	89.0a	7.0a	8.8a	11.5a	14.0a	48.3a	70.5a	49.3a

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No.	Treatment details	Brown Planthopper (No./10hills)												Mean
		RPR			SKL				WGL					
		60DT	80DT	100DT	49DT	53DT	64DT	68DT	61DT	70DT	75DT	77DT	81DT	
1	Botanical-Insecticide 1	6.3b	48.3bc	23.8b	62.3a	31.0b	54.5a	39.8b	25.8ab	40.5ab	69.5a	29.8a	26.5ab	36.34
2	Botanical-Insecticide 2	5.0bc	47.8bc	23.3b	66.0a	26.8b	55.5a	42.8b	24.3ab	46.3a	81.0a	20.3a	24.5bc	31.45
3	All Botanical	5.0bc	50.5b	23.0b	60.8a	25.3b	62.5a	39.3b	24.5ab	41.3ab	65.0a	25.3a	33.3a	38.76
4	All Insecticide	4.3c	42.8c	22.5b	63.3a	25.0b	61.0a	43.8ab	21.3b	34.8b	61.3a	17.5a	17.8c	31.18
5	Control (Water Spray)	10.0a	70.3a	37.8a	67.3a	43.3a	62.0a	50.3a	29.8a	43.3a	80.5a	38.8a	29.8ab	48.21

Botanical-Insecticide 1:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT), Cartap hydrochloride 50% SC 2g/l (60-65 DAT)
Botanical-Insecticide 2:	Neemazal 1% EC 2ml/l (25-30 DAT), Neemoil 10 ml/l (45-50 DAT), Triflumezopyrim 10% SC 0.48ml/l (60-60 DAT)
All Botanical:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT) , Neem oil 10ml/l (60-65 DAT)
All Insecticide:	Chlorantraniliprole 20% SC 0.2ml/l (25-30 DAT), Cartap hydrochloride 50% SC 2g/l (50-55 DAT),Triflumezopyrim 10% SC 0.48ml/l (65-70 DAT)

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Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

S. No.	Treatment Details	Whitebacked Planthopper (No./10 hills)																
		BPT						GNV				LDN						
		55DT	63DT	92DT	98DT	115DT	122DT	40DT	60DT	80DT	100DT	50DT	55DT	60DT	70DT	75DT	85DT	90DT
1	Botanical-Insecticide 1	163.3a	67.5bc	29.5a	13.5a	4.3a	2.8a	142.3b	125.0b	104.0c	86.5c	17.5a	12.0b	12.3b	11.3b	12.0b	9.3b	10.0b
2	Botanical-Insecticide 2	171.8a	83.3b	20.3a	12.5a	4.5a	2.8a	142.5b	117.8b	77.0d	63.5d	18.3a	11.3b	11.5b	11.0b	12.5b	3.3c	4.5c
3	All Botanical	194.3a	64.8c	30.8a	14.3a	4.8a	2.5a	141.3b	135.3b	131.8b	107.0b	18.0a	12.0b	12.0b	11.0b	12.3b	10.3b	11.0b
4	All Insecticide	176.5a	67.8bc	20.5a	13.3a	5.5a	2.5a	120.0b	93.3c	47.0e	40.0e	17.8a	9.8b	10.8b	9.5b	9.8b	3.0c	3.8c
5	Control (Water Spray)	178.8a	136.8a	16.8a	14.8a	5.0a	2.0a	165.8a	168.3a	154.5a	138.0a	18.0a	23.0a	26.8a	34.3a	45.0a	51.0a	35.0a

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

S. No.	Treatment Details	Whitebacked Planthopper (No./10 hills)											
		MND	MTU	NDL				NVS			NWG		
		65DT	50DT	30DT	40DT	50DT	60DT	60DT	80DT	83DT	50DT	65DT	75DT
1	Botanical-Insecticide 1	9.3a	32.8a	3.8ab	15.5a	13.8b	13.3a	6.0a	10.8a	8.0b	101.5b	113.0b	21.0b
2	Botanical-Insecticide 2	7.8a	21.8a	2.5b	18.5a	18.0ab	16.3a	6.0a	10.8a	4.0d	117.0b	107.0b	15.0bc
3	All Botanical	11.5a	21.3a	3.0b	18.8a	15.0b	13.0a	6.3a	10.8a	6.5c	120.0b	96.0b	34.0a
4	All Insecticide	8.3a	17.5a	5.5ab	16.0a	27.8a	11.5a	6.0a	11.0a	2.5e	55.8c	57.5c	10.0c
5	Control (Water Spray)	10.0a	30.5a	8.5a	19.3a	18.3ab	13.5a	6.5a	11.3a	13.5a	151.0a	173.5a	42.0a

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Whitebacked Planthopper (No./10 hills)																	Mean
S. No.	Treatment Details	RGL			SKL				WGL								
		30DT	50DT	75DT	49DT	53DT	64DT	68DT	40DT	61DT	70DT	75DT	77DT	81DT	93DT		
1	Botanical-Insecticide 1	34.5abc	60.3bc	50.0ab	17.0a	13.5b	21.0a	14.5b	5.5a	15.3a	22.5ab	45.8a	14.5ab	18.8a	6.8ab	35.4	
2	Botanical-Insecticide 2	31.0bc	63.0bc	63.3ab	16.0a	13.5b	19.5a	14.3b	8.5a	15.3a	28.3a	49.5a	10.3b	14.5ab	3.3d	34.0	
3	All Botanical	37.3ab	70.5b	66.0ab	16.0a	14.8ab	19.0a	13.5b	7.3a	16.8a	25.5ab	40.3a	14.0ab	20.8a	10.3a	38.2	
4	All Insecticide	28.8c	51.3c	56.5b	16.5a	14.0b	21.3a	13.0b	5.8a	13.8a	21.0b	38.5a	11.0b	8.8b	2.5b	27.5	
5	Control (Water Spray)	41.0a	90.3a	68.5a	17.0a	19.3a	22.0a	18.3a	9.0a	16.0a	22.8ab	45.0a	18.5a	18.3a	5.5ab	49.6	

Botanical-Insecticide 1:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT), Cartap hydrochloride 50% SC 2g/l (60-65 DAT)
Botanical-Insecticide 2:	Neemazal 1% EC 2ml/l (25-30 DAT), Neemoil 10 ml/l (45-50 DAT), Triflumezopyrim 10% SC 0.48ml/l (60-60 DAT)
All Botanical:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT), Neem oil 10ml/l (60-65 DAT)
All Insecticide:	Chlorantraniliprole 20% SC 0.2ml/l (25-30 DAT), Cartap hydrochloride 50% SC 2g/l (50-55 DAT), Triflumezopyrim 10% SC 0.48ml/l (65-70 DAT)

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Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No.	Treatment details	Leaf folder Damage (% Damaged Leaves)																	
		ARD	BPT					CHN		GNV		JDP						KRK	
		45DT	58DT	65DT	93DT	100DT	117DT	15DT	30DT	60DT	90DT	30DT	30DT	50DT	50DT	70DT	70DT	30DT	50DT
1	Botanical-Insecticide 1	2.4b	6.7b	4.2b	2.0ab	3.1a	1.3a	1.7c	0.6bc	3.3b	3.3b	11.1a	8.2a	6.1a	2.7b	5.0bc	3.3c	9.2	5.5b
2	Botanical-Insecticide 2	3.0ab	10.8a	4.0b	1.4b	2.6a	1.0b	2.8b	1.1b	2.9b	2.6b	6.4b	6.9ab	6.4a	3.6b	7.3a	4.4ab	8.8	6.9b
3	All Botanical	3.4ab	9.0ab	3.4b	3.5a	3.2a	1.3ab	1.3c	0.8bc	5.4a	4.6a	8.6ab	6.7ab	7.1a	3.8b	6.3ab	3.6bc	6.3	7.2b
4	All Insecticide	2.7b	8.5ab	2.9b	1.3b	2.7a	1.1ab	1.2c	0.4c	1.9c	1.5c	7.9b	3.8b	8.2a	2.5b	3.6c	1.5d	7.7	8.2b
5	Control (Water Spray)	4.3a	7.9ab	7.0a	2.5ab	2.8a	1.0b	3.5a	2.8a	5.8a	5.2a	8.9ab	8.8a	5.9a	7.7a	5.9ab	4.9a	10.9	11.8a

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No.	Treatment details	Leaf folder Damage (% Damaged Leaves)																
		LDN							MLN	MND	MSD		NDL			NVS		
		41DT	46DT	55DT	61DT	66DT	75DT	80DT	79DT	50DT	DAT	DAT	50DT	60DT	90DT	30DT	50DT	80DT
1	Botanical-Insecticide 1	6.2a	4.3b	4.3b	4.5b	4.8b	2.5c	2.5c	27.5b	3.7cd	10.7c	4.6b	1.1a	1.9a	1.7a	5.8d	7.1d	7.0d
2	Botanical-Insecticide 2	6.1a	4.1b	4.4b	4.2b	4.4b	4.0b	4.1b	25.6b	5.2c	7.4d	2.2c	0.9a	1.6a	2.1a	7.6c	9.0c	7.9c
3	All Botanical	6.4a	4.3b	4.4b	4.5b	4.5b	4.0b	4.1b	26.7b	7.6b	14.9b	5.8b	1.1a	1.3ab	1.8a	9.2b	10.0b	9.1b
4	All Insecticide	6.5a	3.0c	2.4c	2.0c	2.1c	1.8c	2.0c	27.8b	2.3b	3.6e	0.9c	0.7a	.06b	1.9a	4.7d	6.0e	6.1e
5	Control (Water Spray)	6.2a	7.4a	7.7a	8.8a	9.2a	10.6a	13.1a	56.5a	15.9a	21.8a	10.3a	1.3a	1.6a	2.2a	13.5a	14.1a	13.3a

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

Sl. No.	Treatment details	Leaf folder Damage (% Damaged Leaves)																		Mean
		NWG			PSA		RCI		RGL		RPR		SKL				TTB			
		30DT	45DT	60DT	30DT	50DT	63DT	67DT	30DT	50DT	40DT	60DT	49DT	57DT	64DT	72DT	30DT	50DT		
1	Botanical-Insecticide 1	6.0b	10.4b	12.2c	10.1bc	13.4b	55.8a	15.5cd	1.6b	2.4ab	3.1ab	2.1b	1.1a	1.2ab	2.3ab	2.4ab	3.4d	4.5c	6.5	
2	Botanical-Insecticide 2	5.5b	11.7b	19.5b	9.1bc	11.3b	54.8a	17.0c	2.2ab	2.8ab	2.7b	2.3b	1.4a	1.2ab	2.1ab	2.7ab	5.7c	5.6c	6.6	
3	All Botanical	6.2b	13.2b	22.8b	10.8d	11.9b	53.0a	33.3b	2.4a	3.8ab	2.4b	2.3b	1.4a	1.5ab	2.1ab	3.0ab	10.7b	8.6d	7.6	
4	All Insecticide	3.4c	6.2c	6.4d	8.1c	4.2c	52.5a	11.8d	1.6b	1.4b	2.7b	1.8b	1.4a	0.9b	1.8b	2.2b	2.5d	2.6d	4.9	
5	Control (Water Spray)	7.3a	19.4a	34.6a	15.7a	16.5a	56.8a	59.3a	2.8a	4.2a	4.2a	3.4a	1.0a	1.8a	2.3a	3.4a	23.9a	15.3a	11.4	

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Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Green Leafhopper (No./10 hills)																	
		BPT						GNV				JDP						MSD	
		55DT	63DT	92DT	98DT	115DT	122DT	40DT	60DT	80DT	100DT	30DT	30DT	50DT	50DT	70DT	70DT	DT	DT
1	Botanical-Insecticide 1	5.8a	4.5a	10.0b	15.8b	20.0a	10.8b	21.8b	21.0b	19.5b	17.8b	7.5a	5.5a	18.0a	9.5b	15.5b	4.5b	115.5c	117.8c
2	Botanical-Insecticide 2	5.5a	6.0a	16.0a	26.0a	25.3a	14.3a	22.5ab	18.8b	16.0bc	12.8bc	8.0a	7.3a	15.0a	5.0b	16.8b	10.0b	62.5d	48.5d
3	All Botanical	5.3a	4.8a	12.5ab	24.3a	22.5a	12.8ab	21.8b	20.5b	18.3bc	14.5bc	6.0a	9.5a	19.3a	6.3b	19.3ab	10.0b	137.5b	132.b
4	All Insecticide	4.8a	7.0a	15.0ab	26.8a	25.5a	12.0ab	18.5b	16.0b	13.3c	10.3c	11.0a	5.0a	17.3a	6.0b	16.0b	6.5b	28.5e	23.8e
5	Control (Water Spray)	6.0a	4.5a	12.5ab	21.5ab	20.8a	12.3ab	27.0a	29.5a	29.3a	29.0a	5.5a	8.5a	14.0a	22.3a	25.3a	18.0a	240.0a	248.5a

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Green Leafhopper (No./10 hills)																Mean
		NVS				RCI		RGL		RPR		SKL				TTB		
		60DT	63DT	80DT	83DT	63DT	67DT	30DT	50DT	40DT	60DT	49DT	53DT	64DT	68DT	30DT	50DT	
1	Botanical-Insecticide 1	4.5a	4.5b	9.0a	7.0b	62.8b	13.5c	4.5a	36.0ab	4.8b	4.0ab	10.8b	6.3b	15.8b	13.8b	4.5d	3.5d	19.0
2	Botanical-Insecticide 2	4.3a	2.5cd	8.8a	3.3d	66.5ab	17.8c	4.3a	41.3a	4.3b	3.3bc	12.3ab	8.3b	15.0b	13.8b	17.5c	18.8c	17.0
3	All Botanical	4.5a	3.5bc	8.8a	4.5c	62.8b	25.3b	3.8a	44.0a	4.3b	3.8b	13.0ab	7.3b	15.8ab	12.3b	31.0b	34.8d	22.8
4	All Insecticide	4.8a	1.5d	9.0a	2.5e	69.5a	9.0d	3.5a	29.3b	3.0b	2.0c	13.8a	8.5b	19.5a	14.0b	3.3d	2.8d	13.5
5	Control (Water Spray)	4.5a	6.3a	9.0a	13.0a	64.0ab	66.0a	5.5a	46.a	7.8a	5.5a	12.5ab	12.3a	16.8ab	18.3a	42.3a	48.8a	33.9

Botanical-Insecticide 1:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT), Cartap hydrochloride 50% SC 2g/l (60-65 DAT)
Botanical-Insecticide 2:	Neemazal 1% EC 2ml/l (25-30 DAT), Neemoil 10 ml/l (45-50 DAT), Triflumezopyrim 10% SC 0.48ml/l (60-60 DAT)
All Botanical:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT) , Neem oil 10ml/l (60-65 DAT)
All Insecticide:	Chlorantraniliprole 20% SC 0.2ml/l (25-30 DAT), Cartap hydrochloride 50% SC 2g/l (50-55 DAT), Triflumezopyrim 10% SC 0.48ml/l (65-70 DAT)

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Hispa (% Damaged Leaves)					Mean
		MLN	MTU	RCI		RGL	
		77DT	30DT	29DT	35DT	30DT	
1	Botanical-Insecticide 1	47.8b	3.40a	59.8a	34.8b	0.3ab	29.2
2	Botanical-Insecticide 2	50.0b	4.1a	62.0a	36.8b	0.3ab	30.7
3	All Botanical	50.8b	3.2a	62.3a	35.8b	0.2ab	30.5
4	All Insecticide	53.1b	2.9a	59.8a	14.5c	0.1b	26.1
5	Control (Water Spray)	92.1a	3.2a	61.3a	65.3a	0.4a	44.6

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Whorl Maggot (% Damage Leaves)										
		CHN		JDP						MTU	NDL	
		15DT	30DT	30DT	30DT	50DT	50DT	70DT	70DT	30DT	30DT	40DT
1	Botanical-Insecticide 1	2.3d	0.9d	14.8a	7.3b	10.0a	5.5bc	7.0b	4.1b	1.5a	11.6b	8.7b
2	Botanical-Insecticide 2	3.2c	1.4c	12.1a	7.6b	11.8a	6.7b	7.6ab	4.2b	1.6a	16.7ab	11.3a
3	All Botanical	3.8b	2.0b	14.1a	9.0ab	11.6a	7.2b	9.8a	4.2b	1.1a	15.4ab	11.4a
4	All Insecticide	1.6e	0.5d	13.4a	4.0c	10.5a	3.6c	6.8b	2.6c	1.1a	17.5a	10.3ab
5	Control (Water Spray)	4.8a	2.7a	13.9a	9.9a	14.9a	9.6a	9.0ab	5.5a	1.7a	15.5ab	9.7ab

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Whorl Maggot (% Damage Leaves)								Mean
		NDL			KRK	RGL	RNR	TTB		
		50DT	60DT	70DT	DAT	30DT	DAT	30DT	50DT	
1	Botanical-Insecticide 1	10.6a	6.2ab	3.1a	1.3ab	1.8b	2.5a	2.7d	3.7d	5.6
2	Botanical-Insecticide 2	11.4a	8.0a	2.8a	1.5a	1.8b	3.5a	6.6c	6.2c	6.6
3	All Botanical	12.7a	8.0a	2.5a	1.0abc	1.6b	2.1a	11.6b	11.4b	7.4
4	All Insecticide	10.8a	4.1b	2.4a	0.5c	1.1c	2.5a	2.0d	1.4e	5.1
5	Control (Water Spray)	12.8a	7.9a	3.8a	0.8bc	2.1a	3.8a	24.4a	18.0a	9.0

Table: 2.13 Insect pests incidence in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Grasshopper Damage (% Leaf Damages)						Mean
		KHD						
		30DT	37DT	50DT	57DT	65DT	72DT	
1	Botanical-Insecticide 1	6.2ab	1.0b	6.7ab	0.9b	7.9b	0.7c	3.9
2	Botanical-Insecticide 2	6.6a	0.9bc	7.2ab	0.7c	8.2b	1.0bc	4.1
3	All Botanical	5.3b	0.9bc	6.0bc	0.9bc	7.7b	1.2b	3.7
4	All Insecticide	6.1ab	0.5c	5.4c	0.4d	6.1c	0.2d	3.2
5	Control (Water Spray)	5.5b	2.0a	7.8a	2.2a	9.9a	2.1a	4.9

Botanical-Insecticide 1:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT), Cartap hydrochloride 50% SC 2g/l (60-65 DAT)
Botanical-Insecticide 2:	Neemazal 1% EC 2ml/l (25-30 DAT), Neem oil 10 ml/l (45-50 DAT), Triflumezopyrim 10% SC 0.48ml/l (60-60 DAT)
All Botanical:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT) , Neem oil 10ml/l (60-65 DAT)
All Insecticide:	Chlorantraniliprole 20% SC 0.2ml/l (25-30 DAT), Cartap hydrochloride 50% SC 2g/l (50-55 DAT), Triflumezopyrim 10% SC 0.48ml/l (65-70 DAT)

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Table: 2.13 Incidence of Natural enemies in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Mirid bugs (No./10 hills)									
		BPT						GNV			
		55DT	63DT	92DT	98DT	115DT	122DT	40DT	60DT	80DT	100DT
1	Botanical-Insecticide 1	9.3a	12.0a	9.0ab	11.0a	15.8a	6.3a	26.0a	28.3ab	17.8c	10.3b
2	Botanical-Insecticide 2	11.0a	15.0a	9.0ab	8.5a	15.8a	7.3a	28.5a	28.0ab	16.3c	9.5b
3	All Botanical	11.0a	14.0a	6.5b	10.8a	15.3a	6.5a	23.8a	34.0a	40.0b	45.0a
4	All Insecticide	10.3a	13.8a	9.0ab	10.3a	11.8a	7.8a	28.0a	20.3b	14.3c	6.8b
5	Control (Water Spray)	11.3a	13.0a	11.0a	11.8a	13.8a	7.0a	25.5a	35.3a	49.0a	45.5a

Table: 2.13 Incidence of Natural enemies in different treatments, IBET, Kharif 2019

Mirid bugs (No./10 hills)															
S. No.	Treatment details	LDN			MTU	NVS	SKL				WGL				Mean
		60DT	70DT	75DT	50DT	DT	60DT	75DT	60DT	75DT	70DT	75DT	77DT	81DT	
1	Botanical-Insecticide 1	6.3bc	7.5b	7.8b	38.0a	12.0c	14.0a	26.3a	17.3a	31.0a	4.8ab	18.8a	2.8b	6.8a	14.7
2	Botanical-Insecticide 2	6.0c	7.0b	7.3b	23.0a	9.0d	14.3a	26.5a	16.8a	34.0a	3.3b	18.3a	6.3ab	8.3a	14.3
3	All Botanical	7.3b	6.5b	7.0bc	32.8a	16.0b	14.5a	25.8a	19.3a	34.0a	3.0b	18.3a	11.0a	8.5a	17.8
4	All Insecticide	5.8c	6.3b	6.0c	17.8a	6.8e	16.5a	24.5a	18.8a	33.3a	2.5b	16.8a	3.5b	7.0a	12.9
5	Control (Water Spray)	9.0a	10.3a	10.5a	39.5a	19.0a	16.5a	27.8a	20.8a	34.5a	7.3a	22.3a	4.8b	8.8a	19.7

Table: 2.13 Incidence of Natural enemies in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Spiders/(No .10 hills)											
		BPT						CHP		GNV			
		55DT	63DT	92DT	98DT	115DT	122DT	56DT	76DT	40DT	60DT	80DT	100DT
1	Botanical-Insecticide 1	12.8a	5.3a	9.8a	6.0ab	8.5a	5.8a	9.0b	10.8c	27.8a	28.3a	21.0b	15.0b
2	Botanical-Insecticide 2	13.3a	6.0a	10.8a	7.3a	8.3a	5.0a	9.0b	7.3d	30.8a	29.3a	20.8b	16.0b
3	All Botanical	13.5a	5.0a	10.3a	5.3b	8.3a	5.0a	11.0ab	13.0b	32.5a	31.3a	32.8a	33.3a
4	All Insecticide	12.0a	4.8a	8.5a	6.8ab	7.0a	4.8a	6.5c	5.0e	27.5a	20.3b	14.0b	7.8c
5	Control (Water Spray)	15.0a	5.5a	9.5a	7.0ab	7.5a	4.8a	12.5a	15.5a	29.5a	32.5a	37.3a	37.3a

Botanical-Insecticide 1:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT), Cartap hydrochloride 50% SC 2g/l (60-65 DAT)
Botanical-Insecticide 2:	Neemazal 1% EC 2ml/l (25-30 DAT), Neem oil 10 ml/l (45-50 DAT), Triflumezopyrim 10% SC 0.48ml/l (60-60 DAT)
All Botanical:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT) , Neem oil 10ml/l (60-65 DAT)
All Insecticide:	Chlorantraniliprole 20% SC 0.2ml/l (25-30 DAT), Cartap hydrochloride 50% SC 2g/l (50-55 DAT), Triflumezopyrim 10% SC 0.48ml/l (65-70 DAT)

Table: 2.13 Incidence of Natural enemies in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Spiders (No. /10 hills)									
		MTU		NDL							
		30DT	50DT	30DT	40DT	50DT	60DT	70DT	80DT	90DT	100DT
1	Botanical-Insecticide 1	13.8a	27.3a	8.3a	7.0b	12.8ab	13.0a	17.0a	21.5ab	18.0ab	27.0a
2	Botanical-Insecticide 2	14.0a	20.8a	10.5a	9.3ab	9.8b	16.3a	15.3ab	20.3b	14.3b	31.5a
3	All Botanical	16.0a	25.a	8.8a	8.5ab	11.3ab	13.0a	15.0ab	21.0ab	20.0a	38.8a
4	All Insecticide	16.3a	26.3a	8.5a	11.0a	10.0b	17.5a	13.0b	21.0ab	17.3ab	29.0a
5	Control (Water Spray)	17.3a	28.8a	9.3a	7.0b	14.0a	13.8a	14.8ab	28.8a	17.5ab	31.8a

Table: 2.13 Incidence of Natural enemies in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Spiders (No. /10 hills)											Mean
		NVS	SKL				WGL						
		80DT	40DT	60DT	75DT	32DT	61DT	70DT	75DT	77DT	81DT	93DT	
1	Botanical-Insecticide 1	17.0c	4.3a	5.0a	2.8a	3.3b	5.3a	11.5a	22.0a	14.0a	19.8a	14.3a	13.5
2	Botanical-Insecticide 2	15.3d	3.8a	4.5a	2.5a	3.3b	6.3a	11.5a	20.0a	11.0a	17.0a	15.8a	13.2
3	All Botanical	23.5b	4.5a	4.0a	2.5a	5.3a	6.3a	13.5a	21.8a	3.0b	20.0a	17.3a	15.1
4	All Insecticide	4.5e	3.8a	5.0a	2.5a	5.0a	4.8a	13.0a	20.3a	12.8a	15.8a	16.8a	12.1
5	Control (Water Spray)	35.5a	4.0a	5.0a	2.8a	5.5a	4.8a	13.8a	22.8a	14.3a	17.8a	17.0a	16.3

Table: 2.13 Incidence of Natural enemies in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Coccinellids (No./10hills)												Mean	
		BPT				SKL			WGL						
		92	98	115	122	40	60	75	40	61	70	77	81		93
		DT	DT	DT	DT	DT	DT	DT	DT	DT	DT	DT	DT		DT
1	Botanical-Insecticide 1	2.8	4.8	2.8	2.8	3.0	2.8	2.3	3.5	2.8	2.3	4.5	8.5	4.0	3.58
2	Botanical-Insecticide 2	ab	a	a	a	a	b	a	a	ab	b	ab	a	b	4.02
		2.3	4.3	3.3	3.5	3.0	3.0	2.3	4.8	2.0	3.3	3.5	10.8	6.5	
3	All Botanical	b	a	ab	a	a	ab	a	a	b	ab	b	a	ab	4.85
		3.8	4.5	4.3a	3.5	2.8	4.3	1.8	3.0	2.0	5.5	8.3	10.0	9.5a	
4	All Insecticide	a	a	a	a	a	a	a	a	b	a	a	a	9.5a	3.79
		2.3	4.5	3.5	2.8	2.8	4.0	1.8	5.3	2.5	3.8	4.0	7.3	5.0	
5	Control (Water spray)	b	a	ab	a	a	ab	a	a	ab	ab	ab	a	b	4.54
		3.3a	5.0	3.5a	3.5	2.8	3.8	2.8	3.5	3.5	5.0	5.8	11.8	5.5	
			a	b	a	a	ab	a	a	a	ab	ab	a	b	

Botanical-Insecticide 1:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT), Cartap hydrochloride 50% SC 2g/l (60-65 DAT)
Botanical-Insecticide 2:	Neemazal 1% EC 2ml/l (25-30 DAT), Neem oil 10 ml/l (45-50 DAT), Triflumezopyrim 10% SC 0.48ml/l (60-60 DAT)
All Botanical:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT) , Neem oil 10ml/l (60-65 DAT)
All Insecticide:	Chlorantraniliprole 20% SC 0.2ml/l (25-30 DAT), Cartap hydrochloride 50% SC 2g/l (50-55 DAT),Triflumezopyrim 10% SC 0.48ml/l (65-70 DAT)

Table: 2.14 Grain Yield in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Grain Yield (Kg/ha)													MND
		ARD	CBT	CHN	CHP	CHT	CTC	GVT	JDP	KHD	KJT	KRK	LDN	MLN	
1	Botanical-Insecticide 1	6716.7a	2941.1a	4787.5d	4450.7b	1550.0a	4100.0b	7634.0a	3862.5b	5308.3a	2330.0c	2237.5a	7160.5b	2013.9a	4052.0ab
2	Botanical-Insecticide 2	5416.7ab	2907.6a	5812.5c	4318.5bc	1475.0a	3800.0c	7938.0a	4050.0ab	5216.7a	3010.0a	2393.8a	7111.1b	1898.1a	3894.6ab
3	All Botanical	5416.7ab	2643.5a	6487.5b	4200.9c	1962.5a	3366.7d	7488.0a	4000.0b	5079.2ab	2500.0b	2068.8a	7000.0b	1805.6a	3670.0b
4	All Insecticide	6316.7a	3384.8a	6825.0b	4920.7a	1787.5a	4300.0a	8168.0a	4375.0a	5358.3a	3140.0a	2137.5a	7543.2a	1805.6a	4645.0a
5	Control (Water Spray)	4733.3b	2587.0a	7275.0a	3451.8d	1900.0a	2650.0e	6668.0b	3137.5c	4640.0b	1710.0d	2106.3a	6395.1c	715.3b	2680.0c

Table: 2.14 Grain Yield in different treatments, IBET, Kharif 2019

S. No.	Treatment details	Grain Yield (Kg/ha)												Mean	IOC (%)
		MTU	MSD	NDL	NVS	NWG	PUS	RCI	RGL	RNR	RPR	TTB	WGL		
1	Botanical-Insecticide 1	1833.6d	2706.3c	3675.0a	4171.3b	4184.8bc	5497.9b	4302.6b	5520.0ab	6213.5a	5981.3a	3977.0b	4269.3c	4286.5	18.6
2	Botanical-Insecticide 2	3699.5a	3176.3b	4037.5a	4071.7c	4784.6b	5165.6bc	4190.3b	5194.0bc	6272.6a	5706.3a	3832.0c	4846.0b	4393.0	21.6
3	All Botanical	2708.5bc	2265.0d	4012.5a	3869.5d	3136.1cd	4960.9c	3654.8c	5028.0c	5980.9ab	6053.1a	3389.0d	3670.6d	4089.2	13.2
4	All Insecticide	3429.4ab	3306.3a	4450.0a	4246.3a	6115.1a	6170.8a	4789.8a	5684.0a	6334.2a	5712.5a	4110.0a	5554.7a	4781.2	32.3
5	Control (Water Spray)	2174.4cd	1475.0e	4225.0a	3630.5e	2773.8d	4174.9d	3149.1d	4864.0c	5335.9b	4975.0b	2964.0e	3548.4d	3613.0	

Botanical-Insecticide 1:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT), Cartap hydrochloride 50% SC 2g/l (60-65 DAT)
Botanical-Insecticide 2:	Neemazal 1% EC 2ml/l (25-30 DAT), Neem oil 10 ml/l (45-50 DAT), Triflumezopyrim 10% SC 0.48ml/l (60-60 DAT)
All Botanical:	Neemazal 1% EC 2ml/l (25-30 DAT), Eucalyptus oil 2ml/l (45-50 DAT) , Neem oil 10ml/l (60-65 DAT)
All Insecticide:	Chlorantraniliprole 20% SC 0.2ml/l (25-30 DAT), Cartap hydrochloride 50% SC 2g/l (50-55 DAT), Triflumezopyrim 10% SC 0.48ml/l (65-70 DAT)

2.4. ECOLOGICAL STUDIES

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. Climate change effects have become visible in India affecting the temperature and rainfall patterns. 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 pest incidence, the trial on Effect of planting dates on insect pest incidence (**EPDP**) was continued and efforts were made to relate pest dynamics with the abiotic factors of various locations.

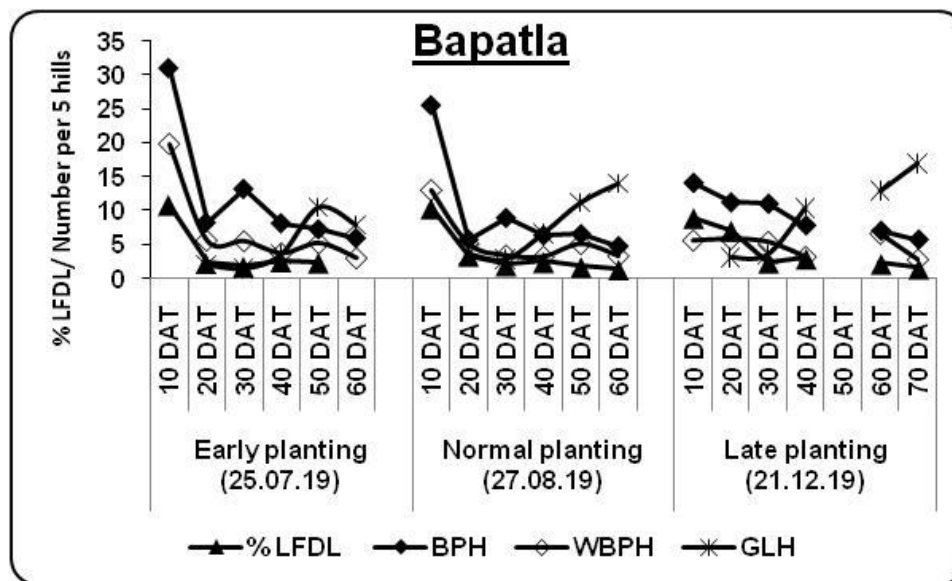
In India, rice is grown traditionally by manual transplanting method which requires more water and labour leading to high crop production costs. To overcome these constraints, farmers are gradually shifting to alternative methods of rice cultivation, weed management tactics and crop residue management strategies to improve the productivity of rice-based cropping systems. In view of these changes in agronomic practices in rice cultivation, three trials on - Effect of iron seed coating on insect pest incidence (**ESCP**), Influence of crop establishment methods on pest incidence (**IEMP**) and Cropping systems influence on pest incidence (**CSIP**) were planned in collaboration with Agronomy to know the effect of these changes on insect pest incidence.

i) Effect of Planting Dates on Insect Pest Incidence (EPDP)

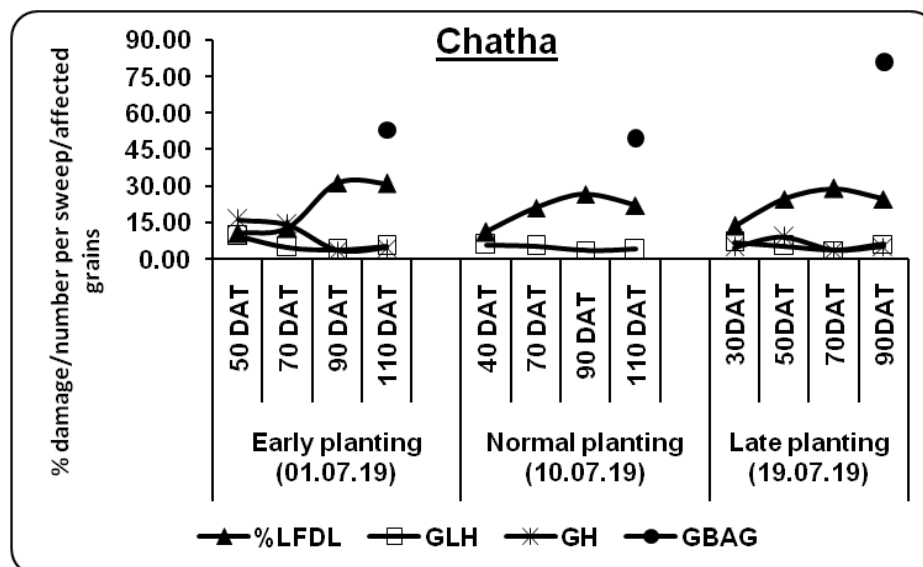
During *Kharif* 2019, effect of planting dates on insect pest incidence trial was conducted at 22 locations. At each location, most popular variety of that region was planted at three dates *viz.*, normal planting as per the recommended package of practices of that region, 20 days earlier to normal planting, designated as 'early planting' and 20 days later than the normal planting, designated as 'late planting'. Each time, sowing of the nursery and planting was done separately in 500 sq. m area. Observations on insect pest incidence were recorded on ten randomly selected hills at 10-day interval starting from the first appearance of the pest. Location wise pest incidence at different dates of planting is discussed here.

1) Bapatla (15° 90'N & 80°47'E), Andhra Pradesh: Incidence of leaf folder, BPH, WBPH and GLH was observed in different plantings in BPT 5204.

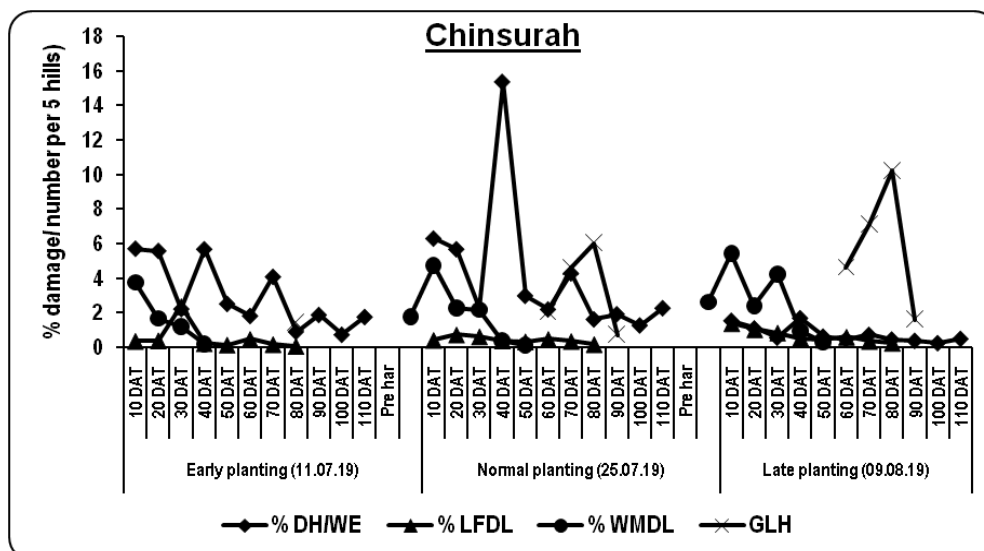
In general, the pest incidence was low, below ETL across the plantings. However, the incidence was high and crossed ETL at 10 DAT but declined in later stages. Grain yields of 4320, 3880 and 3532 kg/ha were recorded in early, normal and late plantings, respectively.



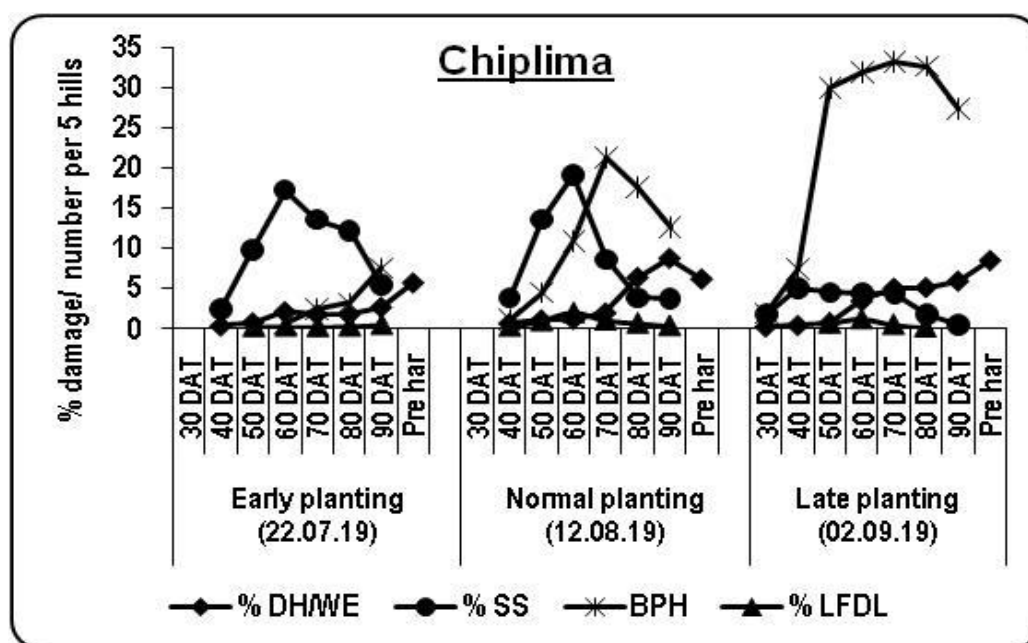
2) Chatha (32° 69'N & 74° 85'E), Jammu & Kashmir: Incidence of leaf folder was high in all the three plantings (21.37%, 20.23% and 22.91%) in Basmati 370 variety grown in this trial. Grasshopper population was also high in early planting at 50 DAT (16.11/sweep) and 70 DAT (14.00/sweep). Gundhi bug damage was observed up to 53.22% in early planting, 49.67% in normal planting and 81.11% in late planting. Grain yield ranged from 3404 to 4728 kg/ ha in different plantings.



3) Chinsurah (22° 88'N & 88° 39'E) West Bengal: Very low incidence of leaf folder (<3%), whorl maggot (<5%) and GLH (<3/hill) was observed. Incidence of stem borer (<5%) was also low except at 50 DAT in normal planting (15.37%). Grain yield ranged between 3960 and 4900 kg/ ha in all the three plantings.



4) Chiplima (21° 46'N & 83° 98'E), Orissa: Gall midge incidence recorded on swarna variety was high and exceeded ETL in early planting starting from 60 DAT (17.28% SS) till 80 DAT (12.16% SS) and in normal planting at 50 DAT (13.59% SS) and 60 DAT (19.20% SS). Incidence of stem borer, leaf folder and BPH was low in all the three plantings. Grain yield of 3800, 3560 and 2600 kg/ ha was recorded in early, normal and late plantings, respectively.



5) Gangavathi (15° 43' N & 76° 53' E), Karnataka: 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 on RP Bio 226 grown in this trial. 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). Stem borer (< 2% DH & <6% WE), leaf folder (<3% DL) and GLH (<5 hoppers/hill) damage was low. Grain yields of 7190, 6264 and 5068 kg/ ha were recorded in early, normal and late plantings, respectively.

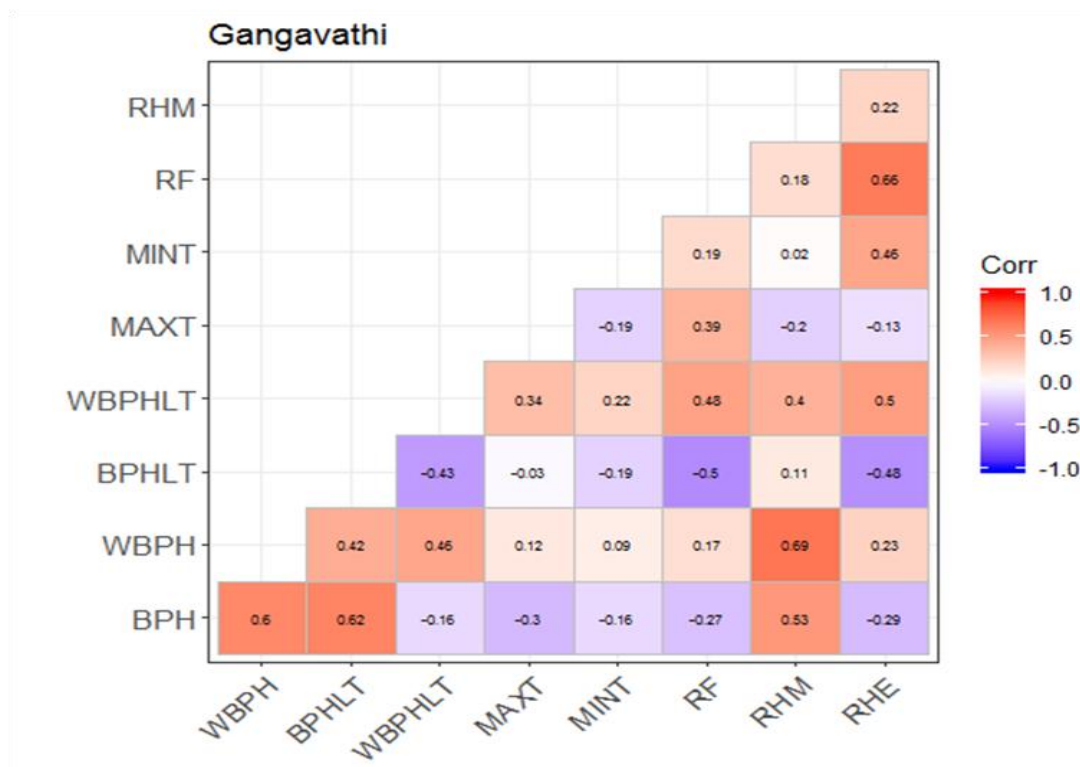
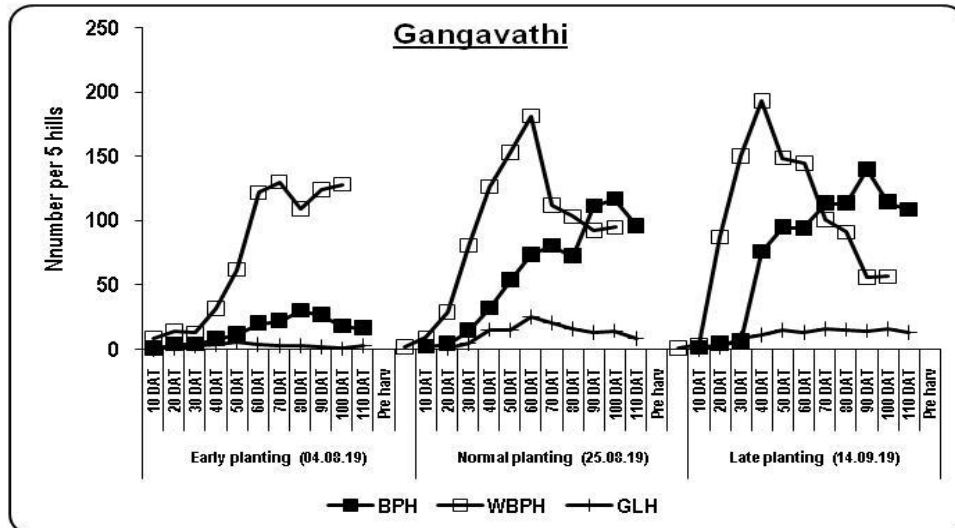
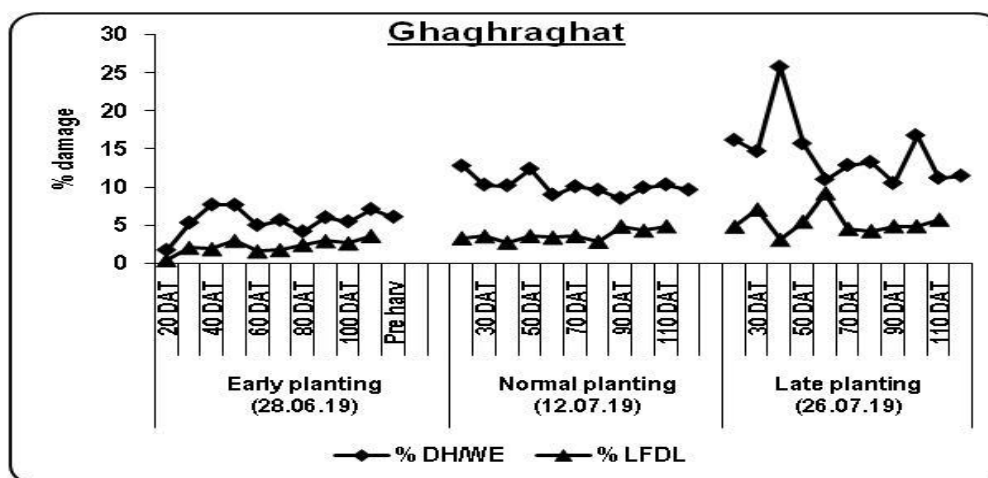


Fig 2.1 Correlation matrix between field incidence, light trap catches and weather parameters at Gangavathi, Kharif 2019

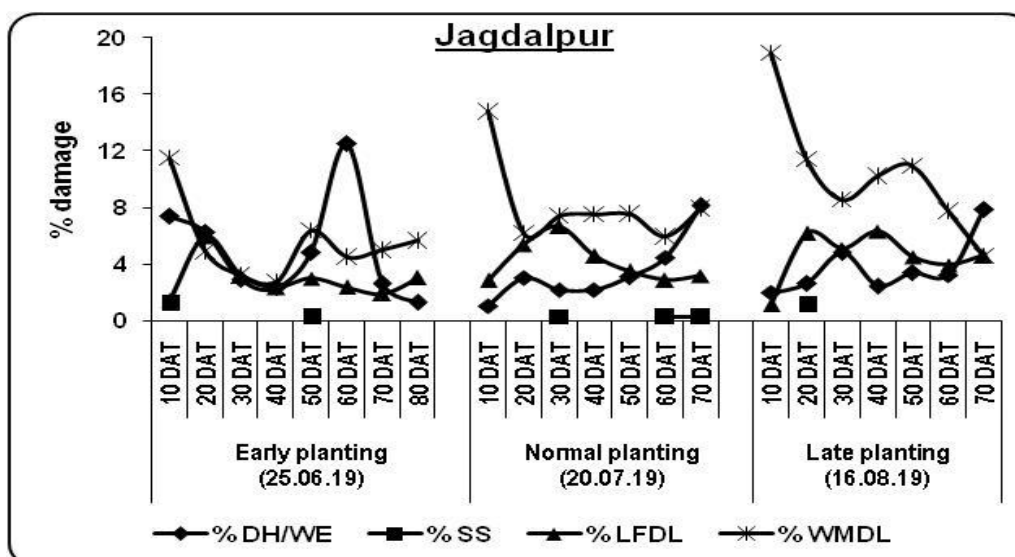
The relation between the pest incidence, light trap catches and ten days preceding weather parameters, i.e., maximum temperature, minimum temperature, relative humidity morning, relative humidity evening and rainfall was estimated using Pearson correlation coefficients (**Fig 2.1**).

There was significant positive correlation between BPH and WBPH incidence in the field (0.60) and light trap catches (0.62). Similarly, relative humidity morning had significant positive impact on the field incidence of both BPH (0.53) and WBPH (0.69).

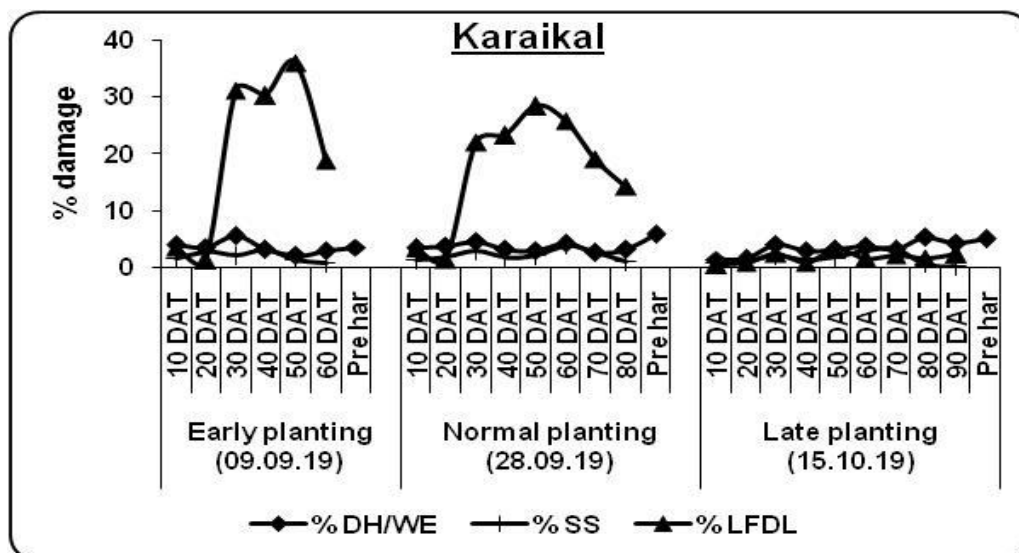
6) Ghaghraghat (23° 27' N & 84° 45' E), Uttar Pradesh: High incidence of stem borer was observed during vegetative stage from 20 DAT onwards in normal planting (12.8 – 10.34% DH) and late planting (16.2–16.8% DH) with highest damage at 40 DAT (25.83% DH) in late planting. However, white ear damage was low in early and normal plantings compared to 11.49% in late planting. Leaf folder damage was low in all the three plantings (2.25–5.43%). Early, normal and late plantings recorded grain yield of 4040, 3248 and 2660 kg/ ha, respectively.



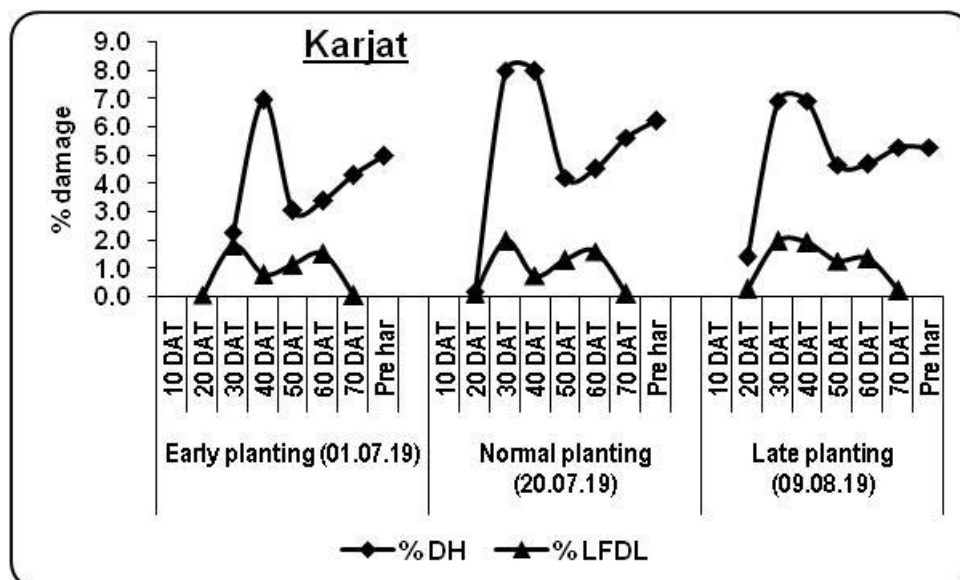
7) Jagdalpur (19° 4' N & 82° 0' E), Chattisgarh: Low incidence of stem borer (1.06-12.48% DH), gall midge (0.27-1.25% SS) leaf folder (1.12-6.67% DL), BPH (0.1-0.7 hoppers/5 hills), WBPH (0.1-0.4 hoppers/5 hills) and GLH (0.9-8.2 hoppers/5 hills) was observed in Swarna variety in all the three plantings. Only, incidence of whorl maggot crossed ETL in all the three plantings with highest damage in late planting at 10 DAT (18.91%). Grain yield varied from 3727 to 4840 kg/ ha in all the three plantings.



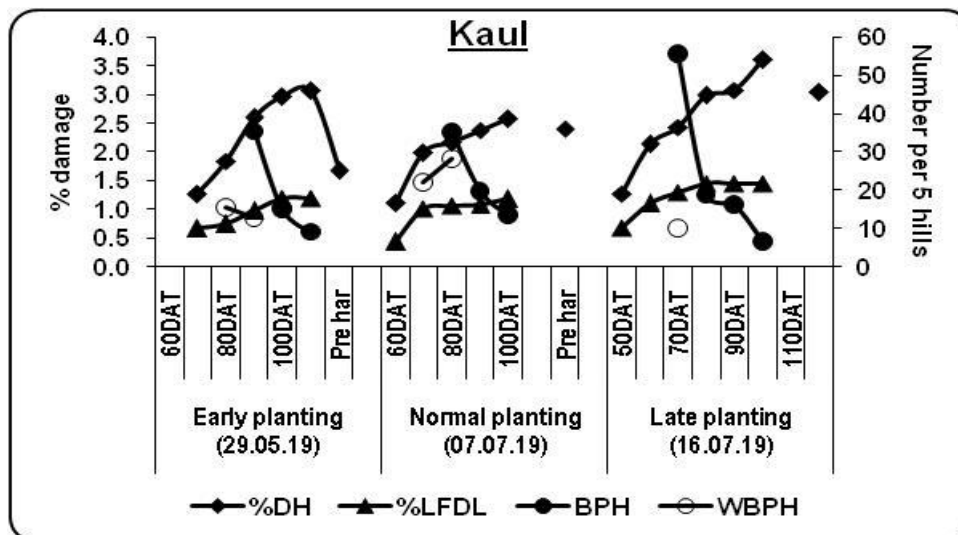
8) Karaikal (10° 92' N & 79° 84' E), Puducherry: High incidence of leaf folder was observed starting from 30 DAT to 60 DAT (31.13 – 35.99%) in early planting and 30 DAT to 80 DAT (14.24 – 28.34%) in normal planting while it was low (<5%) in late planting. Low incidence of stem borer (1.34 – 5.79%) and gall midge (0.19 – 3.77%) was observed in all the three planting and grain yield ranged between 2080 and 2880 kg/ha.



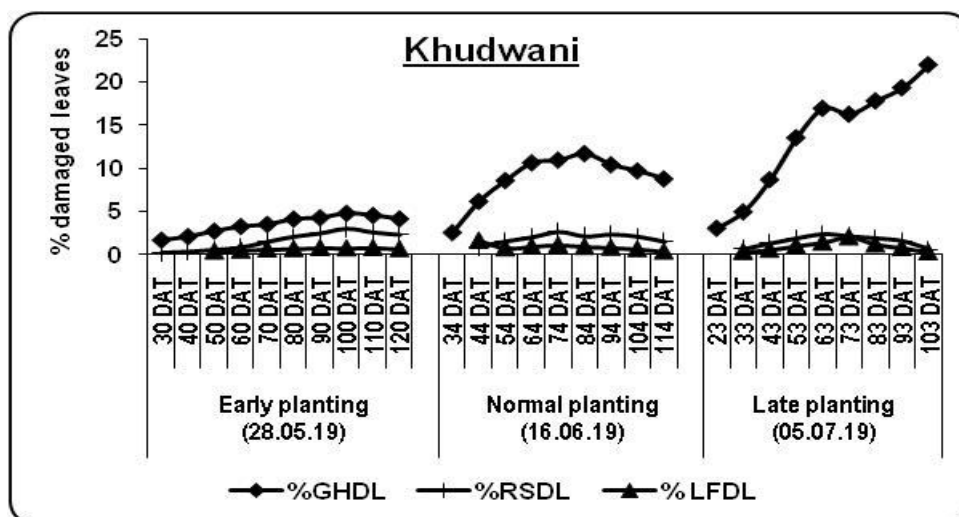
9) Karjat (18° 92' N & 73° 33' E), Maharashtra: Very low incidence of stem borer (0.2 – 8.0%) and leaf folder (<2% DL) was reported from all the three plantings in Karjat 10 variety grown in this trial. Yield of 3560 – 3680 kg/ ha was recorded in various plantings.



10) Kaul (29° 85' N & 76° 66' E), Haryana: Low incidence of stem borer (1.1 – 3.6%), leaf folder (0.44 – 1.46%), BPH (6.7 – 55.7 hoppers/5 hills) and WBPH (10.0 – 28.2 hoppers/5 hills) was registered in all the three plantings in HKR 127 variety grown in this trial. Grain yield varied from 3120 to 3720 kg/ ha in three plantings.

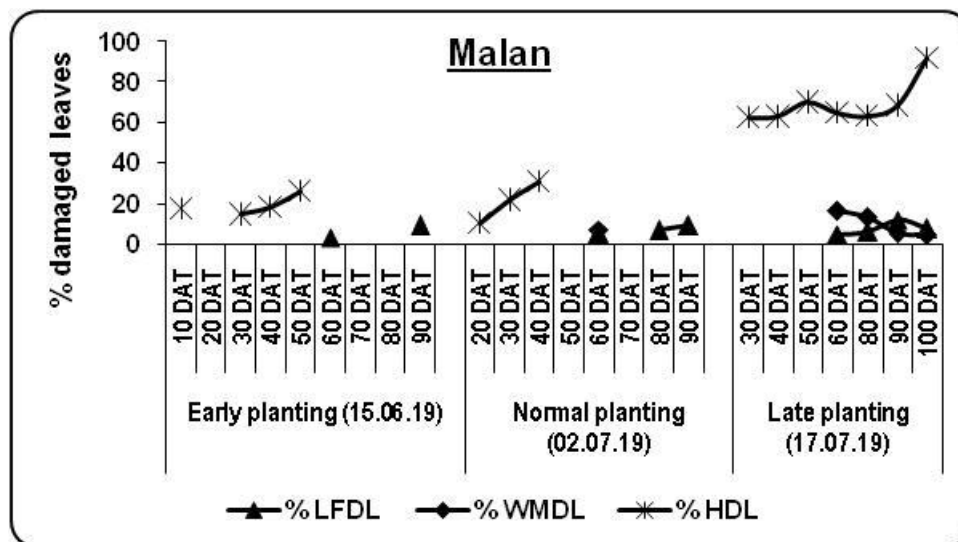


11) Khudwani (33° 71' N & 75° 10' E), Jammu & Kashmir: Incidence of grasshopper was high on Shalimar rice- 4 variety in late planting from 53 to 103 DAT (13.55 – 21.98 % DL) and from 64 DAT to 94 DAT (10.43 – 11.71% DL) in normal planting while it was low in early planting. Very low incidence of leaf folder (<3% DL) and rice skipper (<3% DL) was reported in all the three plantings.

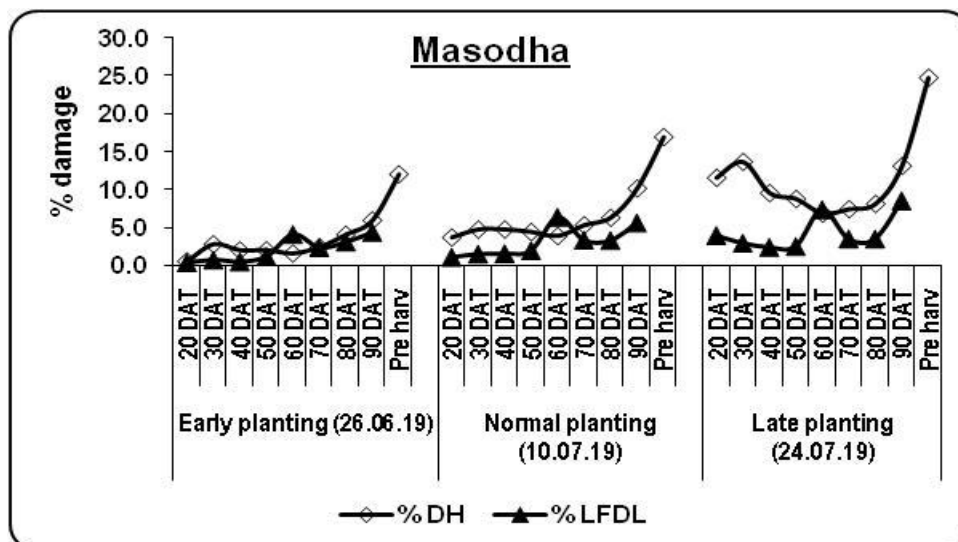


12) Malan (32° 11' N & 76° 25' E), Himachal Pradesh: Very high incidence of hispa was reported in late planting (62.08 – 91.52% HDL) as compared to normal planting (10.04 – 30.91% DL) and early planting (14.40 – 25.75% DL) in Kasturi variety. Whorl maggot incidence was high in late planting (4.44 – 16.21% DL) and only at 60 DAT (7.14%DL) in normal

planting. Low incidence of leaf folder was recorded in all the three plantings except at 90 DAT in late planting (11.9% DL).



13) Masodha (26°77' N & 82° 14'E), Uttar Pradesh: Stem borer and leaf folder incidence was observed in Pusa Basmati 1 variety grown in this trial. Stem borer damage was observed in all the three plantings at both vegetative and flowering stages. However, dead heart damage crossed ETL only in late planting at 20 to 30 DAT (11.59 – 13.68% DH) while white ears were observed above ETL in all the three plantings (12.05 – 24.74% WE). Low incidence of leaf folder was reported in all the three plantings (0.41 – 8.48% DL). Yield ranged from 2510 to 3600 kg/ ha in all the three plantings.



14) Navasari (20° 94' N & 72° 95' E), Gujarat: Stem borer incidence was high in all the three plantings in GR 11 variety. Stem borer damage crossed ETL at 70 DAT onwards up to pre harvest in early planting (11.28 – 15.59% DH & 11.12% WE), at 50-90 DAT in normal planting (10.37 – 20.13% DH) and at 30 DAT to pre harvest in late planting (10.74 – 31.42% DH & 17.39% WE) with highest damage in late planting. Low incidence of leaf folder (0.16 – 6.37% DL), horned caterpillar (0.01 – 2.95% DL), BPH, WBPH and GLH with less than 2 hoppers / hill was reported. Grain yield of 3830 to 4561 kg/ ha was recorded in all the three plantings.

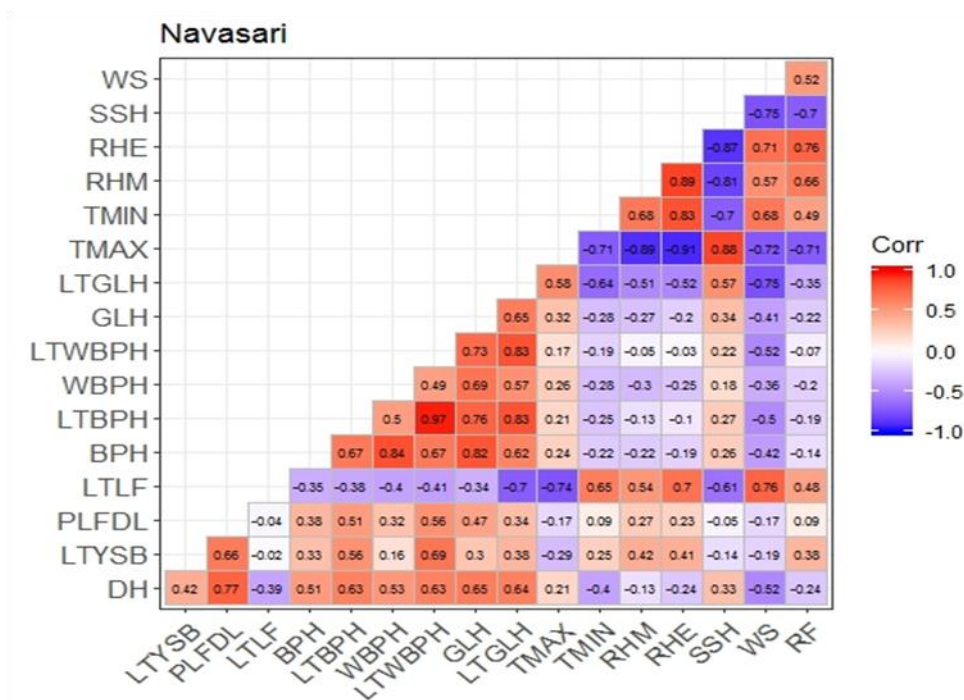
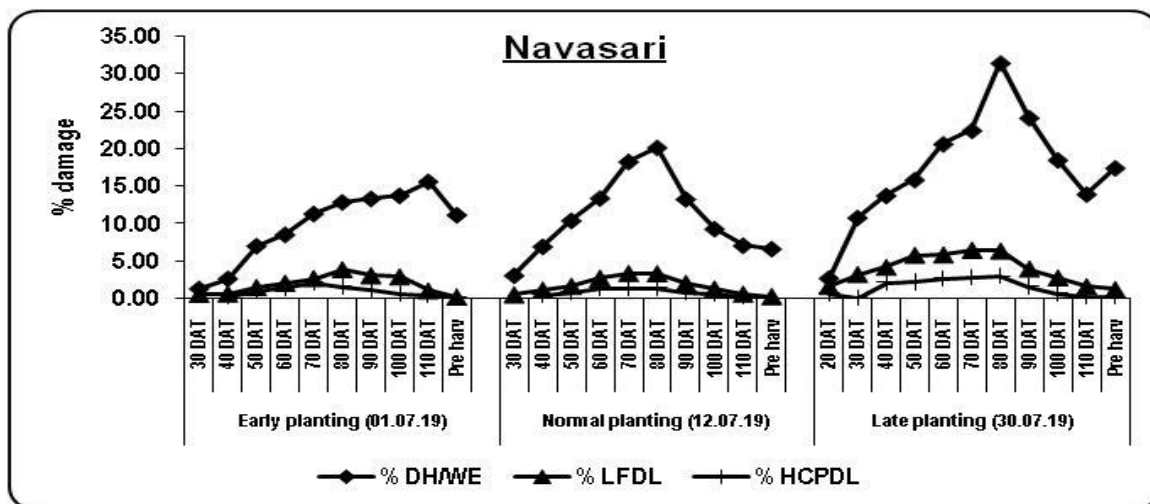
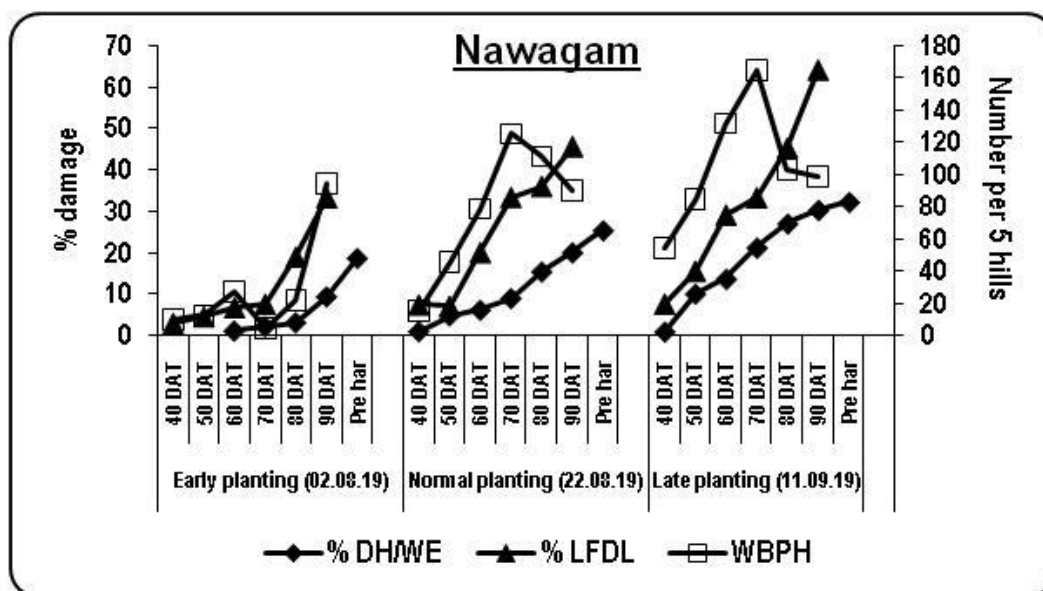


Fig 2.2 Correlation matrix between field incidence, light trap catches and weather parameters at Navasari, Kharif 2019

Correlation between field incidence, light trap catches and preceding ten days weather parameters revealed a significant positive relationship between light trap catches of YSB with relative humidity morning (0.42) and relative humidity evening (0.41). A negative non-significant relationship was observed between YSB light trap catches and maximum temperature (**Fig 2.2**). However, dead heart incidence in the field showed a significant negative relation with wind speed (-0.52) and minimum temperature (-0.40). Similarly, a significant negative correlation was observed between leaf folder light trap catches and maximum temperature (-0.74) and sunshine hours (-0.61) while it was positively significant with minimum temperature (0.65), morning RH (0.54), evening RH (0.70) and wind speed (0.76). However the relation between field incidence of dead hearts or white ears and leaf folder damage with weather parameters was not significant.

15) Nawagam (23° 26' N & 71° 95' E), Gujarat: Dead heart damage due to yellow stem borer was high in late planting starting from 60 - 90 DAT (13.54 - 30.22%) and at 90 DAT (19.96%) in normal planting in GR 11 variety. White ears incidence was very high in late planting (32.16%) followed by normal planting (25.29%) and early planting (18.59%). Leaf folder incidence was also very high in late planting starting from 50 - 90 DAT (15.49 - 64.09%) followed by normal planting from 60 - 90 DAT (20.02 - 45.62%) and early planting at 80 - 90 DAT (18.91 - 33.27%). WBPH incidence crossed ETL from 50 - 90 DAT (84.4 - 164.3 hoppers/ 5 hills) in late planting, during 60 - 90 DAT in normal planting (78.1 - 124.8 hoppers/5 hills) and at 90 DAT in early planting (93.7 hoppers/5hills). Very low yield of 2320 kg/ ha was recorded in late planting followed by 2530 kg/ ha in normal planting and 4240 kg/ ha in early planting.



A significant positive correlation was found between light trap catches and preceding ten days maximum temperature (LT YSB = 0.85; LTLF = 0.67 & LTWBPH= 0.81). Field incidence of all the three pests was negatively

correlated with minimum temperature and morning, evening relative humidity (Fig 2.3).

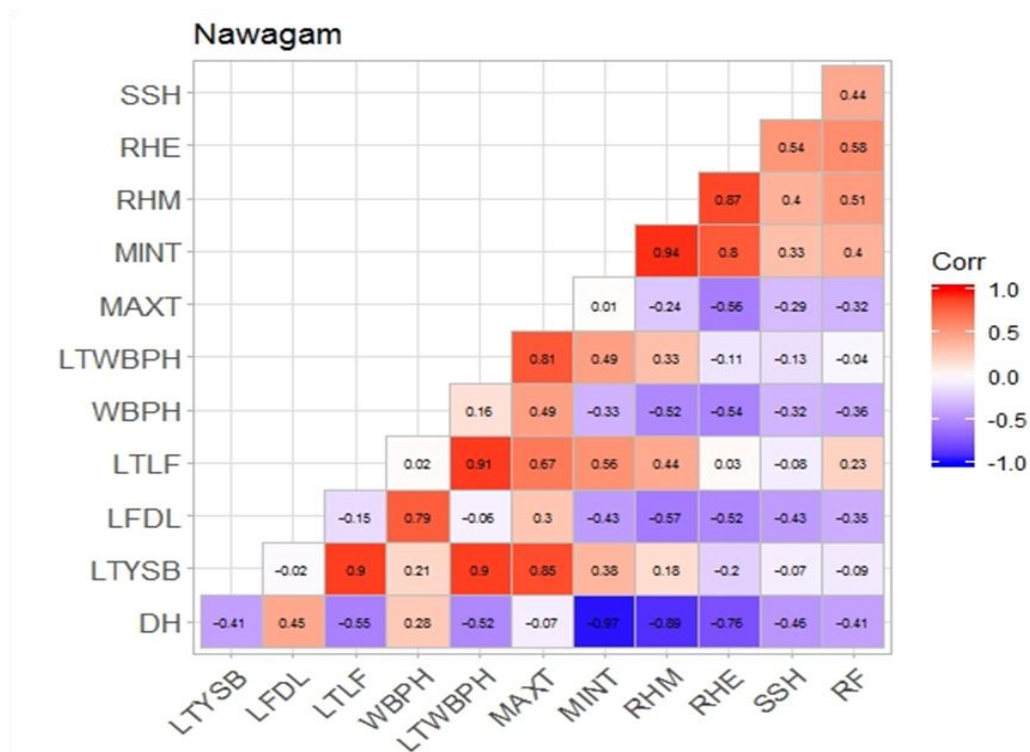
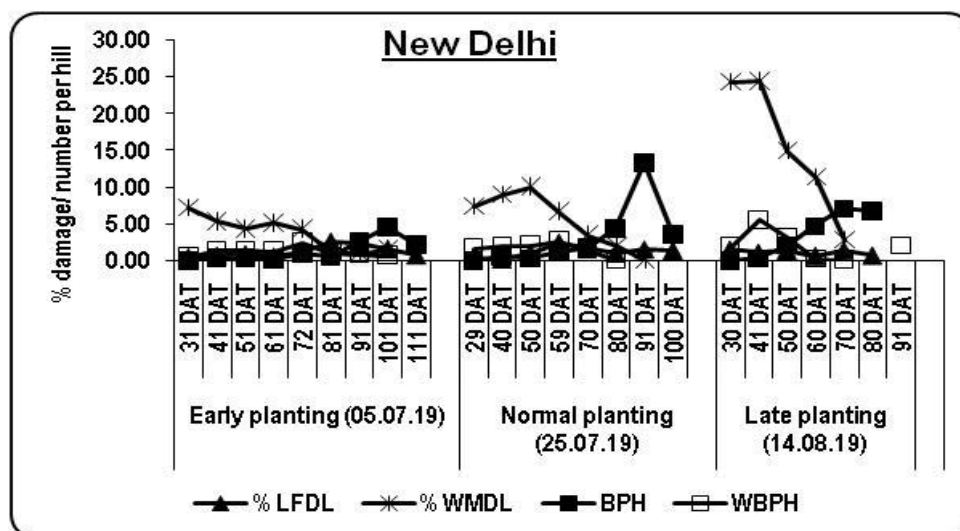
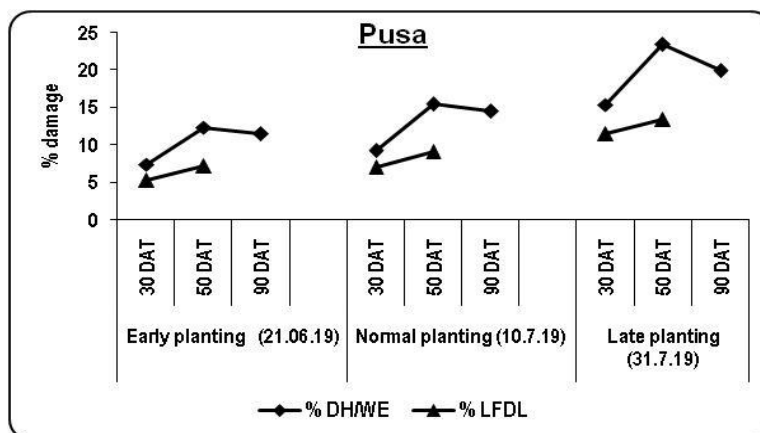


Fig 2.3 Correlation matrix between field incidence, light trap catches and weather parameters at Nawagam, Kharif 2019

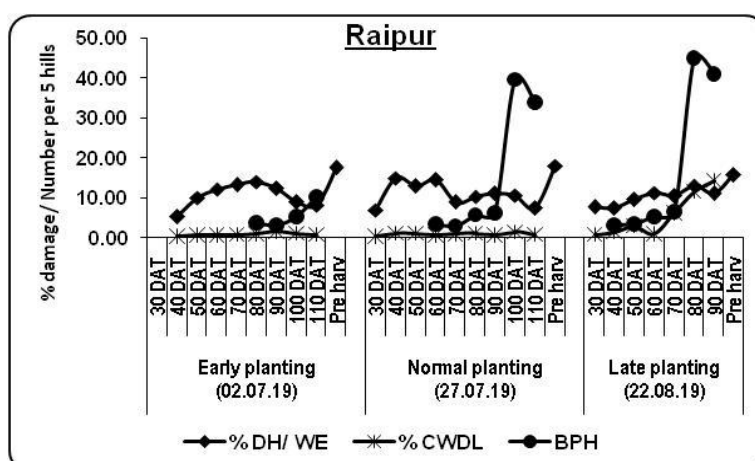
16) New Delhi (28° 61' N & 77° 20' E): High incidence of whorl maggot was observed in late planting starting from 30 DAT till 60 DAT (11.32 – 24.29%DL) as compared to normal and early plantings (<10%) in Pusa 1121 grown in this trial. Very low incidence of leaf folder (<3%), BPH (<8 hoppers/hill) except in normal planting at 91 DAT (13 hoppers/hill) and WBPB (<6 hoppers/hill). Spiders (<0.3 – 2.8/hill) and rove beetles (<0.02 – 2.42/hill) were also recorded in all the three plantings.

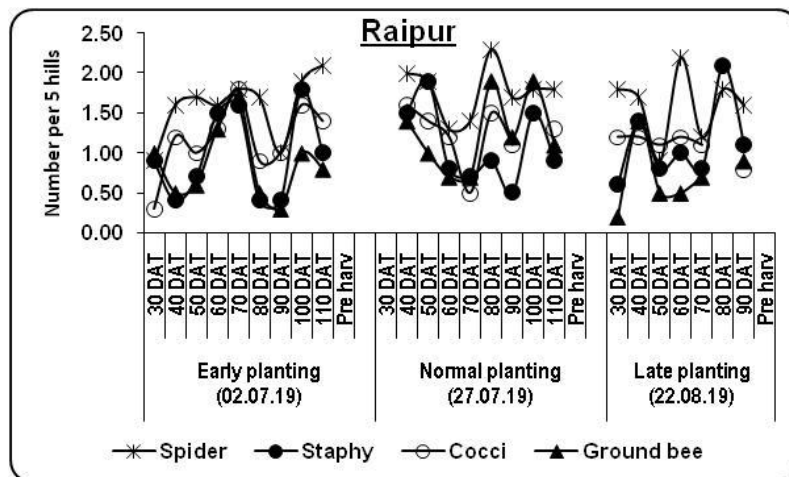


17) Pusa (25°98'N & 85°64' E), Bihar: Stem borer incidence was reported high in late planting resulting in 19.38% dead hearts and 19.92% white ears in Rajendra mansuri variety grown in this trial. Low incidence of leaf folder was observed in all the three plantings (5.3 – 13.38%). Grain yield of 3970 to 5090 kg/ ha was recorded in three plantings.

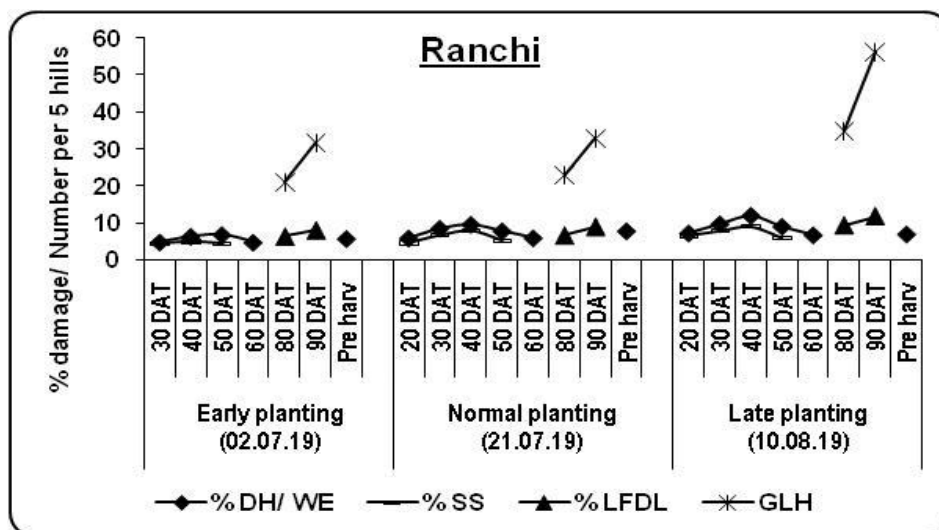


18) Raipur (21° 25'N & 81°63'E), Chhattisgarh: High incidence of stem borer was observed from 50 to 90 DAT (10.07 – 14.00% DH) in early planting, 40 to 60 DAT (12.89 – 14.99% DH) in normal planting and 60 to 90 DAT (10.59 – 11.25% DH) in late planting in Swarna variety grown in this trial. White ear damage of 17.66%, 18.03% and 15.77% was recorded in early, normal and late plantings, respectively. Incidence of leaf folder (<2%), whorl maggot (<2%), hispa (<2%), BPH (0 - 9/hill), WBPH (<1/hill), GLH (<2/hill) was very low. High caseworm incidence was recorded in late planting at 80 – 90 DAT (11.62 – 14.39%DL). Grain yield ranged between 4640 and 6120 kg/ ha in different plantings. Incidence of spiders (0.9-2.30/5 hills), staphylinid beetles (0.40 – 2.10/5hills), ground beetles (0.20 – 1.90/ 5 hills) and coccinellids (0.30 – 1.80/ 5 hills) was also recorded in all the three plantings.

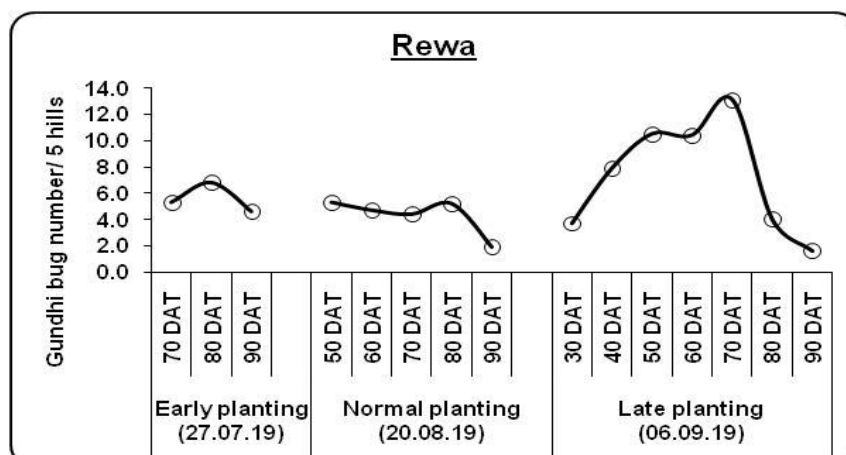




19) Ranchi (23° 34'N & 85°31'E), Jharkhand: Low incidence of stem borer (4.72 – 12.08% DH), gall midge (4.36 – 9.06% SS), leaf folder (6.37 – 11.78% DL), hispa (3.88 – 8.27% DL) and GLH (4.20 – 11.26/hill) was noticed in all the three plantings on Birsa Vikas Sugandha 1 variety grown in this trial. Grain yield varied from 3413 to 4408 kg/ ha in three plantings.



20) Rewa (24° 54'N & 81° 30'E), Madhya Pradesh: Very low incidence on only gundhi bug was recorded in all the three plantings in PS3 variety grown in this trial.



21) Sakoli (21° 08'N & 79° 99'E), Maharashtra: Gall midge incidence was very high in late planting starting from 40 to 110 DAT (10.10 – 51.91% SS) followed by normal planting at 60 – 100 DAT (13.27 – 16.87% SS) while incidence was low in early planting (<6% SS). Stem borer damage was high in late planting between 90 and 120 DAT (14.59 – 26.28%) compared to normal (<9%) and early plantings (<8%). Incidence of leaf folder (<6%), BPH (<16/hill), WBPH (<4/hill) and GLH (<3/hill) was very low. Grain yield of 4720, 4108 and 1960 kg/ ha was recorded in early, normal and late plantings, respectively.

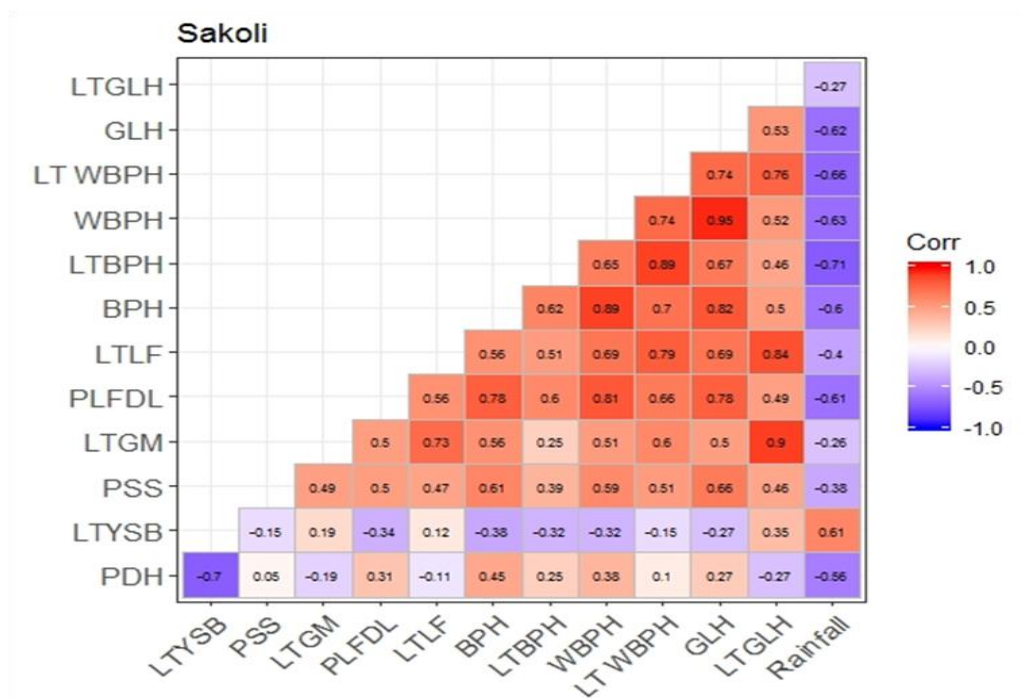
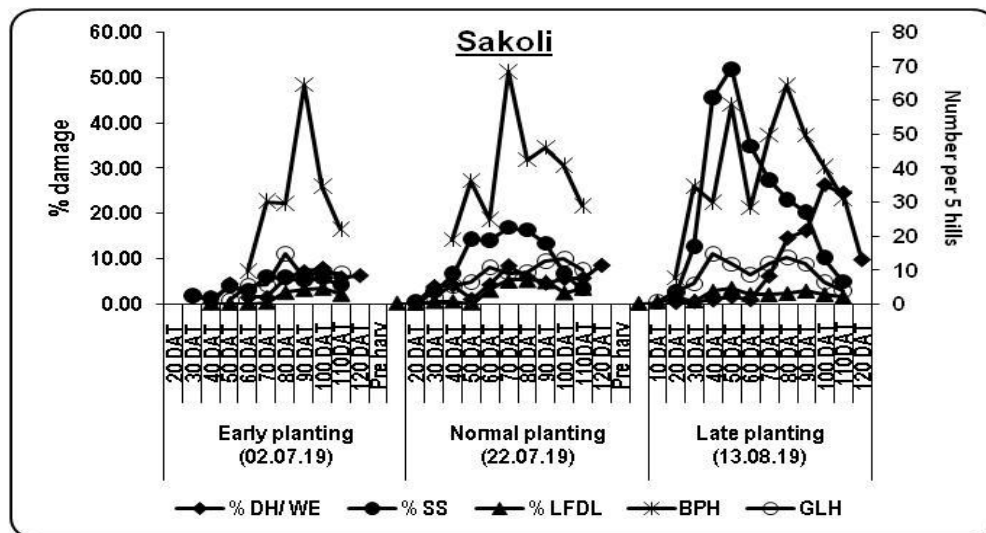
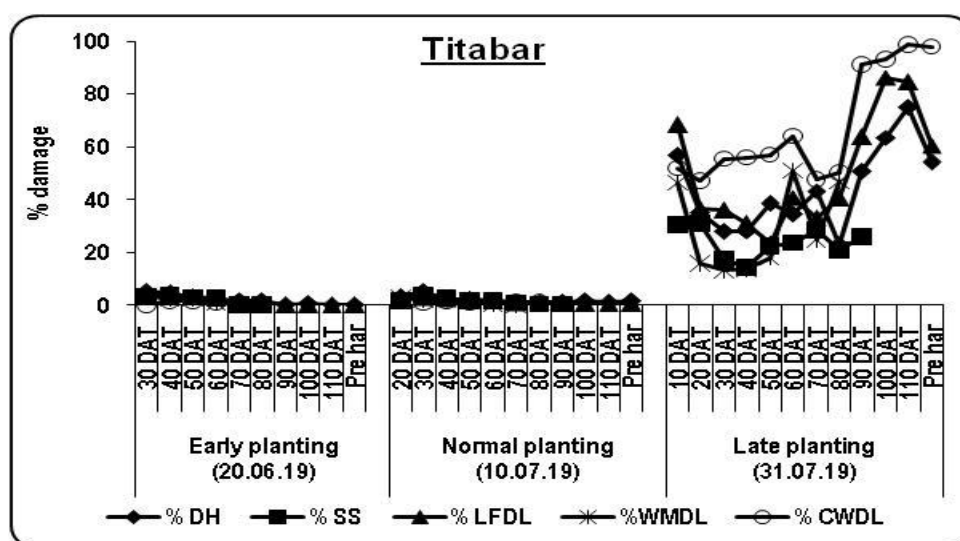


Fig 2.4 Correlation matrix between field incidence, light trap catches and weather parameters at Sakoli, Kharif 2019

A significant negative correlation was observed between preceding rainfall and field incidence of various pests (**Fig 2.4**). Light trap catches of planthoppers were found significantly positively correlated with field incidence whereas it was significantly negative with respect to stem borer.

22) Titabar (26° 58'N & 94° 19'E): Incidence of stem borer, gall midge, leaf folder, whorl maggot and caseworm was very high in late planting in Ranjit variety as compared to early and late plantings. Stem borer damage was very high in late planting and crossed ETL starting from 10 DAT onwards till harvest (22.82 – 75.07% DH & 54.26%% WE). Similarly, gall midge incidence also crossed ETL from 10 – 90 DAT (14.22 – 31.01%) in late planting. Highest Leaf folder damage exceeded ETL from 10 DAT to harvest stage (23.65-86.29%) and highest damage was observed at 100 DAT, while whorl maggot incidence ranged from 13.28 to 50.91% DL from 10 – 80 DAT, in late planting. Caseworm damage was also high in late planting from 10 DAT till harvest (47.23 – 98.58%). Very low incidence of GLH, thrips and WBPH was reported in all the three plantings. Grain yield varied from 4880 to 5500 kg/ ha in all the three plantings.



The relation between light trap catches, field incidence of pests and preceding weather parameters was assessed using Pearson correlation coefficients (**Fig 2.5**). Data analysis revealed a significant negative correlation between preceding minimum temperature and field incidence of per cent dead hearts (-0.61), per cent leaf folder damaged leaves (-0.66). A significant positive correlation was found between rainfall and light trap catches of YSB (0.72) and leaf folder (0.76). Relative humidity evening was significantly positively correlated with gall midge catches in light trap (0.54) while sunshine hours were significantly negatively correlated (-0.42).

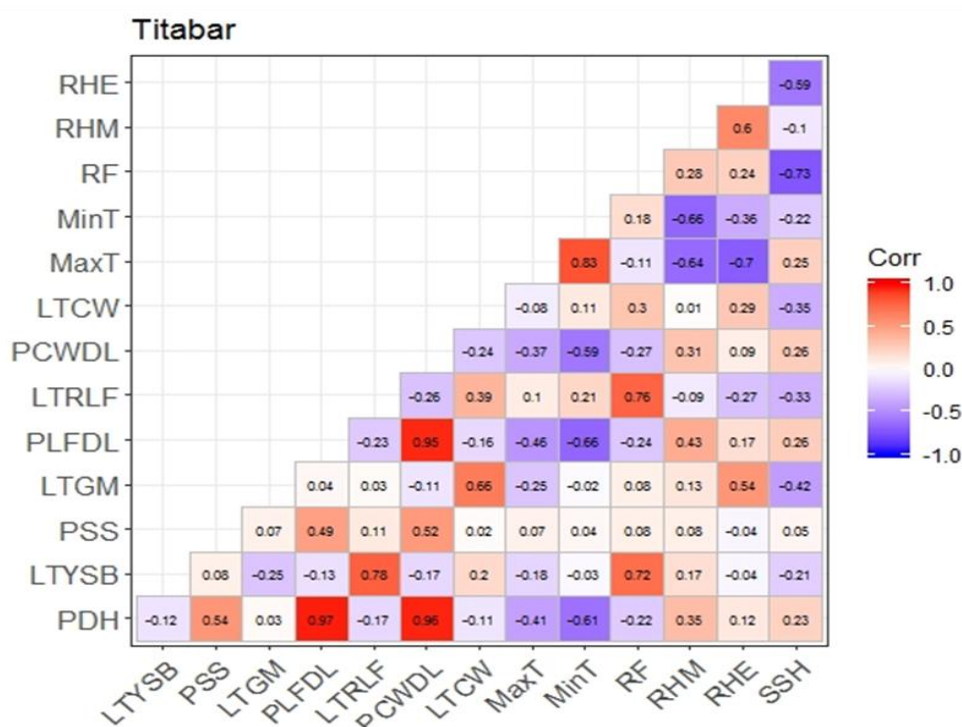


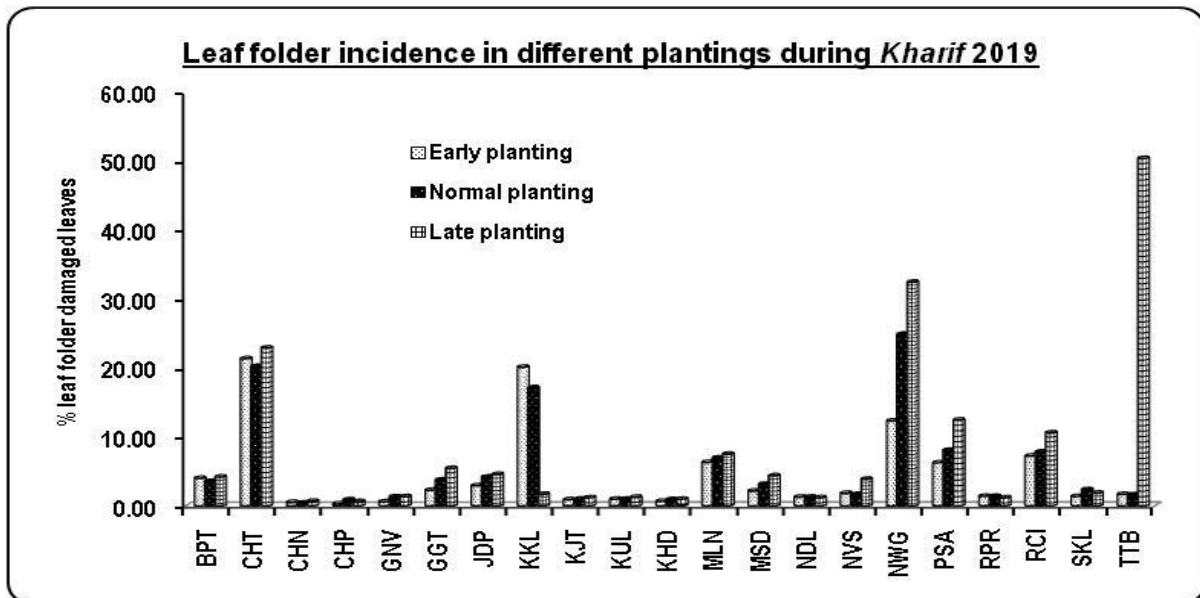
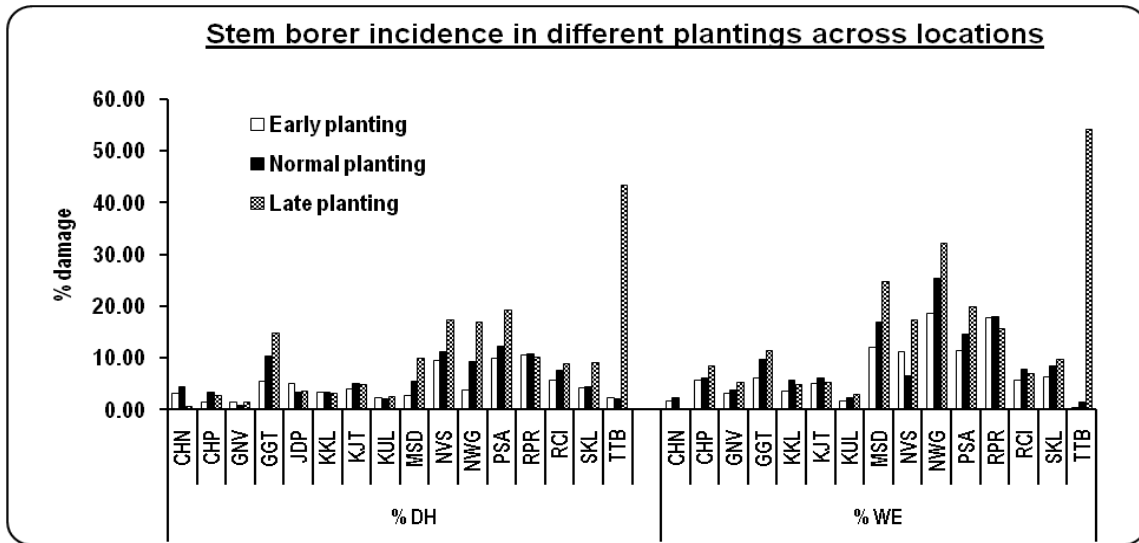
Fig 2.5 Correlation matrix between field incidence, light trap catches and weather parameters at Titabar, Kharif 2019

Insect Pest incidence across locations in EPDP

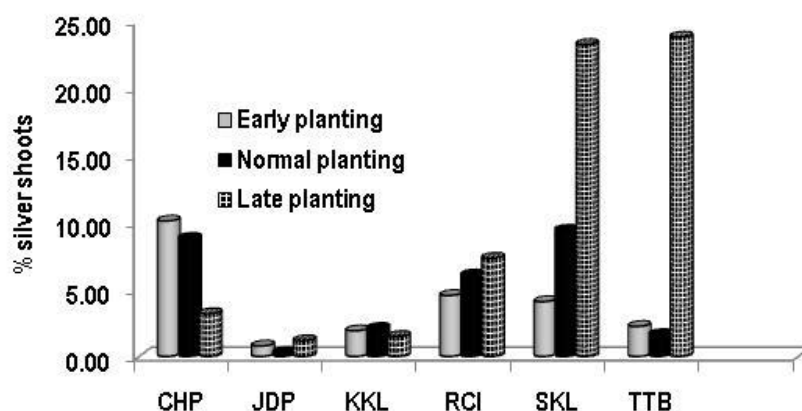
In general, insect pest incidence was low to moderate in EPDP trial across locations during *Kharif* 2019. Incidence of stem borer was reported from 16 locations with maximum damage in late planting. Highest dead heart damage was observed in late planting at Titabar (43.33%) followed by Pusa (19.38%) and Navasari (17.38%). Similarly, maximum white ear damage was also observed in late planting at Titabar (54.26%) followed by late planting at Nawagam (32.16%) and normal planting at Nawagam (25.29%). Gall midge incidence was also the highest (23.85% SS) in late planting at Titabar among 6 locations, followed by Sakoli (23.29). However, the damage was low at other locations and in other two plantings.

Among the foliage feeding insects, leaf folder incidence was observed at 21 locations with maximum damage in late planting at Titabar (50.44% DL) followed by Nawagam (32.47% DL in late planting and 24.90% DL in normal planting). However, at Chatha, more than 20% damage was observed in all the three plantings while it varied from 17.15 (normal planting) to 20.12% (late planting) at Karaikal. Whorl maggot incidence was recorded at 6 locations and late planting had higher incidence compared to early and normal plantings at all the locations. Hispa damage was reported from 3 locations and Malan centre recorded highest damage of 68.85% in late planting, 20.81% in normal planting and 18.89% in early planting. Case worm incidence was observed at two locations with maximum damage (67.52%) in late planting at Titabar.

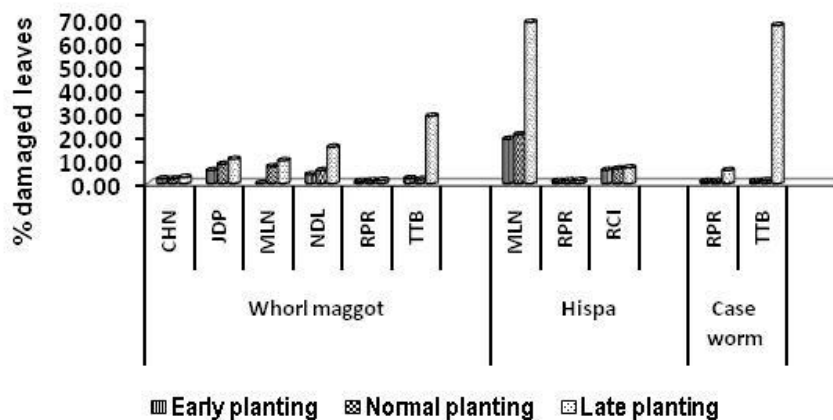
Among the sap sucking insects, WBPH incidence was more as compared to BPH incidence across locations and plantings. BPH incidence was observed at 10 locations with maximum numbers at Gangavathi in late planting (79.10/5 hills) and normal planting (60.02/5 hills). WBPH incidence was recorded from 9 locations with maximum population in late planting at Nawagam (105.70/5hills) followed by late planting (94.03/5 hills) and normal planting (89.53/5hills) at Gangavathi. GLH incidence was reported from 10 locations. The incidence was less than 10% in different plantings at all the locations except Ranchi, which recorded higher population (26.35 - 45.60/5 hills) in all the three plantings.



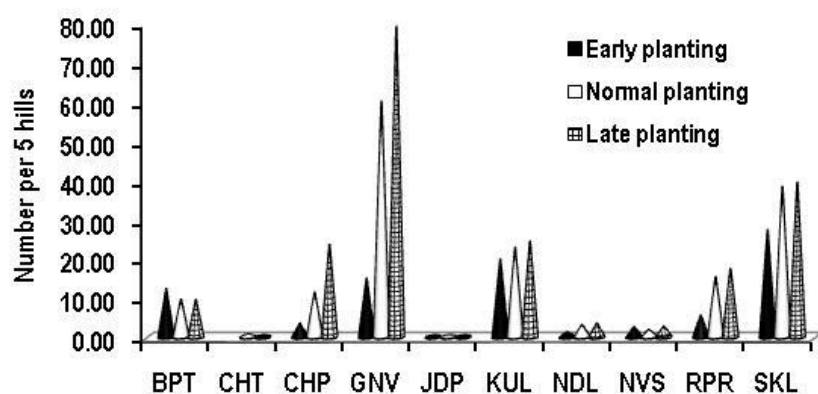
Gall midge incidence in different plantings

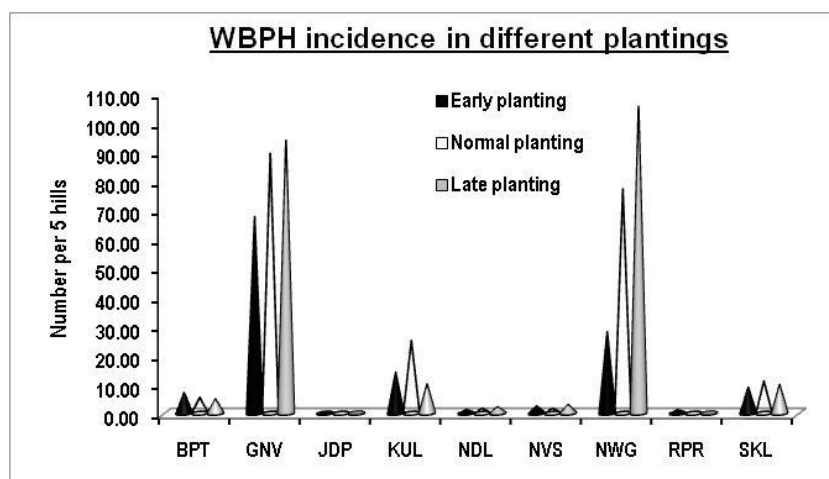


Incidence of foliage feeders at different locations



BPH incidence in different plantings





During *Kharif* 2019, the insect pest incidence was low to moderate in different dates of planting across 22 locations. Incidence of stem borer, gall midge, leaf folder, whorl maggot, hispa, caseworm, BPH, WBPH and GLH was found high in late planting as compared to early and normal plantings (**Fig 2.6**). At Titabar, pest incidence of stem borer, leaf folder and gall midge was significantly high compared to other locations. Low incidence of grasshopper was observed at Chatha and Khudwani, horned caterpillar at Navasari and rice skipper at Khudwani.

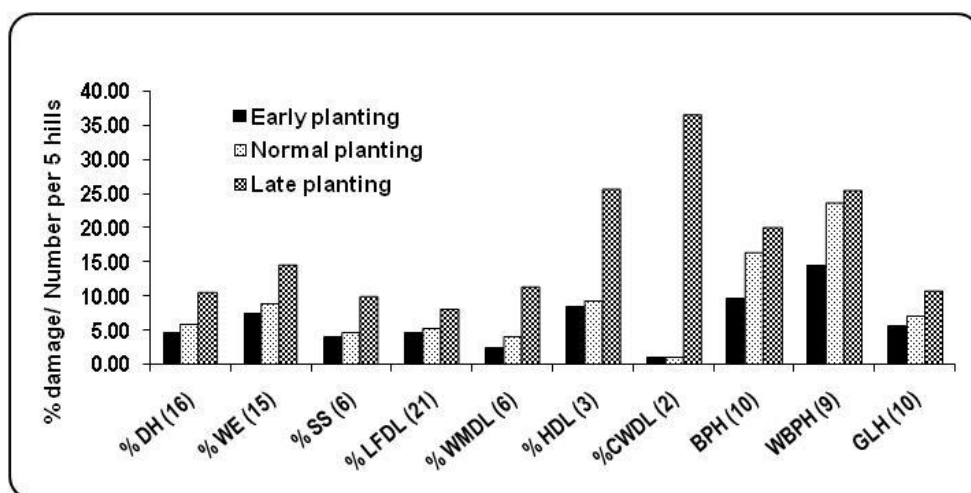


Fig 2.6 Insect pest incidence in different dates of planting during *Kharif* 2019

Effect of planting dates on insect pest incidence (EPDP) trial was conducted at 22 locations during *Kharif* 2019. Incidence of stem borer was reported from 16 locations with maximum damage in late planting. Highest dead heart damage was observed in late planting at Titabar (43.33% DH & 54.26% WE) followed by Pusa (19.38% DH) and late planting at Nawagam (32.16% WE). Gall midge incidence was noticed at 6 locations with maximum damage in late planting at Titabar (23.85% SS) followed by Sakoli (23.29% SS). Among the foliage feeding insects, leaf folder incidence was observed at 21 locations with maximum damage in late planting at Titabar (50.44% DL) followed by Nawagam in late planting (32.47% DL) and normal planting (24.90% DL).

Whorl maggot incidence was recorded at 6 locations and late planting resulted in higher incidence as compared to early and normal plantings. Hispa damage was reported from 3 locations and Malan centre recorded highest damage of 68.85% in late planting. Case worm incidence was observed at 2 locations with maximum damage (67.52%) in late planting at Titabar. Among the sap sucking insects, WBPH incidence was more as compared to BPH incidence across locations and plantings. BPH incidence was observed at 10 locations with maximum numbers at Gangavathi in late planting (79.10/5 hills) and normal planting (60.02/5 hills). WBPH incidence was recorded from 9 locations with maximum population in late planting at Nawagam (105.70/5hills) followed by late planting (94.03/5 hills) and normal planting (89.53/5hills) at Gangavathi. Low incidence of grasshopper at Chatha and Khudwani (<10%), horned caterpillar at Navasari and rice skipper at Khudwani was observed.

ii) Effect of Iron seed coating on insect pest incidence (ESCP)

Seed priming and seed coating treatments which help to increase the germination rate and improve the anchorage are essential in direct seeding in puddle soils. The high-density Fe coated seeds have also been reported to be resistant to bird damage and seed borne diseases. Keeping this in view, a collaborative trial with Agronomy (YET 4 – Enhancing the productivity of direct seeded rice with iron coating under different rice ecologies) was initiated with an objective to assess and generate useful information on the impact of iron seed coating on insect pest incidence.

During *Kharif* 2019, observations on insect pest incidence were recorded at 3 locations, *viz.*, Raipur, Karjat and Chiplima. The field trial was laid out, in split plot design with 4 dates of sowings at one week interval as main plots and 5 establishment methods (T1- Iron coated seed, seed rate 25 kg/ha, broadcasting in 1-2 mm water level condition (Direct sowing) T2- Iron coated seed, seed rate 25 kg/ha, broadcasting in wet Condition (Direct sowing) T3 – Un-coated seed, seed rate 25 kg/ha, broadcasting in 1-2 mm water level condition (Direct sowing) T4 – Uncoated seed, seed rate 25 kg/ha, broadcasting in wet condition (Direct sowing) T5 – Normal transplanting 21-25 days after sowing as subplots in 3 replications. Standard procedures were followed to record observations on insect pest incidence in all treatments. The results are summarized below.

At **Raipur**, there was low to moderate incidence of stem borer (5.2-16.7% DH & 8.4-3.3% WE) and low incidence of leaf folder (0.5–3.7% LFDL), whorl maggot (0.5-3.0% WMDL), case worm (0.0-4.0% CWDL), hispa (0.4–3.9% HDL), brown planthopper (3 – 9 hoppers/hill) and green leaf hopper (0 – 5 hoppers/hill) in Swarna variety grown in this trial. Dead heart and white ear damage by stem borer was at par in different dates of sowings whereas sub plot T1 (Iron coated seed, seed rate 25 kg/ha, broadcasting in 1-2 mm water level condition -Direct sowing) recorded significantly lowest dead heart damage (7.7% DH) compared to other sub plots (**Table 2.15**). White ear damage was at par in all the sub plots. Interaction effects are almost at par

with each other in different treatments. Observations on natural enemies were also recorded to know the impact of seed coating. Data revealed that Spiders (0-4/hill) and Coccinellids (0-4/hill) were relatively higher than Staphylinid and Rove beetles (0-3/hill).

Table 2.15 Effect of Iron Seed Coating on Pest Incidence (ESCP) at Raipur, Kharif 2019

Main plots		%DH	%WE	%LFDL	%WMDL	BPH (No./hill)
1 st sowing (19.07.2019)		8.7(3.0)a	14.5(3.9)a	1.3(1.3)b	1.5(1.4)b	5(2)ab
2 nd sowing (26.07.2019)		8.7(3.0)a	14.4(3.8)a	1.9(1.5)a	1.5(1.4)b	6(2)a
3 rd sowing (02.08.2019)		9.8(3.2)a	16.4(4.1)a	1.8(1.5)ab	1.8(1.5)a	5(2)b
4 th sowing (09.08.2019)		10.8 (3.3)a	15.4(3.9)a	1.9(1.5)a	1.7(1.5)ab	6(2)a
LSD (0.05)	Main plots	0.32	0.38	0.17	0.07	0.63
CV(%)		11.39	10.9	13.01	5.28	6.13
Sub plots						
T1 = Broadcasting of Iron coated seed in 1-2 mm water level		7.7(2.8)b	15.0(3.9)a	1.6(1.4)a	1.3(1.3)b	5(2)ab
T2 = Broadcasting of Iron coated seed in wet soil condition		10.6(3.3)a	14.6(3.9)a	1.5(1.4)a	1.6(1.4)ab	5(2)ab
T3 = Broadcasting of un coated seed in 1-2 mm water level		9.5(3.1)ab	16.6(4.1)a	1.6(1.4)a	1.8(1.5)a	6(3)a
T4 = Broadcasting of un coated seed in wet soil condition		10.1(3.2)a	14.4(3.9)a	2.0(1.6)a	1.5(1.4)ab	5(2)b
T5 = Normal transplanting		9.6(3.1)ab	15.3(4.0)a	2.0(1.6)a	1.9(1.5)a	6(3)a
LSD (0.05)	Sub plots	0.33	0.29	0.21	0.16	1.14
CV(%)		12.64	8.79	17.56	13.5	11.83
1 st sowing (19.07.2019)	T1	6.1(2.6)d	14.4(3.8)abc	1.1(1.2)de	1.2(1.3)b	5(2)abc
	T2	11.2(3.4)abc	14.1(3.8)abc	1.5(1.4)abcde	1.8(1.5)a	5(2)bc
	T3	8.9(3.0)abcd	14.7(3.9)abc	0.6(1.1)e	1.6(1.4)a	6(3)abc
	T4	7.9(2.9)bcd	15.5(4.0)abc	1.3(1.4)abcde	1.2(1.3)b	4(2)c
	T5	9.5(3.2)abcd	13.8(3.8)abc	2.1(1.6)abcd	1.9(1.5)a	6(2)abc
2 nd sowing (26.07.2019)	T1	8.3(2.9)abcd	14.8(3.9)abc	1.1(1.3)cde	1.6(1.5)a	5(2)abc
	T2	9.5(3.2)abcd	15.6(4.0)abc	1.6(1.4)abcde	1.6(1.4)a	7(3)ab
	T3	8.9(3.0)abcd	15.6(4.0)abc	1.8(1.5)abcde	2.0(1.6)a	6(3)abc
	T4	7.8(2.9)bcd	13.7(3.8)abc	2.3(1.7)abc	1.0(1.2)b	4(2)c
	T5	9.0(3.1)abcd	12.5(3.6)bc	2.6(1.8)a	1.5(1.4)a	7(3)a
3 rd sowing (02.08.2019)	T1	7.4(2.8)cd	15.7(4.0)abc	1.7(1.4)abcde	1.5(1.4)a	5(2)bc
	T2	10.3(3.3)abc	15.9(4.0)abc	1.6(1.4)abcde	1.6(1.4)a	5(2)abc
	T3	9.6(3.2)abcd	18.5(4.4)a	2.2(1.6)abcd	1.6(1.5)a	5(2)abc
	T4	12.1(3.5)ab	15.3(4.0)abc	2.1(1.6)abcd	1.8(1.5)a	5(2)bc
	T5	9.5(3.2)abcd	16.7(4.1)abc	1.5(1.4)abcde	2.2(1.6)a	5(2)abc
4 th sowing (09.08.2019)	T1	9.0(3.1)abcd	14.9(3.9)abc	2.4(1.7)ab	1.0(1.2)b	6(2)abc
	T2	11.3(3.4)abc	13.0(3.6)c	1.2(1.3)bcde	1.4(1.3)b	5(2)abc
	T3	10.7(3.3)abc	17.7(4.3)ab	1.7(1.5)abcde	2.0(1.5)a	7(3)ab
	T4	12.5(3.6)a	13.3(3.7)bc	2.4(1.7)abcd	2.2(1.6)a	5(2)abc
	T5	10.3(3.3)abc	17.8(4.3)ab	1.8(1.5)abcd	1.9(1.5)a	5(2)abc
LSD (0.05)	M in S	0.66	0.58	0.43	0.32	0.47
	S in M	0.67	0.64	0.42	0.3	0.44

Table 2.16 Effect of Iron seed coating on pest incidence (ESCP) at Karjat, Kharif 2019

Main plots		% DH			% WE
		15 DAT	30 DAT	45 DAT	Pre har
1 st sowing (03.07.2019)		6.4(2.5)a	2.0(1.4)a	2.1(1.5)a	7.1(2.7)a
2 nd sowing (10.07.2019)		4.2(2.1)a	0.11(0.7)b	0.7(1.0)b	6.9(2.6)a
3 rd sowing (17.07.2019)		4.9(2.1)a	1.7(1.4)a	1.3(1.3)ab	4.8(2.3)b
4 th sowing (24.07.2019)		0.8(1.0)b	0.2(0.8)b	0.7(1.0)b	4.1(2.1)b
LSD (0.05)		0.92	0.53	0.32	0.23
CV(%)		13.39	14.75	29.88	10.85
Sub plots					
T1 = Broadcasting of Iron coated seed in 1-2 mm water level		4.8(2.1)a	1.4(1.2)a	1.9(1.5)a	6.0(2.5)ab
T2 = Broadcasting of Iron coated seed in wet soil		4.3(2.0)a	1.6(1.3)a	0.8(1.1)b	4.8(2.2)b
T3 = Broadcasting of un coated seed in 1-2 mm water level		3.7(1.7)a	0.5(0.9)a	0.7(1.1)b	7.1(2.7)a
T4 = Broadcasting of un coated seed in wet soil		3.2(1.8)a	0.9(1.1)a	1.5(1.3)ab	4.7(2.2)b
T5 = Normal transplanting		4.4(2.0)a	0.5(0.9)a	1.0(1.1)b	6.0(2.5)ab
LSD (0.05)		0.57	0.36	0.30	0.42
CV(%)		15.36	10.15	30.53	20.74
Interactions					
1 st sowing (03.07.2019)	T1	4.6(2.2)abc	3.4(1.8)ab	3.1(1.9)a	6.2(2.6)abcd
	T2	5.3(2.4)abc	4.3(1.9)a	1.8(1.4)abc	4.6(2.2)bcd
	T3	10.3(3.2)a	0.8(1.0)cd	2.1(1.6)ab	9.6(3.1)a
	T4	4.9(2.2)abc	1.3(1.3)abcd	1.7(1.5)abc	6.4(2.6)abcd
	T5	6.6(2.5)abc	0.0(0.7)d	1.7(1.4)abc	8.3(2.9)ab
2 nd sowing (10.07.2019)	T1	5.2(2.4)abc	0.0(0.7)d	1.0(1.2)bcd	6.5(2.6)abcd
	T2	4.6(2.2)abc	0.0(0.7)d	1.0(1.2)bcd	8.0(2.9)abc
	T3	3.1(1.9)abcd	0.0(0.7)d	0.0(0.7)d	8.8(3.0)ab
	T4	3.5(1.8)abcd	0.6(1.0)cd	0.5(1.0)cd	4.9(2.3)bcd
	T5	4.8(2.3)abc	0.0(0.7)d	1.1(1.2)bcd	6.2(2.5)abcd
3 rd sowing (17.07.2019)	T1	8.4(2.8)a	2.2(1.6)abc	1.7(1.5)abc	6.0(2.5)abcd
	T2	5.5(2.2)abc	1.3(1.3)abcd	0.5(0.9)cd	3.3(1.9)d
	T3	1.2(1.1)cd	1.1(1.2)abcd	1.0(1.2)bcd	6.6(2.7)abcd
	T4	3.2(1.9)abcd	1.8(1.5)abc	2.6(1.7)ab	3.5(2.0)cd
	T5	6.1(2.5)ab	2.1(1.5)abcd	0.5(1.0)cd	4.7(2.3)bcd
4 th sowing (24.07.2019)	T1	1.0(1.1)cd	0.0(0.7)d	2.0(1.6)abc	5.3(2.4)abcd
	T2	1.8(1.3)bcd	0.9(1.1)bcd	0.0(0.7)d	3.3(1.9)d
	T3	0.0(0.7)d	0.0(0.7)d	0.0(0.7)d	3.4(2.0)d
	T4	1.1(1.1)cd	0.0(0.7)d	1.0(1.2)bcd	3.8(2.1)cd
	T5	0.0(0.7)d	0.0(0.7)d	0.6(0.9)cd	4.8(2.3)bcd
LSD (0.05)	M in S	1.14	0.72	0.62	0.84
	S in M	1.37	0.83	0.64	0.38

At **Karjat**, only stem borer incidence was observed in different sowings and treatments in Swarna variety (**Table 2.16**). Though the dead heart incidence was significantly high in first sowing starting from 15 DAT to 45 DAT (2.0-6.4%

DH) and 7.1% WE at pre-harvest compared to other sowings, the stem borer damage did not reach ETL. Similarly, dead heart damage was at par in different sub-plot treatments while white ears were relatively high (7.1% WE) in T3 subplot (Broadcasting of uncoated seed in 1-2 mm water).

At **Chiplima**, stem borer, gall midge and brown planthopper incidence was observed in first sowing in different treatments in Swarna variety grown in this trial (**Table 2.17**). Gall midge incidence was very high in normal transplanting (18.9-30.3% SS) and was at par with T3 (hydro primed flooded treatment – 20.3-24.8% SS) compared to other treatments during 55 to 75 DAT. Similarly, BPH incidence was significantly high in normal transplanting (26-39 hoppers/hill) which was at par with T3 (25-39 hoppers/hill). Stem borer incidence was low both at vegetative and reproductive stages in all the treatments.

Pest incidence data from only Karjat and Raipur were included for analysis of impact of sowing on pest occurrence (**Fig 2.7**). The stem borer damage across the sowings was not significant with dead heart damage of 0.1 to 10.8% and 4.1 to 16.4% white ears across the treatments. Data from all three locations were considered for analysis of effect of iron coating on pest incidence. The different iron coated seed treatments across locations revealed no significant differences in dead heart damage of 0.5 to 10.6% and white ear damage of 3.9 to 16.6% across all the locations (**Fig 2.8**). Gall midge incidence recorded only at Chiplima, was lowest in T2 treatment (9.2% SS) and significantly superior to remaining treatments. It was high in T5- normal transplanting (24.6% SS) on par with T3 treatment with uncoated seed (22.6% SS). Similarly BPH population was lowest in T2 treatment (11 hoppers/hill) followed by other Iron seed coated treatments (19 hoppers/hill) compared to normal (33 hoppers/hill) transplanting and uncoated seed treatments (32 hoppers/hill). Incidence of other pests like leaf folder, whorl maggot, case worm and hispa was very low (<5%) to draw valid conclusions.

Table 2.17 Effect of Iron seed coating on insect pest incidence (ESCP) at Chiplima, Kharif 2019

Treatments	% DH		% WE	% SS		BPH	
	55 DAT	75 DAT	Pre har	55 DAT	75 DAT	55 DAT	75 DAT
T1: Fe coated flooded	3.0(1.9)b	5.5(2.4)b	6.2(2.6)a	16.0(4.0)b	11.8(3.5)b	17(4)bc	21(5)b
T2: Fe coated dry	2.4(1.7)b	1.6(1.4)c	3.9(2.1)b	11.0(3.4)c	7.4(2.8)c	9(3)d	12(3)c
T3: Hydro primed flooded	5.6(2.5)a	7.6(2.9)a	7.6(2.9)a	24.8(5.0)a	20.3(4.6)a	25(5)ab	39(6)a
T4: Hydro primed dry	2.6(1.7)b	5.0(2.3)b	7.8(2.9)a	14.8(3.9)b	10.5(3.3)b	16(4)cd	22(5)b
T5: Normal transplanting	7.4(2.8)a	5.5(2.4)b	6.3(2.6)a	30.3(5.5)a	18.9(4.4)a	26(5)a	39(6)a
LSD (0.05)	0.56	0.47	0.38	0.54	0.46	0.84	1.03
CV(%)	14.01	10.83	7.84	6.6	6.63	10.16	10.81

Across the locations, there were no significant differences with respect to stem borer damage (0.5 – 10.6% DH & 3.9 – 16.6% WE). However, at Chiplima, T2 treatment (Fe coated seed in dry condition) showed significantly lower incidence of gall midge (9.2 – 13.9% SS) and BPH (11 – 19 hoppers/ hill).

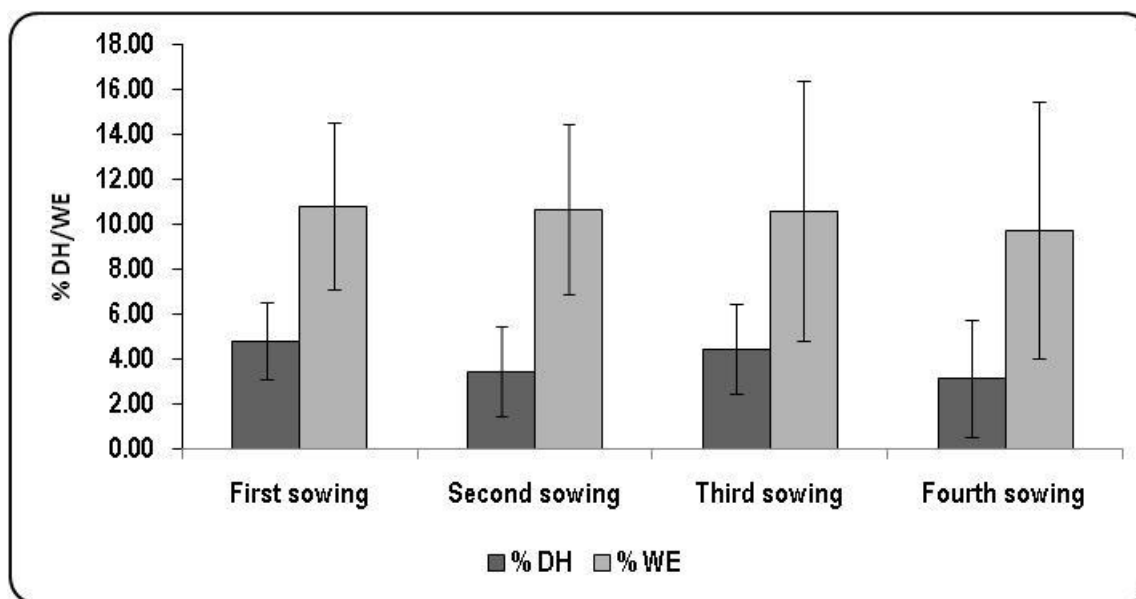


Fig. 2.7 Effect of seed coating on pest incidence in different sowings across locations, Kharif 2019

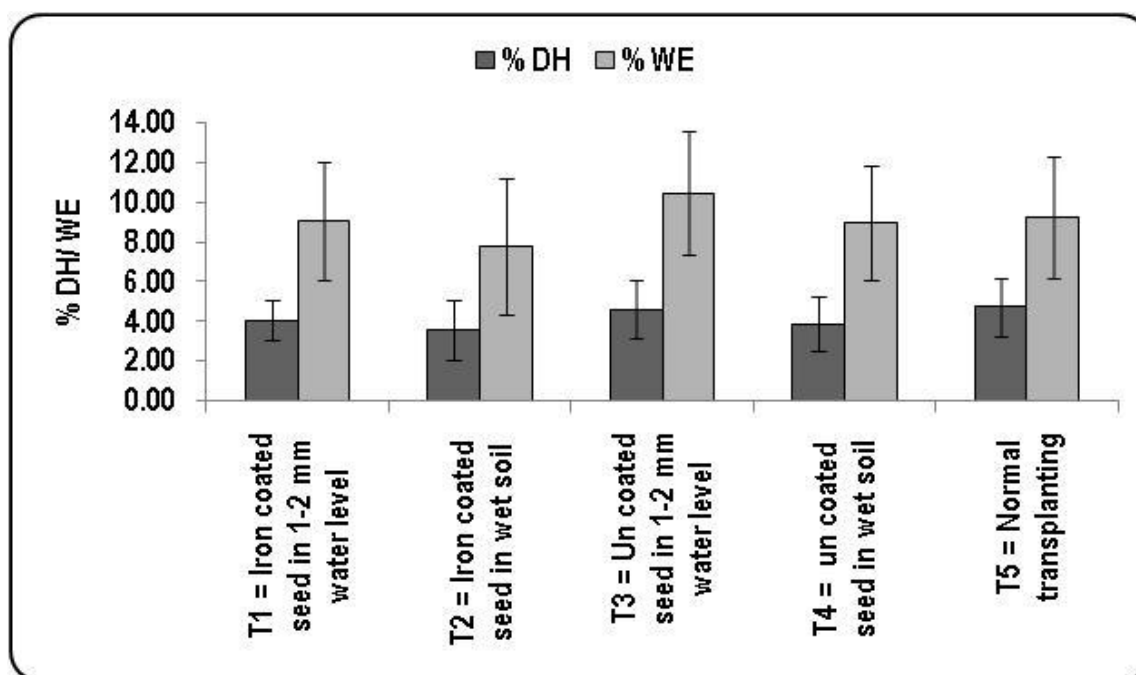


Fig 2.8. Effect of seed coating on pest incidence across locations, kharif 2019

Effect of iron seed coating on insect pest incidence (ESCP), initiated this year in collaboration with agronomy revealed, low pest incidence across the locations in different treatments. Stem borer incidence was at par in different seed coated treatments (0.5 – 10.6% DH & 3.9 – 16.6% WE) and also in different sowings (0.1 – 10.8% DH & 4.1 – 16.4% WE). However, gall midge (9.2 – 13.9% SS) and BPH incidence (11-19/hoppers hill) was found low in seed coated treatments compared to normal transplanting (24.6% SS & 33/hill) and T3 treatment with uncoated seed (22.6%SS & 32/hill).

iii) Influence of Establishment Methods on Pest Incidence (IEMP)

In India, rice is grown traditionally by manual transplanting method which requires more water and labour leading to high crop production costs. To overcome these constraints, the farmers are gradually shifting to alternative methods of rice cultivation like direct seeding, aerobic rice, mechanical transplanting etc. Hence, a collaborative trial with Agronomy section was initiated in order to assess the influence of crop establishment methods and weed management strategies on pest incidence.

The field trial was laid out in split plot design with three replications. Main plot treatments comprised of three different crop establishment methods (M1: Mechanised transplanting, M2: Puddled direct seeding and M3: Unpuddled dry direct seeding. The sub plot treatments comprised of four weed management treatments (S1 = Weed free; S2 = Weedy check; S3 = Mechanical weeding using weeder; S4 = Chemical weed control (pre and post emergence herbicide application)

During *Kharif* 2019, the trial was conducted at eight locations, *viz*, Aduthurai, Chiplima, Jagdalpur, Ludhiana, Malan, Mandya, Moncompu and Rajendranagar. Standard procedures were adopted to record insect pest incidence in different main and sub plot treatments. The results are summarized below.

At **Aduthurai**, the three main plots included mechanical transplanting, puddled direct seeding and unpuddled direct seeding methods of crop establishment, while the four sub plots consisted of weed free, weedy check, mechanical weeding and chemical weed control treatments. Incidence of stem borer, hispa, whorl maggot and BPH was observed (**Table 2.18**). Dead heart incidence was low in different crop establishment methods and sub-plots with weed management treatments except in weedy check which recorded 10.70% DH exceeding ETL (**Table 2.18**). However, white ear damage was high in all the main plots (15.74-27.54%) and sub plots (17.44 to 24.24%). Lowest white ear damage was recorded in Mechanised transplanting (15.74% WE) followed by puddled direct seeding (19.73% WE), while maximum white ear damage was observed in unpuddled direct seeding (27.54% WE). There were significant differences among the treatments. Among the sub-plots, weed free plot exhibited least white ear incidence (17.44%) significantly superior to mechanical weeding (20.30% WE), chemical weed treatment (22.02% WE), while weedy check treatment recorded highest incidence (24.24%). Interactive effects revealed that mechanised transplanting with weed free subplot showed the least white ear incidence (10.50%) followed by mechanical weeding subplot (15.50% WE) which was at par with puddled direct sowing with weed free sub plot (16.33% WE). These three treatments were significantly superior to rest of the treatments. Similarly, hispa damage was also significantly low in

mechanised transplanting main plot (8.47% DL) and weed free sub plot (10.23% DL) while highest damage was recorded in unpuddled direct sowing (27.54% DL) and weedy check sub plot (24.24% DL). Whorl maggot (maximum of 8.23% DL and BPH (2.16 hoppers/hill) incidence was very low across main and sub plots. Though there were significant differences, no trends were discernible on the effect of the treatments on these two pests.

Table 2.18 Influence of Crop Establishment Methods on Pest Incidence at Aduthurai, Kharif 2019

Treatments		% DH	% WE	% HDL	% WMDL	BPH/hill
Mechanised transplanting	Weed free	6.73g	10.50i	3.67j	2.67h	0.60g
	Weedy check	9.43cd	19.43f	13.57f	6.17e	1.53de
	Mechanical weeding	7.07g	15.50h	17.03i	2.27g	0.97f
	Chemical weed control	7.93f	17.53g	9.60h	4.27f	1.10f
Puddled direct seeding	Weed free	7.23g	16.33h	11.97g	5.47e	1.30ef
	Weedy check	10.73b	23.67d	17.07c	8.43ab	2.17b
	Mechanical weeding	8.70e	18.20g	14.47e	7.17d	1.60de
	Chemical weed control	8.97de	20.70e	15.50d	7.57cd	1.83cd
Unpuddled direct seeding	Weed free	8.60e	25.50c	15.07de	7.37d	1.57de
	Weedy check	11.93a	29.63a	18.83a	8.83a	2.80a
	Mechanical weeding	9.33cd	27.20b	16.60c	8.13bc	2.00bc
	Chemical weed control	9.97c	27.83b	17.83b	8.60ab	2.27b
LSD (0.05)		0.67	0.66	0.63	0.48	0.32
S in M		0.62	0.84	0.71	0.84	0.34
Main plots						
M1 = Mechanised transplanting		7.79c	15.74c	8.47c	4.09c	1.05c
M2 = Puddled direct seeding		8.91b	19.73b	14.75b	7.16b	1.73b
M3 = Unpuddled direct seeding		9.96a	27.54a	17.08a	8.23a	2.16a
LSD (0.05)		0.23	0.63	0.47	0.74	0.20
CV (%)		2.27	2.64	3.06	10.08	10.87
Sub plots						
S1 = Weed free		7.52d	17.44d	10.23d	5.17d	1.15d
S2 = Weedy check		10.70a	24.24a	16.49a	7.81a	2.17a
S3 = Mechanical weeding		8.37c	20.30c	12.70c	6.19c	1.52c
S4 = Chemical weed control		8.96b	22.02b	14.31b	6.81b	1.73b
LSD (0.05)		0.39	0.38	0.37	0.28	0.19
CV (%)		4.39	1.83	2.74	4.35	11.45

At **Chiplima**, five crop establishment methods, viz., normal transplanting, sowing behind the plough, mechanical line sowing, manual line sowing and broadcasting were evaluated with MTU 1156 variety. Low incidence of stem borer (2.07 to 6.62 DH% during 55 to 75 DAT & up to 6.91% WE), gall midge (3.09 to 7.33 SS% during 55 to 75 DAT) and BPH (29-33 to 38.00 hoppers/5 hills) was observed in all the establishment methods (**Table 2.19**). Broadcasting method showed pest damage at par with normal

transplanting method, however there were no discernible trends among the treatments.

Table 2.19 Influence of Crop Establishment Methods on Pest Incidence at Chiplima, Kharif 2019

Treatments	% DH		% WE	% SS		BPH/ 5 hills
	55 DAT	75 DAT	Pre har	55 DAT	75 DAT	75 DAT
T1 = Normal transplanting	5.00 (2.11)a	4.47 (2.09)ab	2.97 (1.69)b	7.33 (2.71)a	5.95 (2.42)ab	31.00 (5.56)b
T2 = Sowing behind the plough	4.33 (2.07)a	4.71 (2.15)ab	5.88 (2.39)ab	7.39 (2.71)a	8.34 (2.89)a	34.67 (5.88)ab
T3 = Mechanical line sowing	2.23 (1.47)b	4.53 (2.12)ab	6.91 (2.61)a	3.09 (1.75)c	4.94 (2.21)b	29.33 (5.41)b
T4 = Manual line sowing	2.07 (1.42)b	3.71 (1.92)b	3.89 (1.97)ab	5.22 (2.28)b	6.04 (2.46)ab	30.67 (5.53)b
T5 = Broadcasting	5.47 (2.32)a	6.62 (2.55)a	5.91 (2.43)a	5.91 (2.43)ab	6.63 (2.55)ab	38.00 (6.16)a
LSD 0.05	0.53	0.61	0.73	0.37	0.54	0.58
CV (%)	14.91	14.79	17.40	8.32	11.43	5.40

At **Jagdalpur**, the trial was carried out with Durgeshwary variety and included three main plots with mechanical transplanting, puddled direct seeding and unpuddled dry direct seeding methods of crop establishment and four sub plots with weed free, weedy check, mechanical weeding and chemical weed control treatments. Observations were recorded on incidence of stem borer, leaf folder, whorl maggot and GLH. Low incidence of stem borer was recorded in all the treatments (0.7 to 9.7% DH) except in weedy check sub plot of unpuddled dry direct seeding which showed 17.9% dead heart damage at 70 DAT (**Table 2.20**). Leaf folder (up to 8.7 % DL), whorl maggot (maximum of 10.7% DL) and GLH (highest of 12.7 hoppers/10 hills) incidence was also low and there were no significant trends in the impact of treatments on pest incidence.

At **Ludhiana**, three establishment methods, viz., ridge planting, flat planting and bed planting were practiced at three plant densities of 33 plants, 25 plants and 20 plants per square meter with PR 121 variety. Very low incidence of stem borer, leaf folder and planthoppers was observed in all the treatments (**Table 2.21**).

At **Malan**, Direct seeding, normal transplanting and semi dry rice methods were evaluated in this trial. Incidence of leaf folder was observed ranging from 13.89 to 23.24% DL during 45 to 90 DAT in different crop establishment methods with maximum damage in normal transplanting method (17.68 – 23.24% LFDL) followed by semi dry rice and direct seeding (**Table 2.22**).

Table 2.20 Influence of Crop Establishment Methods on Pest Incidence at Jagdalpur, Kharif 2019

Treatments		% DH		%LFDL	% WMDL	GLH/10 hills
		50 DAT	70 DAT	70 DAT	70 DAT	70 DAT
Mechanised transplanting	Weed free	0.8(1.0)b	2.5(1.6)b	8.2(3.0)a	9.4(3.1)ab	9.3(3.1)a
	Weedy check	0.7(1.0)b	6.7(2.6)ab	6.1(2.5)a	13.7(3.8)a	7.0(2.7)a
	Mechanical weeding	0.8(1.0)b	2.7(1.7)b	8.1(2.7)a	9.8(3.2)ab	10.7(3.3)a
	Chemical weed control	5.5(2.3)a	3.8(1.6)b	5.0(2.3)a	10.0(3.2)ab	8.3(2.8)a
Puddled direct seeding	Weed free	0.0(0.7)b	1.7(1.4)b	7.3(2.8)a	8.3(2.9)ab	5.0(2.3)b
	Weedy check	1.0(1.1)b	4.5(2.0)ab	8.7(3.0)a	7.7(2.8)ab	8.7(3.0)a
	Mechanical weeding	1.8(1.3)ab	5.8(2.4)ab	6.0(2.5)a	5.5(2.4)b	8.0(2.8)a
	Chemical weed control	0.0(0.7)b	0.9(1.1)b	7.8(2.9)a	9.2(3.1)ab	2.3(1.7)b
Unpuddled dry direct seeding	Weed free	2.3(1.4)ab	3.5(2.0)ab	7.7(2.8)a	10.5(3.3)ab	3.7(1.9)b
	Weedy check	0.0(0.7)b	17.9(4.0)a	5.9(2.5)a	9.7(3.2)ab	6.7(2.6)a
	Mechanical weeding	0.0(0.7)b	5.0(2.0)ab	8.6(3.0)a	9.7(3.2)ab	12.7(3.5)a
	Chemical weed control	1.3(1.3)ab	0.9(1.1)b	6.0(2.5)a	10.5(3.2)ab	8.0(2.7)a
LSD (0.05) M in S		0.93	2.05	1.13	0.97	1.14
S in M		1.1	2.04	1.14	1.23	1.55
Main plots						
M1 = Mechanised transplanting		2.0(1.4)a	3.9(1.9)a	6.9(2.6)a	10.7(3.3)a	8.8(3.0)a
M2 = Puddled direct seeding		0.7(0.9)a	3.2(1.7)a	7.5(2.8)a	7.7(2.8)a	6.0(2.5)a
M3 = Unpuddled direct seeding		0.9(1.0)a	6.8(2.3)a	7.0(2.7)a	10.0(3.2)a	7.8(2.7)a
LSD (0.05)		0.82	1.02	0.59	0.91	1.22
CV (%)		15.92	16.25	19.10	25.73	39.76
Sub plots						
S1 = Weed free		1.0(1.0)a	2.6(1.7)b	7.7(2.9)a	9.4(3.1)a	6.0(2.4)b
S2 = Weedy check		0.6(0.9)a	9.7(2.8)a	6.9(2.7)a	10.3(3.3)a	7.4(2.8)ab
S3 = Mechanical weeding		0.8(1.0)a	4.5(2.0)ab	7.6(2.7)a	8.3(2.9)a	10.4(3.2)a
S4 = Chemical weed control		2.3(1.4)a	1.8(1.3)b	6.3(2.6)a	9.9(3.2)a	6.2(2.4)a
LSD (0.05)		0.54	1.18	0.66	0.56	0.66
CV (%)		19.20	21.42	24.52	18.14	24.55

At **Mandya**, three crop establishment methods, *viz.*, mechanical transplanting, direct seeding and normal transplanting were assessed. Low incidence of stem borer (3.31-5.75% DH & 5.29 to 9.54% WE), leaf folder and case worm (<5.00% DL) as well as BPH (up to 9.00 hoppers/5 hills) was observed in all the methods in KMP 175 variety (**Table 2.23**).

Table 2.21 Influence of Crop Establishment Methods on Pest Incidence at Ludhiana, Kharif 2019

Establishment methods	Plants/m ² (Spacing)	% DH	% LFDL	PH/hill
		40 DAT	40 DAT	40 DAT
Ridge planting	33 plants (30 x 10 cm)	1.9 ± 0.2	2.3 ± 0.5	2.4 ± 0.5
	25 plants (30 x 13 cm)	1.6 ± 0.3	2.0 ± 0.5	2.0 ± 0.4
	20 plants (30 x 16 cm)	1.5 ± 0.3	1.6 ± 0.4	1.9 ± 0.5
Flat planting	33 plants (15 x 20 cm)	2.1 ± 0.4	2.4 ± 0.6	1.3 ± 0.3
	25 plants (20 x 20 cm)	2.1 ± 0.3	1.7 ± 0.3	1.3 ± 0.3
	20 plants (25 x 20 cm)	1.3 ± 0.4	1.5 ± 0.3	1.2 ± 0.3
Bed planting	33 plants (33.75 x 9 cm)	3.2 ± 0.5	4.1 ± 0.8	1.1 ± 0.3
	25 plants (33.75 x 12 cm)	3.2 ± 0.5	3.1 ± 0.6	1.0 ± 0.2
	20 plants (33.75 x 15 cm)	2.3 ± 0.3	2.3 ± 0.5	0.9 ± 0.2

Table 2.22 Influence of Crop Establishment Methods on Pest Incidence at Malan, Kharif 2019

Establishment methods	% Leaf folder damaged leaves			
	45 DAT	60 DAT	75 DAT	90 DAT
Direct seeding	13.89 (3.71)a	14.44 (3.78)b	14.72 (3.82)a	17.85 (4.21)ab
Normal transplanting	17.68 (4.20)a	19.55 (4.42)a	17.00 (4.11)a	23.24 (4.81)a
Semi dry rice	15.65 (3.94)a	15.74 (3.94)ab	15.19 (3.89)a	16.32 (4.01)b
LSD 0.05	0.56	0.62	0.59	0.61
CV (%)	9.68	10.47	10.27	9.69

Table 2.23 Influence of Crop Establishment Methods on Pest Incidence at Mandya, Kharif 2019

Establishment methods	% Dead hearts					% WE
	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	Pre har
Mechanical transplanting	3.31 ± 1.97	6.15 ± 1.64	3.33 ± 0.76	2.50 ± 0.91	1.24 ± 0.32	5.29 ± 1.44
Direct seeding	3.58 ± 1.44	4.22 ± 1.02	4.92 ± 1.15	3.50 ± 1.03	1.83 ± 0.27	9.29 ± 2.31
Normal transplanting	5.74 ± 2.26	5.24 ± 1.00	5.75 ± 0.78	4.44 ± 1.22	3.65 ± 0.80	9.54 ± 1.97
Establishment methods	% Leaf folder damaged leaves					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
Mechanical transplanting	0.54 ± 0.22	1.55 ± 0.49	4.19 ± 0.57	2.02 ± 0.69	1.02 ± 0.32	
Direct seeding		1.76 ± 0.35	3.40 ± 0.72	2.91 ± 0.69	1.92 ± 0.56	0.67 ± 0.30
Normal transplanting	0.61 ± 0.28	2.35 ± 0.76	4.61 ± 0.73	3.36 ± 0.57	2.15 ± 0.69	0.52 ± 0.13
Establishment methods	% Case worm damaged leaves					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
Mechanical transplanting	0.36 ± 0.22	0.62 ± 0.20	0.92 ± 0.19	1.58 ± 0.38	1.26 ± 0.36	0.40 ± 0.16
Direct seeding		0.37 ± 0.15	1.08 ± 0.40	1.44 ± 0.29	0.58 ± 0.18	
Normal transplanting	0.32 ± 0.20	0.82 ± 0.14	1.32 ± 0.32	1.97 ± .41	1.52 ± 0.33	1.15 ± 0.24
Establishment methods	BPH numbers per 5 hills					
	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	
Mechanical transplanting	0.40 ± 0.24	2.80 ± 0.86	5.60 ± 1.29	4.60 ± 0.93	2.40 ± 0.51	
Direct seeding	0.80 ± 0.37	2.20 ± 0.80	5.00 ± 1.30	5.60 ± 1.50	1.80 ± 0.58	
Normal transplanting	2.60 ± 1.21	4.00 ± 1.30	9.00 ± 1.73	8.20 ± 1.66	3.20 ± 0.86	

At **Moncompu**, drum seeding and normal transplanting methods were practiced with cono weeding and chemical weed control by spraying pre and post emergence herbicides. Uma variety was grown in this trial. Low incidence of stem borer (<9.0% DH & <5% WE), leaf folder (<1% LFDL), BPH (<8/hill), WBPH (<4/hill) and GLH (<2/hill) was observed in both the crop

establishment methods and weed management sub plots (**Table 2.24**). Incidence of gall midge was also observed but only in chemical weed control sub plot of normal transplanting method (<2% SS).

Table 2.24 Influence of Crop Establishment Methods on Pest Incidence at Moncompu, Kharif 2019

Main plots	Sub plots	% DH		% WE	% SS	% LFDL	BPH/hill
		30 DAT	90 DAT	Pre har	60 DAT	60 DAT	90 DAT
Drum seeding	Cono weeding		1.42 ± 0.6	4.33 ± 0.5		0.25 ± 0.1	6.80 ± 3.0
	Chemical weed control		1.58 ± 0.8	3.08 ± 0.9		0.14 ± 0.1	5.80 ± 2.5
Normal Transplanting	Cono weeding	1.55 ± 1.0	8.06 ± 3.5	2.82 ± 1.2		0.30 ± 0.2	7.00 ± 1.2
	Chemical weed control	1.47 ± 0.9	3.58 ± 1.0	4.36 ± 0.8	1.79 ± 0.9	0.16 ± 0.2	6.00 ± 2.9

At **Rajendranagar**, the three establishment methods included normal transplanting, wet seeding (line sowing under puddle condition) and dry sowing converted to wet method. RNR 15048 (Telangana sona) variety was grown in this trial in all the methods. Very low incidence of stem borer was observed in all the three methods (**Table 2.25**).

Table 2.25 Influence of Crop Establishment Methods on Pest Incidence at Rajendranagar, Kharif 2019

Establishment methods	% DH	% WE
	55 DAT	97 DAT
Normal transplanting	3.75 ± 0.11	5.49 ± 1.86
Wet seeding (Line sowing under puddle condition)	3.27 ± 0.13	1.99 ± 1.08
Dry sowing converted to wet	1.11 ± 0.05	1.12 ± 0.22

Among the crop establishment methods, across the locations, the pest incidence was found relatively high in dry direct seeding followed by normal transplanting method (**Fig 2.9**). White ears caused by stem borer were found high in dry direct seeding followed by puddled direct seeding which might be due to very high incidence at Aduthurai, resulting in skewness. BPH population was observed high in normal transplanting method compared to other methods.

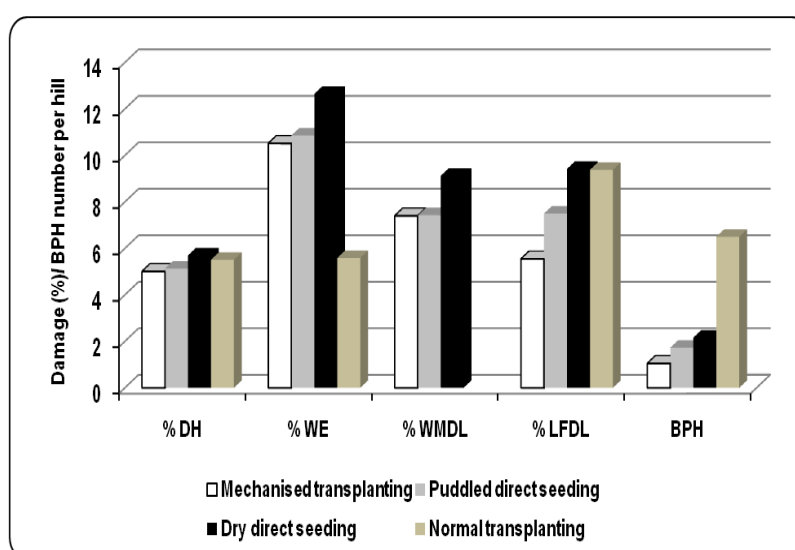


Fig 2.9. Influence of crop establishment methods on pest incidence (IEMP) across locations, Kharif 2019

Influence of crop establishment methods on pest incidence (IEMP) trial, initiated this year in collaboration with Agronomy, revealed that dry direct seeding recorded relatively high stem borer (12.65% WE), leaf folder (9.42% LFDL) and whorl maggot (9.12% WMDL) damage followed by normal transplanting method (10.86% WE; 9.38% LFDL). BPH numbers were found high in normal transplanting (6.5/hill) method as compared to dry direct seeding, puddle direct seeding and mechanised transplanting methods. Since this was the first year of this trial the findings need further years of observation, testing and validation.

iv) Cropping Systems Influence on Pest Incidence (CSIP)

Rice based cropping system is the major crop production system being practiced by Indian farmers involving rotation with crops like other cereals, pulses, cotton and vegetables. Generally, normal transplanting method is followed in raising the rice crop. However, due to the constraints in water and labour availability, farmers have been forced to look into the alternative methods like direct seeding in wet and dry conditions, aerobic rice etc. Similarly, incorporation of crop residues is known to help *Rabi* crops in rice based cropping systems. As rice straw contains about 1-2% of Potassium, incorporation of rice straw acts as a good source of nutrients for crops grown after rice. Keeping these in view, a trial on cropping systems influence on pest incidence (CSIP) was initiated in collaboration with Agronomy section (CA/SM 1- Conservation Agriculture/ System based management practices in rice and rice based cropping systems to utilise resources and enhance the productivity and profitability) to evaluate the influence of different rice crop establishment methods under different residue management strategies with the main aim of realising the potential of the sequence crop to improve the overall productivity of the rice based cropping system.

The field trial was laid out in split plot design with three replications. Main plot treatments comprised of three different crop establishment methods (M1: Transplanting, M2: Wet seeding (line sowing under puddled conditions) and M3: Aerobic rice – Dry rice cultivation). The sub plot treatments comprised of three different Residue/straw management techniques (S1: No residue, S2: Incorporation of 15 cm height of rice straw from ground, S3: Incorporation of 30 cm height of rice straw from ground) to be superimposed for *Rabi* crops. During *Kharif* 2019, the trial was conducted at two locations, *viz*, Karjat, and Jagdalpur. Standard procedures were followed to record observations on insect pest incidence in all treatments. The results are summarized below.

At **Karjat**, only stem borer was observed and incidence was low in all the three methods of crop establishment and residue management strategies. However, the incidence crossed ETL in M3 - aerobic rice (10.2% DH) and S1- No residue sub-plot (10.9% DH), at 60 DAT. The white ear incidence ranged from 8.1 to 10.8 across main plot and sub plot treatments. There were no

significant differences among the treatments in pest incidence at both vegetative and reproductive stages (**Table 2.26**).

At **Jagdalpur**, incidence of stem borer, leaf folder, whorl maggot and GLH was observed. Stem borer incidence at vegetative stage did not exceed 7.0% DH across the treatments, while leaf folder damage was also low ranging between 4.5 and 7.3% DL. Whorl maggot incidence was observed up to a maximum of 11.1% and GLH populations were recorded up to 12.7 hoppers/5 hills. Due to low pest incidence all the treatments were on par and no trends were discernible (**Table 2.27**).

A collaborative trial on cropping systems influence on pest incidence (CSIP) was initiated this year to evaluate the influence of different rice crop establishment methods under different residue management strategies with the overall objective of realising the potential of the sequence crop to improve the overall productivity of the rice based cropping system. During Kharif 2019, the trial was conducted at, Karjat and Jagdalpur. At both these locations, incidence of stem borer, leaf folder, whorl maggot and GLH was too low to draw valid conclusions.

Table 2.26 Influence of cropping systems on pest incidence at Karjat, Kharif 2019

Treatments		% DH				% WE
		15 DAT	30 DAT	45 DAT	60 DAT	90 DAT
M1= Transplanting	S1	8.0(2.8)a	8.3(2.8)a	10.3(3.2)a	14.2(3.8)a	14.1(3.7)a
	S2	6.2(2.5)a	6.4(2.5)a	7.7(2.7)a	7.8(2.8)a	8.0(2.8)b
	S3	4.5(2.1)a	5.3(2.2)a	6.8(2.6)a	7.3(2.7)a	7.0(2.7)b
M2 = Wet seeding	S1	5.9(2.4)a	6.1(2.4)a	6.8(2.6)a	8.6(2.9)a	8.7(2.9)ab
	S2	5.6(2.3)a	5.9(2.3)a	6.5(2.5)a	8.7(2.9)a	8.6(2.9)ab
	S3	2.4(1.5)a	4.5(2.1)a	5.2(2.3)a	7.6(2.8)a	7.3(2.7)b
M3 = Aerobic rice	S1	5.4(2.3)a	4.4(2.1)a	5.8(2.4)a	9.9(3.1)a	9.6(3.1)ab
	S2	5.8(2.4)a	5.6(2.3)a	6.1(2.5)a	10.1(3.2)a	10.5(3.2)ab
	S3	5.4(2.3)a	4.2(2.0)a	6.7(2.6)a	10.5(3.2)a	10.1(3.2)ab
LSD (0.05)	M in S	1.23	1.58	1.00	1.00	0.87
	S in M	1.27	1.84	1.42	1.13	0.97
Main plots						
M1= Transplanting		6.2(2.5)a	6.6(2.5)a	8.3(2.8)a	9.8(3.1)a	9.7(3.1)a
M2 = Wet seeding		4.6(2.1)a	5.5(2.3)a	6.2(2.5)a	8.3(2.9)a	8.2(2.8)a
M3 = Aerobic rice		5.5(2.3)a	4.7(2.1)a	6.2(2.5)a	10.2(3.2)a	10.1(3.2)a
LSD (0.05)		0.54	0.90	0.79	0.54	0.46
CV (%)		13.97	23.14	18.15	10.56	8.96
Sub plots						
S1 = No residue		6.4(2.5)a	6.2(2.4)a	7.6(2.7)a	10.9(3.3)a	10.8(3.2)a
S2 = 15 cm ht. of rice straw		5.9(2.4)a	5.9(2.4)a	6.8(2.6)a	8.9(2.9)a	9.0(3.0)a
S3 = 30 cm ht of rice straw		4.1(2.0)a	4.6(2.1)a	6.2(2.5)a	8.5(2.9)a	8.1(2.8)a
LSD (0.05)		0.51	0.66	0.42	0.41	0.36
CV (%)		17.67	22.53	12.72	10.81	9.44

Table 2.27 Influence of cropping systems on pest incidence at Jagdalpur, Kharif 2019

Treatments		% DH	% LFDL		% WMDL		GLH (NO./10 hills)
		70 DAT	50 DAT	70 DAT	50 DAT	70 DAT	70 DAT
M1= Transplanting	S1	4.5(2.2)a	7.1(2.7)a	5.9(2.5)a	6.7(2.7)b	4.5(2.2)a	7.0(2.3)ab
	S2	4.5(2.1)a	7.0(2.7)a	2.6(1.7)b	6.6(2.6)b	4.6(2.2)a	10.3(3.0)a
	S3	1.5(1.1)a	7.2(2.8)a	5.1(2.4)a	7.3(2.7)b	6.0(2.5)a	12.7(3.7)a
M2 = Puddled direct seeding	S1	3.6(1.8)a	5.6(2.4)a	4.6(2.2)ab	9.8(3.2)a	6.5(2.5)a	7.7(2.7)ab
	S2	7.6(2.5)a	5.3(2.4)a	7.2(2.8)a	8.3(3.0)a	8.6(3.0)a	7.3(2.7)ab
	S3	2.0(1.3)a	9.0(3.1)a	6.3(2.6)a	10.4(3.3)a	5.8(2.5)a	5.7(2.3)ab
M3 = Unpuddled dry direct seeding	S1	5.1(1.8)a	4.1(2.1)a	5.0(2.3)ab	11.2(3.4)a	5.1(2.4)a	1.7(1.3)b
	S2	8.9(2.9)a	7.5(2.8)a	5.6(2.5)a	9.9(3.2)a	8.5(2.9)a	9.3(3.0)ab
	S3	2.7(1.8)a	5.6(2.4)a	5.6(2.5)a	12.2(3.6)a	8.4(2.9)a	7.3(2.7)ab
LSD (0.05)	M in S	1.95	1.01	0.64	0.34	1.25	1.76
	S in M	1.93	1.02	0.65	0.59	1.13	1.64
Main plots							
M1= Transplanting		3.5(1.9)a	7.1(2.7)a	4.5(2.2)a	6.9(2.7)b	5.1(2.3)a	10.0(3.0)a
M2 = Puddled direct seeding		4.4(1.9)a	6.6(2.6)a	6.0(2.5)a	9.5(3.2)ab	6.9(2.6)a	6.9(2.6)a
M3 = Unpuddled dry direct seeding		5.6(2.2)a	5.8(2.4)a	5.4(2.4)a	11.1(3.4)a	7.3(2.7)a	6.1(2.3)a
LSD (0.05)		1.12	0.61	0.38	0.52	0.50	0.80
CV (%)		23.25	18.00	12.25	12.93	14.73	23.14
Sub plots							
S1 = No residue		4.4(1.9)a	5.6(2.4)a	5.2(2.3)a	9.3(3.1)ab	5.4(2.4)a	5.4(2.1)a
S2 = 15 cm ht. of rice straw		7.0(2.5)a	6.6(2.6)a	5.2(2.3)a	8.3(2.9)b	7.2(2.7)a	9.0(2.9)a
S3 = 30 cm ht of rice straw		2.1(1.4)a	7.3(2.8)a	5.7(2.5)a	10.0(3.2)a	6.7(2.6)a	8.6(2.9)a
LSD (0.05)		1.12	0.58	0.37	0.19	0.72	1.02
CV (%)		25.40	21.87	15.25	6.13	27.32	37.67

v) Evaluation of Pheromone Blends for Insect pests of Rice (EPBI)

Pheromones serve as a tool for monitoring pest populations and help in controlling insect pests. They are highly specific to the target pest and safe to other non-target pests and natural enemies in the ecosystem. Pheromones are being successfully used in monitoring and management of insect pests in most of the agricultural crops. In rice, yellow stem borer pheromones are being used widely by farmers for monitoring and mass trapping as an eco friendly IPM strategy. Keeping this success in view, preliminary studies have been carried out in the last few years to develop pheromone technology for other key pests, pink stem borer and leaf folder. Some of the blends at specified doses have been found effective in laboratory and field assays. Hence, a new trial was initiated during *Kharif* 2019 with an objective to evaluate these blends and doses of pheromone compounds for monitoring rice leaf folder and pink stem borer. The trial was conducted at 8 locations, *viz.*, Aduthurai, Coimbatore, Jagdalpur, Ludhiana, Navasari, Pattambi, Raipur and Titabar for rice leaf folder and four locations, Ludhiana, Pattambi, Raipur and Warangal for pink stem borer.

The trial was constituted with three blends for rice leaf folder comprising of one RLF blend which was found effective at IIRR and other AICRIP locations

previously, one multispecies blend with both RLF and YSB pheromone compounds and one control blend treated with hexane, replicated thrice. Similarly, pink stem borer blend and control blend were evaluated with three replications. These traps were placed randomly in the field and at each observation, adults caught in each trap was recorded along with observations on field population counts through disturb and count method (DCM), sweep net catches and light trap catches. The results of these evaluations were summarised below.

Rice leaf folder catches were high in RLF blend at Ludhiana followed by Titabar (**Table 2.28**). However, at other locations, the catches were low in RLF blend despite the presence of adult population in the field indicating the need for further retesting and confirmation. Multispecies blend was found to attract both RLF and YSB at Ludhiana alone and needs further assessment.

Table 2.28 Evaluation of pheromone blends for rice leaf folder, Kharif 2019

Pheromone blends	Trap catches							
	LDN	CBT	JDP	NVS	PTB	RPR	ADT	TTB
RLF blend	26	3	4	3	0	2	0	7
Multispecies blend (RLF + YSB)	6 + 3				0	2	0	
Control blend	4	1	2	0	0	1	0	1
Disturb & Count method (DCM)		3		10	11			2
Sweep net catches	22	0		3	10		6	8
Light trap catches	40	0		8	1		10	34

All values are mean of three pheromone traps/ catches

In general, pink stem borer population was low at all the tested locations as evident by sweep net and light trap catches. Pheromone trap catches of adult male moths were also low at all the locations indicating the need for further testing (**Table 2.29**).

Table 2.29 Evaluation of pheromone blends for Pink stem borer, Kharif 2019

Pheromone blends	Trap catches			
	LDN	PTB	RPR	WGL
PSB blend	4	2	5	0
Control blend	0	2	0	0
Sweep net catches	0	2		0
Light trap catches	2	1		0

All values are mean of three pheromone traps/catches

Evaluation of pheromone blends for insect pests of rice (EPBI) was a new trial initiated with an objective to evaluate pheromone blends and doses against rice leaf folder and pink stem borer. During Kharif 2019, the trial was conducted at 12 locations for both pests. Rice leaf folder catches were high in RLF blend at Ludhiana (26/trap) followed by Titabar (7/trap). However, at other locations, catches were low in pheromone traps in spite of the presence of adult population in the field, which needs further evaluation. Multispecies blend attracted both rice leaf folder and yellow stem borer, however it needs further investigation.

2.4. BIOCONTROL AND BIODIVERSITY STUDIES

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

i) Ecological Engineering for Planthopper Management (EEPM)

This trial has the objective of habitat management through cultural and non-pesticidal methods along with floral diversity to increase natural biological control and augment egg predators of hoppers for managing planthoppers by enhancing natural enemy fitness. Data were recorded on insect pests mainly hoppers and their natural enemies and analyses were done using the independent 't' test or ANOVA. The trial was conducted at eight locations during kharif 2019 *viz.*, Bapatla, Gangavathi, Moncompu, Mandya, New Delhi, Malan, Rajendranagar and Warangal.

1. Bapatla

The intervention adopted in the ecological engineering plots were organic manuring, alleyways, border planting of marigold and application of neem based neem oil formulation. The population of hoppers were on par (**Table 2.30**) and among their natural enemies, spiders were significantly higher in ecological engineering plots (10.1/10 hills as compared to 7.7/10 hills in farmer's practice).

Table 2.30 Effect of ecological engineering on populations of hoppers and their natural enemies at Bapatla, EEPM, kharif 2019

Parameters	Population of hoppers (No./ hill)				Population of natural enemies (No./ 10 hills)					
	BPH		WBPH		Green mirids		Spiders		Coccinellids	
	EE	FP	EE	FP	EE	FP	EE	FP	EE	FP
Mean	4.15	5.85	6.60	6.73	13.9	11.2	10.1	7.7	0.39	0.31
t value	0.17 ^{NS}		7.07 ^{NS}		1.81 ^{NS}		2.17*		1.14 ^{NS}	
df	198		198		198		198		198	
P - value	0.86		0.71		0.07		0.03		0.26	

2. Gangavathi

Two interventions *viz.*, alleyways and growing border crop of cowpea were undertaken in the ecological engineering (EE) plots. Four observations were recorded on planthoppers and their natural enemies throughout the crop period. In the ecological engineering plots the hopper population was higher ranging from 13.20/hill at 40 DAT to a maximum of 158.00/hill at 80 DAT, thereafter decreasing to 33.00 at 100 DAT (**Fig.2.10**) which was significantly higher than that of the population in Farmers Practice plots with chemical interventions, where the highest was observed at 80 DAT (40.00/hill).

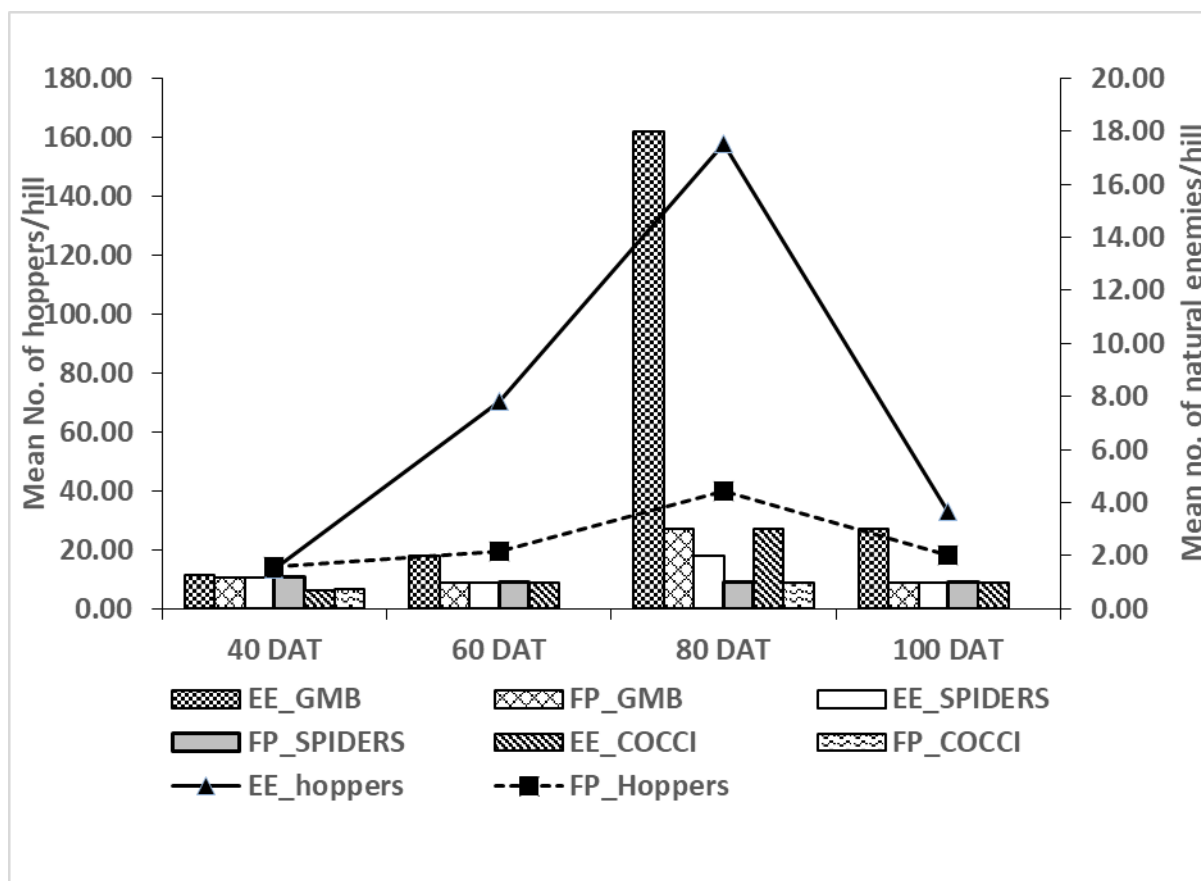


Fig.2.10 Abundance of hoppers and its natural enemies at Gangavathi, EEPM, kharif 2019

The mean hopper numbers over the crop period were significantly higher in EE plots (68.65/hill) in comparison to farmers' practices (FP) (22.98/hill, **(Table 2.31)**). But, the population of green mirids, spiders and coccinellids were significantly higher in EE plots indicating a positive trend for these practices in conservation of natural enemies. The green mirid number in the ecological engineering plots (60.75/10 hills) was 5 times higher than that of the farmers practice (15.40/10hills). Similarly the coccinellid population in EE treatment was three times higher (14.2/10 hills) as compared to the population in FP treatment (4.30/ 10hills). Mean parasitisation by three species of parasitoids in the EE plots was significantly higher (31.15%; $t = 7.01$; $P = <0.01$) compared to 12.53 % under farmers practice. The egg parasitisation was assessed by two methods – egg bating and by destructive sampling. The parasitisation per cent was significantly higher in the ecological engineering plots in both methods of assessment and on all dates of sampling (Table). The per cent parasitisation ranged from 14- 17 per cent in the EE treatment while it ranged from 4 -7 per cent in the FP treatment. Three species of parasitoids were observed in both treatments. While the parasitisation by *Oligosita sp* in EE plots was up to 35.87 per cent *Anagrus sp* was dominant in FP treatments accounting for 37.21 % (**Fig 2.11**). There is no mention of yield and BC at this centre.

Table: 2.31 Effect of ecological engineering on populations of hoppers and their natural enemies at Gangavathi, EEPM, *kharif* 2019

A. Hoppers and its predators

Parameters	Hoppers (No./ hills)		Population of natural enemies (No./ 10 hills)					
			Green mirids		Spiders		Coccinellids	
	EE	FP	EE	FP	EE	FP	EE	FP
Mean	67.88	19.66	50.75	8.10	20.30	8.35	17.50	4.85
t value	10.49 **		10.72**		9.19**		10.14**	
df	398		398		398		398	
P - value	<0.01		<0.01		<0.01		<0.01	

B. Parasitoids

Parameters	*Egg Parasitisation % at								Mean parasitisa- tion %	
	% parasitisation by egg baiting		40 DAT		60 DAT		75 DAT			
	EE	FP	EE	FP	EE	FP	EE	FP	EE	FP
Mean	17.67	7.25	15.78	3.91	15.90	4.27	14.28	4.41	15.91	4.96
t value	2.28*		4.89**		6.67**		1.59**		8.14**	
df	48		48		48		48		198	
P - value	<0.01		<0.01		<0.01		<0.01		<0.01	

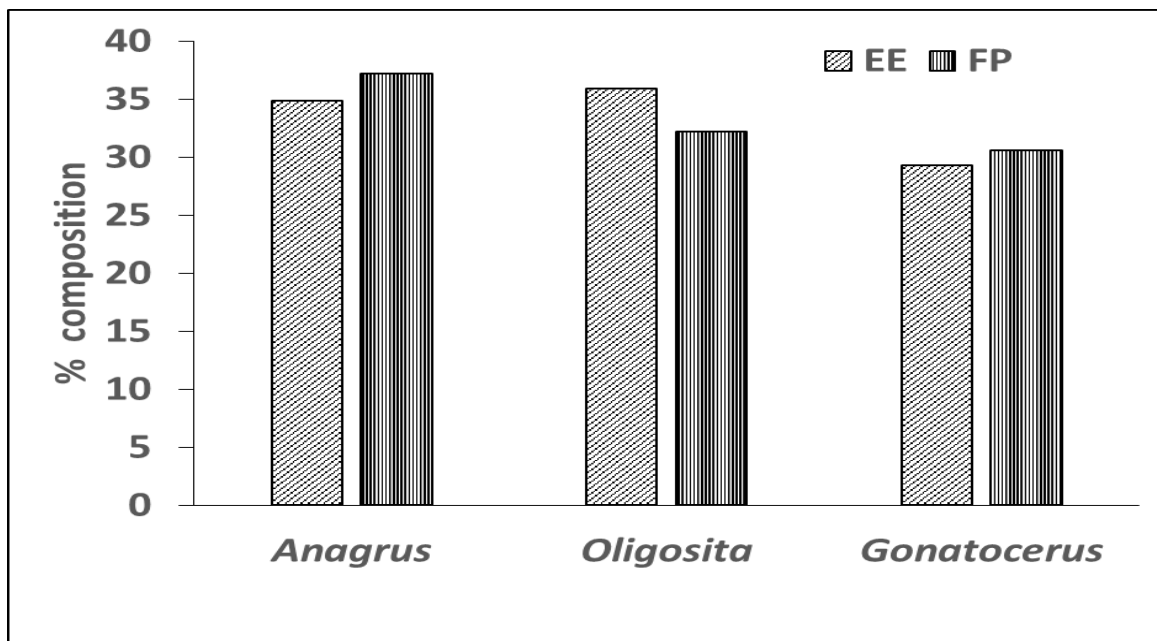


Fig.2.11 Per cent composition of egg parasitoids of hoppers at Gangavathi, EEPM, *kharif* 2019

3. Malan

At Malan three treatments were tested in natural farming systems *viz.*, (i) with bund flora of French marigold along with recommended fertilizers (ii) with bund flora of French marigold with Azolla application and without fertilizers (iii) only natural farming. The key pest observed was the leaffolder and the percent damaged leaves varied significantly among the treatments on all four observation dates. The mean maximum leaf damage (24.37 %) was found in the treatment with fertilizer application (**Table 2.32**) which was on par with the natural farming with no bund crop. The most effective treatment for reduction in leaffolder damage was bund cropping along with azolla application (12.26%). On the other hand the mirid bug population was on par in bund cropping treatment with and fertilizers and significantly higher than the plots without bund crop (5.0 - 6.48/ hill) (**Table 2.33**).

Table 2.32 Effect of ecological engineering on leaffolder incidence at Malan, EEPM, *kharif* 2019

Treatment	% leaves damaged by Leaffolder				
	I observation	II observation	III observation	IV observation	Mean
With bund flora (Marigold) and RFD	23.29 (28.85)	27.70 (31.59)	23.02 (28.66)	23.46 (28.97)	24.37
With bund flora (Marigold)+ Azolla application	11.88 (20.14)	11.72 (20.00)	11.79 (20.07)	13.65 (21.36)	12.26
Natural Farming with no bund flora	20.19 (26.61)	15.72 (23.34)	14.23 (22.16)	13.85 (21.85)	16.00
CD (p=0.05%)	2.30	4.36	1.15	3.99	

Table 2.33 Effect of ecological engineering on abundance of mirid bugs at Malan, EEPM, *kharif* 2019

Treatment	Mirid bugs (No./ hill)			
	I observation	II observation	III observation	IV observation
With bund flora (Marigold) and RFD	9.21	10.12	9.76	9.38
With bund flora (Marigold)+ Azolla application	9.38	9.14	9.52	9.92
Natural Farming with no bund flora	5.00	6.48	5.00	5.46
CD (p=0.05%)	1.12	NS	1.46	0.83

4. Moncompu

Bund planting of marigold was taken up in EE plots. The pooled analysis revealed that number of hoppers was significantly higher in FP plots (**Table 2.34**) on 60 and 90 DAT with a mean population of 8.21/ hill as compared to 2.8/hill in EE plots. The population of pest were however low due to submergence by floods. Among the natural enemies recorded coccinellids (5.85/10 hills) was significantly higher in EE treatment as compared to 4.13/10 hills in FP treatment.

Table 2.34 Effect of ecological engineering on hoppers and their natural enemies at Moncompu, EEPM, kharif 2019

Parameters	Hoppers (No./hill)		Green mirids (No./10 hills)		Spiders (No./10 hills)		Coccinellids (No./10 hills)	
	EE	FP	EE	FP	EE	FP	EE	FP
Mean	2.80	8.21	3.10	2.60	2.17	2.00	5.85	4.13
t value	4.88		0.49		0.45		2.77*	
df	198		398		398		398	
P - value	<0.01		NS		NS		0.02	

5. Mandya

Floral diversity was increased in EE plots by growing cowpea and *sun hemp* on the bunds, alleyways and application of vermicompost. The mean population of hoppers in EE plots (12.36/ hill) was significantly higher compared to that of FP plots (8.66/hill) (**Table 2.35**). However a reverse trend was observed in case of natural enemies and was significantly higher in the ecological engineering plots. Coccinellids, spiders and mirids were observed at 28.10, 37.10 and 10.80 per ten hills in the EE treatment as compared to 12.51, 21.51 and 3.47 in the FP treatment.

Table 2.35 Effect of ecological engineering on hoppers and their natural enemies at Mandya, EEPM, kharif 2019

Parameters	Hoppers (No./hill)		Green mirids (No./10 hills)		Spiders (No./10 hills)		Coccinellids (No./10 hills)	
	EE	FP	EE	FP	EE	FP	EE	FP
Mean	12.36	8.66	10.80	3.47	37.10	21.51	28.10	12.51
t value	5.70**		8.61**		8.26**		8.45**	
df	98		398		398		398	
P - value	<0.01		<0.01		<0.01		<0.01	

6. New Delhi

Five treatments were tested. Four of these had bund plantings of (i) crops - Sesamum, Soybean, Sunflower, (ii) flower crops- Marigold, Balsam and Gaillardia (iii) combination of crops and flowering crops (iv) natural weeds

(V) control with no border crop. Observations were recorded on damage by stemborer, leaffolder, whorl maggot and population of hoppers and their natural enemies over the crop period. A mixed population of brown planthopper and white backed planthoppers were observed. The BPH population peaked from 84-94 DAT and mean ranged from 10.9 -27.8 / hill among the various treatments which were on par. The incidence of stem borers assessed by white ear damage was significantly different among the treatments with the lowest damage observed in plot with a border of crops- Sesamum, Soybean, Sunflower (0.95 %) while the highest was observed in plots without a border crop (1.74%) (**Table 2. 36**). The population of natural enemies such as spiders and mirids were also highest in the crop associated these crops (34.75 and 125.25/ 10 hills respectively).

Table 2.36 Effect of ecological engineering on abundance of pests and natural enemies at New Delhi, EEPM, *kharif* 2019

Treatment	%WE	Spiders (No./10 hills)	Mirids (No./10 hills)	Plot Yield (Kg)
Crops (Sesamum, Soybean, Sunflower)	0.95 (5.60)	34.75	125.25	4530
Flowers - (Marigold, Balsam, Galardia)	1.19 (6.20)	27.00	120.75	4805
Natural Weeds	1.55 (7.10)	17.50	58.00	4125
Crops + Flowers	1.07 (5.91)	34.25	108.50	5610
CONTROL	1.74 (7.52)	20.25	49.25	4000
CD (p=0.05%)	1.15	8.06	40.74	1020

7. Rajendranagar

Three treatments- Farmers practice plots with chemical interventions (FP), Ecological engineering plots with and without alternate wetting and drying (EEP 1 and EEP 2 respectively) were tested. Practices followed in EE plots were, alleyways, alternate wetting and draining of water, increase in floral diversity on bunds by planting yellow marigold in addition to no chemical plant protection measures. The mean population of hoppers ranged from 15-22 among the treatments and did not differ significantly. But the yield was found to be significantly higher in the ecological engineering treatment with alternate wetting and drying (4410kg/ha) (**Table 2.37**)

Table 2.37 Effect of ecological engineering on hoppers and their natural enemies at Rajendranagar, EEPM, kharif 2019

Treatment	Hoppers (No./ hill)	Spiders No./ 10 hills)	Yield (kg/ha)
EEP-I	22.3	5.1	4410
EEP-II	18.33	4.7	4000
FP	15.34	4.9	3530
CD(0.05)	NS	NS	388.50
SEM	-	-	133.17

8. Warangal

Three treatments- Farmers practice plots with chemical interventions (FP), Ecological engineering plots with and without alternate wetting and drying (EEP 1 and EEP 2 respectively) were tested. Practices followed in EE plots were, alleyways, alternate wetting and draining of water, increase in floral diversity on bunds by planting marigold in addition to no chemical plant protection measures. Five observations were recorded on the two planthoppers and their natural enemies through the crop period. A mixed population of BPH and WBPH was observed. The population of brown planthopper reached a peak at 100 DAT and was highest in the FP treatment 127.47/hill and lowest (28.87/ hill) in ecological engineering treatment with alternate wetting and drying (**Table 2.38**). The hopper numbers were consistently lowest in the EEP-I treatment plots indicating that alternate wetting and drying along with ecological engineering can reduce hopper population. The populations of spiders and coccinellids were significantly different at 111 DAT in the three treatments. The number of spiders were higher in ecological engineering plots without alternate wetting and drying (24.80/10 hills). The number of coccinellids at 111 DAT was also significantly higher in EEP II plots (11.87/ 10 hills). Mirid bugs were on par in all treatments.

The EE plots yielded higher (**Table 2.39**) with the highest being in EEP-I (4455 kg /ha) while the FP plots yielded an average of 3238 kg/ha. The B: C ratio was also higher in the ecological engineering plots than FP plots and the highest BCR of 1.94 was observed in EEP-I plots with alternate wetting and drying. FP plots showed lowest B: C ratio of 1.29.

Table 2.38 Effect of ecological engineering on populations of hoppers and their natural enemies at Warangal, EEPM, *kharif* 2019

A. Hoppers

	BPH (No. / 10 hills)			WBPH (No. / 10 hills)		
	74DAT	100 DAT	111DAT	74DAT	100 DAT	111DAT
EEP-I	80.40	28.87	18.93	60.67	10.40	10.60
EEP-II	98.27	105.73	58.67	68.47	33.47	31.87
FP	84.20	127.47	62.80	61.00	42.13	34.00
CD(0.05)	11.88	47.21	20.56	NS	17.32	10.28
SEM	2.80	14.83	6.16	-	4.68	3.29

B. Natural enemies of hoppers

Treatments	Spiders No. / 10 hills	Coccinellids No. / 10 hills	Mirids No. / 10 hills
	111 DAT	111 DAT	Mean
EEP-I	20.33	8.60	22.67
EEP-II	24.80	11.87	18.67
FP	23.20	9.47	17.67
CD(0.05)	2.25	1.78	NS
SEM	0.58	0.47	-

Table 2.39 Grain Yield and Benefit cost ratio of Ecological engineering at Warangal, EEPM, *kharif* 2019

Treatment	Grain yield (Kg/ha)	B:C ratio
EEP-I	4454.72	1.94
EEP-II	3958.86	1.73
FP	3238.07	1.29
CD(0.05)	357.46	0.16
SED	151.40	0.08

Table 2.40 Natural enemy population on marigold planted on bunds in EEP plots* *kharif* 2019

Treatments	Mirids		Coccinellids		Spiders	
	80 DAT	100 DAT	80 DAT	100 DAT	78 DAT	95 DAT
EEP-I	0.16	0.06	0.20	0.46	1.04	1.38
EEP-II	0.22	0.04	0.20	0.40	1.04	1.16

*Mean of 50 marigold plants

Low populations of mirids, coccinellids and spiders were also observed on the marigold plants grown on the bunds indicating a sharing of natural enemies (**Table 2.40**).

Ecological engineering for pest management was taken up in eight locations with a combination of interventions such as organic manuring, alleyways, spacing management, water management and growing of flowering plants on bunds. The results also indicated that water management along with ecological engineering significantly reduced hopper population at Warangal (18.93/hill) when compared to farmers practice (127.47/hill) while increasing yields. Stem borer damage was significantly lower in ecological engineering treatments with various bund crops at New Delhi. Such interventions increased the natural enemy populations like mirids, spiders and coccinellids. Increased egg parasitisation of hoppers was observed at Gangavathi with a mean parasitisation of 15.91 with ecological engineering as compared to 4.96 % in farmer's practices. At Warangal, the benefit cost was also significantly higher with ecological engineering (1.94) when compared to Farmers practice (1.29).

ii) Bio-intensive pest management trial (BIPM)

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

The trial involved mainly two treatment blocks *viz.*, i) Bio-intensive pest management (BIPM) which was again split into - one sub block receiving seed treatment and application of *Trichoderma* and - another sub block with *pseudomonas* and ii) Input intensive pest management or Farmers Practice block (FP) spread over an area of a minimum of half acre for each block planted with a local popular variety of the region. The results of the trials at various locations are given below.

1. Bapatla

The practices under BIPM treatment were seed treatment with *Psuedomonas*, installation of pheromone traps and application of neem oil

twice during the season. Observations were recorded on incidence of leaffolders and hoppers and their natural enemies. The FP plots recorded significantly higher leaffolder damage throughout the crop season (**Fig 2.12**) ranging from 2.58 to 12.58% as compared to 1.59 to 4.60 in the BIPM plots. The mean per cent leaves damaged by leaffolder was significantly higher in FP plots (10.42%) as compared to BIPM (2.84%)(**Table 2.41**). The hopper population was very low ranging from 1.09 to 2.23 per hill and there was no difference between the treatments.

Table 2.41 Pest incidence under Bio-intensive pest management trial at Bapatla, *khari* 2019

Parameters	LF		WBPH		BPH	
	(% damage)		(No./ hill)		(No./ hill)	
	BIPM	FP	BIPM	FP	BIPM	FP
Mean	2.84	10.42	1.09	1.20	1.79	2.23
t value	7.85**		0.58 ^{NS}		1.98 ^{NS}	
df	78		100		100	
P - value	<0.01		NS		NS	

* LF- leaffolder; WBPH – white-backed planthopper; BPH – brown planthopper

The population of beneficial insects were on par in both treatments (**Table 2.42**). The yield, however was significantly higher in FP treatment (5665 kg/ha) (**Table 2.42**).

Table 2.42 Population of natural enemies and yield under Bio-intensive pest management trial at Bapatla, *khari* 2019

Parameters	Spiders		Coccinellids		Mirids		Yield*	
	(No./ 10 hills)		(No./ 10 hills)		(No./ 10 hills)		(kg/ha)	
	BIPM	FP	BIPM	FP	BIPM	FP		
Mean	7.1	7.6	3.50	3.25	8.40	10.30	3910	5665
t value	0.51 ^{NS}		0.32 ^{NS}		1.37 ^{NS}		8.63**	
df	100		100		100		10	
P - value	0.61		0.75		0.17		<0.01	

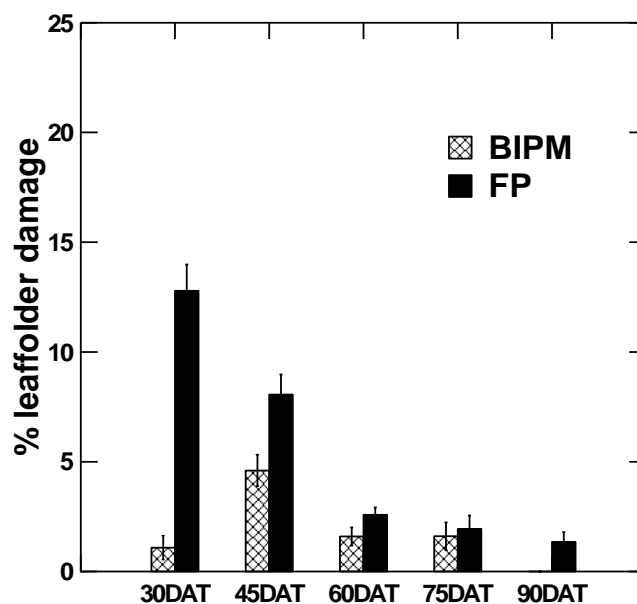


Fig 2.12 Leaffolder damage under Bio-intensive pest management trial at Bapatla, *kharif* 2019

2. Chinsurah

Observations were recorded on the damage by whorl maggot, stem borer, leaffolder and natural enemies like spiders, coccinellids and staphylinids. Whorl maggot incidence observed in the early crop growth ranged from 3.94 to 4.09 % DL and was on par in the two treatments (Table 2.xxx). The dead heart damage by stem borer was significantly higher in FP plots (13.93%) than that of BIPM plots (7.69%). A similar trend was observed with white ear damage in the reproductive phase with 5.47 % damage recorded in BIPM plots as compared to 19.35% in FP plots (**Table 2.43**). The populations of other pests were low.

Table 2.43 Pest incidence under Bio-intensive pest management trial at Chinsurah, *kharif* 2019

Parameters	WM		DH		WE	
	(% damage)		(% damage)		(% damage)	
	BIPM	FP	BIPM	FP	BIPM	FP
Mean	4.09	3.94	7.69	13.93	5.47	19.35
t value	0.01NS		4.86**		8.67**	
df	58		58		22	
P - value	0.10		<0.01		<0.01	

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

The natural enemy population was relatively higher in the BIPM plots. But only the number of spiders (2.83/ 10 hills) was significantly higher than that of FP plots (1.50/10 hills). However there were no significant differences in populations of coccinellids between the treatments. Due to the lower stem

borer damage in the vegetative and reproductive phase the yield was significantly higher in BIPM plots (7297 kg/ha) than that of FP plots (5433 kg/ha)(**Table 2.44**).

Table 2.44 Population of natural enemies and yield under Bio-intensive pest management trial at Chinsurah, kharif 2019

Parameters	Spiders		Coccinellids		Yield*	
	(No./ 10 hills)		(No./ 10 hills)		(kg/ha)	
	BIPM	FP	BIPM	FP		
Mean	1.67	0.33	2.67	1.36	7297	5433
t value	2.25*		1.56NS		12.63**	
df	34		34		10	
P - value	0.02		0.12		<0.01	

*projected yield

3. Jagdalpur

Incidence of whorl maggot, thrips, leaffolder, stem borer, BPH and GLH were observed. The pest incidence was low for all pests. The per cent leaves damaged by whorl maggot leaffolder and thrips were lower in BIPM plots compared to farmer's practice plots but statistically on par. However damage by stem borer was significantly lower in BIPM plots (6.00% DH or WE?) as compared to farmers' practice (8.91%) (**Table 2.45**). BIPM plots yielded significantly higher (4162 kg/ha) than that of FP plots (3573 kg/ha).

Table 2.45 Pest incidence under Bio-intensive pest management trial at Jagdalpur, kharif 2019

Parameters	Per cent damage by								Yield	
	WM		Thrips		LF		SB		Kg/ha	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	5.95	6.85	1.25	1.57	3.89	5.13	6.00	8.91	4162	3573
t value	1.74 ^{NS}		0.68 ^{NS}		1.46 ^{NS}		0.47 *		2.88*	
df	40		22		40		10		10	
P - value	0.32		0.14		0.20		0.02		0.02	

*WM- whorl maggot; LF- leaffolder; SB- stemborer

4. Karjat

At this location, three modules were tested. The BIPM 1 and 2 differed in spraying with two organisms, *Trichoderma* and *Pseudomonas* respectively and were similar in all other bio intensive interventions. Observations were recorded on the pest incidence, mainly stem borer. Though the dead hearts caused by stem borer was significantly lower in FP treatment at 30 DAT they increased consistently until 90 DAT, while the incidence declined in the BIPM treatments (**Fig 2.13**). However, there were no significant differences in mean dead heart incidence among the treatments (**Table 2.46**). The white ear damage was significantly higher in FP (10.86%) as compared to 1.87 and 3.17 % in BIPM plots. The yield was on par in the BIPM plots

(3500 and 3466 kg/ha) and significantly higher compared to FP plots (2626.67 kg/ha).

Table 2.46 Pest incidence under Bio-intensive pest management trial at Karjat, kharif 2019

Parameters	Mean DH/WE (% damage)	Mean white ears (% damage)	Yield (kg/ha)
BIPM1	10.05	1.87	3500.00
BIPM2	11.36	3.17	3466.67
FP	12.87	10.86	2626.67
CD (p=0.05%)	NS	2.21*	209.58*

* DH-Dead Heart; WE- white ears

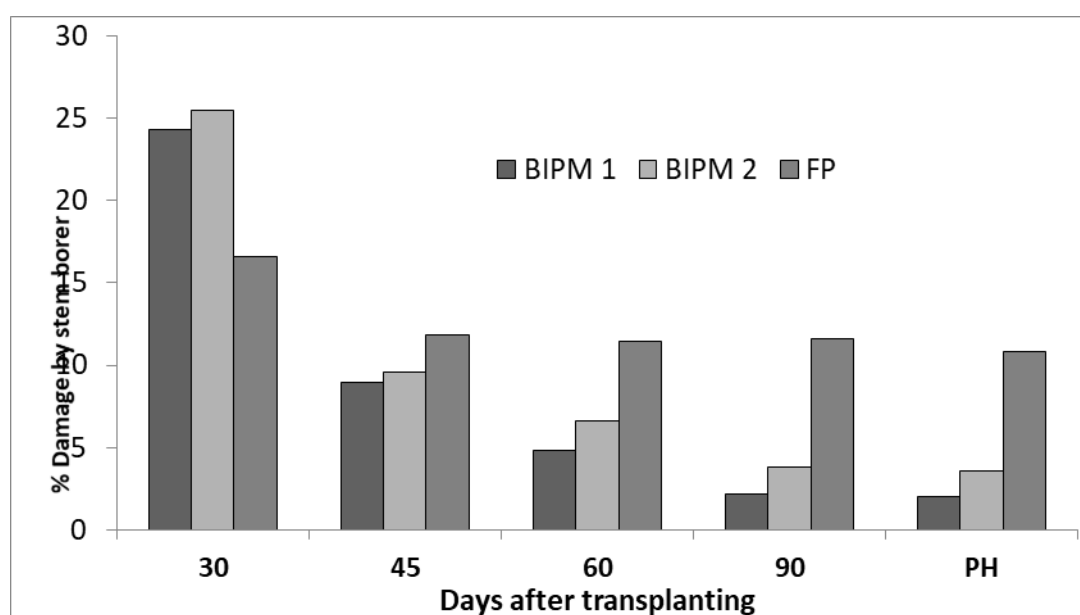


Fig 2.13 Stem borer damage under Bio-intensive pest management trial at Karjat, kharif 2019

5. Ludhiana

The trial involved treatments planted with variety PR 121, in six replications. The practices followed in BIPM plots were application of vermicompost @ 500 g/ m² and rice husk ash @ 100 g/ m² of nursery bed, seed dressing with phosphorus solubilizing microorganisms (PSM) (@ 10 g/ kg seed and *Pseudomonas subtilis* and *P. argentinensis* (@ 10 g / kg seed at the time of sowing; root dipping with PSM and *Pseudomonas spp* before transplanting; Field ploughing thoroughly to incorporate weed and straw into soil; 2.5 tonnes/ ha of vermicompost as basal + 400 kg neem cake/ ha half as basal and half as top dressing at active tillering stage; Clipping of leaf tips before field transplanting; Pheromone traps for mass trapping of stem borers @ 20/ha; Flower plants of marigold, soybean, cosmos, sesame on bunds for natural enemies; need based application of nimbecidine @ 5 ml/L; proper plant spacing and water management for planthoppers. The practices followed in the FP treatment included application of urea 50 kg/ acre,

Table 2.47 Pest incidence under Bio-intensive pest management trial at Ludhiana, *kharif* 2019

Parameters	LF		WM		Spiders		Coccinellids		Ichneumonid		Braconid	
	% damage		% damage		(No./hill)		(No./hill)		(No./10 sweeps)		(No./10 sweeps)	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	5.58	5.73	1.55	2.41	46.00	34.00	14.57	9.29	63.00	50.14	55.86	41.43
t value	0.08 ^{NS}		1.38 ^{NS}		1.10 ^{NS}		1.29 ^{NS}		1.23 ^{NS}		2.04*	
df	12		8		12		12		12		12	
P - value	0.94		0.20		0.30		0.23		0.24		0.05	

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

spraying chlorpyrifos @ 1.0 l/ acre at 60 DAT and imidacloprid (Confidor 17.8 SL) @ 40 ml / acre at 70 DAT.

Incidence of whorl maggot, stem borer, leaffolder, BPH, WBPH and natural enemies including predators like spiders, coccinellids and the parasitoids like ichneumonids and braconids were observed. Pest incidence was low and whorl maggot and leaf folder damage did not exceed 5.5%. The two treatments were on par for all pest incidences (**Table 2.47**). The beneficials such as spiders and coccinellids recorded in BIPM plots though higher in numbers in BIPM plots were on par with FP plots. The Braconid numbers per ten sweeps was significantly higher in the BIPM plots (55.86/10 hills) compared to that of Farmers' practice plots (41.43/10 hills). The yields were on par in both FP (7601kg/ha) and BIPM plots (7634 kg/ha) (Table 2. xxx)

6. Moncompu

Incidence of stem borer and natural enemies were observed in BIPM and Farmers' practice plots. The incidence of dead hearts in BIPM (9.03%) was on par with that of farmer's practice plots (11.58%) (**Table 2.48**). On the other hand white ear damage was significantly higher in FP (14.38%) as compared to BIPM treatment (10.75%). The number of coccinellid per 10 hills (3.40) was higher in BIPM than that observed in FP (2.62) (**Table 2.49**). The yield was on par in both treatments (Table 2.xxx) while straw yield was significantly higher in Farmers practice (7318 kg/ha) as compared to 5914 kg/ha in BIPM plot.

Table 2.48 Pest incidence under Bio-intensive pest management trial at Moncompu, kharif 2019

Parameters	DH		WE	
	(% damage)		(% damage)	
	BIPM	FP	BIPM	FP
Mean	9.03	11.58	10.75	14.38
t value	1.30NS		1.96*	
df	82		22	
P - value	0.19		0.05	

* DH-Dead Heart; WE- white ears

Table 2.49 Yield parameters under Bio-intensive pest management trial at Moncompu, kharif 2019

Parameters	Coccinellids		Spiders		Grain Yield		Straw Yield	
	(No./ 10 hills)		(No./ 10 hills)		(kg/ha)		(kg/ha)	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	3.40	2.62	1.48	1.24	4796	4986	5914	7318
t value	2.20*		0.96NS		0.44NS		2.20*	
df	82		82		8		8	
P - value	0.02		0.34		0.67		0.05	

Table 2.50 Pest incidence under Bio-intensive pest management trial at Pattambi, *kharif* 2019

Para-meters	Leaffolder (% damage)						Gall midge (% silver shoots)						Stem borer (% White ears)	
	60 DAT		75 DAT		Mean		30 DAT		45 DAT		60 DAT		Mean	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	53.99	39.44	20.89	28.99	21.41	17.46	32.31	22.15	52.06	35.73	33.95	18.76	44.61	34.94
t value	2.34*		2.42*		0.85 ^{NS}		2.55*		2.31*		2.98*		1.92 ^{NS}	
df	10		10		58		10		10		10		46	
P - value	0.04		0.04		0.40		0.03		0.04		0.02		0.25	

Table 2.54. Pest incidence under Bio-intensive pest management trial at Ranchi, *kharif* 2019

Para-meters	Hispa		LF		DH		SS		WE		Yield	
	% damage		% damage		% damage		(No./10 hills)		% damage		Kg/ha	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	4.52	3.79	4.06	3.08	5.04	2.78	4.42	3.38	4.77	4.01	3433	4011
t value	1.71 ^{NS}		3.63 ^{NS}		4.94 ^{NS}		3.34 ^{NS}		1.74 ^{NS}		1.95 ^{NS}	
df	38		58		58		58		18		10	
P - value	0.98		0.10		0.06		0.08		0.10		0.08	

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

7. Pattambi

The practices followed in BIPM plots were application of Neem cake + Vermicompost as per recommended; growing marigold, cowpea on bunds and application of Azadirachtin 0.003% at 15, 30, 45, 60 and 75 DAT. Incidence of whorl maggot, gall midge, leaffolder, caseworm, stem borer and predators like spiders, coccinellids and mirids was recorded. The mean per cent leaves damaged by leaffolder were significantly higher in BIPM plots reaching a maximum of 53.99 % (**Table 2.50**) compared to farmer's practice plots (39.44 %). Damage by gall midge was also significantly higher in BIPM plots (mean of 44.61%) as compared to farmers' practice (34.94%). On the other hand, white ear damage due to stem borer was significantly lower in BIPM treatment (6.40%) as against 19.21% in FP plots.

The spider population (13.75/10 hills) and coccinellids (10.83) was significantly higher in the BIPM plots compared to that of Farmers' practice plots (7.58 and 5.75 respectively) (**Table 2.51**). However, yields were low in both treatments though BIPM plots (2239 kg/ha) yielded higher than that of FP plots (1562 kg/ha).

Table 2.51 Population of natural enemies and yield under Bio-intensive pest management trial at Pattambi, kharif 2019

Parameters	Spiders		Coccinellids		Mirid		Yield*	
	(No./10 hills)		(No./10 hills)		(No./10 hills)		(kg/ha)	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	13.75	7.58	10.83	8.00	8.33	5.75	2239	1562
t value	4.14**		4.33**		4.08**		3.55**	
df	22		22		22		38	
P - value	<0.01		<0.01		<0.01		<0.01	

*projected yield

8. Raipur

Four modules were tested at this location. Two BIPM modules with variations of *Pseudomonas* (BIPM1) and *Trichoderma* (BIPM2) treatments and two farmers' practices- one with inorganic fertilization and no crop protection (FP1) and another with crop protection (FP2) were tested. Incidence of stem borer, leaffolder, whorl maggot and predators like spiders, coccinellids were recorded throughout the crop growth period. The per cent leaves damaged by whorl maggot and leaffolder were low in both treatments. The mean per cent dead hearts were on par in BIPM 1, 2 and FP2 (13.26, 13.71 and 13.54 respectively) as compared to 17.50 % in FP 2 treatment (**Table 2.52**). There were no significant differences in the incidence of white ears among the treatments. Population of BPH was higher in the FP treatments (26.19 and 27.15 per 10 hills) as compared to the BIPM treatments (20.38 and 22.31/10 hills). Among the natural enemies, only ground beetle population was significantly higher in the two BIPM treatments (2.86 and 2.38 respectively) (**Table 2.53**).

The egg parasitisation of stem borers was observed to be 15.80 % in BIPM 1 compared to 4.87 % in FP 2. The egg parasitoids *Telenomus* and

Trichogramma we accounted for 40 and 60 per cent of the parasitoid composition, respectively. The yield was highest in FP2 (5805.92 k/ha).

Table 2.52 Pest incidence and yield under Bio-intensive pest management trial at Raipur, kharif 2019

Treatments	Stem borer		BPH	Yield
	% Dead hearts	% White ears	(No./ 10 hills)	(Kg/ha)
BIPM1	13.26 (21.27)	20.84 (27.14)	20.38	4797.56
BIPM 2	13.71 (21.72)	19.39 (26.10)	22.81	4601.85
FP 1	17.50 (24.68)	20.43 (26.83)	26.19	4526.85
FP 2	13.54 (21.58)	17.52 (24.69)	27.15	5805.92
CD (p=0.05%)	1.67	NS	1.79	

* DH – Dead heart; BPH –brown planthopper; WE- white ear

Table 2.53 Population of natural enemies under Bio-intensive pest management trial at Raipur, kharif 2019

Treatments	Spiders (No./ 10 hills)	Coccinellids (No./ 10hills)	Ground beetle (No./ 10hills)	Staphylinid (No./ 10hills)
IPM1	3.12	2.50	2.86	2.38
BIPM 2	3.31	2.57	2.38	1.86
FP 1	3.00	2.38	1.95	1.57
FP 2	2.81	2.19	1.93	2.00
CD (p=0.05%)	NS	NS	0.71	NS

9. Ranchi

Incidence of hispa, stem borer, leaffolder and gall midge were recorded throughout the crop growth period. There were no significant differences in pest incidence between the two treatments. (**Table 2.54**). FP plots yielded higher (4011kg/ha) than that of BIPM plots (3433 kg/ha) though statistically at par.

10. Titabar

The treatments were planted with Keteki Joha variety, in six replications of plot size 100 m². The practices followed in BIPM plots were wet seed treatment with *Pseudomonas fluorescens* prepared @10g/litre of water per kg of seed, seedling root dip treatment with Azospirillum and Phosphorous solubilizing bacteria (PSB) @ 600g culture for 1 ha, application of vermicompost @ 500g/ sq m and rice husk ash @100g/ sqm of the nursery bed; application of vermicompost @ 2.5ton/ ha + green manure crop @ 2.5t/ ha half as basal and half at active tillering stage, clipping of rice seedlings before transplanting, mass trapping of stem borer with pheromone trap @ 20 traps/ha, (2 in 600 sqm); *Trichogramma japonicum* for stem borer and *T. chilonis* for leaf folder @ 5cc egg/ ha. Neem oil @ 5 ml/liter of water was applied when the insect pest incidence was observed. Pigeonpea and marigold were grown on the border of the plot. The practices followed in the FP treatment were no seed treatment; no fertilizer in nursery, application of N- 60kg, P₂O₅ -20kg and K₂O -40 kg/ha and no application of insecticides.

. The damage by leaffolder (0.88%), whorl maggot (0.78%) and caseworm (0.714 %) were significantly lower (**Table 2.55**) in BIPM plots as compared to FP plots (19.35, 9.06 and 16.62% respectively). Similar trend was observed

for dead hearts caused by stem borer in BIPM treatment (1.38 %) compared to the significantly higher damage of 29.92 % in FP plots. The abundance of natural enemies was also found to be higher in BIPM treatment. The spider and coccinellid numbers per ten hill was significantly higher in BIPM plots (3.89 and 4.67 respectively) as compared to less than one in FP treatment (Table 2.xx). The yield on the other hand was highest in FP2 (5805.92 k/ha), however BIPM plots yielded significantly higher (5321kg/ha) than FP plots (3020 kg/ha) (**Table 2.56**).

The egg parasitisation of stem borers was assessed and a mean of 55.75 % was observed in BIPM compared to 11.64 % in FP treatment. Three egg parasitoids - *Tetrastichus*, *Telenomus* and *Trichogramma* were observed accounting for 28.57, 20.23 and 51.19 per cent of the parasitisation respectively.

Table 2.55 Pest incidence and yield under Bio-intensive pest management trial at Titabar, kharif 2019

Para- meters	LF		WM		DH		CW		Yield	
	(% damage)		(% damage)		(% damage)		(% damage)		(kg/ha)	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	0.88	19.37	0.78	9.06	1.38	29.92	0.71	16.62	5321	3020
t value	17.50**		17.22**		36.30**		18.13**		37.14**	
df	58		58		58		58		10	
P - value	<0.01		<0.01		<0.01		<0.01		<0.01	

WM- whorl maggot; DH- Dead heart; CW- caseworm; LF- leaffolder; *projected yield

Table 2.56 Population of natural enemies under Bio-intensive pest management trial at TITABAR, kharif 2019

Parameters	Spiders		Coccinellids		Mirid		% egg parasitisation	
	(No./10 hills)		(No./10 hills)		(No./10 hills)			
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	3.89	0.71	4.67	0.72	0.78	0.64	55.75	11.64
t value	17.25**		19.13**		2.85		10.13**	
df	58		58		58		48	
P - value	<0.01		<0.01		NS		<0.01	

Bio intensive pest management trial was initiated to explore the feasibility of bio-intensive approaches for managing pests for organic rice cultivation. The trial was conducted in 10 locations this year. The stem borer incidence was reduced in BIPM plots as in Chinsurah (5.47 %), Jagdalpur (6.0%), Raipur (13.26%) and Titabar (1.38 %) as compared to farmers practice where it was 19.35, 8.91, 17.50 and 29.92 % respectively. In Ludhiana and Ranchi, the pest incidence was on par with that of Farmers' practice. The natural enemies were higher in BIPM plots in all locations. The results also indicated an increase in natural enemy population in the organic BIPM plots.

2.5. INTEGRATED PEST MANAGEMENT

i) Integrated pest management special trial (IPMs)

Rice crop is affected by a number of biotic factors including insects, diseases and weeds which act as major constraints at various stages of crop growth. Holistic management of these pests in an effective way needs farmers to be empowered with knowledge and skills to take appropriate decisions at farm level. Keeping this in view, IPMs trial was continued in association with agronomists and plant pathologists in farmers' fields. The major aim of this trial is to validate IPM practices from a basket of options available and demonstrate to farmers the management of pests in a sustainable way.

IPMs trial was conducted at 13 locations during *Kharif* 2019. At 7 locations viz., Karjat, Mandya, Pantnagar, Pusa, Rajendranagar, Raipur and Sakoli, the trial was carried out in three farmers' fields. At Jagdalpur, the trial was conducted in two farmers' fields while in the rest of 5 locations, i.e., Chinsurah, Gangavathi, Ludhiana, Malan and Titabar, the trial was carried out in one farmer field. Location wise details of farmers, villages, pest incidence and management practices followed were discussed below:

Chinsurah: IPM trial was conducted in Sri Narayan Chandra Mondal's field at Bele Village, Radhanagar post, Pandua block in Hooghly district, West Bengal. Practices followed in IPM and FP plots are given below:

Practices followed in IPMs trial at Chinsurah, *Kharif* 2019

	IPM practices	Farmers practices
Area/ variety	1 acre; Swarna	1 acre; Swarna
Nursery	<ul style="list-style-type: none"> • Application of 8 kg of 10:26:28 complex 	
Main field	<ul style="list-style-type: none"> • Field preparation with power tiller, cutting of bunds and leveling the field • Application of 105:100:27 kg urea, SSP & MOP • Application of Butachlor + hand weeding • Application of Ferterra @ 4 kg/ acre • Application of Coragen @ 60 ml/ acre • Application of carbendazim • Installation of pheromone traps @ 6/acre for stem borer mass trapping 	<ul style="list-style-type: none"> • Field preparation with power tiller, cutting of bunds and leveling the field • Application of 80 kg 10-26-26; Urea 40 KG • Hand weeding two times • Application of Phorate 10 G @ 4.5 kg/ acre • Triazophos @ 750 ml/ acre two times • Application of Carbendazim

Very low incidence of stem borer, leaf folder, whorl maggot, hispa, BPH, WBPH and GLH was observed in Swarna variety grown at this location in both IPM and farmer practices plots (**Table 2.57**). The data on weed population and biomass showed significant decrease in IPM by 42.58 and 32.57%; 52.85 and 33.33% respectively than in farmers practice. Higher BC ratio (1.59) was obtained in IPM plot compared to FP plot (1.45) mainly due to higher grain yield that resulted in increased returns (**Table 2.58**).

Table 2.57 Insect pest incidence in IPMs trial at Chinsurah, Kharif 2019

Treatments	% DH	% WE	% LFDL	% WMDL	% HDL	BPH	WBPH	GLH
	85 DAT	Pre har	36 DAT	29 DAT	64 DAT	50 DAT	64 DAT	78 DAT
IPM	0.25 ± 0.20	0.74 ± 0.33	0.05 ± 0.05	0.94 ± 0.27	0.00 ± 0.00	0.00 ± 0.00	0.80 ± 0.80	38.80 ± 5.33
FP	7.81 ± 0.35	8.74 ± 0.64	0.70 ± 0.07	2.53 ± 0.59	0.74 ± 0.18	13.60 ± 1.31	3.20 ± 0.97	48.4 ± 7.61

Table 2.58 Returns and BC ratio in IPMs trial at Chinsurah, Kharif 2019

Treatments	Yield (q/ha)	Gross Returns (Rs.)	Cost of Cultivation (Rs)	Net Returns (Rs.)	BC Ratio
IPM	45.34	82972	52245	30727	1.59
FP	39.81	72852	50403	22449	1.45

Price of paddy = 1830 Rs/ q

Gangavathi: IPMs trial was conducted in Sri Suryarao's field at Vidyanagar village, Koppal district of Karnataka state. BPT 5204 was grown in both IPM and FP plots. Practices followed in both IPM and FP plots were given below:

Practices followed in IPMs trial at Gangavathi, Kharif 2019

IPM practices	Farmers Practices
Variety – BPT 5204	Variety – BPT 5204
<ul style="list-style-type: none"> • Seed treatment with Carbandezim @ 2g / kg seed • Fertilizer application @ 60:30:30 kg NPK /ha • Forming alleyways of 30 cm • Grown marigold on bunds • Installation of pheromone traps @ 8 traps/ ha • Sprayed Chlorpyrifos 20 EC @ 2ml / liter at 45 DAT • Followed alternate wetting and dring • Sprayed Tilt (Propiconazole) @ 1ml / liter water • Sprayed Metarhizium @ 2 g/ liter water at 60 DAT 	<ul style="list-style-type: none"> • Fertilizer application @ 120:60:60 kg NPK /ha • Application of weedicide, Butachlor @ 400 ml/ac • Application of Ferterra @ 4 kg at 25 DAT • Sprayed Chlorpyrifos 20 EC @ 2ml / liter at 50 DAT • Application of Triflumezopyrim @ 94 ml / acre at 60 DAT • Sprayed Merger (Tricyclazole + Mancozeb) @ 2 g / liter water at 45 DAT • Sprayed Tilt (Propiconazole) @ 1ml / liter water at 65 DAT • Sprayed Natio (Trifloxystrobin + Tebiconazole) at 85 – 90 DAT

Very low incidence of stem borer and leaf folder (<2%) was observed in both the treatments (Table...). Planthopper incidence was high in both IPM and FP plots up to 57 DAT and WBPH population was higher than BPH population. Incidence of BPH and WBPH started at 15 DAT in both IPM and FP plots with highest populations in IPM plots initially (**Fig 2.14**). Highest

population of WBPH was found in IPM plot from 22 DAT to 57 DAT (177 - 391/5hills) while it ranged between 150 and 355 in FP plots. Though, initially, WBPH population was high in IPM plots but from 64 DAT onwards, it declined due to appropriate IPM interventions whereas the population remained high in FP plots. On the other hand, BPH population was high in FP plot initially and later got reduced (**Fig 2.14**).

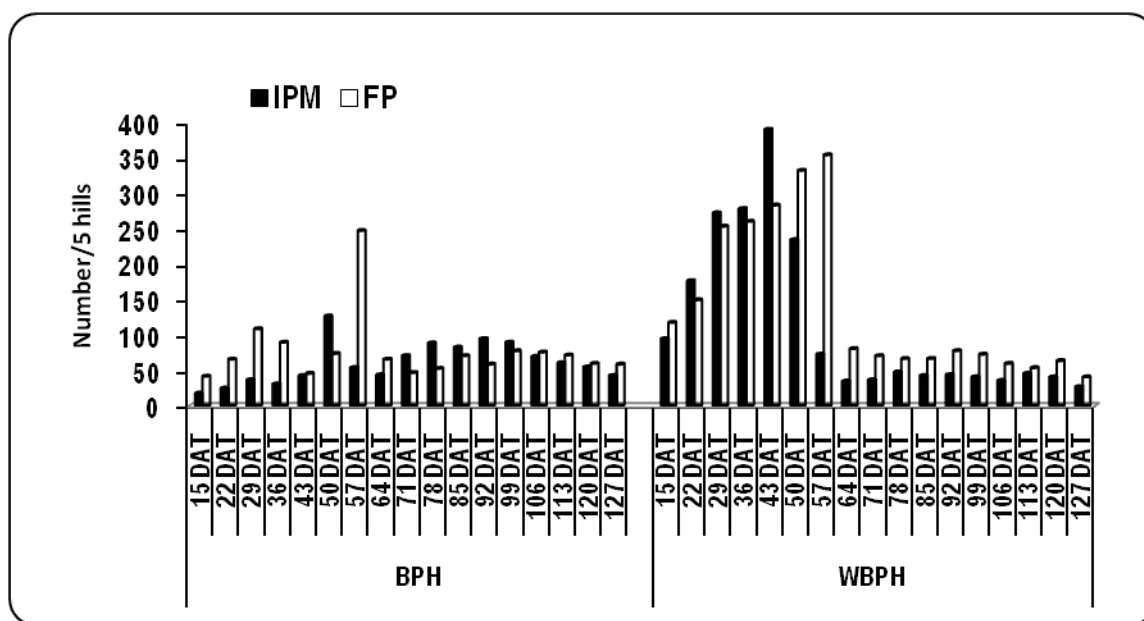


Fig 2.14 Planthopper population in IPM and FP plots in IPMs trial at Gangavathi, Kharif 2019

Table 2.59 Pest incidence and BC ratio in IPMs trial at Gangavathi, kharif 2019

Treatments	% DH	% LFDL	GLH	Yield (q/ha)	Gross Returns (Rs.)	Cost of Cultivation (Rs.)	Net Returns (Rs.)	BC ratio
	71 DAT	78 DAT	57 DAT					
IPM	1.56 ± 0.30	0.79 ± 0.16	2.0 ± 0.3	67.88	139154	62473	76681	2.23
FP	2.05 ± 0.18	0.92 ± 0.07	13.4 ± 1.6	63.66	130503	70610	59893	1.85

Price of paddy = 2050 Rs/ q

IPM adopted fields showed significantly low weed intensity 63.48 & 50% in weed population and 40.51% in weed biomass. Grain yield of 67.88 q/ ha was recorded in IPM plot compared to FP plot (63.66 q/ ha) resulting in higher gross returns (**Table 2.59**). High gross returns due to high price of paddy and low cost of cultivation in IPM plot resulted in high BC ratio (2.23) compared to FP plot (1.85).

Jagdalpur: IPMs trial was conducted in two farmer's field's viz., Sri Pooran Bagel and Smt Santi Bai of Chokar village, Bastar district of Chattisgarh.

Low incidence of stem borer, leaf folder, gall midge, whorl maggot, hispa, BPH, WBPH and GLH was observed in both IPM and FP plots. Caseworm and thrips incidence was also noticed in both IPM and FP plots. Practices followed in IPM and FP plots were given below:

Practices followed in IPMs trial at Jagdalpur, Kharif 2019		
	IPM Practices	Farmers Practices
Area	1 acre	1 acre
Variety	Dhaniya	Dhaniya
Nursery	• Application of 3.2 kg N, 2 kg P, 1.2 kg K / 400m ² nursery	• Application of 2 kg N, 1 kg P, 1 kg K / 400m ² nursery
Main field	<ul style="list-style-type: none"> • Application of 80:50:30 kg NPK per hectare • Seedlings transplanted at spacing of 20/15 cm; Left alleyways of 30 cm after 10 rows. • Applied Butachlor 1.5 kg ai/ha at 4 DAT+ 1 hand weeding • Nitrogen top dressing at 45 DAT • Applied chlorpyrifos + Cypermethrin @ 1 lit/acre at 35 DAT • Sprayed Tricyclazole @ 125 g/ acre against blast 	<ul style="list-style-type: none"> • Application of 80 kg N, 50 kg P & 30 Kg K/ acre • Applied phorate 10 G @ 5kg/ha • Hand weeding twice • Sprayed Carbendazim @ 200 g/ha against blast

Grain yields were higher in IPM plots (40.16 Q/ ha) than FP plots (34.28 Q/ ha). BC ratio was also higher in IPM plots (3.83) compared to FP plots (3.03) mainly due to high gross returns and low cost of cultivation (**Table 2.60**).

Table 2.60 Insect pest incidence, returns and BC ratio in IPMs trial at Jagdalpur, Kharif 2019

Farmer's Name	Treatments	% DH	% WE	% LFDL	% WMDL	Yield Q/ ha	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
		60 DAT	Pre har	45 DAT	45 DAT					
F1 = Sri Pooran Bagel	IPM	3.01 ± 0.76	5.97 ± 1.84	8.53 ± 1.96	6.02 ± 1.73	40.48	85008	22000	63008	3.86
	FP	0.00 ± 0.00	0.00 ± 0.00	9.27 ± 0.82	5.10 ± 1.28	34.64	72744	23750	48994	3.06
F2 = Smt Santi Bai	IPM	2.60 ± 1.17	4.95 ± 0.72	1.95 ± 0.64	17.46 ± 0.93	39.84	83664	22000	61664	3.80
	FP	2.25 ± 1.49	3.44 ± 1.02	4.91 ± 1.22	9.03 ± 1.85	33.92	71232	23750	47482	3.00
IPM		2.81	5.46	5.24	11.74	40.16	84336	22000	62336	3.83
FP		1.13	1.72	7.09	7.02	34.28	71988	23750	48238	3.03

Price of paddy = 2100 Rs./q

Karjat: IPMs trial was conducted in three farmers' fields' viz., Sri Datta Lakshman Modak of Arwand village, Sri Ragho Damu Mune of Barane village and Sri Ravindra Pandurang Kadam of Salokh village in Karjat taluq of Raigad district, Maharashtra State. Practices followed in both IPM and FP plots were given below:

Practices followed in IPMs trial at Karjat, Kharif 2019

Practices adopted	IPM practices	Farmers practices
Area	1 acre	1 acre
Varieties	1) Sri Datta Lakshman Modak, Arwand village - Karjat-3 2) Sri Ragho Damu Mune, Barane village - Karjat 3 3) Sri Ravindra Pandurang Kadam, Salokh village – Karjat 7	Karjat 3 Karjat 3 Karjat 7
Nursery	Seed treatment with carbendazim @ 10 g/ 10 kg seed Raised bed 3x1m treated with rice husk (hull) ash @3kg/bed	Land burned with waste materials Application of Phorate 1 kg
Main field	<ul style="list-style-type: none"> • Deep ploughing • Application of FYM 4 T, Suphala 215 Kg, Urea 87 Kg • 2-3 seedlings transplanted at a spacing 20 x15 cm. • Alleyways of 40cm left after every 10 rows • Bispyribasodium 250ml/ha (Nomini gold). • Pheromone traps @ 8 / acre • Use of bird perches in the field • Use Vaibhav sickle for harvesting • Application of Cartap hydrochloride 18 kg/ha (one application) 	<ul style="list-style-type: none"> • Deep ploughing • Application of FYM 2 T,Urea 145 kg, Suphala 75 kg • 4-5 seedlings transplanted randomly • Hand weeding once • Phorate 10 kg/ha (two applications)

Table 2.61 Insect pest incidence and weed parameters in IPMs trial at Karjat, kharif 2019

Treatments		% DH	% DH	% DH	Weed Popl	Weed biomass	Yield
		36 DAT	43 DAT	50 DAT	No./m ²	g/m ²	Kg/ha
IPM		6.2(2.3)b	9.4(2.9)b	12.7(3.6)a	3.4(1.9)a	1.6(1.2)b	2965a
FP		10.6(2.9)a	15.1(3.9)a	17.3(4.2)a	2.6(1.7)a	2.5(1.7)a	2405b
LSD (0.05)		0.39	0.47	0.61	0.43	0.32	65
F1- Sri. Datta Lakshman Modak		11.7(3.5)a	11.3(3.4)b	8.8(3.0)c	2.8(1.8)a	1.5(1.3)b	2687ab
F2 - Sri Ragho Damu Mune		0.0(0.7)b	7.0(2.6)c	16.4(4.1)b	3.5(1.9)a	3.4(1.9)a	2596b
F3- Sri Ravindra Pandurang Kadam		13.5(3.7)a	18.4(4.3)a	19.9(4.5)a	2.79(1.8)a	1.4(1.2)b	2772a
LSD (0.05)		0.32	0.53	0.38	0.3	0.2	102
F1- Sri. Datta Lakshman Modak	IPM	8.9(3.1)b	8.3(2.9)d	7.8(2.9)d	2.6(1.7)b	0.0(0.70d)	2950b
	FP	14.5(3.9)a	14.3(3.8)bc	9.7(3.2)cd	3.0(1.9)ab	2.99(1.8)b	2424c
F2 - Sri Ragho Damu Mune	IPM	0.0(0.7)c	4.2(2.0)d	13.9(3.8)bc	5.0(2.3)a	4.9(2.3)a	2848b
	FP	0.0(0.7)c	9.8(3.2)cd	18.9(4.4)ab	2.0(1.5)b	1.9(1.5)c	2344c
F3 -Sri Ravindra Pandurang Kadam	IPM	9.8(3.2)b	15.7(4.0)ab	16.4(4.1)b	2.6(1.7)b	0.0(0.7)d	3096a
	FP	17.3(4.2)a	21.1(4.6)a	23.4(4.9)a	2.8(1.8)b	2.7(1.8)bc	2448c
LSD (0.05)		0.45	0.74	0.53	0.4	0.29	145

Higher incidence of dead hearts was observed in IPM plots (6.2 to 12.7% DH) compared to Farmers Practice plots (10.6 to 17.3%) (**Table 2.61**). Grain yield was higher in IPM plots (2965 kg/ha) than FP plots (2405 kg/ha) resulting in higher gross returns and BC ratio (**Table 2.62**).

Table 2.62 Returns and BC ratio in IPMs trial at Karjat, Kharif 2019

Farmers	Treatments	Yield (q/ ha)	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	BC ratio
F1- Sri. Datta Lakshman Modak, Arwand village	IPM	29.5	59625	42183	17442	1.41
	FP	24.2	46950	42650	4300	1.10
F2 - Sri Ragho Damu Mune, barane village	IPM	28.5	57375	42183	15192	1.36
	FP	23.4	45875	42800	3075	1.07
F3 -Sri Ravindra Pandurang Kadam, Salokh village	IPM	31.0	62075	42183	19892	1.47
	FP	24.5	50125	43915	6210	1.14

Ludhiana: PR 121 variety was grown in IPMs trial conducted at Sri Inderjit Singh's field of Sudhar village, Ludhiana district, Punjab State. Very low incidence of stem borer, leaf folder, whorl maggot, BPH and WBPH was observed in both the treatments (**Table 2.63**). Observations on natural enemies like spiders, coccinellids, ichneumonids and braconids were also taken in both IPM and FP plots. Sheath blight and false smut diseases recorded at Ludhiana revealed that the disease severity is too low to draw valid conclusions. Grain yield was relatively high in IPM (73.52 q/ ha) as compared to FP plot (72.48 q/ ha) resulting in higher BC ratio (3.26) due to high gross returns and low cost of cultivation.

Practices followed in IPMs trial at Ludhiana, Kharif 2019

	IPM Practices	Farmers Practices
Variety	PR 121	PR 121
Nursery	<ul style="list-style-type: none"> Seed treatment with 20 g Bavistin 50 WP and 1 g Streptocycline Application of urea @ 1.0 kg and Zinc sulphate @ 1 kg/ acre nursery 	<ul style="list-style-type: none"> Application of urea @ 1.0 kg/ acre nursery and Zinc sulphate @ 1 kg/ acre nursery
Main field	<ul style="list-style-type: none"> Alley ways of 30 cm after every 2 m Application of Butachlor @ 1.2 L/ acre Sprayed Fame 480 SC @ 20 ml/acre Sprayed Chess @ 120 g/ acre & Tilt @ 200ml/ acre Recommended dose of neem coated urea-90 kg/ acre Growing flowering plants like green gram, black gram, soybean, cowpea, sesamum, Marigold. Water management for planthoppers 	<ul style="list-style-type: none"> Applied urea 120 kg and zinc sulphate 25 kg/ acre Application of Butachlor @ 1.2 L/ acre Application of Mortar @ 170 g/ acre Sprayed Chess @ 120g/acre Sprayed Tilt @ 200ml/ acre

Table 2.63 Insect pests and disease incidence in IPMs trial at Ludhiana, kharif 2019

Treatments	% DH	% WE	% LFDL	% WMDL	BPH	WBPH	Yield Q/ ha	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
	66 DAT	Pre har	87 DAT	52 DAT	80 DAT	73 DAT					
IPM	4.45 ± 0.3	3.56 ± 0.5	5.06 ± 0.6	4.24 ± 0.5	19 ± 2.1	21 ± 2.0	73.52	133439	40970	92469	3.26
FP	5.86 ± 1.5	5.28 ± 0.7	7.98 ± 0.3	5.63 ± 0.7	13 ± 1.0	30 ± 1.9	72.48	131551	44960	86591	2.93

Price of paddy = Rs.1815

Malan: The trial was conducted in Sri Krishan Kumar's field of Jia Haar village, Kangra district, Himachal Pradesh. HPR 2880 was grown in IPM field and Jheni, a local variety was grown in FP plot. Incidence of black beetle and hispa was observed starting from 15 DAT onwards. Very high incidence of hispa was observed from 15 DAT onwards and the damage increased with increase in crop growth however, got reduced after 57 DAT. Hispa damage was severe in FP plot as compared to IPM plot with damage ranging from 33.3 to 94.7% (**Table 2.64**). Dead heart damage caused by black beetle was also higher in FP plot (38.8 – 60.3%) than IPM plot (13.0 – 22.3%) during 15 to 50 DAT. The weed population was 50% lower in IPM adopted field compared to FP plot. Hence, weed biomass was also found low in IPM plot at 57 DAT (**Table 2.65**). IPM plot showed higher yield (34.88 q/ha) than FP plot (16.88 q/ ha). Net returns were negative in FP plot (0.88) due to low grain yield and high cost of cultivation while IPM plot showed high BC ratio (1.37).

Practices followed in IPMs trial at Malan, Kharif 2019

	IPM Practices	Farmers Practices
Variety	HPR 2880	Jheni local variety
Nursery	<ul style="list-style-type: none"> • Line sowing • Application of FYM 	<ul style="list-style-type: none"> • Broadcast nursery • Application of urea @ 30 kg
Main field	<ul style="list-style-type: none"> • Application of 90 kg N, 40 kg P and 40 kg K. • Application of herbicide – Bispyribac sodium salt • Sprayed Chlorpyrifos • Application of Bavistin 	<ul style="list-style-type: none"> • Applied of 30 kg urea

Table 2.64 Pest incidence in IPMs trial at Malan, kharif 2019

Treatments	% DH due to black beetle				% HDL				
	15 DAT	29 DAT	36 DAT	50 DAT	15 DAT	36 DAT	50 DAT	57 DAT	85 DAT
IPM	19.42 ± 0.8	22.28 ± 3.8	16.9 ± 5.9	12.96 ± 2.4	14.9 ± 0.5	20.2 ± 1.9	17.2 ± 2.9	24.8 ± 3.1	8.81 ± 0.3
FP	60.3 ± 8.0	51.0 ± 8.6	40.4 ± 7.8	38.8 ± 4.2	33.3 ± 4.7	41.1 ± 3.4	58.1 ± 0.7	94.7 ± 2.3	96.6 ± 3.5

Table 2.65 Weed dynamics, returns and BC ratio in IPMs trial at Malan, Kharif 2019

Treatments	Weed Population (No./m ²)		Weed biomass (g/m ²)		Yield (q/ ha)	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	BC ratio
	29DAT	57 DAT	29DAT	57 DAT					
IPM	16.90 ± 1.4	15.76 ± 1.7	19.42 ± 2.0	19.46 ± 2.1	34.88	62784	45861	16923	1.37
FP	29.60 ± 2.6	45.60 ± 3.5	18.20 ± 0.9	38.28 ± 4.4	16.88	30384	34686	-4302	0.88

Price of Paddy = RS. 1800/Q

Mandya: IPMs trial was conducted in three farmers' fields i.e., in the fields of Sri Mahadevu, Sri Jayaramu and Sri Shivalinga at Ganadalu village of Mandya district in Karnataka State. Practices followed in IPM and FP plots are given in table below:

Practices followed in IPMs trial at Mandya, Kharif 2019

Practices adopted	IPM practices	Farmers practices		
		Sri Mahadevu	Sri Jayaramu	Sri Shivalinga
Area	1 acre	1 acre	1acre	1acre
Variety	MTU 1001 /MTU 1001/ BR 2655	MTU 1001	MTU 1001	BR 2655
Fertilizers applied	Urea 45 kg/ acre, SSP 125 kg/ acre, MOP 35 kg/ acre, Top dressing 45 kg urea	Urea 50 kg/ acre, 10:26:26 complex fertilizer 100 kg/ acre, MOP 25 kg/ acre	100 kg - 10:26:26 complex fertilizer; 100 Kg Urea	100Kg - 10:26:26 complex fertilizer; 50 Kg Urea/ acre
Nursery	Seed treatment with Carbendazim @ 4 g/kg of seed			
Main field	• Transplanting with 20 x 15cm spacing	• Randomly transplanted	• Randomly transplanted	• Randomly transplanted
	• Alley ways of 30cm after every 2m	• Pretilachlor @ 400 ml/ acre + two hand weedings	• Butachlor @ 400 ml/ acre + two hand weedings	• Butachlor @ 1.2 lit/ acre + two hand weedings
	• Londax power @ 4kg/ac - herbicide at 3 DAT + one hand weeding	• Carbofuran 4G application @ 8 kg/ acre	• Carbofuran 4G application @ 8 kg/ acre	• Carbofuran 4G application @ 8 kg/ acre
	• Installation of pheromone traps for monitoring stem borer @ 8 traps / ha	• Chlorantrini prole (Coragen) @ 60 ml/ acre	• Fluben diamide 48 SC @ 0.1 ml/ liter	• one spray of Chloropyriphos 20EC @ 2ml/lit
	• Application of Fipronil 5 SC @ 1.5 ml/l	• Tebuconazole (Nativo) @ 0.4 g/l	• Imidacloprid 17.8 SL @ 0.3 ml/l	• Hexaconazole 5 EC @ 2ml/liter
	• Zinc sulphate @ 8 kg/ acre	• Dinotefuron 20 SG @ 250 g/ ha at 70 DAT	• Propiconazole 25 EC @ 1 ml/l	• Buprofezin 25 EC (Applaud) @ 1.4 ml/liter
	• Tricyclazole 75WP @ 0.6g/lit			

Table 2.66 Insect pest and disease incidence in IPMs trial at Mandya, Kharif 2019

Farmer Name	Treatments	% DH	% WE	% LFDL	% CWDL	BPH	Leaf blast % severity
		50 DAT	Pre har	36 DAT	57 DAT	85 DAT	43 DAT
F1- Sri Mahadevu	IPM	3.4 ± 0.8	4.0 ± 1.2	1.3 ± 0.2	0.6 ± 0.1	5.8 ± 0.8	4.5 ± 0.6
	FP	6.2. ± 1. 0	6.2 ± 1.9	4.7 ± 0.5	2.0 ± 0.4	14.8 ± 1.2	9.2 ± 1.3
F2 - Sri Jayaramu	IPM	4.3 ± 1. 0	3.2 ± 1.0	1.5 ± 0.3	0.9 ± 0.2	7.4 ± 0.9	3.6 ± 0.5
	FP	6.0 ± 1.1	7.8 ± 2.6	4.9 ± 0.9	2.2 ± 0.5	13.2 ± 2.1	7.9 ± 0.9
F3- Sri Shivalinga	IPM	3.3 ± 1.1	5.0 ± 1.6	1.5 ± 0.3	1.5 ± 0.5	5.8 ± 0.9	2.7 ± 0.3
	FP	5.6± 1.5	3.9 ± 0.8	3.7 ± 0.6	2.5 ± 0.8	10.8 ± 1.6	4.6 ± 1.0
IPM		3.67	4.07	1.43	1.00	6.00	3.60
FP		5.93	5.97	4.43	2.23	13.00	7.23

Incidence of stem borer, leaf folder, caseworm and BPH was observed in both IPM and FP plots in all the three farmers' fields. In general, pest

damage was very low across the farmers' fields (**Table 2.66**). Leaf blast incidence was recorded in both IPM and FP plots in all the three farmers' fields at Mandya. Leaf blast severity was low in IPM plots as compared to FP plots due to the adoption of IPM practices. Weed population and weed biomass was low in both IPM and FP plots in all the three farmers' fields (**Table 2.67**).

Table 2.67 Weed population and weed biomass in IPMs trial at Mandya, Kharif 2019

Farmer name	Treatments	Weed population (No./m ²)		Weed biomass (g/m ²)	
		29 DAT	57 DAT	29 DAT	57 DAT
F1- Sri Mahadevu	IPM	1.60 ± 0.75	2.60 ± 1.17	0.20 ± 0.10	1.00 ± 0.48
	FP	2.20 ± 0.66	3.80 ± 1.07	0.51 ± 0.26	1.52 ± 0.46
F2 - Sri Jayaramu	IPM	1.80 ± 0.58	4.00 ± 0.84	0.27 ± 0.09	1.55 ± 0.34
	FP	4.00 ± 0.71	4.40 ± 0.51	1.20 ± 0.25	1.98 ± 0.28
F3- Sri Shivalinga	IPM	1.80 ± 0.80	2.60 ± 0.98	0.43 ± 0.21	0.86 ± 0.41
	FP	2.80 ± 0.86	2.68 ± 0.87	0.86 ± 0.28	0.60 ± 0.25
IPM		1.73	3.07	0.30	1.14
FP		3.00	3.63	0.86	1.37

High grain yield was recorded in IPM plots with 58.3 q/ ha in IPM plot of Sri Jayaramu's field followed by IPM plot of Sri Mahadevu's field (54.3 q/ ha). High BC ratios were obtained in IPM plots (1.73) compared to FP plots (1.33) (**Table 2.68**).

Table 2.68 Grain yield , Gross returns and BC ratio in IPMs trial at Mandya, Kharif 2019

Farmer name	Treatments	Yield	Gross Returns	Cost of cultivation	Net Returns	BC ratio
		q/ha	(Rs.)	(Rs.)	(Rs.)	
F1- Sri Mahadevu	IPM	54.3	86880	48425	38455	1.79
	FP	47.8	76480	54250	22230	1.41
F2 - Sri Jayaramu	IPM	58.3	93280	48050	45230	1.94
	FP	51.6	82560	56500	26060	1.46
F3- Sri Shivalinga	IPM	45.6	70680	48300	22380	1.46
	FP	39.1	60605	54775	5830	1.11
IPM		52.73	83613	48258	35355	1.73
FP		46.17	73215	55175	18040	1.33

Price of paddy = Rs.1600/q (F1 & F2); Rs.1550/q (F3)

Pantnagar: IPM trial was conducted in two villages in three farmers' fields' viz., Sri Nand Gopal's field in Dineshpur village, Ward No.2, Sri Prakash Sarkar's field and Sri Sachin Mandal's field in Panchananpur village, Dineshpur, Udham Singh Nagar mandal of Uttarakhand State. Varieties grown and practices followed in IPM and FP plots are given below:

Practices followed in IPMs trial at Pantnagar, Kharif 2019

Sri Nand Gopal, Dineshpur village, Ward No.2, Udham Singh Nagar, Uttarakhand		
	IPM	FP
Area	2500 sq.m	2500 sq.m
Variety	PR 126	PR 126
Main Field	• Application of NPK @ 100 kg/ ha, Zinc @ 25 kg/ ha, urea @ 120 kg/ ha	• Application of NPK @ 120 kg/ acre, Chelated Zinc @ 6 kg/ha and urea 120 kg/ ha.
	• Application of Pretilachlor @ 1.5 L/ ha	• Application of Pretilachlor 50 EC @ 1.5 liter/ ha, Nominee Gold @ 200 ml/ ha
	• Sprayed Cartap hydrochloride 50% SP@ 600g/ha- two times	• Application of Cartap hydrochloride 4G @ 19 kg/ ha, Monocrotophos 36 SL @ 1500ml/ha,Buprofezin 25 SP @1000 ml /ha
	• Applied streptocycline @15 g/ha + copper oxycloide @ 500 g/ha	• Applied Streptocycline @ 15g/ha + Copper oxycloide @ 500g/ha, Hexaconazole 5% EC @ 2000 ml/ha
	• Installed pheromone traps for YSB @ 8/ ha	
Sri Prabhaskar & Sri Sachin Mandal, Panchananpur, Dineshpur, Udham Singh Nagar, Uttarakhand		
Area	2500 sq.m	2500 sq.m
Variety	HKR 47	HKR 47
Main Field	• Application of NPK 100 kg/ ha, Zinc 25 kg and Urea 120 kg	• Application of NPK 120 kg/ ha, Chelated Zinc @ 6 kg/ ha and Urea 120 kg/ha
	• Application of Pretilachlor @ 1.5 L/ ha	• Applied Pretilachlor 50 EC @ 1.5 liter/ ha , Nominee Gold @ 200 ml/ ha
	• Sprayed Cartap hydrochloride @ 600g/ha- two times	• Application of Cartap hydrochloride 4.0G @ 19 kg/ ha, Chlorantraniliprole 18.5 % SC (Coragen) @150 ml/ha, Acephate75 SP @1250 g/ha
	• Applied streptocycline @15 g/ha + copper oxycloide @ 500g/ha	• Applied Streptocycline @ 15g/ha + Copper oxycloide @ 500g/ha, Cocide 2000 @ 500 g/ha
	• Installed pheromone traps for YSB @ 8/ ha	

Table 2.68 Pest incidence in IPMs trial at Pantnagar, kharif 2019

Farmer's name	Treatments	% DH			% LFDL	% WMDL	% HDL	BPH	Yield
		43 DAT	50 DAT	57 DAT	36 DAT	22 DAT	22 DAT	71 DAT	kg/ ha
F1- Sri Nand Gopal	IPM	10.11 ± 2.63	9.99 ± 1.03	12.32 ± 1.37	2.59 ± 0.49	2.91 ± 0.74	1.95 ± 0.64	46.0 ± 2.02	5664 ± 88
	FP	9.89 ± 1.47	8.63 ± 1.24	7.25 ± 1.57	2.04 ± 0.44	2.44 ± 1.02	1.89 ± 0.97	31.80 ± 1.59	5869 ± 135
F2 - Prabhaskar	IPM	6.04 ± 1.64	10.35 ± 1.23	14.30 ± 1.91	1.95 ± 0.50	4.78 ± 0.87	3.52 ± 0.78	46.80 ± 4.35	5423 ± 111
	FP	8.19 ± 1.96	14.26 ± 1.95	7.11 ± 1.41	1.31 ± 0.49	5.51 ± 1.91	3.43 ± 1.24	29.20 ± 1.71	5689 ± 134
F3 = Sri Sachin Mandal	IPM	6.18 ± 0.72	5.36 ± 1.33	8.55 ± 1.34	3.61 ± 0.60	5.00 ± 1.68	2.91 ± 1.34	15.60 ± 2.44	5667 ± 133
	FP	6.09 ± 1.26	3.34 ± 0.65	6.07 ± 0.90	0.98 ± 0.43	6.97 ± 2.30	1.97 ± 1.02	14.40 ± 1.96	5948 ± 46
IPM		7.44	8.57	11.72	2.72	4.23	2.79	36.13	5585
FP		8.06	8.74	6.81	1.44	4.97	2.43	25.13	5835

Low incidence of leaf folder, whorl maggot, hispa, BPH, WBPH and GLH was observed in both IPM and FP plots (**Table 2.68**). Stem borer damage crossed ETL in IPM and FP plots during 43 to 57 DAT. Grain yield ranged from 5423 to 5948 kg/ha in both the treatments with higher yield in FP plot (5835 kg/ ha).

Pusa: IPM trial was conducted in three farmer's fields i.e., two farmers Samastipur area *viz.*, Sri Sushil Kumar Rhakur and Smt Sukhsagar Devi from Ratras, Warisnagar, Samastipur and one from Darbhanga area, Sri Ram Sevak Rai of Khutwara, Kabariya, Darbhanga in Bihar State. Varieties grown and practices followed in IPM and FP plots are given below in a Table.

Incidence of stem borer and leaf folder was observed in both the treatments. Damage by both pests was low in IPM field as compared to farmer's practices fields. Weed population and weed biomass was also relatively low in IPM at both 30 DAT and 60 DAT (**Table 2.69**). Grain yield varied from 41.22 to 59.82 q/ha and resulted in high BC ratio in IPM plot (2.96) compared to farmer's practices plots (2.56 – 2.79) (**Table 2.70**).

Practices followed in IPMs trial at Pusa, Kharif 2019

	Pusa farm	Sri Sushil Kumar Rhakur	Smt Sukhsagar Devi	Sri Ram Sevak Rai
	IPM	FP1	FP2	FP3
Area	1 acre	1 acre	1 acre	1 acre
Variety	Rajendra Mansuri	Rajendra Mansuri	Rajendra Mansuri	Rajendra Mansuri
Main Field	<ul style="list-style-type: none"> Seed treatment with Carbendazim @ 2 g/ kg seed Transplanting at 20 x 15 cm spacing Application of RDF Application of Butachlor @ 1.5 kg ai/ ha after one week of transplantation Installed pheromone traps for YSB @ 3/ acre Application of Bispyribac sodium 20 g ai/ ha at 20 DAT Application cartap hydrochloride 50 WP @ 600g / ha at 50 DAT 	<ul style="list-style-type: none"> Transplanting at 20 x 15 cm spacing Application of RDF Sprayed Chlorpyriphos 20 EC @ 500 ml ai/ ha at 20 DAT 	<ul style="list-style-type: none"> Transplanting at 20 x 15 cm spacing Application of RDF Hand weeding at 30 DAT Application of Carbaryl 50 WP @ 30 kg/ ha 	<ul style="list-style-type: none"> Transplanting at 20 x 15 cm spacing Application of RDF Hand weeding at 30 DAT

Table 2.69 Insect pest incidence and weed parameters in IPMs trial at Pusa, kharif 2019

Treatments	% DH		% WE	% LFDL		Weed population (No./ m ²)		Weed dry mass (g/m ²)	
	30 DAT	50 DAT	Pre har	30 DAT	50 DAT	30 DAT	60 DAT	30 DAT	60 DAT
IPM	5.18 ± 0.49	5.78 ± 0.35	6.31 ± 0.40	6.33 ± 0.37	5.48 ± 0.41	8.54 ± 0.49	9.78 ± 0.47	10.96 ± 0.40	12.32 ± 0.51
FP1	10.22 ± 0.68	11.34 ± 0.76	12.21 ± 0.46	7.55 ± 0.34	8.35 ± 0.54	9.82 ± 0.40	12.26 ± 0.39	13.60 ± 0.82	14.54 ± 1.08
FP2	12.41 ± 0.62	13.62 ± 0.76	13.68 ± 0.64	9.42 ± 0.30	11.26 ± 0.45	12.72 ± 0.36	16.24 ± 0.35	18.83 ± 0.57	20.44 ± 0.52
FP3	13.63 ± 0.69	13.74 ± 0.79	14.39 ± 1.01	10.15 ± 0.90	13.54 ± 0.50	14.12 ± 0.38	15.76 ± 0.37	19.94 ± 0.47	19.64 ± 0.34
IPM	5.18	5.78	6.31	6.33	5.48	9	10	10.96	12.32
FP	12.09	12.9	13.42	9.04	11.05	12	15	17.46	18.21

Table 2.70 Grain yield & BC ratio in IPMs trial at Pusa, Kharif 2019

Treatments	Yield Q/ ha	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
IPM	59.82	109770	37133	72637	2.96
FP1	50.48	92631	33155	59476	2.79
FP2	43.26	79382	30950	48432	2.56
FP3	41.22	75639	29320	46319	2.58
IPM	59.82	109770	37133	72637	2.96
FP	44.99	82551	31142	51409	2.65

Price of paddy = Rs.1835/q

Rajendranagar: IPMs trial was conducted at Boorjugadda thanda, Shamshabad mandal, Rangareddy district of Telangana State in six farmers' fields with three IPM farmers (Sri M. Kishan, Sri M. Tariya and Sri A.Srisailam) and three non IPM farmers (Sri L Mudavath, Sri M Basha and Sri M Seethiya). Practices followed in IPM and FP fields are given below:

Practices followed in IPMs trial at Rajendranagar, Kharif 2019

	IPM Practices	Farmers Practices
Variety	RNR 15048	Tellahamsa
Nursery	<ul style="list-style-type: none"> Applied of 4 kg urea, 6 kg SSP and 2 kg MOP Applied Carbofuran 3 G 	<ul style="list-style-type: none"> Application of 4 kg urea, 6 kg SSP and 2 kg MOP
Main field	<ul style="list-style-type: none"> Applied 80 kg N, 90 kg P and 15 kg K Applied Chlorantraniliprole @ 0.3 ml/liter water (60ml/ acre) at panicle initiation stage Adopted alleyways Applied weedicide Topstar @ 36 g/ acre at 3-5 DAT(except farmer 3) + one hand weeding 	<ul style="list-style-type: none"> Application of 110 kg N, 100 kg P and 0 kg K. Sprayed Chlorpyrifos @ 2.5 ml/ liter water Sprayed Flubendamide @ 40 ml/acre Sprayed Tricyclazole @ 120 g/ acre Hand weeding

Table 2.71 Pest incidence and BC ratio in IPMs trial at Rajendranagar, Kharif 2019

Farmer's names	Treatments	% DH	% WE	% LFDL	Weed Population	Yield Q/ha	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	BC ratio
					No./m ²					
Sri M Kishan	IPM	1.42 ± 0.48	3.98 ± 1.14	0.00 ± 0.00	10.80 ± 1.28	59.50	119000	53650	65350	2.22
Sri L Mudavath	FP	0.00 ± 0.00	12.89 ± 3.53	2.36 ± 0.42	21.2 ± 6.40	49.00	87955	61895	26060	1.42
Sri M Tariya	IPM	8.28 ± 1.06	0.00 ± 0.00	0.14 ± 0.09	9.8 ± 1.46	56.01	112020	49075	62945	2.28
Sri M Basha	FP	2.55 ± 0.43	9.05 ± 0.86	0.21 ± 0.21	2.40 ± 1.21	50.75	91096	58658	32438	1.55
Sri A Srisailam	IPM	1.88 ± 0.87	0.17 ± 0.17	0.00 ± 0.00	98.80 ± 6.87	61.25	122500	49025	73475	2.50
Sri M seethiya	FP	1.58 ± 0.68	0.00 ± 0.00	0.00 ± 0.00	48.40 ± 10.94	56.00	100520	58220	42300	1.73
IPM		3.86	1.38	0.05	336	5892	117840	50583	67257	2.33
FP		1.38	7.31	0.86	24	5192	93190	59591	33599	1.57

Price of paddy = Rs.2000/q (IPM farmers); Rs.1795/q (non IPM farmers)

Low incidence of stem borer and leaf folder damage was observed in both IPM and FP farmer's fields except in FP plot of Sri L Mudavath wherein white ear damage exceeded the ETL (12.9%). Weed population was found very high in IPM field of Sri A Srisailam (98.80/m²) and FP plot of Sri M Seethya (48.40/m²). Grain yield was relatively high resulting in high BC ratio in IPM fields (2.33) compared to FP fields (1.57) **(Table 2.71)**.

Raipur: IPM trial was carried out in three farmers fields, i.e, Sri Bhagwat Yadaw, Sri Yogendra Yadaw, Sri Ved Prakash Yadaw and data for farmers practices was taken from Sri Govardhan Sahu's field in Bhothle village, Arang block, Raipur district of Chattisgarh State. Practices followed in both IPM and farmers practices were given in the table below **(Table 2.72)**

Practices followed in IPMs trial at Raipur, Kharif 2019

	IPM Practices followed	Farmers Practices followed
Area	3 acres (1 acre each farmer)	1 acre
Variety	Swarna	Swarna
Nursery	<ul style="list-style-type: none"> Seed treatment with Carbendazim @ 2 g/ kg seed Application of 10 kg urea 	<ul style="list-style-type: none"> Application of 10 kg urea
Main field	<ul style="list-style-type: none"> Application of 50 kg DAP, 15 kg MOP & 50 kg Urea Alley ways of 30 cm after every 2 m Early stage weed control (Sathi & Nominee Gold) Regular monitoring Installation of pheromone traps Need based application of cartap hydrochloride and hexaconazole 	<ul style="list-style-type: none"> Application of 50 kg DAP, 50 kg Urea / acre Random planting Application of Profenophos + Cypermethrin Spraying of Propiconazole 25 EC @ 1ml/ liter

Table 2.72 Pest incidence, Returns and BC ratio in IPMs trial at Raipur, Kharif 2019

Farmer name	Treatments	% DH	% WE	% LFDL	BPH
F1 - Bhagwat yadaw	IPM 1	6.20 ± 3.23 (88 DAT)	8.85 ± 3.89 (137 DAT)	2.25 ± 0.59 (81 DAT)	13.60 ± 2.52 (102 DAT)
F2 - Yogendra yadaw	IPM 2	7.06 ± 2.32 (81 DAT)	6.02 ± 2.92 (137 DAT)	3.37 ± 1.25 (60 DAT)	21.80 ± 2.40 (109 DAT)
F3 -Vedprakash Yadaw	IPM 3	23.61 ± 19.23 (109 DAT)	6.20 ± 3.86 (137 DAT)	2.43 ± 0.74 (67 DAT)	13.60 ± 6.57 (116 DAT)
F4 - Govardhan Sahu	FP	9.72 ± 4.21 (102 DAT)	8.44 ± 3.81 (137 DAT)	2.83 ± 0.96 (102 DAT)	38.80 ± 2.63 (95 DAT)
IPM		12.29	7.02	2.68	16
FP		9.72	8.44	2.83	39
Treatments	Yield (q/ ha)	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
IPM	50.60	91839	19500	72339	4.71
FP	46.32	84071	21813	62258	3.85

Price of paddy = Rs. 1815/q

Low incidence of stem borer, leaf folder and BPH was noticed in all the farmers' fields. Slight incidence of hispa, thrips and WBPH was observed. The weed population was 14 and 16.6% higher at 30 and 60 DAS respectively in farmers practice adopted fields. The weed biomass was also 18% and 10% higher in farmers practice fields than IPM implemented fields. High grain yield was recorded in IPM (50.6 q/ ha) resulting in high returns

and high BC ratio (4.71) compared to FP plot (46.32 q/ ha & 3.85, respectively).

Practices followed in IPMs trial at Sakoli, Kharif 2019

Name of the farmer: Sri Suka Raoji Khandait, Village: Dharmapuri, Tahsil: Sakoli; Bhandara district, Maharashtra		
	IPM Practices	Farmer Practices
Variety	Shri Sai	Shri Sai
Nursery	<ul style="list-style-type: none"> Seed treatment with 3% salt solution Seed treatment with Carbandezim @ 2g/ kg seed Applied 12 kg urea Applied Carbofuran @ 1.1 kg ai/ ha, 5 days before pulling seedlings 	<ul style="list-style-type: none"> Seed treatment with 3% salt solution Applied urea 12 kg/ ha Applied Phorate 10 G @ 10 kg/ ha, 5 days before pulling seedlings
Main field	<ul style="list-style-type: none"> Application of fertilizer, 20:20:0:13 - 188 kg /ha Seedlings planted at spacing of 20 x 15 cm Left alleyways of 30 cm after every 2 m or 10 rows. Applied Butachlor @ 1.5 kg a.i./ ha on 5th day after transplanting + 1 manual weeding Applied Cartap hydrochloride 50 WP @ 600g / ha at 60 DAT Installation of pheromone traps with 5 mg lure @ 8 traps/ ha for stem borer monitoring Application of Propiconazole 0.1% at 70 DAT Mid season drainage for BPH management 	<ul style="list-style-type: none"> Application of 20:20:0:13 - 188 kg/ ha Seedlings were planted randomly One manual weeding Top dressing urea @ 63 kg/ha at 32 DAT
Name of the farmer: Sri. Rupchand Genduji Khotale; Village: Dharmapuri, Tahsil: Sakoli; Bhandara district		
	IPM Practices	Farmers Practices
Variety	DRK 2	DRK 2
Nursery	<ul style="list-style-type: none"> Seed treatment with 3% salt solution Seed treatment with Carbandezim @ 2 g/ kg Application of Carbofuran @ 1.1kg ai/ ha, 5 days before pulling seedlings and Applied urea @ 10 kg/ ha 	<ul style="list-style-type: none"> Seed treatment with 3% salt solution and Carbandezim @ 2 g/ kg Applied urea @ 10 kg/ ha
Main field	<ul style="list-style-type: none"> Application of Urea DAP briquette – 175 kg/ ha Seedlings transplanted at spacing of 20 x 15 cm Alleyways of 30 cm after every 2 m or 10 rows. Application of Butachlor @ 1.5 kg a.i./ ha on 4th day after transplanting + 2 manual weedings Installation of pheromone traps with 5 mg lure @ 8 traps/ha for stem borer monitoring Applied Cartap hydrochloride 50 WP @ 600 g/ha at 62 DAT. Application of Propiconazole 0.1% at 80 DAT Mid season drainage for BPH management 	<ul style="list-style-type: none"> Application of Urea DAP briquette – 175 kg/ ha Seedlings were transplanted randomly Two manual weedings
Name of the farmer: Sri. Anil Tularam Khotale, Village: Dharmapuri; Tahsil: Sakoli, Bhandara district, Maharashtra		
	IPM Practices	Farmers Practices
Variety	MTU 1008	MTU 1008
Nursery	<ul style="list-style-type: none"> Seed treatment with Carbandezim @ 2 g/ kg seed Applied Carbofuran @ 1.1kg ai/ ha, 5 days before pulling seedlings from nursery 	<ul style="list-style-type: none"> Applied 20:20:00:13 @ 12 kg Applied Phorate 10G @ 1 kg, 4 days before pulling the seedlings
Main field	<ul style="list-style-type: none"> Applied DAP 125 kg/ ha Alleyways of 30 cm after every 2 m or 10 rows. Applied Butachlor @ 1.5 kg a.i./ ha on 3rd day after transplanting + 2 manual weedings Installation of pheromone traps with 5 mg lure @ 8 traps/ha for stem borer monitoring Applied Carbofuran 3G @ 25 kg/ ha at 45 DAT Applied Cartap 50 WP @ 600 g / ha 64 DAT. Application of Propiconazole 0.1% at 85 DAT Applied Flubendamide 50% WG @ 150g/ ha at 94 DAT Mid season drainage for BPH management 	<ul style="list-style-type: none"> Applied DAP 125 kg/ ha Seedlings were transplanted randomly Two manual weedings done

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

Table 2.73 Insect pest incidence in IPMs trial at Sakoli, Kharif 2019

Farmer Name	Treat ments	% DH	% WE	% SS		BPH (No./ 5 hills)			WBPH	GLH
		43 DAT	Pre har	64 DAT	78 DAT	78 DAT	92 DAT	106 DAT	78 DAT	85 DAT
F1- Sri. Suka Raoji Khandait	IPM	10.9 ± 5.3	5.7 ± 0.6	2.8 ± 0.4	2.7 ± 0.6	166 ± 2.1	126 ± 1.7		49 ± 0.5	52 ± 0.8
	FP	1.0 ± 0.7	10.4 ± 1.6	9.3 ± 1.6	4.1 ± 0.8	212 ± 2.2	146 ± 1.3		54 ± 1.5	45 ± 1.0
F2 - Sri. Rupchand Genduji Khotale	IPM	1.7 ± 0.8	4.8 ± 0.6	4.2 ± 0.3	2.3 ± 0.5	143 ± 1.4	195 ± 2.8	190 ± 2.1	41 ± 1.4	41 ± 1.5
	FP	0.4 ± 0.4	10.3 ± 2.0	3.9 ± 0.8	2.8 ± 0.3	141 ± 1.0	147 ± 2.2	196 ± 2.0	32 ± 1.3	49 ± 1.2
F3- Sri. Anil Tularam Khotale	IPM	8.1 ± 1.7	6.9 ± 1.6	15.8 ± 0.6	26.8 ± 1.6	325 ± 2.0	298 ± 2.7	292 ± 3.8	104 ± 1.2	61 ± 1.0
	FP	14.6 ± 2.8	14.4 ± 1.9	20.5 ± 0.5	27.0 ± 1.8	320 ± 3.5	290 ± 2.4	285 ± 2.4	102 ± 1.4	61 ± 0.9
IPM		6.9	5.8	7.6	10.6	211	206	241	65	51
FP		5.3	11.7	11.2	11.3	224	292	241	63	52

Incidence of stem borer, gall midge, leaf folder, BPH, WBPH and GLH was observed in both IPM and FP plots of all the three farmers' fields (**Table 2.73**). Dead heart and white ear damage was high in Sri Anil Tularam's (F3) FP plot (14.6% DH & 14.4% WE) followed by Sri Suka raoji's (F1) IPM plot (10.9% DH) and Sri Rupchand Genduji's (F2) FP plot (10.35% WE). Mean of all the three farmer's fields data revealed that dead heart damage was low in FP plots (5.3%) than IPM plots (6.9%) whereas white ears were higher in FP plots (11.7% WE) compared to IPM plots (5.8% WE). Very low incidence of leaf folder was observed in both IPM and FP plots across farmers. Gall midge incidence was high in only F3 fields in both FP (20.5–27% SS) and IPM plots (15.8–26.8% SS). BPH and WBPH incidence started at 36 DAT and continued till harvest in F1 and F3 fields whereas it started at 50 DAT in F2 fields. Maximum population was noticed in F3 fields in both IPM (292–325 BPH/5hills) and FP plots (285–320 BPH/ 5hills) followed by F2 fields (143–195 BPH/5hills in IPM and 141–196 BPH/ 5hills in FP) and F1 fields (126–166 BPH/5 hills in IPM & 146–212 BPH/ 5 hills in FP). Similar trend was observed with respect to WBPH and GLH incidence with high numbers in F3 fields. Weed population and weed dry mass data recorded at 30 DAT and 60 DAT revealed that IPM implemented plots had low population and biomass as compared to farmer practices plots (**Table 2.74**). Weed dry mass was very high in FP plots of all the three farmers at 30 DAT (19.4–25.2 g/ m²).

Table 2.74 Weed Population and weed biomass in IPMs trial at Sakoli, Kharif 2019

Farmer Name	Treatments	Weed population (No./m ²)		Weed biomass (g/m ²)	
		30 DAT	60 DAT	30 DAT	60 DAT
F1- Sri. Suka Raoji Khandait	IPM	11.4 ± 1.2	10.8 ± 1.2	8.8 ± 1.1	9.3 ± 0.9
	FP	16.4 ± 1.4	13.6 ± 1.4	21.5 ± 2.4	13.1 ± 1.0
F2 - Sri. Rupchand Genduji Khotale	IPM	10.6 ± 1.1	9.4 ± 1.0	7.8 ± 0.4	8.8 ± 0.8
	FP	15.4 ± 0.9	14.8 ± 1.7	19.4 ± 2.9	13.8 ± 1.3
F3- Sri. Anil Tularam Khotale	IPM	13.8 ± 1.1	10.6 ± 0.7	12.1 ± 1.2	8.8 ± 0.3
	FP	23.4 ± 1.3	15.6 ± 0.7	25.2 ± 2.0	13.4 ± 1.5
IPM		11.9	10.3	9.6	9.0
FP		18.4	14.7	22.0	13.4

Table 2.75 Returns and BC ratio in IPMs trial at Sakoli, Kharif 2019

Farmer Name	Treatments	Yield (Q/ ha)	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
F1- Sri. Suka Raoji Khandait	IPM	44.81	80658	39818	40840	2.03
	FP	34.81	62658	34667	27991	1.81
F2 - Sri. Rupchand Genduji Khotale	IPM	41.20	74160	44064	30096	1.68
	FP	36.02	64836	38996	25840	1.66
F3- Sri. Anil Tularam Khotale	IPM	41.98	75564	48588	26976	1.56
	FP	35.99	64782	39788	24994	1.63
IPM		42.66	76794	44157	32637	1.75
FP		35.61	64092	37817	26275	1.70

Price of Paddy = Rs. 1800/q

Grain yields were relatively high in IPM implemented fields (42.66 q/ ha) as compared to FP plots (35.61 q/ha) resulting in high returns (**Table 2.75**). BC ratio was relatively high in IPM (1.75) than in FP plots (1.70).

Titabar: The trial was conducted at Sri Debanand Das's field at Mazgoan village, Titabar mandal, Jorhat district of Assam. Ranjit sub-1 variety was grown in both IPM and FP blocks. Practices followed were given in the table below.

Practices followed in IPMs trial at Titabar, Kharif 2019

	IPM Practices	Farmers Practices
Variety	Ranjit Sub-1	Ranjit Sub-1
Nursery	<ul style="list-style-type: none"> Seed treatment with Bavistin @ 2 g/ kg seed and Chlorpyrifos 2ml/kg seed 	
Main field	<ul style="list-style-type: none"> Fertilizer application @ 30:20:40 kg NPK/ha Applied Pretilachlor within a week of transplanting Applied paddy weeder to lessen weeds Installed pheromone traps @ 20/ ha for stem borer mass trapping At 60 DAT, applied chlorpyrifos 20EC @ 2ml/L for stem borer management Placed tricho cards for stem borer and leaffolder management Sprayed fresh cowdung solution @250g/L water at mid tillering stage against BLB 	<ul style="list-style-type: none"> Fertilizer application @20:10:10 kg NPK/ha Manual weeding two times

Incidence of stem borer, gall midge, leaf folder, whorl maggot and GLH was observed in both IPM and FP plots at this location (**Table 2.76**). The pest incidence in IPM implemented plots was far below the economic injury level

whereas in FP plot, damage was very high. Stem borer incidence was high starting from 29 DAT and continued till harvest in FP plot (24.1 – 49.8% DH & 15.3% WE). Similarly, gall midge damage crossed ETL from 36 DAT onwards till 85 DAT in FP plot (10.2 – 36.1% SS). High damage by leaf folder was reported from 29 to 85 DAT (23.8 – 38.9% LFDL) and whorl maggot from 36 – 71 DAT (16.9 – 25.8% DL) in FP plot alone. IPM implemented fields recorded 63% lower weed population and 47% lower weed biomass compared to farmers practice adopted fields. High grain yield was recorded in IPM plot (52q/ ha) compared to FP plot (39.5q/ ha) resulting in high returns and high BC ratio (**Table 2.77**).

Table 2.76 Insect pests, diseases and weed incidence in IPMs trial at Titabar, *kharif* 2019

Treat-ments	% DH				% WE	% SS				
	29 DAT	43 DAT	57 DAT	85 DAT	Pre har	36 DAT	43 DAT	57 DAT	78 DAT	85 DAT
IPM	1.2 ± 0.8	1.7 ± 0.6	1.4 ± 0.4	0.8 ± 0.3	0.9 ± 0.4	0.9 ± 0.5	1.4 ± 0.3	1.1 ± 0.5	0.5 ± 0.2	0.3 ± 0.2
FP	24.1 ± 4.8	49.8 ± 3.2	38.0 ± 1.5	25.1 ± 1.2	15.3 ± 0.5	24.4 ± 2.3	36.1 ± 4.3	29.9 ± 1.1	19.6 ± 0.9	10.2 ± 0.8

Treat-ments	% LFDL					% WMDL	
	29 DAT	36 DAT	43 DAT	64 DAT	78 DAT	36 DAT	57 DAT
IPM	1.3 ± 0.5	1.5 ± 0.7	1.6 ± 0.5	0.6 ± 0.2	0.5 ± 0.2	1.5 ± 0.7	0.6 ± 0.3
FP	23.8 ± 3.4	38.9 ± 3.8	35.5 ± 1.4	34.7 ± 1.2	23.8 ± 2.1	16.9 ± 1.6	25.8 ± 2.3

Table 2.77 Returns and BC ratio in IPMs trial at Titabar, *Kharif* 2019

Treatments	Yield (Q/ ha)	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC ratio
IPM	52.02	85833	41035	44798	2.09
FP	39.50	65175	35725	29450	1.82

Price of paddy = Rs. 1650/q

During *Kharif* 2019, IPMs trial was conducted in 13 locations in 28 farmer's fields. Across the locations, stem borer damage was reported from 12 locations with low damage in IPM plots. Both dead heart and white ear damage exceeded ETL only at Karjat, Pusa, Raipur and Titabar with maximum damage in FP plot at Titabar (34.25% DH & 15.3% WE). Leaf folder damage was low at all the reported 10 locations in both IPM and FP plots, except at Pusa (10.04% LFDL) and Titabar (31.34% LFDL) in FP plot. Similarly, Whorl maggot damage was found high in FP plot at Titabar (21.35% WMDL) followed by IPM plot at Jagdalpur (11.74% WMDL). Gall midge incidence was observed at only two locations with maximum damage in FP plots compared to IPM plots (**Table 2.78**). Maximum Hispa damage was reported from Malan in FP plot (96.6% HDL).

Planthopper incidence was recorded at 7 locations with maximum numbers at Sakoli in both IPM (219/ 5 hills) and FP plots (252/ 5 hills) and at Gangavathi in FP plot (248/5 hills). Similarly, WBPH was reported high in FP plot at Gangavathi (355/ 5 hills). Grain yield ranged between 1688 and 7352 kg/ ha in different treatments across locations. Yield was high in IPM plots compared to FP plots at all the locations with maximum yield at

Ludhiana in IPM field (7352 kg/ ha). Similarly, BC ratio varied from 0.88 to 4.71 at various locations in both IPM and FP plots.

Table 2.78 Pest incidence, Grain yield and BC ratio in IPM and FP plots across locations, Kharif 2019

	% Dead hearts											
	CHN	GNV	JDP	KJT	LDN	MND	PNT	PSA	RNR	RPR	SKL	TTB
IPM	0.25	1.56	2.81	9.4	4.45	3.67	9.24	5.48	3.86	12.29	6.9	1.3
FP	7.81	2.05	1.13	15.1	5.86	5.93	7.87	12.5	1.38	9.72	5.3	34.25
	% White Ears											
	CHN	JDP	LDN	MND	PSA	RNR	RPR	SKL	TTB			
IPM	0.74	5.46	3.56	4.07	6.31	1.38	7.02	5.8	0.9			
FP	8.74	1.72	5.28	5.97	13.42	7.31	8.44	11.7	15.3			
	% Leaf folder damaged leaves											
	CHN	GNV	JDP	LDN	MND	PNT	PSA	RNR	RPR	TTB		
IPM	0.05	0.79	5.24	5.06	1.43	2.72	5.91	0.05	2.68	1.1		
FP	0.7	0.92	7.09	7.98	4.43	1.44	10.04	0.86	2.83	31.34		
	% Whorl maggot damaged leaves						% Silver shoots			% HDL		
	CHN	JDP	LDN	PNT	TTB		SKL	TTB		CHN	MLN	PNT
IPM	0.94	11.74	4.24	4.23	1.05		9.1	0.84		0.00	8.81	2.79
FP	2.53	7.02	5.63	4.97	21.35		11.3	24.04		0.74	96.6	2.43
	BPH (No./ 5 hills)								WBPH			
	CHN	GNV	LDN	MND	PNT	RPR	SKL		CHN	GNV	LDN	SKL
IPM	0	54	19	6	36	16	219		0.8	73	21	65
FP	14	248	13	13	25	39	252		3.2	355	30	63
	Grain yield (Kg/ ha)											
	CHN	GNV	JDP	KJT	LDN	MLN	MND	PSA	RNR	RPR	SKL	TTB
IPM	4534	6788	4016	2965	7352	3488	5273	5982	5892	5060	4266	5202
FP	3981	6366	3428	2405	7248	1688	4617	4499	5192	4632	3561	3950
	BC ratio											
	CHN	GNV	JDP	KJT	LDN	MLN	MND	PSA	RNR	RPR	SKL	TTB
IPM	1.59	2.23	3.83	1.42	3.26	1.37	1.73	2.96	2.33	4.71	1.75	2.09
FP	1.45	1.85	3.03	1.1	2.93	0.88	1.33	2.65	1.57	3.85	1.7	1.82

Integrated Pest Management special (IPMs) trial was conducted at 13 locations involving 28 farmers' in a participatory mode across the Country with an objective of managing insects, diseases and weeds in a holistic way by providing a basket of options to the farmers. In general, during Kharif 2019 the pest incidence was low across the locations. However, insect pest incidence exceeded ETL at 8 locations and was observed high in farmer practices plots as compared to IPM plots. Stem borer damage was low in IPM plots than FP plots at 4 locations while dead heart damage was very high in FP plots at Titabar (49.8%), Pusa, Karjat and Sakoli. Gall midge incidence was low in IPM plots (<2% SS) compared to FP plots (10.2 – 36.1% SS) at Titabar while the incidence was high in both IPM and FP plots at Sakoli. Leaf folder incidence was low in IPM at Titabar (<2% LFDL) compared to FP plots (23.8 – 38.9% LFDL). Hispa incidence was low in IPM (8.81-24.8% HDL) compared to FP plots (33.3 – 96.6% HDL) throughout the crop growth period at Malan. Though the populations of planthoppers was high initially in IPM plots (177-391/ 5 hills), they got reduced later with the adoption of IPM practices (< 50/5 hills) at Gangavathi and Raipur.

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

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

During 2019, insect populations in rice ecosystems were recorded daily, throughout the year using light traps (Chinsurah/Robinson type) in 26 locations. Corresponding weather data on temperature, rainfall, relative humidity, sunshine hours, etc. were also collected. Weekly cumulative catches of insects and weekly averages of weather parameters were worked out on standard week (SW) basis. Highlights and trends of the data collected during the year 2019 are presented zone-wise hereunder:

Zone I- Hills

- 1. Himachal Pradesh-Malan (22-44 SW):** WSB, CW, LF, BPH, WBPH, GLH and black beetle were recorded at this location. LF was found active during 27th to 42nd standard weeks and catches were highest during 37th SW (864 moths). WSB made its first appearance in 27th SW and continued up to 43rd SW with a peak population of 63 moths in 32nd SW. CW was found in 22nd to 27th SWs and 33rd to 44th SWs and the moth catches were maximum (62) in 41st SW. Black beetle was recorded continuously up to 40th SW, except during 24 and 25 SWs with a highest catch of 37 beetles in 33rd SW. GLH and BPH were found continuously from 26th to 42nd SW. GLH reached its peak population in 40th SW (38) while BPH catches were highest in 31st SW (29). Stray occurrences of WBPH were also noticed during 28th to 30th SW.
- 2. Jammu & Kashmir-Khudwani (14-44 SW):** Grasshoppers (GH), skippers, LF, scarabaeids, and cutworms were recorded at this centre. GH appeared continuously from 25th to 41st SWs with maximum catch of 26 in 40th SW. LF was found during 29 to 39 SWs with peak activity in 37th SW. Scarabaeids were active from 19th to 23rd SW and highest numbers were observed in 22nd and 23rd SWs (51). Cutworms showed staggered occurrence with moderate catches (24 in 26th SW) in 14 to 15, 25 to 26 and 34 to 35 SWs. Data shows that GH, skipper, and LF were inactive below 10 °C of minimum temperature.

Zone II- Northern

- 3. Haryana-Kaul (35-52SW):** Three stem borers; YSB, WSB, and PSB; LF, BPH and WBPH were recorded at this location. PSB was dominant amongst the stem borers and was found continuously from 39 to 51 SWs. Maximum number of moths (23) were trapped in 41st SW. LF was recorded during 38 to 46 SWs with highest catch of 28 moths in 38th SW. BPH was found during 38 to 43 SWs and highest population was recorded in 39th SW. WBPH was noticed only in 28th and 39th SWs.
- 4. Jammu & Kashmir-Chatha (1-52 SW):** White grub, GSB, GH, LF, GLH and water beetles were recorded. White grub appeared continuously from 16-46 SWs. There were two peaks, one at 28th SW (252) and another at 39th SW (114). GSB started appearing continuously from 14 to 49 SWs and the catches were highest (40) during 20th SW. GH was recorded from 19th SW onwards with peak activity in 28th SW (70). LF activity was recorded from 36th to 51st SW and was at peak in 47th SW (110). GLH was observed throughout the cropping season. Largest catches were found during 47th SW (110).
- 5. Punjab-Ludhiana (1-48 SW):** Three species of stem borers - YSB, PSB and WSB were recorded at this location. YSB and WSB catches were low (22 and 10 respectively), while PSB showed two distinct periods of activity corresponding to the crop growth seasons and highest catch (31) was found in 40th SW. LF, BPH, and WBPH were found only in the *Kharif* season. LF catches were recorded continuously from 28 to 48 SWs and the highest number of moths (260) was observed in 44th SW. BPH was found during 34 to 46 SWs with a peak population of 7700 in 40th SW. WBPH catches were small, highest being 100 in 40th SW. Small numbers of GLH and predators - mirid bugs and rove beetles also were recorded.
- 6. Uttarakhand-Pantnagar (22-48 SW):** YSB, GM, LF, GLH, BPH, WBPH, RH and RGB were recorded at this location. YSB appeared early in the season, from 25th SW and catches consisted of mostly females. Highest count was recorded in 34th SW (373 females and 63 males) followed by a gradual decline. LF also was recorded from 25th SW and showed maximum activity in 31st SW (25). GLH and BPH were active during 32-43 SWs whereas, WBPH was active during 38 to 41 SWs. BPH and WBPH were most active, (667 and 97, respectively) in 38th SW. RGB was found active during 36 to 42 SWs with a peak catch of 72 in 41st SW.

Zone III-Eastern

- 7. Assam-Titabar (1-52 SW):** YSB, WSB, GM, LF, GLH, WM, CW, blue beetle, black bug, mole cricket, gundhi bug and GH were recorded at this location. SBs, GM, and LF were recorded throughout the year but were more abundant during the *Kharif* season. Populations of both the SBs showed gradual increase with progress of the season despite fluctuations. YSB reached the highest population (1967 females and 2061 males) in

38th SW. WSB population was highest (2233) in 40th SW. LF was most active in 40th SW. Two species of GLH - *Nephotettix virescence* and *N. nigropictus* occurred from 18th SW onwards. *N. virescence* reached its peak population (20158) in 38 SW, whereas the *N. nigropictus* (19829) in 40th SW. WM, CW and blue beetle were also observed from 18th SW reaching peak during 40thSW (WM - 365, black bug - 10661 and mole cricket - 340). Large number (up to 11860) of blue beetle was also recorded during 28th SW. Gundhi bug and grasshopper also were recorded in considerable numbers during the crop season. Among the natural enemies; dragonflies, damsel flies, and ground beetles were recorded.

- 8. Odisha-Chiplima (27-52 SW):** SB, GM, LF, GLH, BPH, WBPH and CW were reported from this centre. Pest activity was found only during 34 to 50 SWs. YSB first appeared in 34th SW and catches increased gradually reaching its maximum in 44th SW (19 females, 26 males) followed by a decline. GM showed peak activity in 41st SW (167). Both the species of GLH, *N. virescens* and *N. nigropictus* were recorded and the combined catch was largest (1492) in 44th SW. BPH and WBPH were found active late in the season during 38 to 49 SWs and peak catches were observed in 45th SW in case of BPH (2396) and 43rd SW in case of WBPH (523). LF was found in moderate numbers reaching up to 36 in 40th SW.
- 9. West Bengal-Chinsurah (1-52 SW):** SBs, LF, GLH, BPH, WBPH, WLH and RGB were found active throughout the year. However, temporal distribution of the insect populations revealed two distinct peaks coinciding with *Kharif* and *Rabi* seasons. Also, insect catches in *Kharif* were larger as compared to *Rabi*, particularly that of YSB. In case of YSB, males were more abundant. Maximum number of moths (717 females and 1657 males) were trapped in 20th SW. GLH catches were recorded up to 54 in 44th SW, while BPH and WBPH were most active in 15th SW (375 and 57 respectively). Moderate numbers of WLH were also observed and highest catch was recorded in 16th SW (38).

Zone V- Central

- 10. Chhattisgarh-Raipur (1-52 SW):** SBs, LF, GLH, BPH, ZZLH, CW, RGB and blue beetle and *Spodoptera* sp. were recorded at this location. Among the SBs, YSB and PSB were found throughout the year. YSB catches were highest (77 females and 43 males) in 21st SW. LF was found active in *Kharif* season for a limited period i.e., 38 to 49 SWs and maximum catch (55) was in 45th SW. GLH catches reached peak during the same period (1204) though the pest made its appearance in 35th SW. BPH was found most active during 11 to 23 SWs in *Rabi* and 38 to 51 SWs in *Kharif* and the catch was highest (18000) in 48th SW. Significant catches of ZZLH were also observed during *kharif* season, with a maximum catch (12782) in 48th SW. Blue beetle population reached up to a maximum of 880 in 47th SW. *Spodoptera* moths were attracted in small numbers throughout the year. Generalist predators like coccinellids, ground beetles, rove beetles, and earwigs also were recorded round the year.

Rove beetle catches were considerable and highest count of 112 was recorded in 11th SW.

11. Chhattisgarh-Jagdalpur (1-52 SW): YSB, GM, CW, LF, GLH, BPH, WBPH, ZZLH, RGB, and GH were recorded at this location. YSB occurred throughout the year and was more abundant during the crop growth period. Maximum population was recorded in 8th SW (46 females and 45 males). GM was found during 34 to 45 SWs only with a maximum catch of 14 in 44th SW. LF occurrence was also found restricted to 34 to 50 SWs. GLH was more active during the *Kharif* season and the combined catch of *N. virescens* and *N. nigropictus* reached up to 21874 in 48th SW. BPH was present throughout the year with highest count of 251 in 43rd SW, while WBPH numbers were not considerable. ZZLH population was recorded up to 391 hoppers in 43rd SW. Grasshopper activity picked up from 35th SW and was highest during 48th SW (52). Among the natural enemies, coccinellid and ground beetles were recorded round the year with a maximum of 380 and 201 in 47 and 48 SWs, respectively.

12. Maharashtra-Sakoli (1-52 SW): YSB, GM, LF, GLH, BPH, WBPH and rice moth were recorded at this location. YSB was found active throughout the year. In *Rabi*, YSB was most active (300 females and 64 males) in 18th SW whereas, during *Kharif* the catches were highest during 34th SW (105 females and 32 males). GM occurred during 34 to 46 SWs and the highest catch was recorded in 40th SW (401). LF catch was maximum (48) during 43rd SW. Hoppers showed a distinct seasonal activity during crop growth period. GLH population was highest (539) in 13th SW. BPH and WPH populations reached maximum ((1167 and 409 respectively) in 44 SW. Considerable catches of rice moth (up to a maximum of 52 in 3rd SW) were also recorded. Among the natural enemies, coccinellids were recorded during rainy season.

13. Uttar Pradesh-Mashoda (22-52 SW): YSB, LF, GLH, CW and grasshoppers were recorded from this location throughout the recording period with an increased abundance from August month onwards. YSB showed two peaks one in 34th SW (770) and other in 47th SW (674). LF catch was also maximum during 34th SW (1023). GLH was highest (2871) in 44th SW. CW moth population also was considerable at this location, with a highest catch of 1720 moths in 47th SW. GH were most active in 42nd SW (765).

Zone VI- Western

14. Gujarat-Navsari (1-52 SW): SBs, LF, GLH, BPH, WBPH, RGB, and paddy skipper were found in light trap catches. YSB appeared from 22nd SW and increased gradually along with other SBs reaching peak population (332 females+142 males and 58 respectively) in 37th SW followed by a decline. LF catches also started from 22nd SW and reached peak in 34th SW (196). Sucking pests appeared late in the season and GLH (*N. virescens* and *N. nigropictus*) catches were highest (89 and 65) in 43rd SW. BPH and WBPH also were found in small numbers. Paddy

skipper was first recorded in 26th SW and increased up to 189 in 36th SW followed by a gradual decline.

- 15. Maharashtra-Karjat (1-52 SW):** YSB, LF, GLH, BPH, and WBPH were recorded at this centre, but numbers were not considerable.

VII-Southern

- 16. Andhra Pradesh-Maruteru (22-52 SW):** YSB, GM, LF, GLH, BPH, WBPH, ZZLH, black bug, coccinellids and mirid bug were reported from this centre. YSB catches were highest (1013 females and 713 males) in 49th SW. GM was most active (500) during 44th SW. LF occurred from 36th SW onwards reaching maximum population (999) in 45th SW. BPH and WBPH which appeared from 35th and 37th SW respectively, were found most active during 45th SW with 17133 and 5119 hoppers respectively per trap, while GLH catches were up to 1338 during the same period. ZZLH also was found in considerably higher numbers; up to a maximum of 6844 in 45th SW. Black bug was found throughout the recording period and was most active (1184) in 51st SW. Among the natural enemies, mirid bugs were recorded and the largest catch (2591) was in 44th SW.

- 17. Andhra Pradesh-Bapatla (31-52 SW):** YSB, LF, GLH, BPH, WBPH, ZZLH, CW and natural enemies were reported from this centre. YSB occurred in 31st to 36th SWs and 42nd to 2nd SW. Population was highest (36) in 47th SW. Leaf folder catches were maximum (178) in 46th SW. CW started appearing from 35th SW and was most active (132) in 43rd SW. BPH and WBPH catches started from 33rd and 39th SWs respectively. BPH population was maximum (775) in 44th SW and WBPH (325) in 45th SW. ZZLH also occurred in small numbers. Among the natural enemies, mirid bug catches were considerable and 1202 bugs were recorded in 44th SW.

- 18. Telangana-Rajendra Nagar (1-52 SW):** YSB, PSB, CW, LF, GLH, BPH, blue beetle, GLH, GSB, coccinellids and mirid bugs were recorded at this centre. Overall, insect catches were small. Highest count of YSB (32 females and 48 males) was recorded in 2nd SW. BPH was most active during 43rd and 44th SWs (177).

- 19. Telangana-Warangal (1-52 SW):** YSB, WSB, GM, LF, BPH, WBPH, GLH, and GSB were recorded at this centre. YSB occurred during 1st to 25th SW and again in 38th to 50th SW period. In *Kharif* season population was higher with predominantly males. Population attained maximum level in 47th SW (66 males and 44 females). GM was found throughout the year but was most active in 43rd SW (180 males and 120 females). LF catches were small and found mostly in *Kharif*. Plant hoppers also active mostly in the rainy season. WBPH reached its peak activity (1004) in 44th SW, whereas, in case of BPH, peak population of 2997 was recorded in 48th SW. GLH though recorded throughout the year, was most active in rainy season with a maximum population of 340 in 48th SW. Among the natural enemies; coccinellids, mirid bug and rove beetles were recorded.

Mirid bug was most active during 48th and 49th SWs, coinciding with the maximum population of plant hoppers.

- 20. Tamil Nadu-Aduthurai (1-52 SW):** YSB, LF, GLH, WLH, BPH, GSB, black bug, blue beetle, mole cricket, cricket and water beetle were recorded at this location. Except LF and black bug all the insects were active throughout the year. The insect population showed a sudden spurt in 33rd SW. YSB, GLH, WLH, and blue beetle populations reached highest levels of 3187, 1608, 6346, and 19052 respectively in this week. BPH was most active in 2nd SW (8895) and black bug was most abundant (17468) in 29th SW. Coccinellids, ground beetle, and rove beetle numbers were highest in 33rd SW with catches of 34913, 4776, and 15905 respectively.
- 21. Tamil Nadu-Coimbatore (1-52 SW):** YSB, PSB, CW, LF, GLH, BPH, WBPH, WLH, RGB, GSB, and mirid bugs were recorded but overall, the catches were small. Rove beetles showed a maximum population of 107 in 43rd SW.
- 22. Kerala-Moncompu (1-52 SW):** SBs, LF, GLH, BPH, WBPH, black bug, and natural enemies were recorded. However, data could not be recorded during 33rd SW due to floods. YSB was active till 19th SW with a peak population of (76 males + 62 females) in 7th SW. In rainy season YSB catches were low. Water bug was found almost throughout the year, with a peak population of 233 in 38th SW.
- 23. Kerala-Pattambi (1-52 SW):** YSB, WSB, GM, LF, GLH, BPH, WLH, and CW were recorded in light trap catches. Though YSB was more active in initial four standard weeks, the highest population (359) was recorded in 52nd SW. WSB catches were comparatively smaller and maximum (23) was in 39th SW. GM was active during 30th to 47th SWs with a maximum catch of 602 in 39th SW. Both the GLH species, *N. nigropictus* (3550) and *N. virescens* (1825) reached their peak population levels in the 45th SW. WLH occurred throughout the year. BPH was more active late in the season; and maximum population (1400) was recorded in 43rd SW. CW was found throughout the year except during 19th to 21st SWs and maximum population (130) was recorded in 39th SW. Among the natural enemies, ground beetles, rove beetles and mirid bugs were recorded. Maximum mirid bug catches (1728) occurred in 48th SW.
- 24. Karnataka-Mandya (1-52 SW):** YSB, LF, CW, GLH, and BPH were recorded at this centre. Overall, pest activity was low. YSB was found throughout the year except 23rd and 24th SWs. The pest was more active in *kharif* season with maximum population (229 females and 146 males) in 41st SW. LF appeared from 5th SW and gradually increased up to 13th SW (115 moths) followed by a decline in following summer months. The pest population picked up again in 34th SW and reached a maximum of 190 in 44th SW. CW occurred in 8th to 15th and 30th to 45th SWs, with a maximum population (87) in 37th SW. GLH and BPH activity was low and limited to 35th to 47th SWs and 42nd to 52nd SWs respectively.

25. Karnataka-Gangavati (1-52 SW): YSB, LF, CW, GLH, BPH and WBPH were recorded at this location. 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. LF 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.

26. Puducherry-Karaikal (1-52 SW): SBs, GM, LF, GLH, BPH, WBPH, WLH, and natural enemies were recorded in small numbers at this centre. Among the natural enemies, ground beetle, coccinellids, and rove beetles were recorded. However, staphylinid predator catches were considerable during the crop season with a catch of 348 in 38th SW.

Pest-wise analysis of light trap catches:

Stem borer

Yellow stem borer was recorded in 23 locations, except in KHD, MLN and CHT. Annual cumulative catches were highest at TTB (50144) followed by MTU (16755) and CHN (13710). Weekly highest catches also showed similar trend, highest being in TTB (4028) in 38th SW, MTU (1726) in 49th SW and CHN (2374) in 20th SW. In the previous year highest weekly catch was recorded at PTB (3651) followed by MTU (1843) and PNT (1439) (**Fig. 2.15**).

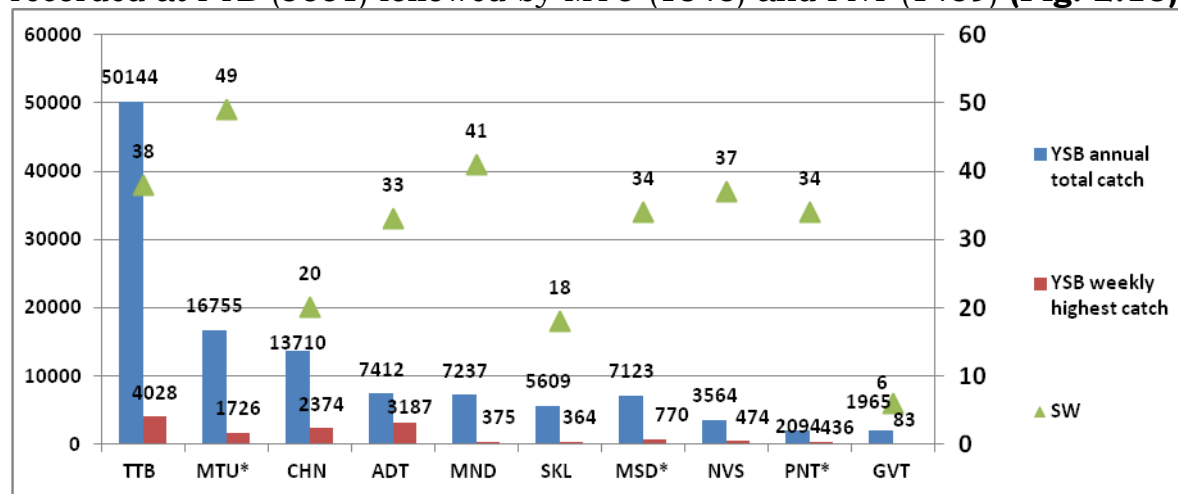


Fig. 2.15 Annual and weekly cumulative light trap catches of yellow stem borer* only kharif data. SW- Peak catch standard week

Gall midge

Gall midge occurrence was observed in nine locations. It was not recorded from Hills and Western Zone. In the Northern Zone it was found in stray incidence at PNT (2). Annual cumulative catches were highest in TTB (3746) followed by MTU (3470) and SKL (2335). In terms of weekly cumulative catches, it was most active in TTB (335) and SKL (401) in 40th SW followed by MTU (500) in 44th SW. Data reveals that late rainy season conditions are favourable for its population build up. In the previous year, it was most active in MTU (5185) followed by BPT (3248) and SKL (600) (**Fig. 2.16**).

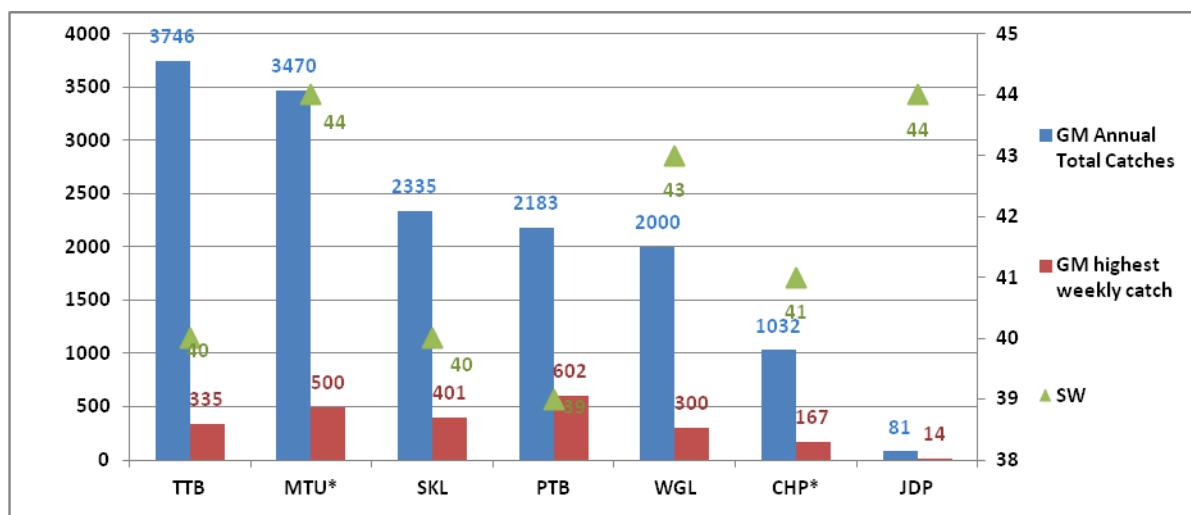


Fig. 2.16 Annual and weekly cumulative light trap catches of gall midge

* only *kharif* data SW- Peak catch standard week

Leaf folder

Leaf folder was recorded at all the 26 reporting centres across the regions. It was most active in TTB (20368), followed by MSD (8867) and MLN (3200) in terms of annual cumulative catches. Whereas, weekly cumulative catches were maximum at TTB (2319) in 40th SW, followed by MSD (1023) in 34th SW, and MTU (999) in 45th SW. In the previous year highest weekly cumulative population was recorded at MLN (1100) followed by BPT (896), and NVS (446) (**Fig.2.17**)

Green leafhopper

Green leafhopper was recorded from 24 centres except KUL and KHD. In TTB (295769) annual cumulative catches were highest followed by JDP (140788), and MSD (42439). Weekly cumulative catches were highest in TTB (36967) in 40th SW, followed by JDP (21874) in 48th SW and PTB (5375) in 45th SW. In the previous year, GLH was reported from 22 locations spread over all the zones. Maximum weekly catches were recorded at JDP (14455) followed by PTB (2053) and GVT (1503) (**Fig. 2.18**).

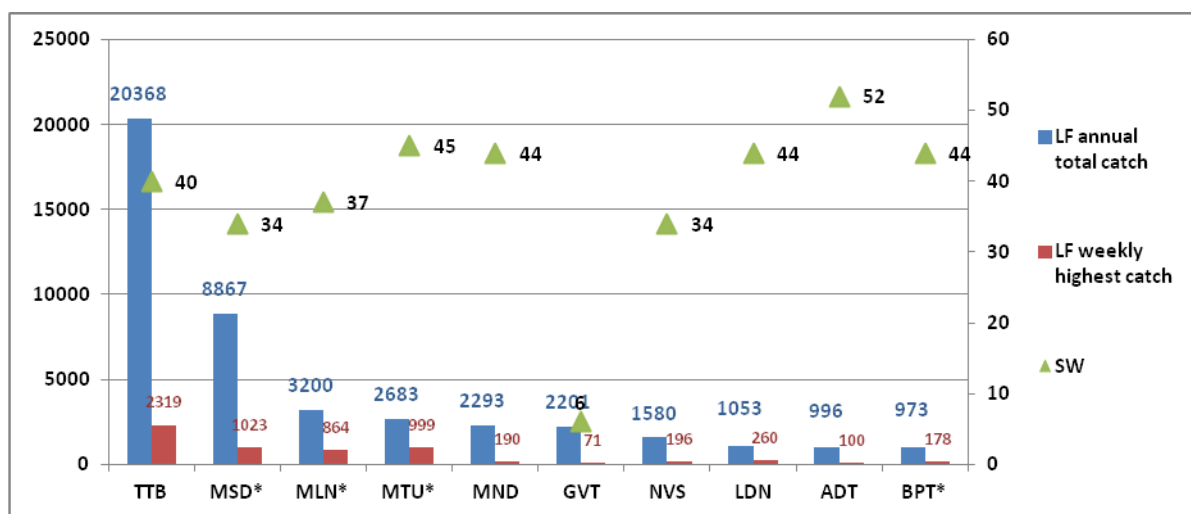


Fig. 2.17 Annual and weekly cumulative light trap catches of leaf folder

* only *kharif* data SW- Peak catch standard week

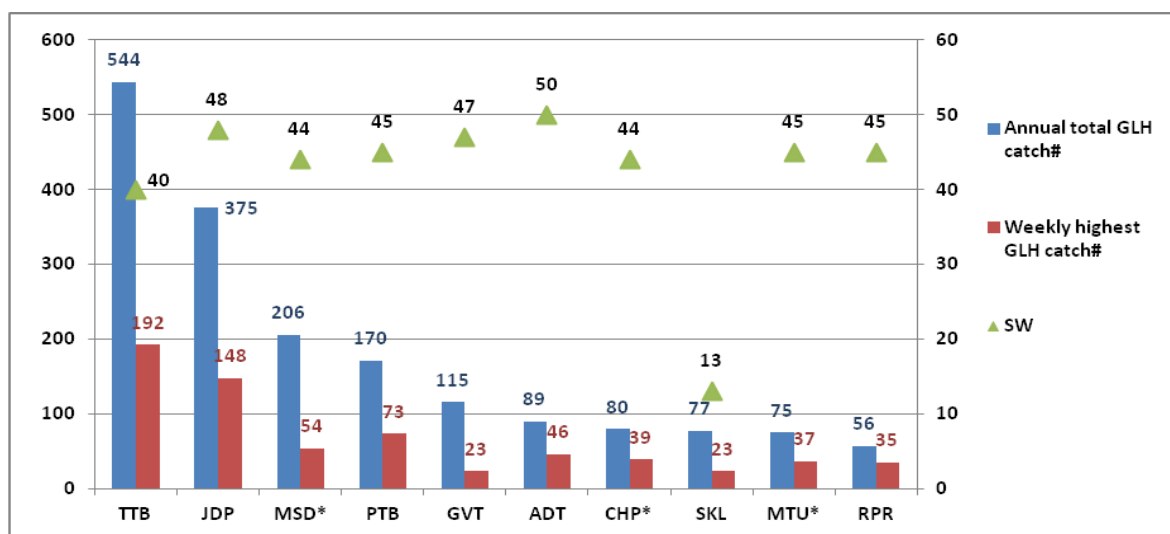


Fig. 2.18 Annual and weekly cumulative light trap catches of Green leafhopper * only *kharif* data #square root transformed SW- Peak catch standard week

Brown planthopper

Brown plant hopper was recorded in 22 locations and did not occur at KHD, CHT, MSD, and TTB. It is interesting to note that the pest was not recorded in TTB, otherwise reported for high incidence of other pests. BPH was most abundant in RPR (71422), followed by MTU (68637) and ADT (23481) on yearly basis. Except in ADT and CHN, where it was found most active in the *rabi* season, in the remaining locations it reached peak population levels in October and November months. Weekly cumulative catches were highest in RPR (18000) in 48th SW, followed by MTU (17133) in 45th SW and ADT (8865) in 2nd SW. In the previous year, it was recorded at all the locations except KHD. Highest weekly population was recorded at ADT (64722) followed by PTB (19300), and GVT (17487) (**Fig. 2.19**).

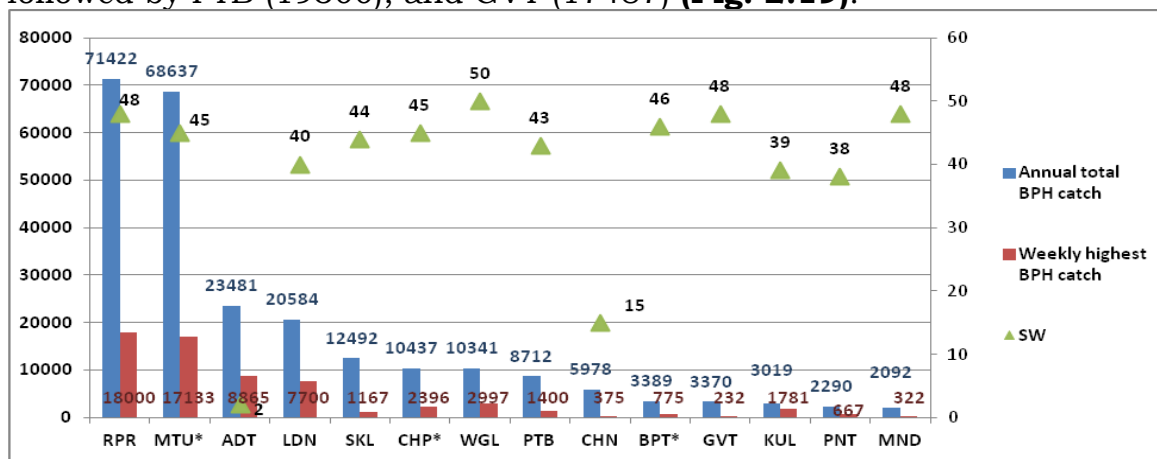


Fig. 2.19 Annual and weekly cumulative light trap catches of brown planthopper * only *kharif* data SW- Peak catch standard week

Whitebacked planthopper

White backed plant hopper was recorded in 16 locations. Annual cumulative catches were highest in MTU (15935) followed by GNV (63745) and SKL

(6217). Whereas, weekly cumulative catches were highest in MTU (5119) in 45th SW followed by WGL (1004) in 44th SW and SKL (409) in 46th SW. In the preceding year it was recorded at 18 locations in all the zones except Hills. Highest weekly cumulative population was recorded in GNV (15685) followed by MTU (5952) and LDN (5215) (**Fig. 2.20**)

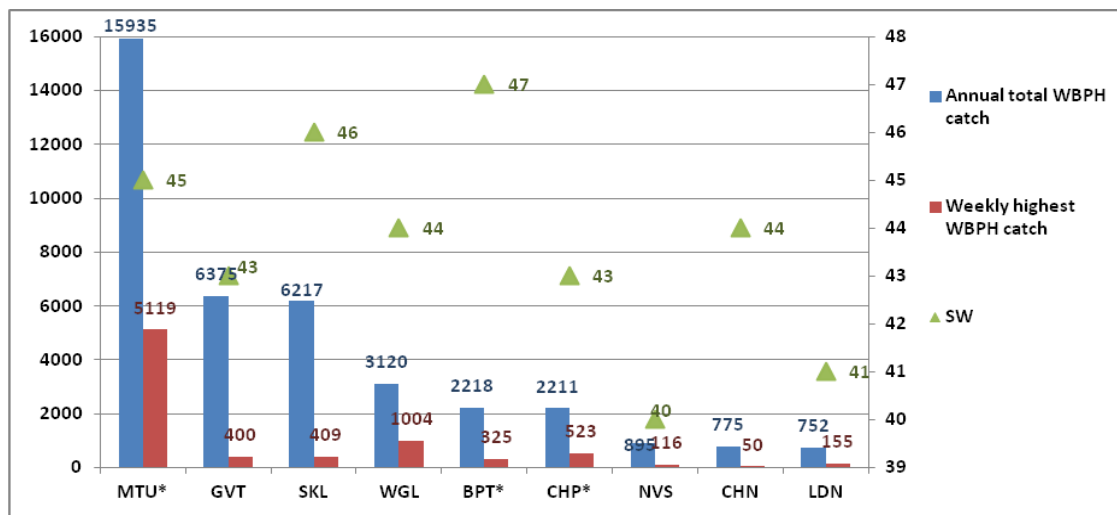


Fig. 2.20 Annual and weekly cumulative light trap catches of white-backed plant hopper * only *kharif* data SW- Peak catch standard week

Among the insect pests of minor importance, **case worm** was recorded in 12 locations: MSD, TTB, PTB, GNV, RPR, MND, BPT, JDP, MLN, CHP, CBT, and RNR. It was most active in MSD (18613), followed by TTB (2009) and PTB (1487). **Black bug** was reported from 5 locations: ADT (43446), TTB (39331), MTU (4164), MLN (273), and MNC (41). **White stem borer** was reported from TTB (25852), MLN (389), PTB (198), LDN (54), and KUL (36). At TTB, it was active throughout the year except in the first, 51st and 52nd SWs with a peak population of 2233 in 40th SW. **Pink stem borer** was also reported from 5 locations: RPR (470), LDN (337), KUL (166), RNR (23) and CBT (7). **Rice gundhi bug** was recorded at 7 locations: TTB (9128), NVS (1225), JDP (483), PNT (197), CHN (161), CBT (69) and RPR (6). It was found more active in September and October months coinciding with the reproductive stage of the crop. **Zigzag leaf hopper** was found in 4 locations: RPR (30856), MTU (19038), JDP (483) and BPT (241). Paddy skipper was reported from Khudwani and Navsari. White grub was a concern at KHD and CHT.

Overall, yellow stem borer leaf folder, and hoppers continued to be the most important pests in terms of numbers as well as spread across the locations. Gall midge continues to be an endemic pest. However, case worm, white stem borer, pink stem borer, black bug, gundhi bug, and zigzag leaf hopper showed an increase in the spread and intensity of incidence posing concern for future. Patterns in seasonal incidence and population build up on the basis of light trap data indicates that the key pests are reaching their peak levels in the months of October and November in the kharif season. Therefore, strategies are to be timed accordingly for the effective management of insect pests in rice.

SUMMARY

2.1 Host Plant Resistance Studies

Two trials, *viz.*, Stem borer screening trial (SBST) and Multiple pest resistance Screening Trial (MRST).

Stem borer screening trial (SBST) - Evaluation of entries in 5 valid field tests identified 13 entries as promising in 2 to 3 of the 5 tests in terms of low dead hearts, white ear damage and high grain yield. Recovery resistance and tolerance could be the mechanism in these entries as they yielded higher despite damage. The mean no. of larvae in the stubbles in these entries varied from ranged from 0.13-1.68/hill.

Multiple resistance screening trial (MRST) - Twenty-three entries were evaluated at Maruteru (MTU) and Rajendranagar (RNR) for multiple pest damage. RP 2068-18-3-5, KAUPTB 0627-2-11, KAUPTB 0627-2-14 and KAUPTB 0627-2-15 showed DS of 5.0 in the field reaction against planthoppers. The stem borer damage level was low at both locations.

2.2 Chemical Control studies

Botanical insecticides trial (BIET) was carried out at 5 locations to evaluate the efficacy of four essential oils and neemazal along with recommended insecticides, dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield. Based on the performance of the treatments in reducing the pest incidence at various locations, the insecticide – rynaxypyr, cedar wood oil and camphor oil were found effective against stem borer damage. Dinotefuran was the most effective treatment against plant hoppers followed by Lemongrass oil. Against leaf folder and whorl maggot, cedar wood oil and eucalyptus oils were found effective and their efficacy was superior to control. Highest grain yield of 4176.6 kg/ha was recorded in rynaxypyr treatment, while among botanicals, eucalyptus oil treatment recorded highest yield (3771.4 kg/ha).

2.3 Ecological Studies

Effect of planting dates on insect pest incidence (EPDP) trial was conducted at Chinsurah and Maruteru. Incidence of stem borer, whorl maggot, BPH and WBPH was observed at both the locations in addition to leaf folder, GLH at Chinsurah and hispa at Maruteru. Stem borer damage crossed ETL in late planting (11.21% DH) at Chinsurah and in normal planting at Maruteru (12.09% WE). At Chinsurah, BPH population was very high at pre-harvest in normal planting (929 hoppers / 5 hills) and between 50 to 60 DAT in late planting (234-548 hoppers/ 5 hills). Incidence of other pests was low in all the three plantings.

2.4 Biocontrol and biodiversity studies

Ecological engineering for planthopper management (EPPM) was taken up in Maruteru and Moncompu with a combination of interventions such as organic manuring and growing of flowering plants on bunds. There were no significant differences between the two treatments due to lower population of hoppers during this season.

Bio intensive pest management trial (BIPM) was taken up at Pattambi. The stem borer incidence at vegetative stage was significantly less and natural enemy population was higher in BIPM plots which also recorded higher yields compared to Farmers practices.

2.5 Integrated pest management studies

Yield loss estimation trial (YLET) was conducted at two locations *viz.*, Chinsurah and Pattambi. Regression analysis revealed a significant negative relationship between white ears and grain yield at Chinsurah ($R^2 = 0.5350$) resulting in 1.7 g reduction in grain yield for every 10% increase in white ear damage. The relationship between white ears and grain yield was negative but not significant at Pattambi.

Integrated Pest Management special (IPMs) trial was conducted at four locations, Chinsurah, Karjat, Maruteru and Pattambi. In general, pest incidence was low to moderate across locations. Incidence of dead hearts was low in both IPM and FP plots at all the locations except at Karjat wherein IPM plot recorded low damage (8.51% DH) as against FP plot (12.07% DH). Similarly, white ear incidence was high only at Pattambi in both IPM (12.74% WE) and FP (14.85% WE) plots. Gall midge incidence was low in IPM plot at 29 DAT (8.64% SS) but later increased to 14.1% at 43DAT at Maruteru. BPH population was also relatively high in IPM plot (67/5 hills) than in FP plot (58/5 hills). Net returns were high in IPM plots at all the locations due to high grain yield and low cost of cultivation resulting in higher BC ratio in IPM plots (1.45–2.53) than farmer practice plots (1.13–2.41).

Rabi 2018-19

2.1. Host Plant Resistance Studies

i) Stem borer screening trial (SBST):

Stem borer Screening trial (SBST) initiated in 2015 was continued during rabi 2018-2019 with 62 entries including nominations from IIRR, Jagtial, and Pattambi, which were specifically bred for stem borer tolerance. The entries were evaluated at 6 locations and observations were recorded on dead heart at vegetative phase, white ear damage and grain yield as well as the larval survival in the stubbles, at harvest. For effective screening two staggered sowings were taken up in most of the locations. The results of the evaluation against yellow stem borer damage from the valid tests are discussed below (**Table 2.79**):

Dead heart damage: The dead heart damage in the trial varied from 2.0 to 42.5% with an average damage of 18.2% DH across 2 locations in 3 valid tests. Evaluation of entries for dead heart damage in two staggered sowings helped in identification of JGL 24267 and RP 5588-B-B-B-B-238 as promising in 2 of the 3 tests with $\leq 10\%$ DH (DS 3.0).

White ear damage: The white ear damage across two locations in 2 valid tests varied from 14.81 to 50.79% with a mean of 15.8%WE. Evaluation of entries identified, JGL 33510, KAUPTB 0627-2-15, RP 5587-B-B-B-253-13, BK 49-76 and BK 39-179 as promising in both the valid tests with $\leq 10\%$ WE (DS3.0). The larval survival per entry varied from 1 to 3 larvae/hill in the stubbles with a mean of one larvae/hill.

Grain yield: JGL 33145*, KAUPTB 0627-2-11, RP 5587-B-B-B-273-1*, RP 5587-B-B-B-46-2, RP 5587-B-B-B-253-2, RP 5587-B-B-B-258-1, RP 5587-B-B-B-274-6, RP 5588-B-B-B-B-61, RP 5588-B-B-B-B-177, RP 5588-B-B-B-B-232, RP5587, JGL 32429, JGL 32979, JGL 33080, JGL 33124, BK 35-155 BK 64-116 and Sasyasree were promising in one of the valid tests with $\geq 15\text{g/hill}$ for grain yield /hill despite stem borer damage. JGL 32429, JGL 33080, KAUPTB 0627-2-11, RP 5587-B-B-B-253-2, RP 5587-B-B-B-258-1, RP 5587-B-B-B-274-6, RP 5587-B-B-B-273-1, RP 5588-B-B-B-B-232, BK 64-116 and RP5587 which were promising in terms of low stem borer damage in 1-2 tests of the 5 valid tests were also promising for grain yield ($\geq 15\text{g/hill}$).

Evaluation of entries in 5 valid field tests identified 13 entries as promising in 2 to 3 of the 5 tests in terms of low dead hearts, white ear damage and high grain yield. Recovery resistance and tolerance could be the mechanism in these entries as they yielded higher despite damage. The mean no. of larvae in the stubbles in these entries varied from ranged from 0.13-1.68/hill.

Table 2.79 Reaction of cultures to stemborer in SBST, Rabi 2018- 2019.

Entry No.	Designation	IIRR	PTB	PTB	SBDH	MTU	PTB	SBWE	SBDH+ SBWE		PTB
		65DT	30DT	50DT	NPT			NPT	NPT		GY/H (G)
		%DH	%DH	%DH	3	%WE	%WE	2	5		
58	BK 39-179	21.05	6.17	22.75	1	8.76	5.36	2	3		12.0
21	JGL 33510	24.02	18.76	17.17	0	5.33	2.50	2	2		10.0
33	KAUPTB 0627-2-15	18.84	13.86	12.33	0	2.00	5.56	2	2		14.5
39	RP 5587-B-B-B-253-13	15.36	19.33	21.34	0	7.87	7.14	2	2		10.5
57	BK 49-76	23.22	10.33	13.88	0	7.11	4.69	2	2		10.0
23	JGL 34505	21.35	3.67	13.21	1	6.68	17.24	1	2		10.0
24	JGL 34508	21.57	18.83	6.92	1	5.69	16.67	1	2		7.5
34	HWR 17	17.80	4.00	15.57	1	6.82	10.81	1	2		9.0
40	RP 5587	19.18	11.44	5.86	1	12.15	3.64	1	2		25.0
50	RP 5588	18.80	3.61	13.28	1	9.60	33.33	1	2		12.5
59	BK 49-42	19.51	9.33	18.11	1	6.04	14.29	1	2		10.5
56	RP 5588-B-B-B-238	19.43	3.61	8.44	2	24.85	23.53	0	2		12.5
1	JGL 24267	5.51	11.78	2.00	2	17.12	14.81	0	2		10.0

ii) Multiple resistance screening trial (MRST)

The trial was constituted with 23 entries and evaluated at Maruteru (MTU) and Rajendranagar (RNR) for multiple pest damage. At MTU, white ear damage due to stem borer and Planthopper counts were reported. RP 2068-18-3-5, KAUPTB 0627-2-11, KAUPTB 0627-2-14 and KAUPTB 0627-2-15 showed DS of 5.0 in the field reaction against planthoppers. The stem borer damage level was low at both locations.

2.2 Botanical and Insecticide Evaluation Trial

Botanical and insecticides Evaluation trial (BIET) was carried out at 5 locations to evaluate the efficacy of four essential oils and neemazal along with recommended insecticides, dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield during Rabi, 2018-19. The details of number and time of applications are given below:

Sl. No.	Location	Date of sowing	Date of planting	Date of harvesting	No of applications	Times of application (DAT)
1	Coimbatore	22-02-2019	20-03-2019	18-06-2019	2	20 & 65
2	Chiplima	12-01-2019	23-02-2019	27-06-2019	3	25, 50 & 65
3	Karjat	18-01-2019	12-02-2019	20-05-2019	2	32 & 51
4	Pattambi	05-11-2018	26-11-2018	28-02-2019	4	15, 40, 60 & 75
5	Raipur	07-01-2019	13-02-2019	24-05-2019	3	29, 50 & 72
6	Chinsurah	15-12-2018	07-02-2019	15-05-2019	3	15, 30 & 50

Observations were recorded on pest incidence, natural enemy counts as well as grain yield as per the standard procedures. The data were subjected to Anova analysis and the performance of the treatments were evaluated based on their efficacy against the major pests specific to each location as well as the grain yields obtained in each treatment.

Pest infestation table (2.80)

Stem borer incidence was recorded in five locations and high dead hearts damage was recorded at Raipur (10.5-20.7%) followed by Pattambi (9.7-17.7%). There were significant differences in damage among the treatments at all locations except, at Raipur at 30 DAT. Mean dead heart damage in treatments with essential oils ranged between 8.9 and 9.9% compared to 12.3% in control, while rynaxypyr was the most effective treatment showing 6.8% DH.

Highest white ear damage was reported from Pattambi (31.3%) followed by Raipur with 22.8% WE in untreated control. All botanicals significantly reduced white ear damage (13.1-15.4%) when compared to 18.8% in control. Rynaxypyr was the most effective treatment against stem borer with 10.8% mean white ear damage. Among botanicals, Camphor and Lemon grass oils were found effective.

Brown planthopper incidence was recorded up to 28.0 hoppers/10 hills at Raipur, while **mixed population of planthoppers** was reported up to 61.20 hoppers/10 hills during 55 to 80 DAT, at Chiplima. There were significant differences in the efficacy among the treatments at both locations (Chiplima and Raipur). Dinotefuran was the most effective treatment with lowest mean population of 11.3 BPH/10 hills at Raipur and 17.8 planthoppers/10 hills at Chiplima as compared to 28.0 and 61.2 per 10 hills, respectively, in control. All essential oils showed similar efficacy (16.0 to 22.0 BPH/10 hills and 36.2 to 45.3 PH/10 hills, respectively), while neem azal treatment 18.0 BPH/10 hills and 33.5 PH/10 hills, respectively, at the two locations.

Leaf folder damage was reported from 2 locations and highest leaf damage was recorded in Pattambi (50.3-74.7%) at 75 DAT except in rynaxypyr treatment. There were significant differences in leaf damage among the treatments at both locations (Coimbatore and Pattambi). Rynaxypyr was the most effective treatment showing mean leaf damage of 4.7%. Among the botanicals, cedar wood oil recorded lowest infestation (16.8% DL) in comparison to 24.3 % in control.

Whorl maggot damage was recorded only in Pattambi. Lowest mean damage of 1.2% was noticed in rynaxypyr when compared to control (7.0%). Among the botanicals, eucalyptus oil was the most effective treatment with 3.2% damage.

Grain Yield (Table: 2.81)

There were significant differences in grain yield among the treatments at all 5 locations. Based on mean yield of these locations, rynaxypyr recorded the highest grain yield of 4176.6 kg/ha with 47.1% increase over control (IOC). Among the essential oils, Eucalyptus oil treatment recorded highest yield of 3771.4 kg/ha (32.8% IOC). All the treatments yielded significantly higher than Control (2839.2 kg/ha).

Botanical insecticides trial was carried out at 5 locations to evaluate the efficacy of four essential oils and neemazal along with recommended insecticides, dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield during Rabi, 2018-19. Based on the performance of the treatments in reducing the pest incidence at various locations, the insecticide –rynaxypyr, cedar wood oil and camphor oil were found effective against stem borer damage. Dinotefuran was the most effective treatment against plant hoppers followed by Lemongrass oil. Against leaf folder and whorl maggot, cedar wood oil and eucalyptus oils were found effective and their efficacy was superior to control. Highest grain yield of 4176.6 kg/ha was recorded in rynaxypyr treatment, while among botanicals, eucalyptus oil treatment recorded highest yield (3771.4kg/ha).

Table 2.80 Insect pest incidence in different treatments, BIET, Rabi 2018-19

S. No.	Common Name	Rate g or ml of form/ha	% Dead hearts								Mean
			CBT		CHP		KJT		PTB		
			32DT	50DT	56DT	75DT	30DT	50DT	30DT	50DT	
1	Camphor Oil	1000	10.3ab	11.0a	2.5bc	1.9b	5.7b	2.1bc	16.2a	17.7a	9.9
2	Cedar wood oil	1000	12.0ab	7.1a	2.7b	2.1b	7.7a	2.5b	11.8b	14.6ab	8.9
3	Eucalyptus oil	1000	12.6ab	9.6a	1.7cd	1.5b	7.4ab	2.4b	16.0ab	15.3ab	9.7
4	Lemon grass oil	1000	11.2ab	11.6a	2.0bc	1.9b	6.2ab	2.6b	16.6a	12.7ab	9.8
5	Neem azal	1000	12.1ab	10.2a	1.9bc	1.8b	6.5ab	1.9bc	15.1ab	15.2ab	9.4
6	Dinotefuran	200	10.6ab	10.1a	1.7cd	1.7b	1.5c	1.9bc	16.0ab	12.8ab	8.6
7	Rynaxypyr	150	7.9b	7.6a	0.8d	0.9b	2.6c	0.9c	12.5ab	9.7b	6.8
8	Untreated Control	Water	13.8a	12.5a	5.3a	6.5a	7.9a	4.7a	15.7ab	14.8ab	12.3

Table 2.80 Insect pest incidence in different treatments, BIET, Rabi 2018-19

S. No.	Common Name	Rate g or ml of form/ha	% White Ears				Mean
			CBT	CHP	PTB	RPR	
1	Camphor Oil	1000	9.7ab	2.9b	19.0ab	20.6a	13.1
2	Cedar wood oil	1000	10.3ab	3.2b	27.7ab	19.4a	15.2
3	Eucalyptus oil	1000	8.4b	2.2b	30.0a	20.8a	15.4
4	Lemon grass oil	1000	9.0ab	2.9b	19.4ab	23.0a	13.6
5	Neem azal	1000	9.3ab	2.6b	28.2ab	19.5a	14.9
6	Dinotefuran	200	7.0b	1.9bc	24.0ab	19.4a	13.1
7	Rynaxypyr	150	7.3b	0.9c	16.0b	19.0a	10.8
8	Untreated Control	Water	12.93a	8.2a	31.3a	22.8a	18.8

Table 2.80 Insect pest incidence in different treatments, BIET, Rabi 2018-19

S. No.	Common Name	Rate g or ml of form/ha	Plant hoppers (No./10 hills)							
			BPH+WBPH				Mean	BPH		Mean
			CHP					RPR		
			55DT	60DT	75DT	80DT		50DT	70DT	
1	Camphor Oil	1000	28.3cd	27.6bc	41.6c	47.3cd	36.2	17.3a	26.6ab	22.0
2	Cedar wood oil	1000	30.6bc	30.3bc	51.3b	57.3b	42.4	12.0ab	22.6bc	17.3
3	Eucalyptus oil	1000	35.0ab	35.0b	51.0b	60.0b	45.3	12.0ab	25.3bc	18.7
4	Lemon grass oil	1000	29.0cd	28.0bc	48.0bc	54.3bc	39.8	12.0ab	20.0bc	16.0
5	Neem azal	1000	24.3de	21.3cd	41.3c	47.0cd	33.5	13.3ab	22.6bc	18.0
6	Dinotefuran	200	13.0f	13.6d	24.6d	20.3e	17.8	6.6b	16.0c	11.3
7	Rynaxypyr	150	21.6e	22.0cd	41.3c	44.3d	32.3	13.3ab	24.0bc	18.7
8	Untreated Control	Water	37.6a	51.6a	71.3a	84.3a	61.2	20.0a	36.0a	28.0

Table 2.80 Insect pest incidence in different treatments, BIET, Rabi 2018-19

S. No.	Common Name	Rate g or ml of form/ha	% Leaf Folder Damage				Mean
			CBT	PTB			
			50DT	45DT	60DT	75DT	
1	Camphor Oil	1000	10.9b	1.7b	9.9a	74.7a	24.3
2	Cedar wood oil	1000	12.2b	1.6b	3.0b	50.3a	16.8
3	Eucalyptus oil	1000	12.3b	1.4b	7.5ab	68.1a	22.4
4	Lemon grass oil	1000	8.6c	0.9b	6.2ab	59.9a	18.9
5	Neem azal	1000	11.7b	1.6b	5.1ab	59.6a	17.5
6	Dinotefuran	200	6.5cd	2.5ab	8.6a	74.6a	23.1
7	Rynaxypyr	150	6.1d	2.5ab	9.0a	1.0b	4.7
8	Untreated Control	Water	15.3a	3.9a	8.5a	69.3a	24.3

Table 2.80 Insect pest incidence in different treatments, BIET, Rabi 2018-19

S. No.	Common Name	Rate g or ml of form/ha	%WM Damage Leaves		Mean
			PTB		
			25DT	45DT	
1	Camphor Oil	1000	9.04	1.04	5.0
2	Cedar wood oil	1000	11.10	1.34	6.2
3	Eucalyptus oil	1000	5.41	0.91	3.2
4	Lemon grass oil	1000	12.61	1.96	7.3
5	Neem azal	1000	13.10	1.61	7.4
6	Dinotefuran	200	8.02	0.95	4.5
7	Rynaxypyr	150	1.24	1.16	1.2
8	Untreated Control	Water	11.39	2.63	7.0

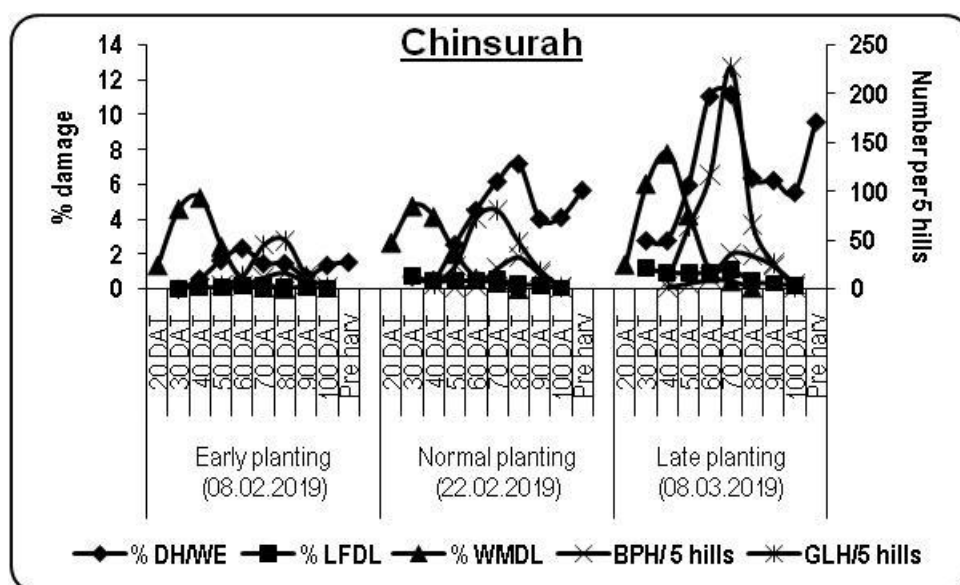
Table 2.81 Grain Yield in different treatments, BIET, Rabi 2018-19

S. No.	Common Name	Rate g or ml of form/ha	Yield (kg)/ha					Mean	IOC (%)
			CBT	CHP	KJT	PTB	RPR		
1	Camphor Oil	1000	3088.8ab	4289.1c	3053.3d	3703.7bc	3991.7ab	3625.3	27.7
2	Cedar wood oil	1000	3170.0ab	4230.3c	3106.6cd	3103.6cd	4008.3ab	3523.8	24.1
3	Eucalyptus oil	1000	3134.4ab	4426.2bc	3373.3b	3943.8ab	3979.2ab	3771.4	32.8
4	Lemon grass oil	1000	3073.3ab	4259.7c	2800.0e	3497.9bcd	3900.0b	3506.2	23.5
5	Neem azal	1000	3177.8ab	4347.8bc	3240.0bc	3480.8bcd	3850.0b	3619.3	27.5
6	Dinotefuran	200	3322.2a	4524.1b	3666.6a	3309.3bcd	3916.7ab	3747.8	32.0
7	Rynaxypyr	150	3255.6a	5033.3a	3760.0a	4492.5a	4341.7a	4176.6	47.1
8	Untreated Control	Water	2886.7b	3388.2d	1720.0f	2863.5d	3337.5c	2839.2	

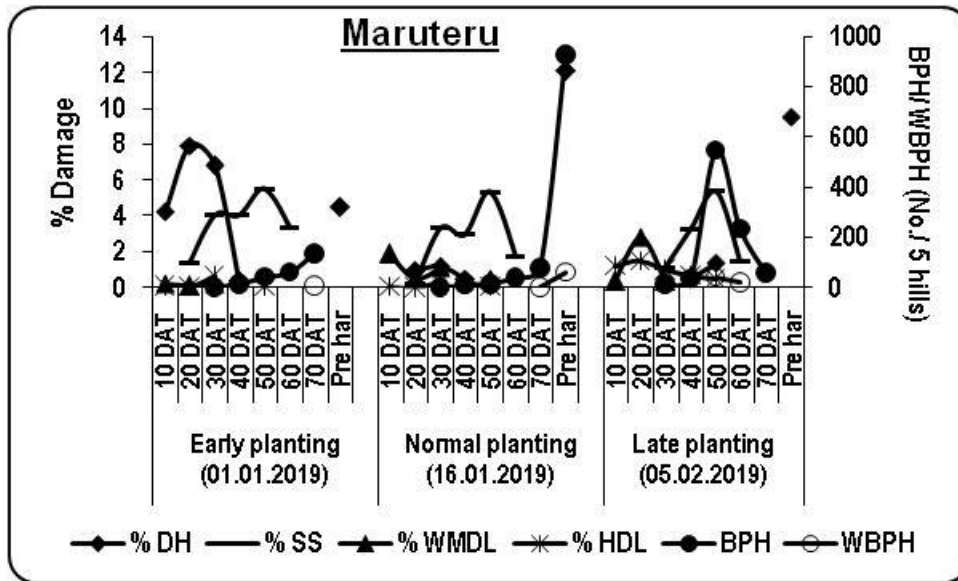
2.3 ECOLOGICAL STUDIES

i) Effect of Planting Dates on Insect Pest Incidence (EPDP)

During *Rabi* 2018-19, the field trial was conducted at two locations, *i.e.*, at Chinsurah and Maruteru. At Chinsuarh, IET 4788 (Satabdi) was grown in all three plantings during boro season. Incidence of stem borer, leaf folder, whorl maggot, BPH, WBPH and GLH was observed. Dead heart damage caused by stem borer exceeded ETL only in late planting at 60 DAT (11.09%DH) and 70 DAT (11.21% DH). Leaf folder (<2% DL), whorl maggot (<8.0% DL) and BPH (2 – 37 hoppers/ 5 hills) incidence was low in all the three plantings. However, GLH incidence was high in late planting starting from 50 DAT to 80 DAT (64 – 227 hoppers/5 hills) followed by normal planting between 60 DAT and 70 DAT (73 – 80 hoppers/5 hills).



At **Maruteru**, incidence of stem borer, whorl maggot, hispa, BPH and WBPH was recorded in IR 64 variety grown in all the three plantings. Stem borer incidence was low in all the three plantings except at pre harvest in normal planting wherein white ears exceeded the ETL (12.09% WE). Incidence of whorl maggot and hispa was very low (< 5% DL) in different plantings. BPH population was high and exceeded ETL at 60 DAT (62 hoppers/5 hills) and 70 DAT (133 hoppers/ 5 hills), in early planting, 70 DAT to pre-harvest (78 – 929 hoppers/ 5 hills) in normal planting, 50 to 70 DAT (58 – 548 hoppers/ 5 hills) in late planting. WBPH population was low in the plantings except at pre-harvest count in normal planting (60 hoppers/ 5 hills).



Effect of planting dates on insect pest incidence (EPDP) trial was conducted at Chinsurah and Maruteru during Rabi 2018-19. Incidence of stem borer, whorl maggot, BPH and WBPH was observed at both the locations in addition to leaf folder, GLH at Chinsurah and hispa at Maruteru. Stem borer damage crossed ETL in late planting (11.21% DH) at Chinsurah and in normal planting at Maruteru (12.09% WE). At Chinsurah, BPH population was very high at pre-harvest in normal planting (929 hoppers/ 5 hills) and between 50 to 60 DAT in late planting (234-548 hoppers/ 5 hills). Incidence of other pests was low in all the three plantings.

2.4. BIOCONTROL AND BIODIVERSITY STUDIES

i) Ecological Engineering for Planthopper Management (EPPM)

This trial was carried out at Maruteru and Moncompu during Rabi 2018-2019.

The EE interventions tested at Maruteru were alleyways, organic manuring and planting of bund flora. The observations on hoppers and their natural enemies were recorded four times starting from 40 DAT. BPH population reached a peak at 75 DAT, however it was on par in EE treatment (27.62 hoppers/hill) and farmers practices (38.36 hoppers/hill) (**Table 2.82**). The population of natural enemies such as green mirids, spiders and coccinellid were also on par. The EE plots yielded (4921 kg/ha) on par with FP plots (4950 kg/ha).

Table 2.82 Effect of ecological engineering on hoppers and its natural enemies at Maruteru, EPPM, rabi 2018-19

Parameters	BPH (No./ hill)		Green mirids (No./ 10 hills)		Spiders (No./ hill)		Coccinellids (No./hill)		Yield (Kg/ha)	
	EE	FP	EE	FP	EE	FP	EE	FP	EE	FP
Mean	27.62	38.36	22.20	31.00	17.00	16.00	5.4	5.4	4921	4950
t value	1.15 ^{NS}		1.23 ^{NS}		0.52 ^{NS}		0.00 ^{NS}		0.21 ^{NS}	
df	98		98		98		98		10	
P - value	0.12		0.22		0.60		1.00		0.80	

**projected yield*

Table.2.83 Effect of ecological engineering on hoppers and its natural enemies at Moncompu, EPPM, rabi 2018-19

Parameters	BPH (No./ 10 hills)		Spiders (No./ 10 hills)		Coccinellids (No./ 10 hills)	
	EE	FP	EE	FP	EE	FP
Mean	1.67	1.47	2.84	2.36	7.24	6.44
t value	0.42 ^{NS}		0.90 ^{NS}		0.80 ^{NS}	
df	98		98		98	
P - value	0.68		0.37		0.42	

At Moncompu, Marigold was tested as bund flora. Four observations were recorded on hoppers and their natural enemies, starting from 15 DAT. Hoppers and their natural enemy population was very low and were on par in both, EE treatment and farmers practices (**Table 2.83**).

Ecological engineering for planthopper management was taken up in Maruteru and Moncompu with a combination of interventions such as organic manuring, and growing of flowering plants on bunds. There were no significant differences between the two treatments due to lower population of hoppers during this season.

ii) Bio-intensive pest management trial (BIPM)

The trial was taken up at Pattambi during the *rabi* season.

Pattambi

Observations were recorded on the damage by whorl maggot, leaffolder, caseworm, stem borer and natural enemies like spiders, coccinellids and mirids. The dead heart damage by stem borer was significantly higher in FP plots (19.31%) compared to that of BIPM plots (7.36%) (**Table 2.84**). However, white ear incidence was at par in both treatments (38.82 and 39.21%, respectively). The natural enemy population *viz.*, number of spiders (16.00/ 10 hills) and coccinellids (13.00/10 hills) was significantly higher in BIPM plots than that of Farmers' practice plots (7.17 and 9.83/ 10 hills respectively). The yield though higher in BIPM plots (3670.33 kg/ha) was on par with that of FP plots (3333.54 kg/ha).

Bio intensive pest management trial was taken up at Pattambi during Rabi 2018. The stem borer incidence at vegetative stage was significantly less and natural enemy population was higher in BIPM plots which also recorded higher yields compared to Farmers practices.

Table 2.84 Pest and natural enemy incidence under Bio-intensive pest management trial at Pattambi, *rabi* 2018-19

A. Pest incidence

Parameters	LF		WM		SS		BB		DH		WE	
	(% damage)		(% damage)		(% damage)		(% damage)		(% damage)		(% damage)	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	6.24	5.51	10.19	11.05	6.26	9.30	1.11	4.22	7.56	19.31	38.82	39.21
t value	0.43 ^{NS}		0.37 ^{NS}		1.56 ^{NS}		2.29*		5.02**		0.06 ^{NS}	
df	26		26		26		26		26		10	
P - value	0.67		0.71		0.13		0.03		<0.01		0.95	

LF- Leaf folder; WM- whorl maggot; DH – Dead heart; WE- white ears; SS- silver shoots; BB- blue beetle

B. Predators

Parameters	Coccinellid		Spiders		Mirids		Yield	
	(No./ 10 hills)		(No./ 10 hills)		(No./ 10 hills)		Kg/ha	
	BIPM	FP	BIPM	FP	BIPM	FP	BIPM	FP
Mean	13.00	9.83	16.00	7.17	11.00	5.50	3670.83	3333.54
value	1.35*		2.83*		3.01**		0.96 ^{NS}	
df	12		12		12		10	
P - value	0.04		0.02		0.01		0.36	

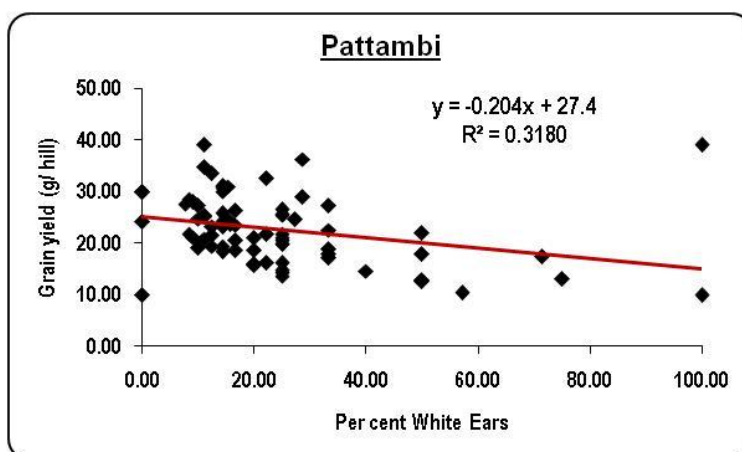
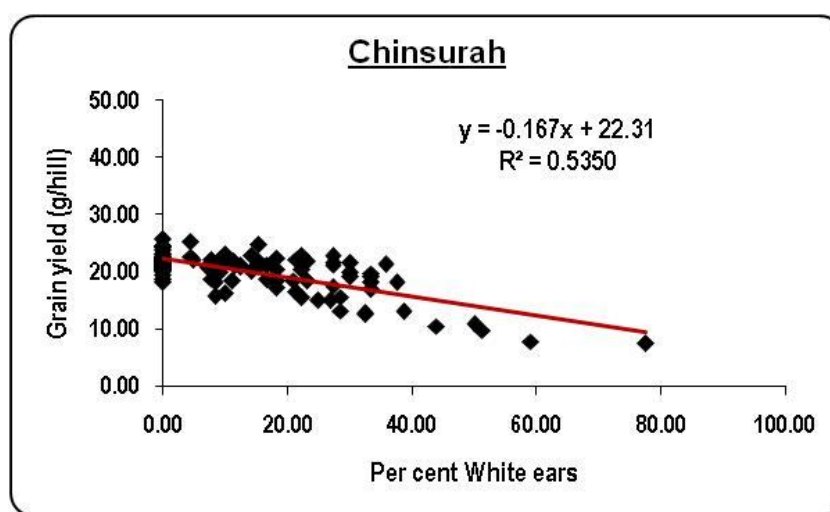
2.5. INTEGRATED PEST MANAGEMENT STUDIES

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

i) Yield Loss Estimation Trial (YLET)

Target pest: Stem borer

At **Chinsurah**, white ear damage ranged between 0.00 and 77.50% with grain yield of 7.55 to 25.70 g per hill in Khitish variety. Linear regression analysis revealed a significant negative relationship between white ears and grain yield ($R^2 = 0.5350$). It indicates a decrease of 1.67 g yield per hill for every 10% increase in white ears.



At **Pattambi**, white ear damage ranged from 0.00 to 100.00% resulting in 9.87 to 39.11 g grain yield per hill. The relationship between white ears and grain yield was negative but not significant.

Yield loss estimation trial was conducted at two locations viz, Chinsurah and Pattambi during Rabi 2018-19. Regression analysis revealed a significant negative relationship between white ears and grain yield at Chinsurah ($R^2 = 0.5350$) resulting in 1.7 g reduction in grain yield for every 10% increase in white ear damage. The relationship between white ears and grain yield was also negative but not significant at Pattambi.

ii) Integrated Pest Management special Trial (IPMs)

IPM special trial was carried out at four locations viz., Chinsurah, Karjat, Maruteru and Pattambi during Rabi 2018-19. Location wise details are discussed below:

Chinsurah: IPMs trial was conducted at Sri Narayan Chandra Mondal's field at Village Bele, Radhanagar, Pandua mandal, Hooghly district of West Bengal. Practices followed in IPM and FP plots were given below:

Practices followed in IPMs trial at Chinsurah, Rabi 2018-19

	IPM practices	Farmers practices
Area/ variety	0.5 acre; IET 4786 (Satabdi)	0.5 acre; IET 4786 (Satabdi)
Nursery	• Application of 1.5 kg mustard cake	• Application of 5 kg mustard cake
Main field	<ul style="list-style-type: none"> • Field preparation with power tiller, cutting of bunds and leveling the field • Application of 31 kg 10:26:26 + Urea @ 28 kg • Application of Butachlor + hand weeding • Application of Ferterra @ 4 kg/ acre • Application of Coragen @ 60 ml/ acre • Application of carbendazim • Installation of pheromone traps @ 6/acre for stem borer mass trapping 	<ul style="list-style-type: none"> • Field preparation with power tiller, cutting of bunds and leveling the field • Application of 30 kg SSP, 23 kg MOP, Urea 30 kg • Hand weeding two times • Application of Carbofuran 3G @ 12 kg/ acre • Spraying of Cartap hydrochloride 50 SP @ 500 g/ acre two times • Application of Carbendazim

Incidence of stem borer, whorl maggot, leaf folder and GLH was low in both IPM and FP plots starting from 15 DAT to pre harvest stage (**Table 2.85**). Grain yield was relatively high in IPM plot resulting in high returns and BC ratio (1.45) compared to farmers practices (1.26) (**Table 2.86**).

Table 2.85 Pest incidence in IPMs trial at Chinsurah, Rabi 2018-19

Treat-ments	% DH				% WE	% WMDL	GLH
	15 DAT	22 DAT	29 DAT	43 DAT	Pre har	22 DAT	64 DAT
IPM	0.71 ± 0.71	2.37 ± 0.41	2.47 ± 0.39	2.34 ± 0.36	2.30 ± 0.18	2.15 ± 0.33	1.20 ± 0.49
FP	4.18 ± 0.70	4.60 ± 0.69	4.81 ± 0.43	3.27 ± 0.56	7.35 ± 1.12	5.21 ± 0.81	1.40 ± 0.68

Table 2.86 Grain yield and Returns in IPMs trial at Chinsurah, Rabi 2018-19

Treatments	Yield (Q/ ha)	Gross Returns (Rs.)	Cost of Cultivation (Rs.)	Net Returns (Rs.)	BC ratio
IPM	49.52	84679	58288	26391	1.45
FP	43.84	74966	59333	15633	1.26

Price of paddy = Rs.1710/q

Karjat: IPMs trial was conducted in three farmers' fields' viz., Sri Ashok Narayan Patil of Bhaliwadi village, Sri Mangesh Ganpat Thakre of Tiware village, Sri Ravindra Hagawane of Takwe village in Karjat mandal of Raigad district, Maharashtra State. Practices followed in both IPM and FP plots are given below:

Practices followed in IPMs trial at Karjat, Rabi 2018-19		
Practices adopted	IPM block	Farmers practices
Area	1 acre	1 acre
Varieties	1) Sri Ashok Narayan Patil, Bhaliwadi village - Zinia 2) Sri Mangesh Ganpat Thakre, Tiware village- Karjat 3 3) Sri Ravindra Hagawane, Takwe village - Karjat 3	Zinia Karjat 3 Karjat 3
Nursery	Seed treatment with carbendazim @ 10 g/ 10 kg seed Raised bed 3x1m treated with rice husk (hull) ash @3kg/bed	Land burned with waste materials
Main field	<ul style="list-style-type: none"> • Deep ploughing • Application of FYM 4 T, Suphala 215 Kg, Urea 87 Kg • 2-3 seedlings transplanted at a spacing 20 x15 cm. • Alleyways of 40cm left after every 10 rows • Bispyribasodium 250ml/ha (Nomini gold). • Pheromone traps @ 8 / acre • Use of bird perches in the field • Use Vaibhav sickle for harvesting • Application of Cartap hydrochloride @ 18 kg/ ha 	<ul style="list-style-type: none"> • Deep ploughing • Application of FYM 2 T,Urea 160 kg, Suphala 100 kg • 4-5 seedlings transplanted randomly • Hand weeding once • Phorate 10 kg/ha (two applications)

Incidence of stem borer and leaf folder was observed in both IPM and FP plots in all the three farmers' fields starting from 36 DAT (**Table 2.87**). Dead heart damage crossed ETL in farmers' practices from 36 to 50 DAT (10.89 – 12.07% DH) compared to IPM plots (7.95 – 10.51% DH). Very low incidence of leaf folder was recorded in only Sri Ravindra Hagawane's field in both IPM and FP plots (<1.0% LFDL). However, BC ratio was low in FP plots (1.29) compared to IPM plots (1.71) due to low grain yield resulting in low gross returns and high cost of cultivation (**Table 2.88**).

Table 2.87 Pest incidence in IPMs trial at Karjat, Rabi 2018-19

Farmer's Name	Treatments	% DH				% LFDL
		36 DAT	43 DAT	50 DAT	57 DAT	43 DAT
Sri Ashok Narayan Patil	IPM	9.83 ± 1.10	10.61 ± 2.12	8.03 ± 0.74	1.60 ± 0.58	0.00 ± 0.00
	FP	14.04 ± 1.4	15.04 ± 1.52	6.38 ± 1.32	2.10 ± 0.90	0.00 ± 0.00
Sri Mangesh Ganpat Thakre	IPM	6.06 ± 1.48	10.87 ± 0.94	11.43 ± 1.53	1.09 ± 0.74	0.00 ± 0.00
	FP	7.74 ± 2.36	13.03 ± 1.59	10.04 ± 2.39	6.16 ± 1.13	0.00 ± 0.00
Sri Ravindra Hagawane	IPM	0.00 ± 0.00	4.04 ± 1.47	12.07 ± 0.84	1.08 ± 0.68	0.49 ± 0.17
	FP	0.00 ± 0.00	8.14 ± 1.77	17.52 ± 1.52	3.36 ± 1.54	0.70 ± 0.18
IPM		7.95	8.51	10.51	1.26	0.49
FP		10.89	12.07	11.31	3.87	0.70

Table 2.88 Grain yield, Returns and BC ratio in IPMs trial at Karjat, Rabi 2018-19

Farmer's Name	Treat-ments	Yield Q/ha	Gross Returns (Rs.)	Cost of Cultivation (Rs.)	Net Returns (Rs.)	BC Ratio
Sri Ashok Narayan Patil	IPM	36.48	73875	42183	31692	1.75
	FP	30.00	60875	45850	15025	1.33
Sri Mangesh Ganpat Thakre	IPM	35.04	71000	42183	28817	1.68
	FP	29.52	59875	46850	13025	1.28
Sri Ravindra Hagawane	IPM	35.36	72125	42183	29942	1.71
	FP	28.24	61000	48760	12240	1.25
IPM		35.63	72333	42183	30150	1.71
FP		29.25	60583	47153	13430	1.29

Maruteru: IPMs trial was conducted at two farmer's fields' viz., Sri N Srinivasa Rao of Vaddiparru village, Poduru mandal and Sri P Chakravarthi of Kavurupalem village, Achanta mandal, Andhra Pradesh State. MTU 1121 was grown in both IPM and FP plots. Practices followed in IPM and FP plots are given below:

Practices adopted	IPM block	Farmers practices
Area	2000 sq	2000 sq
Variety	MTU 1121	MTU 1121
Fertilizers	NPK @ 180-90-90 kg/ha	NPK @ 225-80-90 kg/ha
Nursery	Seed treatment with carbendazim @ 10g/ 10kg seeds	
	Application of carbofuran @800g/ 5cents nursery 5 days before pulling seedlings from nursery for transplantation	
Main field	Formation of alleyways of 30 cm after every 2 m	Formation of alleyways of 30 cm after every 2 m
	NPK @ 180-90-90 kg/ha	NPK @ 225-80-90 kg/ha
	Application of Londax power@10kg/ha within one week after transplantation + one manual weeding	Londax power @10kg/ha within one week after transplantation+one manual weeding
	Installed pheromone traps @ 8 traps/ ha for stem borer monitoring.	Application of Dinotefuran, Pymetrozine and Acephate against brown planthoppers
	One spray of Cartap hydrochloride 50 SP @ 1000 g / ha at 60 DAT	Application of Ferterra granules and Cartap hydrochloride granules against stem borer
	Blanket application of Propiconazole @1.0ml/l	Spraying of Tricyclazole against blast (twice)
	Mid-season drainage should be followed in case of BPH endemic areas.	
	Application of Dinotefuran and Pymetrozine against brown planthoppers	
	Spraying of Tricyclazole @0.6g/l against blast	

Incidence of stem borer, gall midge, leaf folder, whorl maggot, hispa, BPH and WBPH was recorded in both the treatments in both the farmer's fields'. Gall midge incidence was found high in FP plots (14.45% SS) compared to IPM plots (8.64% SS) at 29 DAT. However, gall midge damage increased in IPM plots at 36 DAT (10.87% SS) and 43 DAT (14.10% SS) than in FP plots (8.68 – 10.67% SS). BPH population crossed ETL in both IPM and FP plots

at 43 DAT alone (67 hoppers/5 hills in IPM & 58 hoppers/ 5 hills in FP) and declined at later stage. Incidence of other pests was low in all the treatments (**Table 2.89**).

Table 2.89 Pest incidence in IPMs trial at Maruteru, Rabi 2018-19

Farmer's Name	Treat-ments	% DH	% SS				% LFDL	% WMDL	% HDL	BPH*	WBPH*
		29 DAT	29 DAT	36 DAT	43 DAT	36 DAT	15 DAT	15 DAT	43 DAT	43 DAT	43 DAT
Sri N Srinivasa Rao	IPM	1.45 ± 0.4	9.15 ± 0.9	11.42 ± 1.2	15.34 ± 1.4	0.06 ± 0.0	0.55 ± 0.2	0.94 ± 0.2	66 ± 7	7 ± 1	
	FP	2.37 ± 0.8	13.37 ± 0.3	7.68 ± 0.8	12.72 ± 0.8	0.04 ± 0.0	0.65 ± 0.2	0.98 ± 0.2	56 ± 7	6 ± 1	
Sri P Chakravarthi	IPM	1.10 ± 0.3	8.13 ± 0.9	10.32 ± 1.4	12.86 ± 2.2	0.09 ± 0.0	0.46 ± 0.2	0.79 ± 0.2	68 ± 8	11 ± 1	
	FP	3.53 ± 0.5	15.52 ± 0.5	9.68 ± 0.8	8.62 ± 1.2	0.16 ± 0.0	0.74 ± 0.1	0.85 ± 0.3	60 ± 5	7 ± 1	
IPM		1.30	8.64	10.87	14.10	0.08	0.51	0.87	67	9	
FP		2.95	14.45	8.68	10.67	0.10	0.70	0.92	58	7	

*Number per 5 hills

High grain yield was reported from both IPM and FP plots at both the farmer's fields resulting in high returns and high BC ratio (**Table 2.90**).

Table 2.90 Grain yield, Returns and BC ratio in IPMs trial at Maruteru, Rabi 2018-19

Farmer's Name	Treat-ments	Yield (Q/ ha)	Gross Returns (Rs.)	Cost of Cultivation (Rs.)	Net Returns (Rs.)	BC ratio
Sri N Srinivasa Rao	IPM	95.00	160265	59750	100515	2.68
	FP	97.50	164483	64975	99508	2.53
Sri P Chakravarthi	IPM	85.40	144070	60400	83670	2.39
	FP	88.15	148709	65200	83509	2.28
IPM		90.20	152167	60075	92092	2.53
FP		92.83	156596	65088	91508	2.41

Price of paddy = Rs.1687/q

Pattambi: IPMs trial was conducted at Sri Ummer's field in Parambil house, Kondurkara village, Palakkad district, Kerala State. Uma variety was grown in both IPM and FP plots during *Rabi* 2018-19. The following table shows the practices followed in IPM and FP plots.

Incidence of stem borer, gall midge, leaf folder, whorl maggot, case worm and blue beetle was observed in both IPM and FP plots. White ear damage was high in FP plots (14.85% WE) compared to IPM plots (12.74% WE) while dead heart damage was low in both the treatments throughout the crop growth period (**Table 2.91**). Leaf folder damage was reported from 25 DAT onwards but exceeded ETL in FP plot at 55 DAT (15.32% DL) and 70 DAT (14.31% DL). Incidence of whorl maggot (<4% DL), case worm (<1% DL) and blue beetle (<4% DL) was low in both IPM and FP plots. Grain yield was high in IPM plot (50.80 q/ ha) resulting in higher returns and high BC ratio (1.93) compared to FP plot (1.13) (**Table 2.92**).

LOCATION: PATTAMBI		
	IPM PRACTICES	FARMERS PRACTICES
Farmer 1 – Sri Ummer Haji, Kondurkara village, Palakkad district, Kerala		
Area	4000 sq.m	4000 sq m
Variety	Uma	Uma
Fertilizers	Application of NPK @ 90:45:45	Application of 150 kg Factomphos 75 kg urea and 35 kg Potash
Nursery	<ul style="list-style-type: none"> Seed treatment with Pseudomonas @ 10g/kg seed Seedling dip with Pseudomonas @ 20g/ litre of water 	
Main field	<ul style="list-style-type: none"> Application of Sathy+Pretilachlor @ 40g+400ml/ acre Installed pheromone traps for stem borer mass trapping @ 20 traps/ ha Five sprays with Eco neem 1% at 15, 25, 45, 65 and 80 DAT 	Spraying of Flubendamide, quinal-phos, Chlorantraniliprole and malathion at 30, 60, 75 and 95 DAT

Table 2.91 Pest incidence in IPMs trial at Pattambi, Rabi 2018-19

Treat-ments	% DH	% WE	% SS	% LFDL		% WMDL	% CWDL	% BBDL
	55 DAT	Pre har	45 DAT	55 DAT	70 DAT	35 DAT	25 DAT	25 DAT
IPM	2.03 ± 1.21	12.74 ± 2.60	2.32 ± 0.95	8.48 ± 1.80	8.22 ± 1.79	2.99 ± 0.55	0.23 ± 0.12	3.81 ± 0.60
FP	3.65 ± 1.52	14.85 ± 2.41	1.42 ± 0.40	15.32 ± 0.97	14.31 ± 2.60	3.14 ± 0.62	0.76 ± 0.47	3.24 ± 0.74

Table 2.92 Yield, Returns and BC ratio in IPMs trial at Pattambi, Rabi 2018-19

Treatments	Yield (Q/ ha)	Gross Returns (Rs.)	Cost of cultivation (Rs.)	Net Returns (Rs.)	BC Ratio
IPM	50.80	116840	60625	56215	1.93
FP	41.16	94668	83938	10730	1.13

Price of paddy = Rs.2300/q

Across locations, pest incidence in IPMs trial was low to moderate during Rabi 2018-19. At Karjat, dead heart damage was low in IPM plot (8.51% DH) compared to FP plot (12.07% DH). At Maruteru, gall midge incidence crossed ETL from 29 to 43 DAT and was high in FP plots (10.67 – 14.45% SS) than in IPM plots (**Fig. 2.21.**). At Pattambi, white ear damage was low in IPM plot (12.74% WE) compared to FP plot (14.85% WE). Leaf folder damage was high in FP plot from 55 to 70 DAT (14.31 – 15.32% DL) than in IPM plots (8.22 – 8.48% DL). At Maruteru, BPH population was relatively high in IPM plot (67 hoppers/5 hills) compared to FP plot (58 hoppers/ 5 hills).

At all the locations, grain yield was high in IPM plots compared to FP plots except at Maruteru wherein FP plot out yielded IPM plot. However, BC ratio was relatively high in IPM plots than in FP plots mainly due to high returns and low cost of cultivation (**Figs. 2.22 and 2.23.**)

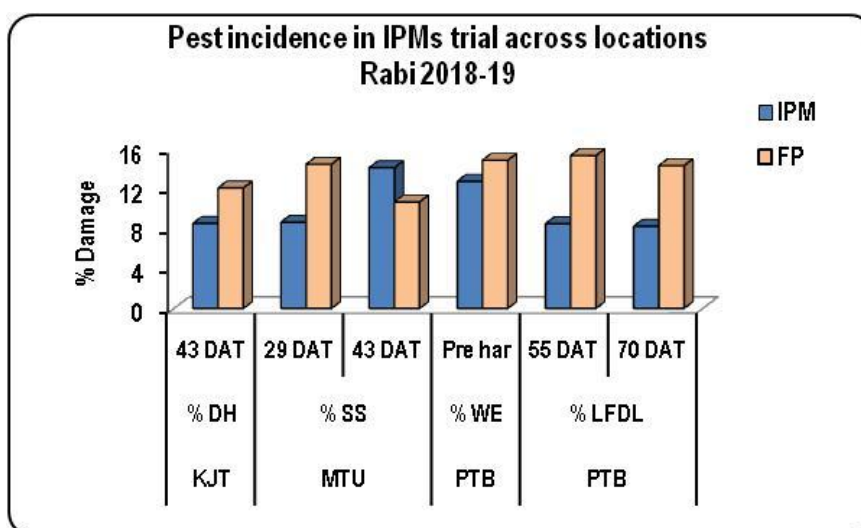


Fig. 2.21. Pest incidence in IPMs trial across locations, Rabi 2018-19

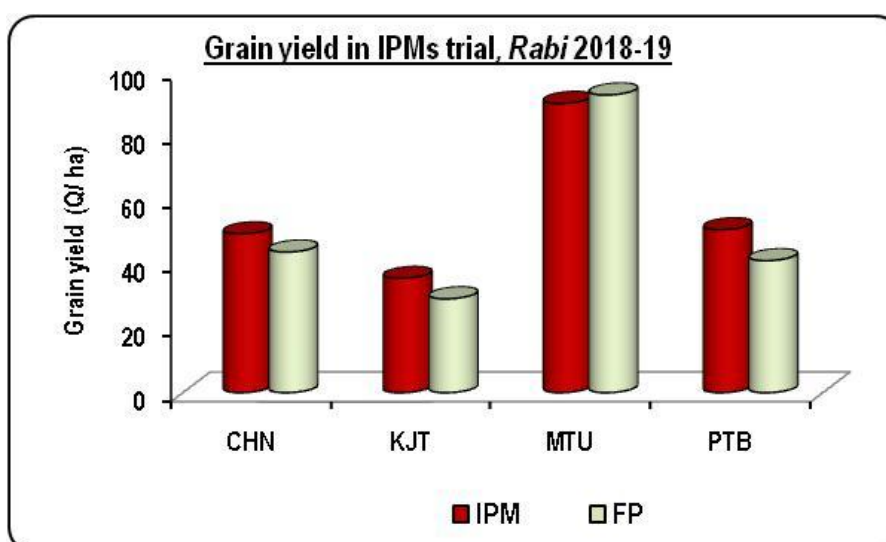


Fig. 2.22. Grain yields in IPMs trial in different locations, Rabi 2018-19

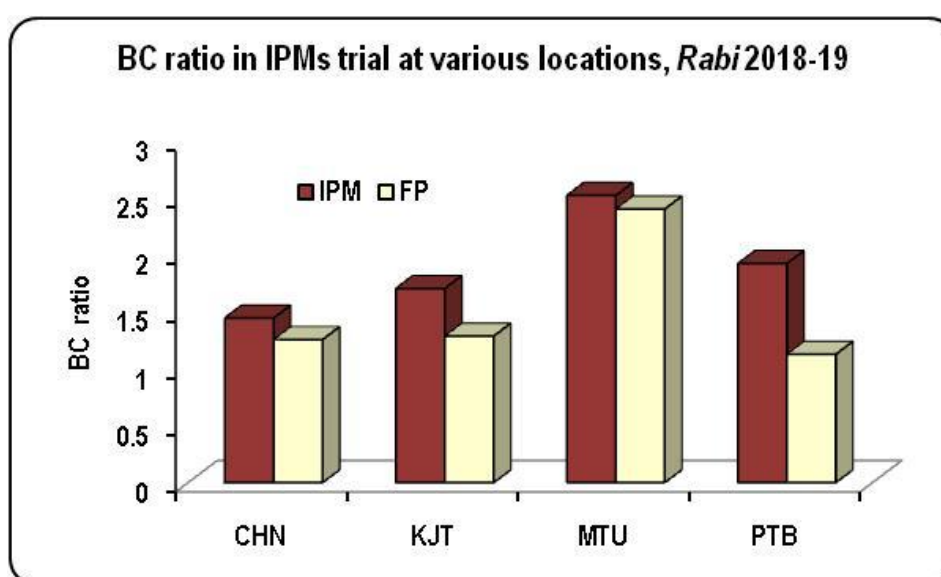


Fig. 2.23. BC ratios in IPMs trial in different locations, Rabi 2018-19

Integrated Pest Management special (IPMs) trial was conducted at four locations, Chinsurah, Karjat, Maruteru and Pattambi during Rabi 2018-19. In general, pest incidence was low to moderate across locations. Incidence of dead hearts was low in both IPM and FP plots at all the locations except at Karjat wherein IPM plot recorded low damage (8.51% DH) as against FP plot (12.07% DH). Similarly, white ear incidence was high only at Pattambi in both IPM (12.74% WE) and FP (14.85% WE) plots. Gall midge incidence was low in IPM plot at 29 DAT (8.64% SS) but later increased to 14.1% at 43 DAT at Maruteru. BPH population was also relatively high in IPM plot (67 hoppers/ 5 hills) than in FP plot (58 hoppers/ 5 hills). Net returns were high in IPM plots at all the locations due to high grain yield and low cost of cultivation resulting in higher BC ratio in IPM plots (1.45 – 2.53) than farmer practice plots (1.13 – 2.41).

Appendix-I

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

Cooperating centres

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

* - Voluntary Centre.

Appendix II

State	Location	Rabi 2018-19		Kharif 2019	
		Sent	Recd.	Sent	Recd.
Funded co-operating centres					
Andhra Pradesh	Maruteru	5	5	13	10
Assam	Titabar	1	0	7	7
Bihar	Pusa	0	0	6	6
Chattisgarh	Jagdalpur	0	0	14	14
	Raipur	1	1	12	10
Gujarat	Navsari	0	0	8	7
	Nawagam	0	0	8	7
Haryana	Kaul	0	0	1	1
Himachal Pradesh	Malan	0	0	10	10
Jammu & Kashmir	Chatha	0	0	7	4
	Khudwani	0	0	5	5
Jharkhand	Ranchi	0	0	8	7
Karnataka	Brahmavar	0	0	0	0
	Gangavathi	4*	0*	11	10
	Mandya	0	0	10	10
Kerala	Moncompu	1	1	11	10
	Pattambi	6	6	12	11
Madhya Pradesh	Rewa	0	0	2	1
Maharashtra	Karjat	4	3	7	7
	Sakoli	0	0	11	10
Manipur	Wangbal	0	0	0	0
Odisha	Chiplima	1	1	10	10
Puducherry	Kurumbapet	0	0	0	0
Punjab	Ludhiana	0	0	13	13
Tamil Nadu	Aduthurai	0	0	7	6
	Coimbatore	1	1	13	10
Telangana State	Rajendranagar	4	3	12	11
	Warangal	0	0	11	11
Uttar Pradesh	Ghaghraghat	0	0	4	4
	Masodha	0	0	7	4
Uttaranchal	Pantnagar	0	0	11	9
West Bengal	Chinsurah	5	5	9	9
Total trials in funded centres		28	26	260	234
% Receipt of data for kharif & rabi		92.9		90.0	
Overall % Receipt of data		90.0			

* - Trials not conducted due to water scarcity.

Voluntary centres - Kharif 2019		Sent	Recd.
Andhra Pradesh	Bapatla	5	5
	Ragolu	8	6
	Nellore	7	0
Manipur	Iroisemba	0	0
New Delhi	New Delhi	4	4
Odisha	Cuttack	12	3
Puducherry	Karaikal	3	3
Telangana State	Jagtial	6	5
Tripura	Arundhutinagar	4	1
Total trials in Voluntary centres		49	27
% Receipt of data		55.1	

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

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AICRIP

PLANT PATHOLOGY

2019-2020

AICRIP Progress Report- Plant Pathology 2019

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3. PATHOLOGY

SUMMARY

The All India Coordinated Rice Pathology Program of the ICAR-Indian Rice Research Institute (formerly as Directorate of Rice Research) is an example of effective linkage and testing mechanism to assess the advanced breeding lines over a wide range of climatic and disease epidemic conditions and also to identify broad spectrum of resistance to major rice diseases. This helps in developing need based management options for controlling major diseases of rice. During 2019, a total of 13 trials were conducted at 49 locations on host plant resistance, field monitoring of virulence of major pathogens and disease management methods. The details on screening nurseries and disease management trials proposed and conducted at various test locations are given in Table 1. The summary of observations is given below. Detailed data on extensive screening of diverse genotypes are furnished in a separate report entitled 'National Screening Nurseries, 2019'.

1. HOST PLANT RESISTANCE (NSN-1, NSN-2, NSN-H, NHSN and DSN)

❖ LEAF BLAST

The entries for leaf blast resistance were evaluated under NSN-1, NSN-2, NSN-Hills, NHSN and DSN at 28, 19, 12, 24 and 24 centres respectively. In majority of the centres the disease pressure was moderate; at few centres it was high (LSI 6- 7). Umium centre exhibited a very high disease pressure (8.2) under hill nursery. The entries that exhibited low over all disease score and high promising index were IET# 27528, 27722, 27773, 27927, 24967, 26464, 27748, 27903, 27736, 27743, 27343, 27894, 26351, 27980, 27390, 28811, 27357, 27369, 27781, 26767 and 27887 under NSN-1; IET #28818, 28298, 28505, 28074, 28071, 28359, 284486, 28279, 28088, 28647, 28362, 28521, 28828 and 28833 under NSN-2. None of the entries recorded resistant reaction across the locations under NSN-H; however a few entries *viz.*, IET # 28193, 28222, 27491, 28211, 27498, 26580, 27506 and 28208 showed moderate resistance. The promising entries under NHSN included IET #28113, 28111, 28115, 28163, 28130, 28162 and 28141. The donors *viz.*, HL18WS-20-5 and HL18WS-20-4 were reported promising under DSN.

❖ NECK BLAST

The entries were evaluated under NSN-1, NSN-2, NSN-Hills, NHSN and DSN at 9, 4, 5, 11 and 8 centers respectively. In most of the centres the screening was carried out under natural infection condition except at few locations, where artificial method of inoculation was followed. In majority of the locations the disease pressure was moderate to high, which was good enough for selection of the best entries. The entries that exhibited low over all disease score and high promising index were IET# 27538, 27547, 27747, 27723, 25212, 27686, 27574, 26684, 26819, 27438, 27346, 26948, 26847, 27743, 27077, 25945, 27285, 27118, 26118 and 27632 under NSN-1; IET# 28732, 28514, 28306, 28462, 28500, 28505, 28521, 28397, 28686, 28723, 28502, 28510, 28532, 28545, 28301, 28302, 28304, 28317, 28290, 28702, 28703, 27730, 28088 and

28828 under NSN-2. The entries with IET No. 28222, 28237, 27466, 26565, 25819, 26588, 26579, 28188, 28223, 28230, 28231, 28238, 28239 and 27463 under NSN-H; IET # 28117, 28187, 28184, 28129, 28128, 28154, 28142 and 28130 under NHSN were found to be promising against neck blast disease with low diseases score across the locations. Under DSN, entries RP-Bio Patho-11, RP-Bio Patho-7, RP-Patho-2, RP-Patho-3, RP-Patho-9, RP-Bio Patho-10, RP-Bio Patho-12, KNM 7787, HL18WS-22-2, HL18WS20-4, RMS-R-6, RMS-R-13 and RP-Bio Patho-8 were found to be highly promising for neck blast disease.

❖ **SHEATH BLIGHT**

The entries were evaluated under NSN-1, NSN-2, NSN-Hills, NHSN, and DSN at 19, 15, 3, 20 and 18 locations, respectively. In majority of the locations, the disease pressure was moderate to very high. None of the entries were found resistant ($SI \leq 3$) against sheath blight in all the nurseries during *Kharif*-2019. The promising entries to sheath blight ($SI \leq 5.0$) were IET Nos. 26684, 27836, 27118, 25912, 27781, 27637, 26692, 27851, 27646, 26927, 27438 and 26118 in NSN-1; 28517, 28293, 28301, 28482, 28471, 28478, 28346, 28732 and 28310 in NSN-2; 28217, 28198, 28212 and 27498 in NSN-H; IET Nos. 28148, 28166, 28141, 28160, 28173, 28152, 28151, 28155 and 28154 in NHSN and entries viz., IET 25692, Phoghak, RP-Patho-9, Gonalasha, CR 4209-2, RMS-R-11, Pankaj, RMS-R-6, KNM 7786, MSM-BB-61, Whazhuopek, GSY-4-9, NWGR 11048, CR 4053-24-40-1, SM-801 and MSM-SB-87 in DSN.

❖ **BROWN SPOT**

The entries were evaluated under NSN-1, NSN-2, NSN-Hills, NHSN and DSN at 19, 15, 6, 15 and 15 centers respectively against brown spot disease across India. In most of the centres the screening was carried out under natural infection condition except at few locations screening was carried out artificially by spraying spore suspension. In majority of the centres the brown spot pressure was moderate to high; and at few centres it was very high with $LSI > 7$. None of entries found resistant ($SI < 4$) under any of the screening nurseries. However, the promising entries with moderate resistance (SI 4-5) were IET # 27077, 28007, 27531, 26861, 27517, 27530, 27386, 26118, 27280, 26635, 27369, 28033, 27438, 27728 and 27732 under NSN-1; IET # 28329, 28763, 28471, 28648, 28649, 28354, 28331, 28344, 28491, 28467, 28827, 28454 and 28671 under NSN-2. The entries with IET No. 28193, 26594, 27468, 28195, 26596, 28223, 28226, 28189, 27504, 27498, 26580 and 28235 under NSN-H; IET#28148, 28144, 28159, 28134, 28181, 28135, 28152, 28121, 28138, 28145, 28161 and 28146 under NHSN and CR 4209-2, CR 4055-11-40-3, CR 4053-24-40-1, CR 4054-26-2-1, CR 4054-26-2-1, CR 4055-11-28-5, KNM 7787 and KNM 7785 under DSN.

❖ **SHEATH ROT**

The entries under NSN-1(353), NSN-2(672), NSN-H(120), NHSN(108) and DSN(151) were screened against sheath rot at 13, 4, 2, 12 and 11 locations, respectively. Some of the highly promising entries that scored less than 3 were IET # 28447, 27900, 28306, 28344, 28346, 28348, 28369, 28454, 28471, 28482, 28416, 28428, 28435, 28654, 28689, 28723, 28751, 28495, 28505,

28517, 28524, 28527, 28532, 28538, 28542, 28543, 28294, 28301, 28303, 28309, 28319, 28289, 28611, 28626 and 28824 in NSN-2; 27472, 26594, 28212 and 28199 in NSN-H and none found resistant in NSN1, NHSN and DSN.

❖ **GLUME DISCOLOURATION**

Glume discolouration (GD) was observed in National Screening Nurseries at Chatha, Lonavala, Navasari and Nawagam. Some of the promising entries were: IET 27541, Tetep, Pusa 44, IET 26767, IET 27518, IET 27528, IET 28834, IET 27703, IET 27950, IET 27621 and IET 27438 in NSN-1; IET 27530, IET 27518, IET 27395, IET 27460, FL 478, IET 26767, IET 27732 in NHSN; NWGR 11048, ISM-3G-4, HL18WS-23-30, RP-Bio Patho-4, NWGR 12016, KNM 7631, KNM 7632 and RMS-R-2 in DSN.

❖ **BACTERIAL LEAF BLIGHT**

The test entries and various checks in different bacterial blight screening nurseries viz., NSN-1, NSN-2, NSN-Hills, NHSN and DSN were evaluated at 25, 15, 4, 21 and 22 locations. The number of entries including checks in different nurseries was 353 in NSN1, 672 in NSN-2, 120 in NSN-Hills, 108 in NHSN and 151 in DSN. Some of the promising entries against bacterial blight in different nurseries were IET # 27378, 28811, 28807, 28014, 27077, 28806, 27294, 28789, 28805, 27823, 28810 and 27637 in NSN 1; IET# 28503, 28751, 28635, 28585, 28654, 28528, 28391, 28467, 28493, 28491, 28311, 28521, 28396, 28432, 28461, 28478, 28063, 28726, 28502, 28299, 28732 and 28543 in NSN 2; IET # 28211, 27466, 27468, 27506 and 28197 in NSN-Hills; IET #28148, 28160, 28143, 28162, 28114, 28136, 28181, 28131, 28163, 28159, 28120 and 28164 in NHSN and KNM 7787, RP-Bio Patho-9, RP-Bio Patho-10, RP-Bio Patho-7, MSM-SB-52, ISM-2G-5412, KNM 7786, RP-Bio Patho-6, RMS-R-16, RMS-R-7, GSY-4-6, CR 4054-26-6-5, RP-Bio Patho-2, CR 4055-11-28-1, GSY-4-7, IET 25692 and RP-Bio Patho-3 in DSN.

❖ **RICE TUNGRO DISEASE**

The entries in NSN-1, NSN-2, NHSN and DSN were evaluated at 2 locations for rice tungro virus disease. The promising entries identified in different nurseries are: IET 28836, IET 26420, IET 27384, and FBR 1-15 in NSN 1; IET 28326, IET 28369, IET 28443, IET 27908, IET 28656, IET 28678, IET 28688, IET 28316, IET 28274, IET 28629, IET 28702, IET 28708, IET 28712 in NSN 2; IET 27461 and IET 26579 in NSNH; IET 28158, IET 28112, IET 28115 and IET 28115 in NHSN and RP-Patho-12, RMS-R-8, RMS-R-12, RMS-R-13, RMS-R-15, RMS-R-16 and CB 15569 in DSN.

❖ **MULTIPLE DISEASE RESISTANT LINES**

In NSN-1, the IET # 27438 entry showed resistant reaction against neck blast and sheath rot while moderate resistant reaction against sheath blight and brown spot. Entries viz., IET# 25212 (resistant against NB, moderate for ShB, ShR), 27077 (moderate reaction against NB, BS,

BLB) and 26118 (moderate reaction against NB, ShB, BS) showed resistant/moderate reaction against three diseases. In NSN-2, IET # 28306 had shown high resistance to two diseases viz., NB and ShR. In addition, IET # 28521 had shown high resistance to NB and moderate resistance to BLB. IET # 28732, 28301, 28304 shown resistance to NB and tolerance to ShB. Under NSN-H, the entries IET # 26594 (moderately resistant to ShB, ShR and BS), 27466 (moderately resistant to NB, ShB and BLB) showed moderately resistant to three diseases. In NHSN, Out of 14 entries, 13 entries showed moderate/ resistant reaction to two diseases; except IET# 28148 expressed moderate resistance against three diseases (ShB, BS and BLB). Entries expressed moderate resistance or tolerance against two diseases are IET#28130 (LB, NB), 28115 (LB, RTD), 28117 (NB, ShR), 28129 (NB, ShR), 28154 (NB, ShB), 28160 (ShB, BLB), 28152 (ShB, BS), 28134 (BS, ShR) expressed moderate resistant reaction against two different diseases. In DSN, CR 4209-2(moderate resistant to ShB, BS and ShR) and Phoghak (moderate resistant to NB, ShB and ShR) showed resistant reaction to three diseases.

II. FIELD MONITORING OF VIRULENCE

1. *Pyricularia oryzae*

The nursery included twenty five cultures consisting of international differentials, near isogenic lines, donors and commercial cultivars. It was evaluated at twenty four locations with different dates of sowing during the crop season to monitor the blast reaction on different host genotypes. Raminad str-3, Tetep and Tadukan were resistant across the locations. Tetep and Raminad str-3 were highly resistant at most of the locations (17) that showed its potentiality as the best donors for resistance against blast disease. Tetep was susceptible at Coimbatore, Gudalur and Upper Shillong and moderately susceptible at Cuttack, Ghaghraghat and Gangavati. Raminad str-3 was susceptible at Coimbatore and Cuttack and also moderately susceptible at Impal, Gudalur, Ghaghraghat and Karjat. Tadukan was showing resistant all the locations except Gangavati, Ghaghraghat, Coimbatore, Upper Shillong, Cuttack and Karjat. Zenith was highly susceptible at Gudalur and Upper Shillong; similarly NP-125 also highly susceptible at Coimbatore and Gudalur. The susceptible checks like HR-12 and Co-39 are showing susceptible reaction at most of the locations but HR-12 recorded moderately resistant reaction at Khudhwani and Co-39 also recorded low disease score at Ranchi, Karjat and Ghaghraghat. The resistant check Rasi was highly susceptible at Gudalur, Upper Shillong, Impal, Almora, Nawagam, Cuttack, Gangavati, Mandy and Rajendranagar. IR 64 was showing susceptible reaction at Coimbatore, Lonovala, Impal, Gudalur and Cuttack. The reaction pattern of genotypes at all the locations was grouped into six major groups. The reaction pattern at Almora, Gudalur, Cuttack, Ghaghraghat, Karjat, Imphal, Ponnampet, Navasari, Coimbatore, Upper Shillong, Nawagam, Gangavati, Jagityala, Hazaribagh, Jagdalpur, Lonovala, New Delhi, IIRR, Mandya and Ranchi were in group one; Pattambi, Mugad, Malan, Khudhwani and Rajendranagar were in group two, three, four, five and six respectively.

2. *Xanthomonas oryzae* pv. *oryzae*

The trial consisted of twenty eight near isogenic lines (IRBB lines) possessing different bacterial blight resistant genes (singly) or various combination 5 BB resistance genes viz., *Xa4*, *xa5*, *Xa7*, *xa13* and *Xa21* in the background of rice cultivar IR 24 and different checks like Improved Samba Mahsuri, TN1 and DV85. The trial was conducted at 26 locations across India. Most of the differentials possessing single bacterial blight resistance genes like *Xa1*, *Xa3*, *Xa4*, *xa5*, *Xa7*, *xa8*, *Xa10*, *Xa11* and *Xa14* were susceptible at most of the locations. BB resistance gene *xa13* was susceptible in 14 locations while *Xa21* was susceptible in 21 locations. The differential, IRBB 55 possessing two BB resistance genes *xa13* and *Xa21* showed susceptibility at 10 hot spot locations. Based on their virulence, the isolates were grouped into high, moderate and low virulence groups. The isolate from Maruteru showed exceptional virulence and all the differentials showed susceptible reaction to this isolate.

III. DISEASE OBSERVATION NURSERY

The trial was proposed at 10 locations and data was received from 9 locations viz., Chinsurah, Kaul, Malan, Mandya, Maruteru, Moncompu, Nawagam, Pusa and Raipur. The incidence of leaf blast was more severe in the late sown crop in Malan and Mandya. The incidence of neck blast was in the early sown crop in Mandya and in the normal sown crop in Moncompu. The severity of sheath blight was more severe in early sown crop in Chinsurah, Mandya, and Moncompu. In the case of BLB, the disease severity was high in the normal sown crop in Moncompu. The severity of brown spot disease was high in the late sown crop in Pusa and Mandya centres. However, in Chinsurah, the disease severity of Brown spot was more in the crop sown in normal conditions when compared to the late or normal sown crop. The severity of the sheath rot disease was found to be high in the late sown crop at Chinsurah and Nawagam. In an attempt to find out the spread of the disease and its correlation with the weather parameters like temperature, rainfall and humidity, the AUDPC was calculated from the centres which had sent their weather data. Accordingly, it was observed that in general, the rainfall had a greater impact on the impact of diseases like sheath rot and sheath blight in the spread among the populations. However, in the case of disease like leaf blast and brown spot the humidity played a major role and is directly correlated with the increase in the spread of the disease among the populations. Further it is possible that heavy rainfall might have washed away the pathogen inocula from the leaves. In contrast, the AUDPC of another disease primarily infecting the leaf, the BLB, was found to increase directly with the total rainfall. This might be due to the ability of the bacterial pathogen to survive in water and spread among the plants.

IV. DISEASE MANAGEMENT TRIALS

1. EVALUATION OF FUNGICIDES AGAINST LOCATION SPECIFIC DISEASES

Trial was conducted with an objective to evaluate new fungicidal molecules viz., Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) and Prochloraz 45% EC (2.0 ml/l) against different disease of rice caused by fungi. Test molecules were compared with other standard fungicides viz., tricyclazole 75% WP (0.6 g/l), azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC (1 ml/l), difenoconazole 25 EC (1.0 ml/l), hexaconazole 5% EC (2.0 ml/l) and propiconazole 25% EC (1.0 ml/l). The fungicides were evaluated against leaf blast (10 locations), neck blast (eight locations), sheath blight (15 locations), sheath rot (five locations), brown spot (six locations) false smut (two locations) and grain discoloration (two locations).

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

2. INTEGRATED DISEASE MANAGEMENT

The IDM trials were conducted at 14 locations. The bioagent, *Trichoderma viride* was supplied by ICAR-NRRI, Cuttack. The results indicated that in all the cases, the treatment with fungicide alone was giving maximum percentage of reduction in disease severity over other treatments. In the case of leaf and neck blast, the treatment T3 and T4 (bioagent as seed treatment alone + propiconazole and bioagent as seed treatment + field application + propiconazole) were on par and was near to the standard check T5 (chemical alone). With respect to grain yield it was observed that yield was onpar and there was no direct correlation between the ratio of disease suppression and increase in grain yield in case of bioagent treated plots. In the case of sheath blight management, it was observed that the treatment T4 (bioagent + propiconazole) was more effective in managing the disease when compared to even the standard check, T5 (chemical alone) in the centres like Chiplima, Faizabad and Pantnagar while they were on par in centres like Maruteru and Pattambi. Again the treatments T3 and T4 were found to increase the grain yield percentage on par with the treatment T5. In the case of BLB, it was observed that none of the treatments had any effective control and the percentage disease control ranged between 5.75 to 8.89% and the percentage grain yield increase ranged between 14.78 to 23.37%. The treatments T3 and T4 were found to be effective and the treatment T5 was found to be the most effective among all the treatments against brown spot and sheath rot diseases. In the case of sheath rot disease, the percentage increase in grain yield was directly proportional to the decrease in the disease severity and the bioagents were able to improve the yield of the crop.

However, in the case of brown spot disease the increase in the grain yield was on par for the treatments T3 to T5 and were not correlated with the decrease in disease severity.

3. SPECIAL TRIAL ON ESSENTIAL OILS

In *Kharif* 2019, eight essential oils were tested for their performance against leaf blast, neck blast, sheath blight, brown spot and false smut diseases, at 15 locations. Two sprays of Neem oil @ 2 ml/l (T7) and Clove oil @ 2 ml/l (T6) are performing better in reducing the leaf blast severity, whereas Neem oil @ 2 ml/l (T7) alone effective in reducing both leaf and neck blast disease severity. In case of sheath blight disease, spraying of Citronella oil @ 2 ml/l (T1), Cedar wood oil @ 2.0ml/l (T3), Nirgundi oil @2.0ml/l (T4), Lemon grass oil @ 2.0 ml/l (T5), Clove oil @ 2 ml/l (T6) and Neem oil @ 2 ml/l (T7) reported as effective. With respect to brown spot, application of Citronella @ 2.0 ml/l (T1) reduced the disease development. Citronella @ 2.0 ml/l (T1) and Neem oil @ 2.0 ml/l are effective against false smut.

INTRODUCTION

The All India Co-ordinated Rice Pathology Programme of Indian Institute of Rice Research (ICAR-IIRR) provides an effective linkage for collaboration among state agricultural universities, National institutes and Department of Agriculture, Agrochemical Industry and others. The objectives of the Programme are:

- To accelerate genetic improvement of rice for resistance against major diseases occurring in different ecosystems of the country.
- To provide a testing mechanism to assess the advanced breeding lines over a wide range of climatic, cultural, soil and disease epidemic conditions.
- To identify broad spectrum of resistance to major rice diseases.
- To monitor and evaluate the genetic variation of rice pathogens.
- To monitor the prevalence of diseases in the country.
- To develop need based disease management practice.
- To identify production constraints in different ecosystems through production oriented survey.

To achieve these objectives during 2019, a total of 13 trials were conducted at 49 locations on host plant resistance, field monitoring of virulence in major pathogens and disease management. Five national screening nurseries comprising of 1404 entries of advanced breeding lines and new rice hybrids were evaluated for their reactions to major rice diseases at 49 locations.

The composition of the nurseries is as follows:

- ❖ National Screening Nursery 1 (NSN-1) - 353 entries drawn from Advanced Variety Trials.
- ❖ National Screening Nursery 2 (NSN-2) - 672 entries from Initial Variety Trials.
- ❖ National Screening Nursery-Hills (NSN-H) - 120 entries from Advanced and Initial Varietal Trials.
- ❖ National Hybrid Screening Nursery (NHSN) - 108 entries from Initial National Hybrid Rice Trials (HRT'S).
- ❖ Donor Screening Nursery (DSN) - 151 entries from different centres.

The virulence patterns of blast and bacterial leaf blight pathogens in the field were monitored, using differentials for respective diseases at disease endemic areas. The prevalence of the diseases was monitored in three sequentially sown disease observation nurseries laid-out in the endemic locations.

The disease management trials were conducted at hot-spot locations to evaluate the efficacy of new fungicides and commercially available combination fungicide formulations against major rice diseases. Production Oriented Survey (POS) was undertaken in 17 centres (16 states) to identify the production constraints in different rice growing ecosystems.

The weather parameters at locations are given in Annexure I to Annexure III. Out of 639 experiments proposed, data were received from 612 experiments of 13 trials indicating the good response with 95.7 % data receipt from the centres.

Table 1: Scientists involved in Pathology Coordinated Programme, Kharif 2019. Dr. M. Srinivas Prasad, PI; Associates: Drs. G.S. Laha, D. Krishnaveni, C. Kannan, D. Ladhakshmi, V. Prakasam, K. Basavaraj and G. S. Jasudasu, ICAR-IIRR, Headquarters, Hyderabad

S.No	Location	Co-operators	Funded/ Voluntary	Experiments	
				Proposed	Conducted
1	Aduthurai	Dr.A. Ramanathan	Funded	14	14
2	Almora	Dr. H. Rajashekara	ICAR	11	11
3	Arundhatinagar	Dr. Abijit Saha	Funded	2	2
4	Bankura	Dr. Partha Pratim Ghosh	Funded	17	24
5	Chatha	Dr. Anil Gupta	Funded	12	18
6	Chinsurah	Drs. Dr.C.K.Bhunia, Dilip Kumar Patra &P. Bandyopadhyay	Funded	13	13
7	Chiplima	Dr. Rini Pal	Funded	9	9
8	Coimbatore	Dr. C. Gopalakrishnan	Funded	17	17
9	Cuttack	Drs. Arup K Mukherjee, Sri Kanta Lenka & Manas Kumar Bag	ICAR	27	23
10	Gangavati	Dr. Pramesh Devana	Funded	23	21
11	Gerua	Dr. Rupankar Bhagawati	ICAR	9	2
12	Ghaghraghat	Dr. Amritlal Upadhayay	Funded	11	11
13	Gudalur	Dr. C. Gopalakrishnan	Voluntary	3	3
14	Hazaribagh	Drs. Amrita Banerjee & Dipankar Maiti	ICAR	14	13
15	ICAR-IIRR	Drs. M. S. Prasad, G. S. Laha, D. Krishnaveni, C. Kannan, D. Ladhakshmi, V. Prakasam, K.Basavaraj and GS Jasudasu	HQ	32	32
16	Imphal	Dr. Susheel Kumar Sharma	ICAR	8	7
17	Jagdapur	Dr. R. S. Netam	Funded	15	16
18	Jagtial	Dr. N. Balram	Voluntary	13	13
19	Karjat	Dr. Pushpa D Patil	Funded	16	15
20	Kaul	Dr. Mahaveer Singh	Funded	7	5
21	Khudwani	Dr. Nazir Ahmad Bhat	Funded	10	8
22	Lonavala	Dr. K. S. Raghuwanshi	Voluntary	20	23
23	Ludhiana	Drs. Jagjeet Singh Lore	Funded	17	17
24	Malan	Dr. SachinUpmanyu	Funded	15	12
25	Mandya	Dr. B. S. Chethana	Funded	18	18
26	Maruteru	Dr. V. Bhuvaneswari	Funded	22	18
27	Masodha (Faizabad)	Dr. Vindeshwari Prasad	Funded	13	13
28	Moncompu	Dr. M. Surendran	Funded	14	16
29	Mugad	Dr. B. C. Kamanna	Voluntary	15	9
30	Navsari	Dr. V. A. Patil	Funded	10	13
31	Nawagam	Dr. Rakeshkumar Gangwar	Funded	17	20
32	Nellore	Dr. P. Madhusudhan	Voluntary	10	5
33	New Delhi	Drs. K.K. Mondal, B. Bishnu Maya & G. Prakash	ICAR	10	10
34	Pantnagar	Drs. Vishwanath , Dr. Bijendrakumar	Funded	15	15
35	Patna	Dr. Md. Reyaz Ahmad	Funded	10	14
36	Pattambi	Dr. Puzhakkalraji	Funded	16	16
37	Ponnampet	Dr. G. N. Hosagoudar	Funded	14	14
38	Portblair	Mr. K. Sakthivel	ICAR	3	3
39	Pusa	Dr. Bimla Rai	Funded	12	12
40	Raipur	Dr. Pradeep Kumar Tiwari	Funded	17	16
41	Rajendranagar	Dr.Talluri Kiran Babu	Funded	14	14
42	Ranchi	Dr. M. K. Barnwal		8	8
43	Rewa	Dr. S. P. Mishra	Funded	11	11
44	Sabour	Dr. Amarendra Kumar	Voluntary	7	7
45	Titabar	Dr. Bubul Chandra Das	Funded	13	13
46	Umiam (Barapani)	Dr Akoijam Ratankumar Singh, Dr. Pankaj Baiswar	ICAR	11	7
47	Upper Shillong	Smt. Kheinkorlin Lyngdoh	Funded	9	5
48	Varanasi	Dr. R. K. Singh	Funded	9	5
49	Wangbal	Dr. Sanaton Sharma	Funded	6	-
Total Experiments (%) 95.7 %				639	612

(All ICAR centres are Voluntary)

1. HOST PLANT RESISTANCE

Screening Nursery (NSN-1, NSN-2, NSN-H, NHSN and DSN)

❖ LEAF BLAST

➤ National Screening Nursery-1 (NSN-1)

The National Screening Nursery (NSN-1) comprised of 353 entries that included national regional and pathology checks. The nursery was evaluated at 28 locations across India under different-agro ecological Zones. The frequency distribution of disease scores and the representative location severity index (LSI) are presented in the Table 2. The screening against leaf blast was carried out under artificial inoculation condition at most the locations. None of the locations showed a very high (LSI ≥ 7.0) disease pressure under NSN-1. The highest disease pressures was recorded at Mandya (LSI 6.3) and lowest (LSI-1.2) at Rewa. The disease pressure was moderate (LSI 4-6) at most of the locations evaluated and that included Pattambi (4.1), Chiplima (4.1), Gangavathi (4.1), Khudwani (4.2), Upper Shilling (4.2), Jagadapur (4.4), IIRR (4.7), Jagtial (4.7), Ranchi (4.8), New Delhi (4.8), Almora (4.9), Navasari (5.0), Karjat (5.0), Hazaribagh (5.0), Umium (5.0), Rajendranagar (5.1), Cuttack (5.5), Coimbatore (5.7), Gudulur (5.7), Gagharghat (5.9) and Lonavala (5.9). The data from locations (Bankura, Mugad, Malan and Rewa) where disease pressure was low (<4.0) was not considered for the selection of promising entries.

The entries that scored SI <4 were considered as promising and presented in Table 3. The entries included IET Nos. 27528, 27722, 27773, 27927, 24967, 26464, 27748, 27903, 27736, 27743, 27343, 27894, 26351, 27980, 27390, 28811, 27357, 27369, 27781, 26767 and 27887 (Table 3).

➤ National Screening Nursery-2 (NSN-2)

The nursery consists of 672 lines drawn from initial variety trials (IVTs). These were evaluated at 19 centres under various ecological zones. The highest disease pressure was recorded at Mandya (LSI 7.4) and the lowest at Bankura (LSI 3.2). None of the locations showed a very high disease (LSI ≥ 7.0) and high (LSI 6.0-7.0) disease pressure. The disease pressure was moderate (LSI 4.0-6.0) at most of the locations viz., Ranchi (4.0), Pattambi (4.0), Mugad (4.0), Malan (4.2), Umium (4.5), Gangavathi (4.5), IIRR (4.7), Rajendranagar (4.8), Almora (4.9), Coimbatore (5.3), Hazaribagh (5.6), Gagharghat (5.6), Ponnampet (5.6), Cuttack (5.7) and Jagtial (5.7). The Performance of entries at locations viz., Bankura (3.2), Jagdalpur (3.6) and Rewa (3.5) was not considered for the selection of best entries, where disease pressure was low (<4.0) (Table 4).

None of the entries were recorded SI less than 3.0, but a few promising entries with low susceptibility index was presented in Table 5 and that included IET # 28818, 28298, 28505, 28074, 28071, 28359, 284486, 28279, 28088, 28647, 28362, 28521, 28828 and 28833.

Table 2: Location severity index (LSI) and frequency distribution of leaf blast scores of NSN-1, Kharif 2019

Score	Location/Frequency of disease score (0-9)																											
	ALM	BNK	CBT	CHP	CTK	GDL	GGT	GNV	HZB	IIRR	JDP	JGT	KHD	KJT	LVN	MGD	MLN	MND	NDL	NVS	NWG	PNP	PTB	RNC	REW	RNR	UMM	USG
0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	2	17	0	0	3
1	4	0	0	6	0	0	0	31	6	7	11	9	4	0	0	1	101	3	33	3	0	1	1	8	68	10	1	6
2	32	0	0	47	0	0	0	124	28	26	42	36	6	0	1	1	33	14	0	7	0	17	8	8	76	0	0	122
3	58	328	25	70	20	25	0	69	74	47	54	24	93	65	4	246	23	25	111	35	63	61	95	12	96	102	22	62
4	43	0	0	102	2	0	0	4	59	112	69	66	101	79	29	41	42	49	4	68	43	36	160	131	76	0	2	11
5	88	23	214	73	234	214	197	24	59	64	61	140	87	67	114	62	44	42	102	115	127	98	50	82	10	135	2	46
6	63	0	3	20	0	3	0	1	31	18	57	19	25	54	102	2	32	39	0	97	43	56	11	60	8	0	6	27
7	34	2	72	35	79	72	155	20	40	52	39	44	13	63	63	0	26	56	67	18	58	56	17	45	1	72	3	33
8	18	0	0	0	0	0	0	5	29	13	10	0	2	7	23	0	5	22	0	9	8	19	9	5	0	0	6	19
9	11	0	38	0	10	38	1	68	25	13	2	12	0	0	16	0	9	102	35	1	10	7	0	0	0	32	5	23
Total	351	353	352	353	345	352	353	346	351	352	351	350	331	335	352	353	315	352	352	353	352	351	351	353	352	351	47	352
LSI	4.9	3.2	5.7	4.1	5.5	5.7	5.9	4.1	5.0	4.7	4.4	4.7	4.2	5.0	5.9	3.5	3.6	6.3	4.8	5.0	5.2	5.1	4.1	4.8	2.6	5.1	5.0	4.2
Screening method	N	A	A	N	A	N	-	A	N	A	N	-	N/A	A	A	N	A	A	A	N	A	N	N	A	A	A	N	N

(N-Natural; A-Artificial)

Table 3: Promising entries with low susceptibility index (≤ 4) and high PI in NSN-1 to leaf blast, *Kharif 2019*

P. No.	IET No.	Location/Frequency of score (0-9)																							SI	Total	<=3*	PI (<=3)**	<=5*	PI (<=5)**	
		ALM	CBT	CHP	CTK	GDL	GGT	GNV	HZB	IIRR	JDP	JGT	KHD	KJT	LVN	MND	NDL	NVS	NWG	PNP	PTB	RNC	RNR	UMM							USG
353	Tetep (R)	2	6	3	5	6	7	2	1	1	2	-	5	3	2	4	3	1	3	3	2	6	3	4	5	3.4	23	14	61	19	83
85	27528	1	5	3	7	5	5	9	3	4	2	6	3	5	5	1	1	3	3	1	3	4	3	-	2	3.7	23	13	57	20	87
327	27722 (R)	3	3	2	3	3	7	3	3	1	4	4	5	5	7	2	3	3	7	3	2	7	3	-	2	3.7	23	15	65	19	83
106	27773	3	5	2	5	5	5	2	5	5	1	3	5	3	6	2	3	4	3	7	3	4	3	-	2	3.7	23	12	52	21	91
201	27927	2	5	4	7	5	7	2	4	4	2	2	4	4	4	3	1	8	5	3	3	4	3	-	2	3.8	23	10	43	20	87
132	24967	4	5	5		5	5	3	2	3	1	4	4	3	6	4	1	6	5	5	4	4	3	-	3	3.9	22	8	36	20	91
281	26464 (R)	4	5	3	3	5	7	3	2	3	2	5	3	6	7	4	5	3	4	5	3	2	3	-	2	3.9	23	12	52	20	87
138	27748	3	5	2	5	5	5	2	4	4	2	5	5	3	4	4	3	5	4	5	3	5	3	-	3	3.9	23	9	39	23	100
290	27903	3	3	2	5	3	5	2	2	4	5	5	4	5	5	5	3	4	5	5	3	4	5	-	2	3.9	23	9	39	23	100
99	27736	2	5	4	7	5	5	1	5	4	3	6	3	3	6	2	1	4	3	5	4	4	5	-	2	3.9	23	9	39	20	87
111	27743	1	5	4	5	5	5	2	3	4	1	2	4	3	6	2	1	6	5	6	3	6	5	-	5	3.9	23	9	39	19	83
276	27343	3	3	2	7	3	7	2	2	4	0	7	3	7	5	4	3	5	5	3	3	6	3	-	3	3.9	23	13	57	18	78
280	27894	2	3	4	5	3	7	3	3	5	2	3	3	5	6	7	3	4	5	3	5	4	3	-	2	3.9	23	12	52	20	87
89	26351 (R)	3	5	4	5	5	5	2	3	4	1	3	5	3	7	3	3	5	5	2	3	5	7	-	2	3.9	23	11	48	21	91
219	27980	2	5	4	5	5	5	3	3	3	3	4	5	4	5	2	1	3	5	5	4	7	5	-	2	3.9	23	9	39	22	96
167	27390	2	5	1	5	5	7	2	3	4	3	5	4	3	5	4	1	6	3	4	4	7	5	-	3	4.0	23	9	39	20	87
326	28811	3	3	2	5	3	7	3	3	1	6	5	5	5	6	2	3	4	5	4	3	8	3	6	2	4.0	24	12	50	19	79
121	27357	2	7	2	7	7	5	7	2	2	2	1	3	3	6	4	3	6	5	6	3	4	5	3	2	4.0	24	12	50	17	71
122	27369	2	5	5	5	5	7	-	1	2	4	3	4	3	6	2	1	5	7	7	3	5	5	3	3	4.0	23	10	43	19	83
134	27781	3	5	3	5	5	5	2	8	2	3	3	5	4	5	4	1	2	5	6	4	4	7	-	2	4.0	23	9	39	20	87
51	26767	1	5	5	7	5	5	1	4	6	3	2	3	5	5	6	1	4	4	2	4	4	7	-	4	4.0	23	7	30	19	83
264	27887	4	5	3	5	5	5	2	3	3	3	5	-	5	5	6	3	5	5	3	4	4	3	-	3	4.0	22	9	41	21	95
340	HR-12	7	9	7	9	9	5	9	9	9	8	9	3	5	9	9	9	7	9	7	7	4	9	9	9	7.8	24	1	4	4	17
353	LSI	4.9	5.7	4.1	5.5	5.7	5.9	4.1	5.0	4.7	4.4	4.7	4.2	5.0	5.9	6.3	4.8	5.0	5.2	5.1	4.1	4.8	5.1	5.0	4.2						

(SI-Susceptibility Index; *No. of locations where the entry has scored ≤ 5 and ≤ 3 ; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 4: Location severity index (LSI) and frequency distribution of leaf blast scores of NSN-2, Kharif 2019

Score	Location/Frequency of score(0-9)																		
	ALM	BNK	CBT	CTK	GGT	GNV	HZB	IIRR	JDP	JGT	MGD	MLN	MND	PNP	PTB	RNC	REW	RNR	UMM
0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	1	24	0	1
1	7	0	0	0	0	52	1	3	31	4	1	168	3	1	2	0	79	32	25
2	28	0	0	0	0	182	32	6	149	20	1	40	0	2	31	8	83	0	246
3	136	602	45	10	0	167	90	83	173	17	380	44	6	43	138	106	116	264	92
4	65	0	186	0	25	6	92	244	140	61	33	111	53	89	317	462	175	0	11
5	203	67	212	467	439	50	125	167	81	262	158	69	82	207	139	78	95	192	28
6	129	0	86	0	1	10	83	74	54	74	53	79	56	121	25	16	90	0	6
7	71	3	97	141	204	22	118	85	24	183	46	48	84	145	14	1	10	115	21
8	25	0	17	0	0	18	88	2	7	7	0	7	69	45	1	0	0	0	24
9	4	0	29	54	3	160	42	5	2	43	0	73	311	12	0	0	0	68	152
Total	668	672	672	672	672	667	671	669	670	671	672	639	664	665	667	672	672	671	606
LSI	4.9	3.2	5.3	5.7	5.6	4.5	5.6	4.7	3.6	5.7	4.0	4.2	7.4	5.6	4.0	4.0	3.5	4.8	4.5
Screening method	N	A	A	A	-	A	N	A	N	-	N	A	A	N	N	A	A	A	N

(N-Natural; A-Artificial)

Table 5: Promising entries with low susceptibility index (≤ 4) and high PI in NSN-2 to leaf blast, *Kharif 2019*

P. No.	IET No.	Location/Frequency of score (0-9)																SI	Total	<=3*	PI (<3)**	<=5*	PI (<5)**
		ALM	CBT	CTK	GGT	GNV	HZB	IIRR	JGT	MGD	MLN	MND	PNP	PTB	RNC	RNR	UMM						
672	Tetep	3	6	5	5	2	1	1	5	1	1	4	2	2	4	3	2	2.9	16	8	50	12	75
610	28818	1	4	5	5	3	2	4	1	3	1	4	1	4	4	5	2	3.1	16	6	38	13	81
404	28298	3	4	7	5	1	2	3	5	3	1	4	4	2	4	1	-	3.3	15	5	33	12	80
344	28505	4	3	5	5	2	3	4	5	3	1	6	3	3	4	1	2	3.4	16	4	25	12	75
624	28074	3	3	5	5	5	4	4	5	3	1	-	-	3	3	1	-	3.5	13	2	15	9	69
604	28071	1	9	5	5	2	2	3	2	3	-	5	5	3	3	3	2	3.5	15	5	33	10	67
39	28359	2	4	7	5	2	3	4	2	3	1	6	5	3	4	5	1	3.6	16	5	31	11	69
139	28486	3	4	5	7	2	4	3	6	3	1	1	5	4	4	3	2	3.6	16	4	25	12	75
448	28279	3	4	5	5	3	2	4	5	4	1	4	5	3	4	3	2	3.6	16	3	19	12	75
642	28088	3	4	7	5	2	3	4	5	3	1	5	6	3	2	3	2	3.6	16	4	25	11	69
227	28647	3	4	5	5	2	5	4	5	3	-	-	-	-	3	1	-	3.6	11	2	18	7	64
42	28362	2	6	7	5	3	2	3	4	3	-	3	6	4	3	1	3	3.7	15	3	20	11	73
361	28521	2	5	7	5	2	2	5	4	3	3	4	4	4	4	3	2	3.7	16	4	25	12	75
649	28828	3	4	5	5	2	2	5	5	5	1	4	7	3	3	3	2	3.7	16	4	25	10	63
655	28833	1	5	5	5	2	3	4	5	5	1	4	6	2	3	5	-	3.7	15	4	27	8	53
659	HR-12	7	9	9	5	9	6	9	9	6	9	9	7	7	6	9	9	7.8	16	0	0	0	0
LSI		4.9	5.3	5.7	5.6	4.5	5.6	4.7	5.7	4.0	4.2	7.4	5.6	4.0	4.0	4.8	4.5						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no.of locations where the entry had scored ≤ 3 and ≤ 5)

➤ **National Screening Nursery-Hills (NSN-Hills)**

The NSN-H included a total of 120 entries screened at 12 locations under hill ecological zones of India. The highest disease pressure was recorded at Umiam (8.2); while it was lowest at Upper Shillong (2.3) (Table 6). The disease pressure was high (LSI 6-7) at Cuttack (6.5) and Lonavala (6.1). Moderate disease pressure (LSI 4-6) was observed at IIRR (4.3), Ponnampet (4.8), Karjat (5.1), Almora (5.2), Imphal (5.5) and Coimbatore (5.6). The data from centres viz., Khudwani (3.4), Malan (2.5), and Upper Shillong (2.3) were not considered for the selection of resistance entries, where disease pressure was low (<4.0) (Table 6).

None of the entries recorded resistant reaction across the locations under hill ecosystem. However a few showed moderate resistance that included IET # 28193, 28222, 27491, 28211, 27498, 26580, 27506 and 28208 (Table 7).

➤ **National Hybrid Screening Nursery (NHSN)**

One hundred and eight hybrids that included checks were evaluated at 24 centres against leaf blast disease under NHSN. The highest disease pressure was observed at Mandya (6.6), while lowest (LSI 2.6) at Nawagam and Upper Shillong. None of the locations showed a very high disease pressure (LSI >7.0). The disease pressure was high (LSI 6-7) at Lonavala (6.1) and Jagtial (6.3). Most of the centres exhibited moderate disease pressure viz., Pattambi (4.1), Karjat (4.1), Gangavathi (4.1), Ranchi (4.2), Khudwani (4.3), Rajendranagar (4.4), IIRR (4.7), Hazaribagh (4.9), Imphal (5.0), Gagharghat (5.3), Nawagam (5.4), Coimbatore (5.4) and Almora (5.4) (Table 8). The Performance of entries at Bankura, Jagdalpur, Mugad, Malan, Ponnampet, Rewa, Umiam and Upper Shillong was not considered for identifying promising entries.

The promising entries with low susceptibility index which showed resistance reaction consistently across the locations was presented in the Table 9 and that included IET# 28113, 28111, 28115, 28163, 28130, 28162 and 28141.

➤ **Donor Screening Nursery (DSN)**

The donor screening nursery comprised of 151 entries including checks were evaluated at 24 locations. None of the locations exhibited a very higher disease pressure with LSI >7.0. The disease pressure was high (LSI 6-7) at Lonavala (6.0), Almora (6.4) and Mandya (6.4). The disease pressure was moderate (LSI 4-6) at centres Ponnampet (4.0), Rajendranagar (4.4), Upper Shillong (4.6), Malan (4.8), Umiam (4.9), IIRR (5.0), Nawagami (5.1), Gagharghat (5.3), Karjat (5.4), Gangavathi (5.4), Hazaribagh (5.4), Jagtial (5.5), Cuttack (5.6) and Coimbatore (5.8) (Table 10). The locations viz., Bankura, Imphal, Jagdalpur, Mugad, Pattambi, Ranchi and Rewa where disease pressure was low (<4.0) were not considered for the selection of promising entries.

None of the entries were found superior over resistant check (3.0); however some of the moderate resistant donors were listed in the Table 11 that included HL18WS-20-5 and HL18WS-20-4.

Table 6: Location severity index (LSI) and frequency distribution of leaf blast scores of NSN-H, Kharif 2019

Score	Location/Frequency of score (0-9)											
	ALM	CBT	CTK	IIRR	IMP	KHD	KJT	LVN	MLN	PNP	UMM	USG
0	0	0	0	0	0	3	0	0	0	0	0	3
1	1	0	0	1	0	2	0	0	49	0	0	6
2	1	0	0	0	0	7	0	1	23	3	1	63
3	39	6	2	31	11	58	19	1	7	27	1	46
4	0	26	0	61	12	40	29	3	22	28	0	2
5	31	31	35	6	43	7	27	46	11	26	5	0
6	16	27	1	2	21	2	11	28	3	10	7	0
7	14	18	70	16	30	1	23	20	2	25	7	0
8	13	2	0	0	2	0	6	9	0	1	23	0
9	5	10	12	3	1	0	0	12	0	0	76	0
Total	120	120	120	120	120	120	115	120	117	120	120	120
LSI	5.2	5.6	6.5	4.3	5.5	3.4	5.1	6.1	2.5	4.8	8.2	2.3
Screening method	N	A	A	A	N	N/A	A	A	A	N	N	N

(N-Natural; A-Artificial)

Table 7: Promising entries with low susceptibility index (<5) and high PI in NSN-H to leaf blast, *Kharif* 2019

P. No.	IET No.	Location/Frequency of score (0-9)									SI	Total	<=3*	PI (<-3)**	<=5*	PI (<-5)**
		ALM	CBT	CTK	IIR	IMP	KJT	LVV	PNP	UMM						
120	Tetep	5	6	5	1	3	3	2	3	2	3.3	9	6	67	8	89
45	28193	3	6	5	3	5	3	5	3	8	4.6	9	4	44	7	78
78	28222	3	4	3	3	3	6	5	7	9	4.8	9	4	44	6	67
2	27491	3	4	7	4	5	3	5	3	9	4.8	9	3	33	7	78
65	28211	3	6	3	4	3	7	6	6	5	4.8	9	3	33	5	56
105	27498	5	7	5	3	5	3	5	3	8	4.9	9	3	33	7	78
31	26580	3	3	5	4	7	5	6	2	9	4.9	9	3	33	6	67
100	27506	5	6	5	3	6	3	5	3	8	4.9	9	3	33	6	67
62	28208	3	5	7	3	6	5	6	3	6	4.9	9	3	33	5	56
107	HR-12	9	9	9	9	7	4	9	7	9	8.0	9	0	0	1	11
LSI		5.2	5.6	6.5	4.3	5.5	5.1	6.1	4.8	8.2						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤5 and ≤3;**Promising index (PI) based on no. of locations where the entry had scored ≤3 and ≤5)

Table 8: Location severity index (LSI) and frequency distribution of leaf blast scores of NHSN, *Kharif* 2019

Score	Location/Frequency of score (0-9)																							
	ALM	BNK	CBT	GGT	GNV	HZB	IIRR	IMP	JDP	JGT	KHD	KJT	LVN	MGD	MLN	MND	NWG	PNP	PTB	RNC	REW	RNR	UMM	USG
0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	13	0	23	0
1	8	0	0	0	9	1	1	0	11	0	0	0	0	0	31	0	0	1	0	11	9	8	23	0
2	2	0	0	0	26	13	0	0	17	2	7	0	1	1	10	0	2	14	0	13	29	0	2	55
3	6	98	1	0	30	24	17	16	33	2	18	42	1	72	3	3	9	36	14	6	22	43	13	40
4	20	0	41	12	6	13	46	26	17	12	35	33	3	7	13	14	14	19	79	33	28	0	8	7
5	18	10	19	73	11	12	18	32	15	19	34	10	40	23	12	21	36	19	8	23	6	36	18	1
6	21	0	27	1	1	10	1	17	7	21	9	6	28	2	11	10	22	7	2	10	0	0	10	0
7	16	0	8	22	5	24	23	15	2	31	4	9	19	3	5	21	19	6	4	9	0	9	6	0
8	12	0	2	0	1	7	0	2	1	6	0	0	2	0	0	13	5	2	0	3	0	0	3	0
9	5	0	10	0	18	4	2	0	2	14	0	0	14	0	2	24	1	0	0	0	0	10	1	0
Total	108	108	108	108	107	108	108	108	108	107	108	100	108	108	87	106	108	104	107	108	107	106	107	103
LSI	5.4	3.2	5.4	5.3	4.1	4.9	4.7	5.0	3.4	6.3	4.3	4.1	6.1	3.6	3.3	6.6	5.4	3.9	4.1	4.2	2.6	4.4	3.0	2.6
Screening method	N	A	A	-	A	N	A	N	N	-	N/A	A	A	N	A	A	A	N	N	A	A	A	N	N

(N-Natural; A-Artificial)

Table 9: Promising entries with low susceptibility index (≤ 4) and high PI in NHSN to leaf blast, *Kharif* 2019

P. No.	IET No.	Location/Frequency of score (0-9)																SI	Total	<=3*	PI (<3)**	<=5*	PI (<5)**
		ALM	CBT	GGT	GNV	HZB	IIRR	IMP	JGT	KHD	KJT	LVN	MND	NWG	PTB	RNC	RNR						
108	Tetep	5	6	5	2	2	1	3	4	3	4	2	5	2	3	4	3	3.4	16	9	56	15	94
4	28113	1	4	5	2	2	4	4	5	4	3	6	4	6	3	2	3	3.6	16	7	44	14	88
1	28111	1	4	5	1	1	3	5	5	4	7	5	4	5	4	1	3	3.6	16	6	38	15	94
6	28115	3	4	5	2	3	3	3	4	4	3	7	3	5	3	2	5	3.7	16	9	56	15	94
63	28163	3	5	5	4	3	3	6	5	3	3	5	3	3	4	2	5	3.9	16	8	50	15	94
25	28130	4	6	5	2	3	5	6	2	2	3	5	7	6	4	1	1	3.9	16	7	44	12	75
61	28162	4	4	5	2	3	3	5	6	3	3	6	4	4	4	2	5	3.9	16	6	38	14	88
38	28141	1	4	5	1	3	4	5	7	5	4	5	3	6	4	1	5	3.9	16	5	31	14	88
95	HR-12	8	9	5	9	9	9	5	7	7	6	9	9	7	5	5	9	7.4	16	0	0	4	25
LSI		5.4	5.4	5.3	4.1	4.9	4.7	5.0	6.3	4.3	4.1	6.1	6.6	5.4	4.1	4.2	4.4						

(SI-Susceptibility Index; *No. of locations where the entry has scored ≤ 5 and ≤ 3 ; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 10: Location severity index (LSI) and frequency distribution of leaf blast scores of DSN, Kharif 2019

Score	Location/Frequency of score(0-9)																							
	ALM	BNK	CBT	CTK	GGT	GNV	HZB	IIRR	IMP	JDP	JGT	KJT	LVN	MGD	MLN	MND	NWG	PNP	PTB	RNC	REW	RNR	UMM	USG
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	0	0	1
1	0	0	0	0	0	4	1	1	2	6	2	0	0	0	25	1	0	2	0	5	64	15	3	10
2	2	0	0	0	0	27	2	1	4	36	12	0	2	2	12	9	15	15	15	33	50	0	17	25
3	25	145	0	6	1	38	39	35	76	48	6	10	1	94	4	12	17	57	62	20	2	62	21	18
4	0	0	28	0	1	2	12	33	20	39	25	38	5	6	9	16	16	19	47	54	1	0	7	35
5	20	6	54	101	126	14	27	28	45	13	33	30	44	31	13	22	50	33	15	22	0	33	19	11
6	18	0	22	0	2	4	21	6	1	2	21	20	56	9	16	12	9	11	4	11	0	0	4	18
7	30	0	29	37	21	3	18	44	3	1	34	30	29	8	15	15	34	13	4	5	0	27	11	4
8	30	0	5	0	0	5	13	0	0	3	6	13	2	0	9	16	7	0	1	0	0	0	7	6
9	25	0	12	7	0	52	17	3	0	2	11	0	12	0	14	48	3	0	2	0	0	10	13	22
Total	150	151	150	151	151	149	150	151	151	150	150	141	151	150	117	151	151	150	150	150	150	147	102	150
LSI	6.4	3.1	5.8	5.6	5.3	5.4	5.4	5.0	3.8	3.4	5.5	5.4	6.0	3.8	4.8	6.4	5.1	4.0	3.7	3.7	1.2	4.4	4.9	4.6
Screening method	N	A	A	A	-	A	N	A	N	N	-	A	A	N	A	A	A	N	N	A	A	A	N	N

(N-Natural; A-Artificial)

Table 11: Promising entries with low susceptibility index (≤ 4) and high PI in DSN to leaf blast, *Kharif 2019*

P. NO	Designations	Location/Frequency of score (0-9)																	SI	Total	≤3*	PI (<3)**	≤5*	PI (<5)**
		ALM	CBT	CTK	GGT	GNV	HZB	IIRR	JGT	KJT	LNV	MLN	MND	NWG	PNP	RNR	UMM	USG						
150	Tetep	3	6	5	5	3	1	1	8	4	2	1	5	3	3	3	2	5	3.5	17	10	59	15	88
94	HL18WS-20-5	5	6	5	5	2	3	4	2	5	4	1	2	4	6	3	7	2	3.9	17	7	41	14	82
92	HL18WS-20-4	3	5	5	5	2	3	4	2	4	6	1	4	3	5	5	5	6	4.0	17	6	35	15	88
84	HR-12	9	9	9	5	9	9	7	6	8	9	9	9	9	3	7	-	9	7.9	16	1	6	2	13
LSI		6.4	5.8	5.6	5.3	5.4	5.4	5.0	5.5	5.4	6.0	4.8	6.4	5.1	4.0	4.4	4.9	4.6						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

❖ NECK BLAST

➤ NSN-1

The National Screening Nursery-1 (NSN-1) for neck blast disease was evaluated at nine locations across India with 353 entries during *Kharif* 2019. The entries were screened under natural conditions in all the centres except at Nawagami and Rajendranagar, where artificial method of screening was followed with spray of spore suspension. The frequency distribution of disease scores and location severity indices are presented in Table 12. The highest and lowest disease pressure was observed at Lonavala (6.8) and Bankura (1.9) respectively. The disease pressure was high (LSI 6-7) at Nellore (6.3) and Lonavala (6.8); while it was moderate (LSI 4-6) at Nawagami (4.0), Jagadapur (4.4), Ponnampet (4.7), Rajendranagar (4.7), Mandya (5.2) and Jagtial (5.3). The data from Bankura was not considered for selection of best entries.

The data presented in the Table 12 depicts the frequency distribution of disease scores along with location severity indices. Some of the promising entries which performed better across all locations include IET # 27538, 27547, 27747, 27723, 25212, 27686, 27574, 26684, 26819, 27438, 27346, 26948, 26847, 27743, 27077, 25945, 27285, 27118, 26118 and 27632 (Table 13).

Table 12: Location severity index (LSI) and frequency distribution of Neck blast scores of NSN-1, *Kharif* 2019

Score	Location/Frequency of score(0-9)								
	BNK	JDP	JGT	LVN	MND	NWG	PNP	RNR	NLR
0	39	15	0	0	0	0	2	10	0
1	170	22	0	7	40	12	43	60	14
2	0	0	0	0	0	0	0	0	0
3	104	81	47	16	101	188	115	61	26
4	1	0	0	0	0	0	1	0	0
5	36	171	224	100	76	111	76	104	116
6	0	0	0	0	0	0	0	0	0
7	3	61	60	104	57	35	70	85	100
8	0	0	0	0	0	0	0	0	0
9	0	2	19	113	78	6	45	33	93
Total	353	352	350	340	352	352	352	353	349
LSI	1.9	4.4	5.3	6.8	5.2	4.1	4.7	4.7	6.3
Screening method	N	N	N	N	N	A	N	A	N

(N-Natural; A-Artificial)

Table 13: Promising entries with low susceptibility index (≤ 4) and high PI in NSN-1 to Neck blast, *Kharif* , 2019

P. No.	IET No.	Location/Frequency of score (0-9)								SI	Total	$\leq 3^*$	PI (≤ 3)**	$\leq 5^*$	PI (≤ 5)**
		JDP	JGT	LNV	MND	NWG	PNP	RNR	NLR						
353	Tetep	0		1	3	3	3	5	3	2.6	7	6	86	7	100
150	27538	0	5	5	1	3	3	1	3	2.6	8	6	75	8	100
154	27547	3	5	3	3	3	1	3	3	3.0	8	7	88	8	100
104	27747	5	5	3	1	3	1	1	5	3.0	8	5	63	8	100
59	27723	0	5	9	3	3	1	1	3	3.1	8	6	75	7	88
20	25212 (R)	0	3	7	9	5	1	0	1	3.3	8	5	63	6	75
169	27686	1	5	5	3	5	1	1	5	3.3	8	4	50	8	100
14	27574	5	5	-	3	3	1	1	5	3.3	7	4	57	7	100
18	26684	3	3	5	5	3	1	0	7	3.4	8	5	63	7	88
175	26819 (R)	1	5	7	5	3	1	0	5	3.4	8	4	50	7	88
7	27438	3	5	-	5	5	1	0	5	3.4	7	3	43	7	100
117	27346	7	5	5	1	3	3	1	3	3.5	8	5	63	7	88
246	26948	1	3	5	3	3	5	1	7	3.5	8	5	63	7	88
133	US 312 (HC)	5	5	5	1	3	1	7	1	3.5	8	4	50	7	88
168	26847(R)	5	3	5	3	3	3	3	5	3.8	8	5	63	8	100
111	27743	5	3	9	1	3	1	5	3	3.8	8	5	63	7	88
37	27077	1	5	7	3	7	1	3	3	3.8	8	5	63	6	75
239	25945	1	5	7	3	3	1	3	7	3.8	8	5	63	6	75
301	27285	3	3	5	1	7	3	1	7	3.8	8	5	63	6	75
5	27118	3	5	5	3	5	1	1	7	3.8	8	4	50	7	88
161	26118	1	5	5	5	3	3	1	7	3.8	8	4	50	7	88
232	27632	0	5	5	5	3	3	0	9	3.8	8	4	50	7	88
340	HR-12	7	5	9	9	7	9	9	9	8.0	8	0	0	1	13
LSI		4.5	5.3	6.8	5.2	4.1	4.7	4.7	6.3						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ NSN-2

A total of 672 entries were evaluated under NSN-2 at four different locations during *kharif* 2019. The screening was done under natural infection condition at all the locations. The location severity index and frequency distribution of scores presented in the Table 14 indicated that, the disease pressure was moderate (LSI 4-6) at Mandya (5.4) and Ponnampet (5.7). The centres *viz.*, Jagdalpur (3.6) and Bankura (2.0) showed lower disease pressure (LSI <4); and hence the data from these centres were not considered for selection of best entries. The entries that had shown low disease scores across the two locations (Mandya and Ponnampet) were listed in Table 15. Since only two centres were considered in selection of best entries, hence it may not help in understanding the resistance/susceptible nature of entries; however a few promising entries are IET# 28732, 28514, 28306, 28462, 28500, 28505, 28521, 28397, 28686, 28723, 28502, 28510, 28532, 28545, 28301, 28302, 28304, 28317, 28290, 28702, 28703, 27730, 28088 and 28828.

➤ NSN-H

A total of 120 entries were evaluated under NSN-hills nursery at five different locations across India under hill ecosystem. The entries were screened under natural infection condition at locations. The location severity index and frequency distribution of scores were presented in the Table 16. The disease pressure was high at Lonavala (6.5) and Ponnampet (6.9); while it was moderate (LSI 4-6) at Malan (4.0) and Imphal (4.5). The disease pressure was low at Almora (2.7) and hence not considered for selection of promising entries. The entries *viz.*, IET#. 28222, 28237, 27466, 26565, 25819, 26588, 26579, 28188, 28223, 28230, 28231, 28238, 28239 and 27463 were found to be promising against neck blast disease across the locations (Table 17).

➤ NHSN

The entries in National Hybrid Screening Nursery (NHSN) were evaluated for neck blast reaction at 11 locations. The entries were screened under natural infection conditions in all the locations except at Nawagami and Rajendranagar; where artificial method of screening was followed. The disease pressure was high at Jagtial (6.1) and Lonavala (6.3); it was moderate (LSI 4-6) Umiam (4.2), Nawagami (4.2) and Madya (4.8). The data from centres (Almora, Bankura, Imphal, Jagdalpur, Malan and Rajendranagar) where the disease pressure was low (LSI<4) were not considered for selection of best entries (Table 18). The entries which showed low disease score across the locations were considered as promising against neck blast and are listed in Table 19. The entries included IET# 28117, 28187, 28184, 28129, 28128, 28154, 28142 and 28130.

Table 14: Location severity index (LSI) and frequency distribution of Neck blast scores of NSN-2, Kharif 2019

Score	Location/Frequency of score(0-9)			
	BNK	JDP	MND	PNP
0	76	75	0	7
1	315	92	16	21
2	0	1	0	0
3	203	186	182	127
4	2	0	0	1
5	71	239	225	180
6	0	0	0	1
7	5	78	119	231
8	0	0	0	0
9	0	0	122	100
Total	672	671	664	668
LSI	2.0	3.6	5.4	5.7
Screening method	N	N	N	N

(N-Natural; A-Artificial)

Table 15: Promising entries with low susceptibility index (≤ 2) and high PI in NSN-2 to Neck blast, Kharif 2019

P. No.	IET No.	Location/Frequency of score (0-9)		SI	Total	$\leq 3^*$	PI (< 3)**	$\leq 5^*$	PI (< 5)**
		MND	PNP						
282	28732	1	0	0.5	2	2	100	2	100
353	28514	1	1	1.0	2	2	100	2	100
412	28306	1	1	1.0	2	2	100	2	100
112	28462	3	0	1.5	2	2	100	2	100
339	28500	3	0	1.5	2	2	100	2	100
344	28505	3	0	1.5	2	2	100	2	100
361	28521	3	0	1.5	2	2	100	2	100
163	28397	3	1	2.0	2	2	100	2	100
267	28686	1	3	2.0	2	2	100	2	100
273	28723	3	1	2.0	2	2	100	2	100
341	28502	1	3	2.0	2	2	100	2	100
349	28510	1	3	2.0	2	2	100	2	100
372	28532	3	1	2.0	2	2	100	2	100
387	28545	1	3	2.0	2	2	100	2	100
407	28301	3	1	2.0	2	2	100	2	100
408	28302	3	1	2.0	2	2	100	2	100
410	28304	3	1	2.0	2	2	100	2	100
423	28317	3	1	2.0	2	2	100	2	100
459	28290	3	1	2.0	2	2	100	2	100
524	28702	1	3	2.0	2	2	100	2	100
525	28703	3	1	2.0	2	2	100	2	100
641	27730	3	1	2.0	2	2	100	2	100
642	28088	1	3	2.0	2	2	100	2	100
649	28828	1	3	2.0	2	2	100	2	100
672	Tetep	1	3	2.0	2	2	100	2	100
659	HR-12	9	9	9.0	2	0	0	0	0
LSI		5.5	5.7						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 16: Location severity index(LSI) and frequency distribution of Neck blast scores of NSN-H, Kharif 2019

Score	Location/Frequency of score(0-9)				
	ALM	IMP	LNV	MLN	PNP
0	21	0	0	0	0
1	33	1	2	28	0
2	0	0	0	0	0
3	30	44	0	17	7
4	0	0	0	0	0
5	24	60	40	26	26
6	0	0	0	0	0
7	10	15	60	15	56
8	0	0	0	0	0
9	0	0	18	6	31
Total	118	120	120	92	120
LSI	2.7	4.5	6.5	4.0	6.9
Screening method	N	N	N	N	N

(N-Natural; A-Artificial)

Table 17: Promising entries with low susceptibility index (≤ 4) and high PI in NSN-H to Neck blast, Kharif 2019

P. No.	IET No.	Location/Frequency of score (0-9)				SI	Total	$\leq 3^*$	PI (< 3)**	$\leq 5^*$	PI (< 5)**
		IMP	LNV	MLN	PNP						
120	Tetep	3	1	-	3	2.3	3	3	100	3	100
78	28222	3	5	1	5	3.5	4	2	50	4	100
95	28237	5	5	1	3	3.5	4	2	50	4	100
13	27466	3	5	-	3	3.7	3	2	67	3	100
25	26565	3	7	1	5	4.0	4	2	50	3	75
27	25819	3	5	1	7	4.0	4	2	50	3	75
36	26588	3	7	1	5	4.0	4	2	50	3	75
38	26579	3	7	1	5	4.0	4	2	50	3	75
40	28188	3	7	1	5	4.0	4	2	50	3	75
79	28223	5	7	1	3	4.0	4	2	50	3	75
86	28230	3	5	1	7	4.0	4	2	50	3	75
88	28231	3	5	1	7	4.0	4	2	50	3	75
96	28238	3	7	1	5	4.0	4	2	50	3	75
97	28239	3	5	1	7	4.0	4	2	50	3	75
14	27463	1	5	5	5	4.0	4	1	25	4	100
107	HR-12	7	9	-	9	8.3	3	0	0	0	0
LSI		4.5	6.6	4.0	6.9						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 18: Location severity index (LSI) and frequency distribution of Neck blast scores of NHSN, Kharif 2019

Score	Location/Frequency of score(0-9)										
	ALM	BNK	IMP	JDP	JGT	LNV	MLN	MND	NWG	RNR	UMM
0	10	14	0	4	0	0	0	0	0	4	2
1	20	57	0	19	2	2	17	11	3	21	2
2	0	0	0	0	0	0	0	0	0	0	16
3	7	29	65	57	3	0	10	28	46	42	27
4	0	0	0	0	0	0	0	0	0	0	14
5	13	7	43	19	41	44	20	34	47	28	20
6	0	0	0	0	0	0	0	0	0	0	14
7	2	1	0	8	57	43	3	23	10	6	4
8	0	0	0	0	0	0	0	0	0	0	1
9	3	0	0	1	5	15	1	8	2	5	7
Total	55	108	108	108	108	104	51	104	108	106	107
LSI	2.7	1.7	3.8	3.2	6.1	6.3	3.5	4.8	4.3	3.5	4.2
Screening method	N	N	N	N	-	N	N	N	A	A	N

(N-Natural; A-Artificial)

Table 19: Promising entries with low susceptibility index (≤ 4) and high PI in NHSN to Neck blast, Kharif 2019.

P. No.	IET No.	Location/Frequency of score (0-9)					SI	Total	$\leq 3^*$	PI (≤ 3)**	$\leq 5^*$	PI (≤ 5)**
		JGT	LNV	MND	NWG	UMM						
108	Tetep	5	1	3	1	3	2.6	5	4	80	5	100
9	28117	5	5	1	1	5	3.4	5	2	40	5	100
94	28187	5	5	3	3	2	3.6	5	3	60	5	100
89	28184	1	7	3	5	2	3.6	5	3	60	4	80
24	28129	7	-	3	1	4	3.8	4	2	50	3	75
22	28128	5	5	3	3	3	3.8	5	3	60	5	100
52	28154	7	5	1	3	3	3.8	5	3	60	4	80
39	28142	5	5	1	5	3	3.8	5	2	40	5	100
28	US-312	7	5	3	3	2	4.0	5	3	60	4	80
107	Swarnadhan	3	1	7	3	6	4.0	5	3	60	3	60
23	Gontra Bidhan-3	5	5	3	5	2	4.0	5	2	40	5	100
25	28130	1	7	5	3	4	4.0	5	2	40	4	80
95	HR-12	5	9	9	5	9	7.4	5	0	0	2	40
LSI		6.1	6.4	4.8	4.3	4.3						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 5 and ≤ 3 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ DSN

A total of 151 entries were evaluated under Donor screening nursery at eight locations during Kharif, 2019. The location severity index and frequency distribution of scores were presented in the Table 20. The disease pressure was high at Jagtial (LSI 6.0); while it was lowest at Jagdalpur (2.3). The disease pressure was moderate (LSI 4-6) at Mandya (5.4), Lonavala (5.7) and Umiam (5.7) while it was low at (<4) Jagadalpur (2.3), Rajendranagar (3.4), Nawagami (3.7) and Imphal (3.9) and hence data from these centres were not

considered for selection of best entries under DSN. The promising entries with low disease pressure across the locations were presented in Table 21 and that included RP-Bio Patho-11, RP-Bio Patho-7, RP-Patho-2, RP-Patho-3, RP-Patho-9, RP-Bio Patho-10, RP-Bio Patho-12, KNM 7787, HL18WS-22-2, HL18WS20-4, RMS-R-6, RMS-R-13 and RP-Bio Patho-8.

Table 20: Location severity index (LSI) and frequency distribution of Neck blast scores of DSN, Kharif 2019

Score	Location/Frequency of score(0-9)							
	IMP	JDP	JGT	LNV	MND	NWG	RNR	UMM
0	0	30	0	0	0	0	16	0
1	0	52	0	3	16	28	29	1
2	0	0	0	0	0	0	0	6
3	80	30	14	0	21	62	33	20
4	0	0	1	0	0	0	0	19
5	71	32	46	96	47	45	38	9
6	0	0	2	0	0	0	0	6
7	0	5	87	34	47	14	17	7
8	0	0	0	0	0	0	0	5
9	0	1	1	11	19	2	3	29
Total	151	150	151	144	150	151	136	102
LSI	3.9	2.3	6.0	5.7	5.4	3.7	3.4	5.7
Screening method	N	N	N	N	N	A	A	N

(N-Natural; A-Artificial)

Table 21: Promising entries with low susceptibility index (≤ 4) and high PI in DSN to Neck blast, Kharif 2019

P. No.	Designations	Location/Frequency of score (0-9)				SI	Total	$\leq 3^*$	PI (≤ 3)**	$\leq 5^*$	PI (≤ 5)**
		JGT	LNV	MND	UMM						
83	Tetep	5	1	3	3	3.0	4	3	75	4	100
127	Whazhuopek	3	5	1	3	3.0	4	3	75	4	100
75	RP-Bio Patho-11	5	-	1	3	3.0	3	2	67	3	100
126	Phoghak	5	5	1	2	3.3	4	2	50	4	100
71	RP-Bio Patho-7	7	-	1	3	3.7	3	2	67	2	67
54	RP-Patho-2	5	5	3	2	3.8	4	2	50	4	100
55	RP-Patho-3	3	5	5	2	3.8	4	2	50	4	100
61	RP-Patho-9	7	5	1	2	3.8	4	2	50	3	75
74	RP-Bio Patho-10	3	7	1	4	3.8	4	2	50	3	75
76	RP-Bio Patho-12	6	5	1	3	3.8	4	2	50	3	75
32	KNM 7787	3	5	5	3	4.0	4	2	50	4	100
91	HL18WS-22-2	3	5	5	3	4.0	4	2	50	4	100
92	HL18WS-20-4	3	5	5	3	4.0	4	2	50	4	100
102	RMS-R-6	3	5	1	7	4.0	4	2	50	3	75
109	RMS-R-13	5	5	1	5	4.0	4	1	25	4	100
72	RP-Bio Patho-8	7	-	1	4	4.0	3	1	33	2	67
137	HR-12	7	9	9	-	8.3	3	0	0	0	0
LSI		6.0	5.7	5.4	5.7						

(SI-Susceptibility Index; *No. of locations where the entry has scored ≤ 5 and ≤ 3 ; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

❖ SHEATH BLIGHT

➤ NSN-1

The National Screening Nursery-1 (NSN-1) was evaluated for resistance to sheath blight at 19 locations across India. The entries were screened by artificial inoculation at most of the centres except Patna where the entries were evaluated under natural condition and disease pressure was 3.7. The highest disease pressure was recorded at Gangavati (8.0) and lowest at Titabar (3.7) through artificial inoculation. The frequency distribution of disease scores and location severity indices (LSI) were presented in Table 22. The disease pressure was very high (LSI >7) at Gangavati (8.0), Mandya (7.8), Maruteru (7.6), Pattambi (7.6), Cuttack (7.2), IIRR (7.4), New Delhi (7.1) and Ludhiana (7.0); high (LSI 6 - 7) at Masodha (6.7); and moderate (LSI 3-6) at Raipur (5.8), Chiplima (5.6), Aduthurai (5.5), Chinsurah (5.3), Pusa (5.0), Bankura (4.7), Moncompu (4.7), Pant Nagar (4.1) and Titabar (4.0). The selection of best entries in NSN-1 was done based on the reaction at those locations where LSI was ≥ 4 . Some of the promising entries with SI ≤ 5.0 are presented in the Table 23. None of the entries were found resistant (SI ≤ 3.0) against sheath blight disease. The promising entries were selected based on low susceptibility index than Swarnadhan (tolerant check) are IET Nos. 26684, 27836, 27118, 25912, 27781, 27637, 26692, 27851, 27646, 26927, 27438 and 26118.

➤ NSN-2

The National Screening Nursery-2 (NSN-2) was evaluated for their resistance to sheath blight at 15 locations. The entries were screened by artificial inoculation at most of the centres except Patna where the entries were evaluated under natural condition and observed a moderate level of disease severity (LSI <3.4). The frequency distribution of disease scores and location severity index (LSI) are presented in Table 24. The disease pressure was very high (LSI >7) at Gangavati (8.0), Mandya (8.0), Maruteru (7.6), Ludhiana (7.0); high (LSI 6 - 7) at Pattambi (6.9), Raipur (6.7), IIRR (6.4), Titabar (6.4) and Masodha (6.1); and moderate (LSI 3-6) at Aduthurai (5.9), Pusa (5.0), Bankura (4.9), Pantnagar (4.7), Moncompu (3.6) and Patna (3.4). The selection of promising entries in NSN-2 was done based on the reaction at those locations where LSI was ≥ 4.0 . Some of the promising entries with SI ≤ 5.0 are presented in the Table 25. None of the entries were resistant (SI ≤ 3.0) against sheath blight. Highly promising entries (IET Nos. 28688, 28455, 28304, 28676, and 28305) were found better than tolerant check (Tetep). Besides, some of the other promising entries *viz.*, IET Nos. 28517, 28293, 28301, 28482, 28471, 28478, 28346, 28732 and 28310 were selected and they found better than Swarnadhan (tolerant check).

Table 22: Location severity index and frequency distribution of sheath blight disease score for NSN-1 entries, *Kharif-2019*

Score	Location/Frequency of score(0-9)																		
	ADT	BNK	CHN	CHP	CTK	GNV	IIRR	LDN	MNC	MND	MSD	MTU	NDL	PNT	PSA	PTB	PTN	RPR	TTB
0	14	0	0	0	0	0	0	0	8	0	0	0	0	4	1	0	36	0	0
1	12	36	0	9	11	0	0	0	38	1	0	0	0	20	11	0	5	19	31
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
3	69	100	62	60	19	1	10	0	74	3	15	0	1	147	59	11	101	35	167
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	98	0	0
5	97	120	175	140	34	16	41	5	120	21	105	28	81	151	203	28	90	119	108
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	91	81	107	92	153	144	172	334	102	161	148	195	160	28	69	153	22	134	35
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	66	16	8	48	135	191	130	12	6	166	84	127	102	2	9	158	0	43	9
Total	349	353	352	349	352	352	353	351	348	352	352	350	344	352	353	350	353	350	350
LSI	5.5	4.7	5.3	5.6	7.2	8.0	7.4	7.0	4.7	7.8	6.7	7.6	7.1	4.1	5.0	7.6	3.7	5.8	4.0
Screening method	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	N	A	A

(N- Natural; A- Artificial)

Table 23: Promising entries with low susceptibility index (SI≤5.0) and high promising index in NSN-1 to sheath blight, Kharif-2019

P.No	IET No.	Location/Frequency of score (0-9)																		SI	Total	<=3	PI (<3)*	<=5	PI (<5)**
		ADT	BNK	CHN	CHP	CTK	GNV	IIRR	LDN	MNC	MND	MSD	MTU	NDL	PNT	PSA	PTB	RPR	TTB						
353	Tetep (TC)	0	3	3	7	5	5	5	7	1	1	5	7	7	5	3	3	7	1	4.2	18	8	44	13	72
18	26684	0	1	3	3	9	7	5	7	3	9	3	5	9	1	5	5	1	3	4.4	18	9	50	13	72
19	Purnendu (Eastern)ZC	3	3	3	5	5	9	5	7	3	9	3	5	5	3	3	5	3	1	4.4	18	9	50	15	83
35	27836	5	3	3	5	5	7	5	7	1	9	5	5	7	3	5	5	3	1	4.7	18	6	33	14	78
5	27118	3	3	5	1	3	9	7	7	1	9	5	5	-	0	7	7	5	3	4.7	17	7	41	11	65
13	25912	0	5	5	9	7	7	5	7	1	7	3	7	7	3	3	3	5	1	4.7	18	7	39	11	61
134	27781	-	5	5	3	7	3	5	7	5	7	5	5	5	5	7	5	1	1	4.8	17	4	24	13	76
20	25212 (R)	3	5	3	3	9	7	3	9	3	9	3	5	7	3	7	3	1	3	4.8	18	10	56	12	67
231	27637	0	5	3	5	7	9	5	7	1	7	3	5	7	5	5	3	5	5	4.8	18	5	28	13	72
155	26692	1	7	5	5	7	7	5	7	0	7	5	5	7	5	3	3	5	3	4.8	18	5	28	12	67
24	27851	3	3	5	3	7	7	5	7	3	7	3	7	7	3	5	5	5	3	4.9	18	7	39	12	67
235	27646	1	5	5	5	7	7	3	7	1	9	5	7	7	3	5	7	1	3	4.9	18	6	33	11	61
244	26927	3	5	3	3	3	5	7	7	3	7	5	7	7	3	3	7	9	3	5.0	18	8	44	11	61
7	27438	5	3	3	1	9	9	7	7	-	9	3	5	7	1	1	5	5	5	5.0	17	6	35	11	65
161	26118	3	1	3	1	7	7	7	7	7	7	5	7	5	7	5	3	5	3	5.0	18	6	33	10	56
352	Swarnadhan (TC)	3	7	7	5	7	9	5	7	3	9	5	7	7	5	1	5	7	1	5.6	18	4	22	9	50
342	T(N1) (SC)	9	7	7	9	7	7	9	7	5	9	7	9	9	5	5	7	7	3	7.1	18	1	6	4	22
LSI		5.6	4.7	5.4	5.6	7.2	8.0	7.4	7.0	4.7	7.8	6.7	7.6	7.1	4.1	5.0	7.6	5.8	4.0						

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3* and ≤5**)

Table 24: Location severity index and frequency distribution of sheath blight disease score for NSN-2 entries, *Kharif-2019*

Score	Location/Frequency of score(0-9)														
	ADT	BNK	GNV	IIRR	LDN	MNC	MND	MSD	MTU	PNT	PSA	PTB	PTN	RPR	TTB
0	5	0	0	0	0	107	0	0	0	0	2	0	110	0	0
1	35	0	0	0	0	89	1	0	0	2	27	1	0	29	29
2	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
3	87	252	0	1	0	154	0	6	1	180	179	42	276	12	61
4	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0
5	214	230	42	301	8	172	6	320	69	405	271	159	228	117	155
6	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0
7	188	148	259	255	626	127	303	316	319	75	156	265	33	375	249
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	132	42	370	109	23	6	353	24	259	2	37	198	0	135	171
Total	661	672	671	669	657	655	663	666	648	664	672	665	672	668	665
LSI	5.9	4.9	8.0	6.4	7.0	3.6	8.0	6.1	7.6	4.7	5.0	6.9	3.4	6.7	6.4
Screening method	A	A	A	A	A	A	A	A	A	A	A	A	N	A	A

(N- Natural; A- Artificial)

Table 25: Promising entries with low susceptibility index (SI≤5.0) and high promising index in NSN-2 to sheath blight, *Kharif-2019*

P.No.	IET No.	Location/Frequency of score (0-9)													SI	Total	≤3	PI (<3)*	≤5	PI (<5)**
		ADT	BNK	GNV	IRR	LDN	MND	MSD	MTU	PNT	PSA	PTB	RPR	TTB						
269	28688	0	5	9	5	7	7	5	5	3	3	5	1	3	4.5	13	5	38	10	77
94	28445	5	3	9	5	5	7	5	5	3	7	3	1	1	4.5	13	5	38	10	77
410	28304	3	5	7	5	7	7	3	5	3	5	3	5	1	4.5	13	5	38	10	77
256	28676	5	5	7	5	7	7	5	5	3	3	5	1	1	4.5	13	4	31	10	77
411	28305	3	5	9	5	7	5	5	5	3	3	3	5	3	4.7	13	5	38	11	85
564	28255	3	7	7	7	7	7	5	-	5	1	7	1	1	4.8	12	4	33	6	50
672	Tetep (TC)	5	5	9	5	7	1	5	9	5	3	3	3	3	4.8	13	5	38	10	77
357	28517	1	3	7	5	7	9	7	5	3	5	3	5	3	4.8	13	5	38	9	69
398	28293	1	3	9	5	7	7	5	5	5	3	3	7	3	4.8	13	5	38	9	69
407	28301	1	3	5	5	7	7	5	7	3	5	5	7	3	4.8	13	4	31	9	69
135	28482	1	3	7	5	7	7	5	7	5	1	7	7	1	4.8	13	4	31	7	54
123	28471	3	5	7	5	7	9	5	7	3	3	5	3	3	5.0	13	5	38	9	69
131	28478	3	3	5	5	7	7	5	7	5	3	5	7	3	5.0	13	4	31	9	69
26	28346	5	3	9	5	-	7	5	5	5	1	3	7	5	5.0	12	3	25	9	75
282	28732	1	3	5	5	7	7	5	7	5	3	5	7	5	5.0	13	3	23	9	69
416	28310	3	5	7	5	7	7	5	5	5	3	5	7	1	5.0	13	3	23	9	69
671	Swarnadhan (TC)	5	9	7	5	7	9	5	9	5	1	3	1	3	5.3	13	4	31	8	62
661	TN1 (SC)	5	9	9	9	7	9	7	7	5	7	7	5	5	7.0	13	0	0	4	31
LSI		5.9	4.9	8.0	6.4	7.0	8.0	6.1	7.6	4.7	5.0	6.9	6.7	6.4	-					

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3* and ≤5**)

➤ NSN-H

The National Screening Nursery - Hills (NSN-H) was evaluated for their resistance to sheath blight at Cuttack, IIRR and Pantnagar. These entries were screened through artificial inoculation in all the locations. The frequency distribution of disease scores and location severity indices are presented in Table 26. The disease pressure was high (LSI 6-7) at IIRR (7.1) and Cuttack (6.9) and moderate at (LSI 3-6) Pantnagar (5.1). The selection of best entries was done based on the reaction at these three locations. None of the entries were resistant ($SI \leq 3.0$) against sheath blight. Some of the promising entries better than tolerant check (Tetep) are IET Nos.28217, 28198, 28212 and 27498 (Table 27).

➤ NHSN

The National Hybrid Screening Nursery (NHSN) was evaluated for their resistance to sheath blight at 20 varied hot spot locations. The entries were screened by artificial inoculation at most of the centres except Patna where the entries were evaluated under natural incidence with moderate disease pressure (LSI 3.5). The frequency distribution of disease score and location severity index (LSI) are presented in the Table 28. The disease pressure was very high ($LSI > 7$) at Maruteru (8.9), Gangavathi (8.2), Mandya (7.3), Titabar (7.2) and Pattambi (7.0); high (LSI 6-7) at Cuttack (6.9), Ludhiana (6.7) and IIRR (6.1); and moderate (LSI 3-6) at Raipur (5.9), Masodha (5.9), New Delhi (5.7), Chinsurah (5.6), Aduthurai (5.5), Bankura (5.4), Pant Nagar (4.9), Kaul (4.4), Pusa (4.2) and Arundhatinagar (4.1); and low ($LSI < 3$) at Moncompu (3.3). Therefore, the data from those centers having $LSI \leq 4.0$ was not considered for selecting the promising entries. None of the entries were showed resistant against sheath blight. Some of the promising entries IET 28148, 28166, 28141, 28160, 28173, 28152, 28151, 28155 and 28154) showed less disease severity index when compare to tolerant check (Swarnadhan) are listed in Table 29.

➤ DSN

The Donor Screening Nursery (DSN) was evaluated for resistance to sheath blight at 18 hot spot locations in India. The entries were screened by artificial inoculation at all the centres except Patna where the entries were evaluated under natural conditions and it was recorded moderate disease pressure (4.5). The frequency distribution of disease scores and location severity index (LSI) were presented in Table 30. The disease pressure was very high ($LSI > 7$) at Maruteru (8.1), Mandya (7.7), Gangavati (7.5) and Ludhiana (7.0); high (LSI 6-7) at IIRR (6.9), Masodha (6.8), Pattambi (6.8), Cuttack (6.8), Kaul (6.5) and Aduthurai (6.4); and moderate (LSI 3-6) at New Delhi (5.7), Chiplima (5.5), Raipur (5.3), Moncompu (4.6), Patna (4.5), Pant Nagar (4.4) and Titabar (3.6). The selection of promising entries in DSN was done based on the reaction at those locations where LSI was ≥ 4.0 . None of the entries were showed resistant (≤ 3) against sheath blight. However, some of the promising entries were presented in the Table 31. The selected promising entries viz., IET 25692, Phoghak, RP-Patho-9, Gonalasha, CR 4209-2, RMS-R-11, Pankaj, RMS-R-6, KNM 7786, MSM-BB-61, Whazhuopek, GSY-4-9, NWGR 11048, CR 4053-24-40-1, SM-801 and MSM-SB-87 performed better than tolerant check Tetep and lower susceptibility index than field tolerant check Swarnadhan.

Table 26: Location severity index and frequency distribution of sheath blight disease score for NSN-H entries, Kharif-2019

Score	Location/Frequency of score(0-9)		
	CTK	IIRR	PNT
0	0	0	0
1	4	0	0
2	0	0	0
3	9	0	22
4	0	0	0
5	22	27	72
6	0	0	0
7	36	61	24
8	0	0	0
9	47	32	2
Total	118	120	120
LSI	6.9	7.1	5.1
Screening method	A	A	A

(N- Natural; A- Artificial)

Table 27: Promising entries with low susceptibility index (SI≤5.0) and high promising index in NSN-H to sheath blight, Kharif-2019

P.No.	IET No.	CTK	IIRR	PNT	SI	Total	≤3	PI (≤3)*	≤5	PI (≤5)**
72	28217	1	7	3	3.7	3.0	2.0	66.7	2	67
51	28198	1	5	5	3.7	3.0	1.0	33.3	3	100
66	28212	3	5	5	4.3	3.0	1.0	33.3	3	100
105	27498	5	5	3	4.3	3.0	1.0	33.3	3	100
120	Tetep (RC)	3	5	5	4.3	3.0	1.0	33.3	3	100
108	IR-65	1	7	5	4.3	3.0	1.0	33.3	2	67
15	Vivekdhan 86 (NC)	3	5	7	5.0	3.0	1.0	33.3	2	67
20	27465	7	5	3	5.0	3.0	1.0	33.3	2	67
30	25826 (R)	5	7	3	5.0	3.0	1.0	33.3	2	67
32	26594	3	7	5	5.0	3.0	1.0	33.3	2	67
63	28209	7	5	3	5.0	3.0	1.0	33.3	2	67
84	28228	3	7	5	5.0	3.0	1.0	33.3	2	67
97	28239	3	7	5	5.0	3.0	1.0	33.3	2	67
114	Ajaya	1	7	7	5.0	3.0	1.0	33.3	1	33
10	27479	5	5	5	5.0	3.0	0.0	0.0	3	100
13	27466	5	5	5	5.0	3.0	0.0	0.0	3	100
87	Sukaradhan -1 (NC)	5	5	5	5.0	3.0	0.0	0.0	3	100
89	28232	5	5	5	5.0	3.0	0.0	0.0	3	100
119	Swarnadhan (TC)	5	5	5	5.0	3.0	0.0	0.0	3	100
109	T(N)1 (SC)	3	9	5	5.7	3	1	33	2	67
LSI		7.0	7.0	7.1	5.1	-	-	-	-	-

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3* and ≤5**)

Table 28: Location severity index and frequency distribution of sheath blight disease score for NHSN entries, Kharif-2019

Score	Location/Frequency of score (0-9)																			
	ADT	BNK	CHN	CTK	GNV	IIRR	KUL	LDN	MNC	MND	MSD	MTU	NDL	PNT	PSA	PTB	PTN	RPR	TB	ARD
0	2	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	9	0	0	0
1	5	0	0	3	0	0	1	0	10	1	0	0	0	1	7	0	7	0	1	6
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	13	26	1	8	0	0	44	1	25	0	1	0	4	19	48	1	47	11	5	49
4	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
5	31	45	76	17	1	55	40	23	26	12	62	1	62	67	35	26	45	40	14	29
6	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	43	25	29	41	41	43	18	71	14	62	42	3	37	15	16	51	0	54	48	16
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	5	12	2	38	65	8	0	8	0	31	3	99	2	0	2	30	0	3	40	0
Total	99	108	108	107	107	108	106	103	94	106	108	103	105	102	108	108	108	108	108	100
LSI	5.5	5.4	5.6	6.9	8.2	6.1	4.4	6.7	3.3	7.3	5.9	8.9	5.7	4.9	4.2	7.0	3.5	5.9	7.2	4.1
Screening method	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	N	A	A	-

(N-Natural; A-Artificial)

Table 29: Promising entries with low susceptibility index (SI≤5.5) and high promising index in NHSN to sheath blight, Kharif-2019

P.No	IET No.	Location/Frequency of score (0-9)																		SI	Total	<=3	PI (<-3)*	<=5	PI (<-5)**
		ADT	BNK	CHN	CTK	GNV	IIRR	KUL	LDN	MND	MSD	MTU	NDL	PNT	PSA	PTB	RPR	TTB	ARD						
108	Tetep	5	5	5	5	7	5	3	5	1	5	9	5	5	3	5	5	9	3	5.0	18	4	22	15	83
46	28148	1	5	3	5	9	5	7	7	9	5	9	7	5	5	3	3	3	3	5.2	18	6	33	12	67
66	28166	5	3	5	3	7	7	3	7	7	5	9	7	1	3	5	7	5	-	5.2	17	5	29	10	59
38	28141	1	7	5	3	7	6	5	7	9	5	7	5	5	3	9	3	5	3	5.3	18	5	28	11	61
59	28160	7	5	5	5	7	5	7	3	7	5	9	5	5	3	5	5	7	1	5.3	18	3	17	12	67
74	28173	3	3	5	5	7	5	5	5	7	7	-	7	5	5	7	7	5	3	5.4	17	3	18	11	65
50	28152	-	7	7	7	-	5	5	-	-	5	-	-	-	7	5	3	5	3	5.4	11	2	18	7	64
62	HRI-174 (NCH)	5	3	5	7	7	5	3	5	9	5	9	5	3	3	7	5	9	3	5.4	18	5	28	12	67
49	28151	9	5	5	7	9	5	3	7	7	5	9	3	3	5	7	3	5	1	5.4	18	5	28	11	61
53	28155	7	3	5	3	7	5	3	7	7	7	9	5	5	3	9	5	7	1	5.4	18	5	28	10	56
52	28154	5	5	5	9	9	5	3	7	7	5	9	5	3	5	7	7	1	1	5.4	18	4	22	11	61
41	MTU-1010 (RCV)	3	3	7	7	7	5	5	7	7	5	9		5	5	5	3	7	3	5.5	17	4	24	10	59
107	Swarnadhan (TC)	5	9	5	5	9	5	5	7	9	5	5	9	5	3	7	7	7	3	6.1	18	2	11	10	56
97	T(N1) (SC)	9	9	7	7	7	9	3	7	7	7	9	7	5	7	7	7	9	7	7.2	18	1	6	2	11
LSI		5.5	5.4	5.6	6.9	8.2	6.1	4.5	6.7	7.4	5.9	8.9	5.7	4.9	4.2	7.1	5.9	7.2	4.1						

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3* and ≤5**)

Table 30: Location severity index and frequency distribution of sheath blight disease score for DSN entries, Kharif-2019

Score	Location/Frequency of score(0-9)																	
	ADT	BNK	CHP	CTK	GNV	IIRR	KUL	LDN	MNC	MND	MSD	MTU	NDL	PNT	PTB	PTN	RPR	TTB
0	1	0	0	0	0	0	0	0	12	0	0	0	0	0	0	1	0	0
1	1	20	4	6	0	0	0	0	12	1	0	0	1	7	0	1	8	15
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	8	39	27	13	2	0	6	0	33	0	3	0	16	44	9	41	38	25
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0
5	42	41	61	25	26	39	48	4	40	14	44	10	54	86	34	48	43	12
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	75	39	43	48	51	82	55	142	48	64	67	46	45	13	72	24	42	6
8	150	152	151	150	151	152	134	151	150	151	150	147	127	151	151	152	151	62
9	22	12	15	57	71	28	24	4	4	71	35	90	10	0	35	0	19	3
Total	299	303	301	299	301	301	267	301	299	301	299	293	253	301	301	303	301	123
LSI	6.4	4.8	5.5	6.8	7.5	6.9	6.5	7.0	4.6	7.7	6.8	8.1	5.7	4.4	6.8	4.5	5.3	3.6
Screening method	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	N	A	A

(N-Natural; A-Artificial)

Table 31: Promising entries with low susceptibility index (SI≤5.5) and high promising index in DSN to sheath blight, Kharif-2019

P.No.	Designation	ADT	BNK	CHP	CTK	GNV	IIRR	KUL	LDN	MNC	MND	MSD	MTU	NDL	PNT	PTB	PTN	RPR	SI	Total	≤3	PI (≤3)*	≤5	PI (≤5)**
151	IET 25692	3	3	-	7	-	7	-	-	0	-	-	-	-	5	-	4	-	4.1	7	3	43	5	71
126	Phoghak	5	1	5	5	7	5	5	7	1	5	5	9	3	1	5	7	3	4.6	17	5	29	13	76
61	RP-Patho-9	7	1	3	7	9	5	7	7	1	5	5	9	1	5	3	5	1	4.8	17	6	35	11	65
128	Gonalasha	5	3	5	9	7	5	5	7	1	7	3	7	3	5	5	4	1	4.8	17	5	29	12	71
13	CR 4209-2	5	5	3	3	9	5	-	7	1	7	7	5	5	3	3	5	5	4.9	16	5	31	12	75
107	RMS-R-11	3	9	3	1	7	5	7	7	1	7	5	-	5	5	5	5	3	4.9	16	5	31	11	69
124	Pankaj	0	5	5	1	5	5	5	7	1	9	5	9	9	5	7	4	3	5.0	17	4	24	12	71
102	RMS-R-6	5	7	5	9	5	5	7	7	1	7	5	5	5	3	3	4	3	5.1	17	4	24	12	71
31	KNM 7786	5	5	5	5	7	5	5	7	0	7	7	7	-	3	5	5	3	5.1	16	3	19	11	69
36	MSM-BB-61	7	1	3	1	7	7	5	7	3	7	9	9	3	3	7	5	3	5.1	17	7	41	9	53
127	Whazhuopek	3	1	7	5	9	5	5	7	3	5	7	7	5	5	5	7	5	5.4	17	3	18	11	65
122	GSY-4-9	5	1	5	5	5	5	5	7	3	9	7	7	7	5	7	3	5	5.4	17	3	18	11	65
18	NWGR 11048	3	1	5	5	9	5	7	7	3	9	7	9	-	1	7	5	3	5.4	16	5	31	9	56
2	CR 4053-24-40-1	7	5	3	3	9	7	5	7	7	7	7	7	3	3	7	3	3	5.5	17	6	35	8	47
129	SM-801	5	3	7	7	5	5	5	7	3	7	7	9	5	3	3	5	7	5.5	17	4	24	10	59
35	MSM-SB-87	1	3	5	9	7	5	5	7	1	9	7	7	7	5	7	5	3	5.5	17	4	24	9	53
83	Tetep (TC)	7	5	5	5	7	8	7	7	0	7	5	9	3	5	3	5	7	5.6	17	3	18	9	53
149	Swarnadhan (TC)	5	7	5	7	5	5	7	5	0	9	5	9	7	5	5	3	7	5.6	17	2	12	10	59
139	T(N)1 (SC)	9	7	7	7	9	9	9	7	7	9	7	7	7	5	9	7	7	7.59	17	0	0	1	6
LSI		6.5	4.8	5.5	6.8	7.5	6.9	6.5	7.0	4.6	7.7	6.8	8.1	5.7	4.4	6.8	4.5	5.3	-	-	-	-	-	-

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3* and ≤5**)

❖ BROWN SPOT

➤ NSN-1

The National Screening Nursery (NSN-1) comprised of 353 entries evaluated at 19 locations across India under different-agro ecological Zones. The entries were screened under natural infection conditions at most of the centres except at Coimbatore, Chinsurah, Gangavathi, Ludhiana and Pusa; where screening was conducted under artificial inoculation with spore suspension. The frequency distribution of disease scores and the representative location severity index (LSI) are presented in the Table 32. The disease pressure was highest at Hazaribagh (7.9), while it was lowest at Upper shilling (0.4). It was very high (LSI ≥ 7) at Lonavala (7.1), Gangavathi (7.0), Ludhiana (7.0), while Moderate disease pressure (LSI 4-6) was observed at Chinsurha (4.2), Mugad (4.5), Khudwani (4.6), Ponnampet (4.6), Coimbatore (4.9), Sabour (5.4), Gagarghat (5.7) and Cuttack (5.9). The selection of promising entries was done based on the data of those locations where LSI was more than 4. The disease pressure was low at centres *viz.*, Bankura (3.0), Jagdalpur (3.5) and Rewa (3.6); hence data from these centres were not considered for the selection of best entries. None of the entry was shown a resistance reaction against brown spot disease under NSN-1; however, a few promising entries with low disease score (<5) across the centres included IET# 27077, 28007, 27531, 26861, 27517, 27530, 27386, 26118, 27280, 26635, 27369, 28033, 27438, 27728 and 27732 (Table 33).

➤ NSN-2

A total of 672 entries were screened under NSN- 2 at 15 locations across the India for brown spot disease. The entries were screened under artificial inoculation conditions at Coimbatore, Gangavathi, Ludhiana, Pusa and Rewa; while it was under natural infection condition at remaining locations. The disease pressure was highest and lowest at Gangavathi (7.8) and Ranchi (1.4) respectively. The disease pressure was very high (LSI ≥ 7) at Ludhiana (7.0) while it was high (LSI 6-7) at Cuttack (6.2), Pusa (6.6) and Hazaribagh (6.9). It was moderate (4-6) at Mugad (4.4), Rewa (4.6), Ponnampet (5.1), Coimbatore (5.5), Chatha (5.7) and Gagarghat (5.7). The disease pressure was very low at Ranchi (1.4), Bankura (3.0) and Jagdalpur (3.2); hence data from this centre was not considered for selection of best entries (Table 34). The promising entries with low disease pressure across the locations presented in Table 35. Some of the promising entries included IET# 28329, 28763, 28471, 28648, 28649, 28354, 28331, 28344, 28491, 28467, 28827, 28454 and 28671.

➤ NSN-H

The NSN-H included a total of 120 entries screened at six locations under hill ecological zones of India. The highest disease pressure was recorded at Cuttack (7.3); while it was lowest at Khudwani (5.1) (Table 36). The disease pressure was high at Coimbatore (6.1) and Lonavala (6.1) while moderate (LSI 4-6) at Almora (5.5) and Ponnampet (5.5). None of the entries recorded resistant reaction across the locations. However, a few showed moderate resistance that included IET # 28193, 26594, 27468, 28195, 26596, 28223, 28226, 28189, 27504, 27498, 26580 and 28235 (Table 37).

Table 32: Location severity index (LSI) and frequency distribution of brown spot scores of NSN-1, Kharif 2019.

Score	Location/Frequency of score(0-9)																		
	BNK	CBT	CHN	CHT	CTK	GDL	GGT	GNV	HZB	JDP	KHD	LDN	LVN	MGD	PNP	PSA	REW	SBR	USH
0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	1	7	0	226
1	11	0	4	0	0	0	0	1	0	5	12	0	0	3	15	0	2	49	120
2	98	6	79	0	0	6	0	2	0	58	22	0	0	3	14	0	73	0	6
3	188	43	60	32	13	43	1	16	3	104	45	2	6	85	82	13	82	81	0
4	2	61	34	0	0	61	0	21	7	101	54	0	25	54	58	4	87	0	0
5	51	175	101	119	176	174	199	45	7	60	107	5	22	158	85	3	81	59	0
6	0	17	44	0	0	17	100	38	14	16	44	0	68	14	26	123	15	1	0
7	3	40	21	172	140	40	1	69	75	0	47	342	56	36	54	195	5	80	0
8	0	9	8	0	0	9	52	42	110	0	0	0	86	0	8	13	0	0	0
9	0	2	2	19	17	2	0	118	135	0	0	2	77	0	10	1	1	83	0
Total	353	353	353	342	346	352	353	352	351	352	331	351	340	353	352	353	353	353	352
LSI	3.0	4.9	4.2	6.0	5.9	4.9	5.7	7.0	7.9	3.5	4.6	7.0	7.1	4.5	4.6	6.5	3.6	5.4	0.4
Screening method	N	A	A	N	N	N	N	A	N	N	N/A	A	N	N	N	A	A	N	N

(N-Natural; A-Artificial)

Table 33: Promising entries with low susceptibility index (<5) and high PI in NSN-1 to brown spot, Kharif 2019

P. No.	IET No.	Location/Frequency of score (0-9)															SI	Total	<=3*	PI (<-3)**	<=5*	PI (<-5)**
		CBT	CHN	CHT	CTK	GDL	GGT	GNV	HZB	KHD	LDN	LNV	MGD	PNP	PSA	SBR						
37	27077	5	2	3	3	5	6	5	4	4	3	7	5	1	7	3	4.2	15	6	40	12	80
143	28007	4	2	5	5	4	5	5	7	2	7	7	3	5	6	1	4.5	15	4	27	11	73
73	27531	3	2	3	5	3	5	5	4	7	7	4	7	4	7	3	4.6	15	5	33	11	73
101	26861	3	5	3	3	3	5	6	9	5	7	7	5	1	7	1	4.7	15	6	40	10	67
74	27517	3	2	7	5	3	5	5	7	3	7	5	5	2	6	5	4.7	15	5	33	11	73
76	27530	5	2	5	5	5	5	5	4	5	7	8	4	1	7	3	4.7	15	3	20	12	80
166	27386	3	2	7	5	3	5	3	7	5	7	7	5	3	7	3	4.8	15	6	40	10	67
161	26118	3	3	3	5	3	6	7	8	5	7	7	3	4	7	1	4.8	15	6	40	9	60
299	27280	3	5	3	5	3	6	6	8	3	7	4	3	1	7	9	4.9	15	6	40	9	60
75	26635 (R)	3	2	5	7	3	5	7	7	5	7	4	5	4	6	3	4.9	15	4	27	10	67
122	27369	3	2	7	7	3	5	-	8	2	7	6	3	6	7	3	4.9	14	6	43	7	50
147	28033	5	3	5		5	5	3	8	2	7	8	3	5	7	3	4.9	14	5	36	10	71
7	27438	5	4	5	5	5	5	6	7	4	7	-	4	3	6	3	4.9	14	2	14	10	71
57	27728	3	2	7	5	3	5	8	4	6	7	8	3	2	6	5	4.9	15	5	33	9	60
58	27732	5	2	3	5	5	5	7	4	7	7	5	5	3	6	5	4.9	15	3	20	11	73
350	IR-50	7	4	7	5	7	8	9	8	4	7	7	6	6	4	5	6.3	15	0	0	5	33
LSI		4.9	4.2	6.0	5.9	4.9	5.7	7.0	7.9	4.6	7.0	7.1	4.5	4.7	6.5	5.4						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤3 and ≤5;**Promising index (PI) based on no. of locations where the entry had scored ≤3 and ≤5)

Table 34: Location severity index (LSI) frequency distribution of brown spot scores of NSN-2, Kharif 2019

Score	Location/Frequency of score(0-9)														
	BNK	CBT	CHT	CTK	GGT	GNV	HZB	JDP	LDN	MGD	PNP	PSA	RNC	REW	SBR
0	0	0	0	0	0	0	0	7	0	0	0	4	135	23	0
1	0	0	0	0	0	0	0	13	0	20	17	0	256	1	69
2	196	1	0	0	0	0	0	166	0	0	0	0	209	69	0
3	367	3	116	31	0	5	0	242	2	157	187	14	36	81	126
4	6	126	0	0	48	45	18	174	0	162	1	3	23	121	0
5	98	253	237	282	283	34	127	54	14	245	243	26	9	178	182
6	0	177	0	0	243	67	96	14	0	37	0	170	3	97	0
7	5	78	250	282	5	65	222	1	629	49	192	442	0	97	146
8	0	32	0	0	93	68	88	0	0	2	0	13	0	1	0
9	0	1	55	77	0	381	117	0	18	0	28	0	0	4	145
Total	672	671	658	672	672	665	668	671	663	672	668	672	671	672	668
LSI	3.0	5.5	5.7	6.2	5.7	7.8	6.9	3.2	7.0	4.4	5.1	6.6	1.4	4.6	5.5
Screening method	N	A	N	N	N	A	N	N	A	N	N	A		A	N

(N-Natural; A-Artificial)

Table 35: Promising entries with low susceptibility index (<5) and high PI in NSN-2 to brown spot, Kharif 2019

P. No.	IET No.	Location/Frequency of score (0-9)												SI	Total	<3*	PI (<3)**	<5*	PI (<5)**
		CBT	CHT	CTK	GGT	GNV	HZB	LDN	MGD	PNP	PSA	REW	SBR						
8	28329	6	3	7	5	5	8	5	3	3	0	4	1	4.2	12	5	42	9	75
315	28763	4	5	5	4	8	4	3	5	3	5	2	5	4.4	12	3	25	11	92
123	28471	6	3	5	6	4	9	7	3	1	7	3	1	4.6	12	5	42	7	58
228	28648	4	5	5	6	9	5	7	3	3	7	0	1	4.6	12	4	33	8	67
229	28649	5	5	5	6	8	5	7	5	5	0	4	1	4.7	12	2	17	9	75
34	28354	4	-	5	6	-	-	-	3	-	7	3	-	4.7	6	2	33	4	67
10	28331	4	5	5	5	7	8	7	1	3	6	3	3	4.8	12	4	33	8	67
23	28344	4	3	7	5	8	6	7	4	3	3	4	3	4.8	12	4	33	8	67
144	28491	4	3	5	6	5	8	7	4	3	6	3	3	4.8	12	4	33	8	67
119	28467	6	3	5	5	5	8	7	5	1	7	0	5	4.8	12	3	25	8	67
648	28827	4	7	5	6	3	5	7	4	5	7	3	1	4.8	12	3	25	8	67
104	28454	6	3	5	6	6	8	7	3	3	6	2	3	4.8	12	5	42	6	50
251	28671	4	3	5	6	6	5	7	5	3	7	2	5	4.8	12	3	25	8	67
567	28257	7	3	3	6	6	5	-	5	5	6	5	3	4.9	11	3	27	7	64
31	28351	4	3	5	6	9	7	7	3	7	3	2	3	4.9	12	5	42	7	58
105	28455	5	3	5	5	8	9	7	3	3	6	4	1	4.9	12	4	33	8	67
157	27668	7	3	5	5	4	9	7	3	3	7	5	1	4.9	12	4	33	8	67
2	28323	4	3	7	5	5	7	7	6	3	0	3	9	4.9	12	4	33	7	58
52	28372	7	3	3	6	7	7	5	4	3	6	5	3	4.9	12	4	33	7	58
268	28687	7	3	5	5	7	7	7	3	5	7	2	1	4.9	12	4	33	7	58
395	28553	4	7	5	6	3	4	7	3	3	7	7	3	4.9	12	4	33	7	58
418	28312	4	3	5	6	9	6	7	3	3	7	5	1	4.9	12	4	33	7	58
669	IR-50	8	7	7	5	9	8	7	5	7	5	5	9	6.8	12	0	0	4	33
LSI		5.5	5.7	6.2	5.7	7.8	6.9	7.0	4.4	5.1	6.6	4.6	5.5						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤3 and ≤5;**Promising index (PI) based on no. of locations where the entry had scored ≤3 and ≤5)

Table 36: Location severity index (LSI) and frequency distribution of brown spot scores of NSN-H, Kharif-2019

Score	Location/Frequency of score(0-9)					
	ALM	CBT	CTK	KHD	LVN	PNP
0	0	0	0	0	0	0
1	0	0	0	1	0	1
2	0	0	0	4	0	0
3	1	1	3	3	3	25
4	18	8	0	21	8	1
5	52	30	26	51	28	45
6	29	39	0	23	35	0
7	14	25	39	15	28	41
8	6	13	0	2	17	0
9	0	4	52	0	1	7
Total	120	120	120	120	120	120
LSI	5.5	6.1	7.3	5.1	6.1	5.5
Screening method	N	A	N	N/A	N	N

(N-Natural; A-Artificial)

Table 37: Promising entries with low susceptibility index (≤ 5.2) and high PI in NSN-H to brown spot, Kharif 2019

P. No.	IET No.	Location/Frequency of score (0-9)						SI	Total	$\leq 3^*$	PI (< -3)**	$\leq 5^*$	PI (< -5)**
		ALM	CBT	CTK	KHD	LNV	PNP						
120	Tetep	5	8	5	1	3	4	4.3	6	2	33	5	83
45	28193	5	6	5	5	4	3	4.7	6	1	17	5	83
32	26594	6	7	3	5	5	3	4.8	6	2	33	4	67
104	VivekDhan 154	4	5	5	4	5	7	5.0	6	0	0	5	83
18	27468	4	5	9	5	5	3	5.2	6	1	17	5	83
48	28195	5	5	9	4	5	3	5.2	6	1	17	5	83
112	CH-46	5	8	5	5	5	3	5.2	6	1	17	5	83
39	26596	4	4	9	5	6	3	5.2	6	1	17	4	67
79	28223	5	5	7	5	6	3	5.2	6	1	17	4	67
82	28226	5	5	7	6	5	3	5.2	6	1	17	4	67
41	28189	4	7	7	7	5	1	5.2	6	1	17	3	50
99	27504	4	6	7	4	3	7	5.2	6	1	17	3	50
105	27498	3	6	5	6	6	5	5.2	6	1	17	3	50
119	26580	5	5	5	5	6	5	5.2	6	0	0	5	83
31	28235	5	7	5	4	5	5	5.2	6	0	0	5	83
92	IR-50	7	7	7	5	7	7	6.7	6	0	0	1	17
LSI		5.5	6.1	7.4	5.2	6.1	5.5						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ **National Hybrid Screening Nursery (NHSN)**

One hundred and eight hybrids including checks were evaluated at 15 centres against brown spot disease under NHSN. The highest and lowest disease pressure was recorded at Gangavathi (7.5) and Lonavala (2.4) respectively. The disease pressure was high (LSI 6-7) at Pusa (6.1) and Lonavala (6.5). Most of the centres exhibited moderate disease pressure viz., Chinsurah (4.6), Coimbatore (5.0), Mugad (5.0), Almora (5.4), Ludhiana (5.4), Gagharghat (5.6) and Hazaribagh (5.8) (Table 38). The Performance of entries at Bankura, Chatha, Jagdalpur, and Khudwani was not considered for identifying promising entries, as the disease pressure was low at these centres (< 4.0).

None of the entries recorded resistance reaction consistently across the locations however a few promising entries that included IET # 28148, 28144, 28159, 28134, 28181, 28135, 28152, 28121, 28138, 28145, 28161 and 28146 (Table 39).

➤ **DSN**

The entries under donor screening nursery (DSN) were evaluated for their resistance to brown spot at 15 locations with 151 entries across the country. The brown spot resistance screening was done under natural infection conditions in most of the centres except at Coimbatore, Cuttack, Gangavathi, Ludhiana Pusa and Rewa; where artificial method of screening was followed. The frequency distribution of disease scores and location severity index (LSI) are presented in Table 40. The highest and lowest disease pressure was recorded at Gangavathi (7.7) and Rewa (1.0) respectively. The disease Pressure was high (LSI 6-7) at Gagharghat (6.0), Cuttack (6.1), Pusa (6.2), Coimbatore (6.7), Lonavala (6.8) and Ludhiana (6.9). The moderate disease pressure (LSI 4-6) was observed at Mugad (4.4), Sabour (4.9), Almora (5.6) and Hazaribagh (5.8). The data from the locations (Bankura, Chatha, Jagdalpur and Rewa), where the disease pressure was low (LSI <4) was not considered for selection of promising entries. The promising donor lines with low disease reaction across the locations were presented in Table 41 and that includes CR 4209-2, CR 4055-11-40-3, CR 4053-24-40-1, CR 4054-26-2-1, CR 4054-26-2-1, CR 4055-11-28-5, KNM 7787 and KNM 7785.

Table 38: Location severity index (LSI) and frequency distribution of brown spot scores of NHSN, Kharif 2019

Score	Location/Frequency of score(0-9)														
	ALM	BNK	CBT	CHN	CHT	GGT	GNV	HZB	JDP	KHD	LDN	LNV	MGD	PSA	REW
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34
1	0	0	0	0	3	0	0	0	0	0	2	0	0	0	14
2	0	40	0	5	0	0	0	1	12	11	0	0	0	0	6
3	4	52	5	0	92	0	1	9	26	32	29	2	11	7	7
4	17	0	37	49	0	17	7	11	43	37	0	6	22	6	26
5	42	14	41	34	11	47	9	27	16	20	20	17	52	12	19
6	27	0	13	15	0	27	13	18	11	8	0	23	6	33	0
7	16	2	4	4	1	0	13	29	0	0	52	31	17	46	2
8	2	0	6	1	0	17	19	7	0	0	0	20	0	4	0
9	0	0	2	0	0	0	45	5	0	0	0	5	0	0	0
Total	108	108	108	108	107	108	107	107	108	108	103	104	108	108	108
LSI	5.4	3.0	5.0	4.6	3.2	5.6	7.5	5.8	3.9	3.8	5.4	6.5	5.0	6.1	2.4
Screening method	N	N	A	A	N	N	A	N	N	N/A	A	N	N	A	A

(N-Natural; A-Artificial)

Table 39: Promising entries with low susceptibility index (≤ 5) and high PI in NHSN to brown spot, Kharif 2019

P.No	IET No.	Location/Frequency of score (0-9)										SI	Total	$\leq 3^*$	PI (< -3)**	≤ 5 *	PI (< -5)**
		ALM	CBT	CHN	GGT	GNV	HZB	LDN	LNV	MGD	PSA						
46	28148	5	4	2	4	5	5	3	5	4	6	4.3	10	2	20	9	90
42	28144	4	4	4	5	5	5	3	5	5	6	4.6	10	1	10	9	90
58	28159	5	3	4	5	6	4	1	8	4	7	4.7	10	2	20	7	70
30	28134	6	3	4	5	6	2	5	5	5	7	4.8	10	2	20	7	70
84	28181	6	4	4	5	8	4	5	6	3	3	4.8	10	2	20	7	70
31	28135	5	4	4	6	4	3	7	5	4	6	4.8	10	1	10	7	70
50	28152	5	4	4	4	5	6	—	—	5	6	4.9	8	0	0	6	75
13	28121	4	4	4	6	6	7	3	5	3	7	4.9	10	2	20	6	60
34	28138	7	4	5	4	7	5	3	8	4	3	5.0	10	2	20	7	70
43	28145	5	5	4	5	6	5	3	7	3	7	5.0	10	2	20	7	70
60	28161	5	6	4	5	6	5	5	8	3	3	5.0	10	2	20	7	70
44	28146	4	5	5	6	5	4	3	7	5	6	5.0	10	1	10	7	70
105	IR-50	5	7	7	6	9	7	7	7	4	3	6.2	10	1	10	3	30
LSI		5.4	5.0	4.7	5.6	7.5	5.8	5.4	6.5	5.0	6.1						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 40: Location severity index (LSI) and frequency distribution of brown spot scores of DSN, Kharif 2019

Score	Location/Frequency of score (0-9)														
	ALM	BNK	CBT	CHT	CTK	GGT	GNV	HZB	JDP	LDN	LVN	MGD	PSA	REW	SBR
0	0	0	0	0	0	0	0	0	2	0	0	0	0	63	0
1	0	8	0	16	0	0	0	0	4	0	0	0	0	35	10
2	0	57	0	0	0	0	5	1	39	0	0	0	0	44	0
3	7	67	1	105	8	1	9	8	47	4	6	28	13	6	44
4	23	2	0	0	0	0	0	13	41	0	10	52	5	3	0
5	53	16	5	23	71	43	10	43	12	3	14	61	6	0	47
6	31	0	59	0	0	80	5	30	5	0	27	2	38	0	0
7	19	1	56	6	55	5	19	41	0	143	26	6	78	0	28
8	9	0	26	0	0	22	15	9	0	0	37	1	4	0	0
9	8	0	3	0	17	0	87	5	0	0	24	0	1	0	15
Total	150	151	150	150	151	151	150	150	150	150	144	150	145	151	144
LSI	5.6	2.8	6.7	3.3	6.1	6.0	7.7	5.8	3.2	6.9	6.8	4.4	6.2	1.0	4.9
Screening method	N	N	A	N	N	N	A	N	N	A	N	N	A	A	N

(N-Natural; A-Artificial)

Table 41: Promising entries with low susceptibility index (≤ 5.2) and high PI in DSN to brown spot, Kharif 2019

P.No.	Designations	Location/Frequency of score (0-9)											SI	Total	* \downarrow 3	PI (\downarrow 3)**	* \downarrow 5	PI (\downarrow 5)**
		ALM	CBT	GNV	HZB	CTK	PSA	SBR	LDN	LVN	GGT	MGD						
13	CR 4209-2	5	6	2	2	5	7	3	7	3	7	4	4.6	11	4	36	7	64
10	CR 4055-11-40-3	5	6	3	5	5	3	3	7	5	5	8	5.0	11	3	27	8	73
2	CR 4053-24-40-1	3	8	3	6	5	3	3	7	8	6	4	5.1	11	4	36	6	55
3	CR 4054-26-2-1	3	7	2	3	5	7	7	7	4	6	5	5.1	11	3	27	6	55
9	CR 4055-11-28-5	5	6	2	6	3	7	5	7	5	5	5	5.1	11	2	18	7	64
32	KNM 7787	4	7	9	3	5	7	3	3	6	6	4	5.2	11	3	27	6	55
30	KNM 7785	6	6	9	6	3	6	3	5	3	6	4	5.2	11	3	27	5	45
147	IR-50	5	7	6	9	7	3	9	7	7	6	4	6.4	11	1	9	3	27
LSI		5.6	6.7	7.7	5.9	6.1	6.2	4.9	6.9	6.9	6.0	4.4						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

❖ **SHEATH ROT**➤ **NSN -1**

The National Screening Nursery 1 consisting of 353 entries was evaluated at 13 locations across the country. The screening was done under artificial inoculation at Chinsurah, Navasari, Raipur and Titabar and under natural condition at the remaining centers. Very high disease pressure ($LSI > 7$) was recorded at Lonavala (7.5) and high disease pressure at Raipur (6.4), Navasari (6.1); moderate disease pressure at Nawagam (5.6), Karjat (5.3), Cuttack (5.2), Chinsurah (4.3), Aduthurai (4.0), Rajendranagar (3.6), Bankura (3.4) and Nellore (3.2). The disease pressure was very low ($LSI < 3$) at Rajendranagar (2.8) and Maruteru (1.3) and hence, the data from these centres was not considered for selecting the resistant entries for sheath rot. The frequency distribution of sheath rot scores are presented in the Table 42 along with location severity indices.

Table 42: Location severity index (LSI) and frequency distribution of sheath rot scores of NSN 1, Kharif -2019

Location/Frequency of score(0-9)													
Score	ADT	BNK	CHN	CTK	KJT	LNV	MTU	NVS	NWG	RNR	RPR	TTB	NLR
0	111	4	24	1	0	0	133	0	0	91	0	190	0
1	24	40	57	0	5	0	118	0	0	8	0	114	52
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	53	204	82	0	61	13	74	22	57	151	8	41	223
4	0	0	0	0	0	0	0	0	0	0	0	0	0
5	46	95	89	314	172	39	25	151	160	97	133	5	67
6	1	0	0	0	0	0	0	0	0	0	0	0	0
7	20	10	66	30	108	131	0	151	106	5	165	0	4
8	0	0	0	0	0	1	0	0	0	0	0	0	0
9	95	0	35	1	7	156	0	29	29	1	46	0	3
Total	350	353	353	346	353	340	350	353	352	353	352	350	349
LSI	4.0	3.4	4.3	5.2	5.3	7.5	1.3	6.1	5.6	2.8	6.4	0.7	3.2
Screening method	N	N	A	N	N	N	N	A	N	N	A	A	

(N-Natural; A-Artificial)

The selection of promising entries was done based on the disease data of those locations where the disease pressure was moderate to very high. The promising entries with $SI \leq 5$ are presented in the Table 43. Some of the promising entries are IET # 27438, 27541, 27555, 27736, 27280, 25212 (R), 27378 and 27387.

Table 43: Promising entries with low susceptibility index and high PI in NSN-1 to sheath rot, Kharif -2019

P.No.	IET No.	Location/Frequency of score (0-9)								SI	Total	<=3*	PI (<3)**	<=5*	PI (<5)**
		ADT	CHN	CTK	KJT	LNV	NVS	NWG	RPR						
7	27438	0	0	0	5	-	7	5	5	3.1	7	3	43	6	86
151	27541	0	0	5	3	-	5	5	7	3.6	7	3	43	6	86
15	CR Dhan 506 (NC)	0	1	5	1	5	7	3	7	3.6	8	4	50	6	75
331	Tetep (DP)	0	1	5	3	-	5	5	7	3.7	7	3	43	6	86
153	27555	0	0	5	3	7	5	5	5	3.8	8	3	38	7	88
99	27736	0	0	#	5	7	7	3	5	3.9	7	3	43	5	71
299	27280	0	3	5	3	3	7	3	7	3.9	8	5	63	6	75
133	US 312 (HC)	0	5	5	3	5	3	3	7	3.9	8	4	50	7	88
19	Purnendu (Eastern)--ZC	0	1	5	3	5	5	7	5	3.9	8	3	38	7	88
20	25212 (R)	0	5	5	1	3	7	5	5	3.9	8	3	38	7	88
308	Samba Mahsuri (RP)	3	5	5	3	5	3	3	5	4.0	8	4	50	8	100
174	27378	0	0	7	3	3	7	5	7	4.0	8	4	50	5	63
182	27387	0	0	5	3	7	7	5	5	4.0	8	3	38	6	75
342	T(N1)	3	7	5	7	9	9	7	7	6.8	8	1	13	2	25
	LSI	4.1	4.3	5.2	5.3	7.5	6.1	5.6	6.4						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ **NSN-2**

The entries in NSN-2 consisting of 672 entries were evaluated at 4 locations viz., Aduthurai, Bankura, Maruteru and Raipur. A high disease pressure was recorded at Aduthurai (6.6) and moderate at Raipur (4.9) and Bankura (3.4). The disease pressure was very low (LSI< 3) at Maruteru (1.2) and hence, the data from this centre was not considered for selecting the resistant entries for sheath rot. At all the centres, the entries were screened under natural condition except at Raipur (artificial inoculation). The frequency distribution of disease scores along with location severity indices are presented in the Table 44. The selection of promising entries was done based on the disease data from Aduthurai and Raipur. Some of the promising entries are IET Nos. 28447, 27900, 28306, 28344, 28346 and 28348 (Table 45).

Table 44: Location severity index (LSI) and frequency distribution of sheath rot scores for NSN- 2 entries, Kharif -2019

Location/Frequency of score(0-9)				
Score	ADT	BNK	MTU	RPR
0	3	8	275	112
1	3	72	201	57
2	0	0	0	0
3	14	391	157	116
4	0	0	0	0
5	243	184	15	103
6	0	0	0	0
7	249	17	0	79
8	0	0	0	0
9	155	0	0	195
Total	667	672	648	662
LSI	6.6	3.4	1.2	4.9
Screening method	N	N	N	A

(N-Natural; A-Artificial)

Table 45: NSN-2 entries with high promising index to sheath rot, Kharif, 2019

P.No.	IET No.	Location/Frequency of score (0-9)		SI	Total	≤3*	PI (<3)**	≤5*	PI (<5)**
		ADT	RPR						
96	28447	3	0	1.5	2	2	100	2	100
125	27900	3	0	1.5	2	2	100	2	100
412	28306	3	0	1.5	2	2	100	2	100
23	28344	1	3	2.0	2	2	100	2	100
26	28346	0	5	2.5	2	1	50	2	100
28	28348	0	5	2.5	2	1	50	2	100
661	T(N1)	9	7	8.0	2	0	0	0	0
	LSI	6.6	4.9						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤3 and ≤5;**Promising index (PI) based on no. of locations where the entry had scored ≤3 and ≤5)

➤ **NSN-H**

The nursery consisting of 121 test entries including checks was evaluated at two centers viz., Lonavala and Karjat. The disease pressure was moderate at Karjat (LSI= 5.9) and Lonavala (4.7). The disease screening was done under natural conditions at both the centres (Table 46). The selection of promising entries was done based on the disease data from those locations where the disease was moderate to very high. Some of the IET Nos. 27472, 26594, 28212 and 27491 were found to be promising against sheath rot (Table 47).

Table 46: Location severity index (LSI) and frequency distribution of sheath rot scores for NSN-H entries, Kharif – 2019

Location/Frequency of score(0-9)		
Score	KJT	LNV
0	0	0
1	0	0
2	0	0
3	7	58
4	0	0
5	56	35
6	0	0
7	49	16
8	0	0
9	119	121
Total	231	230
LSI	5.9	4.7
Screening method	N	N

(N-Natural; A-Artificial)

Table 47: Promising entries with low susceptibility index and high PI in NSN-H to sheath rot, Kharif 2019

P.No.	IET No.	Location/Frequency of score (0-9)		SI	Total	≤3*	PI (<-3)**	≤5*	PI (<-5)**
		KJT	LNV						
16	27472	3	3	3.0	2	2	100	2	100
32	26594	3	3	3.0	2	2	100	2	100
66	28212	3	3	3.0	2	2	100	2	100
2	27491	5	3	4.0	2	1	50	2	100
9	27496	5	3	4.0	2	1	50	2	100
20	27465	5	3	4.0	2	1	50	2	100
109	T(N) 1	7	9	8.0	2	0	0	0	0
LSI		5.9	4.7						

(SI-Susceptibility Index; *No. of locations where the entry has scored ≤3 and ≤5; **Promising index (PI) based on no. of locations where the entry had scored ≤3 and ≤5)

➤ **NHSN**

The NHSN trial consisted of 108 entries including checks was evaluated at 12 locations representing different geographical regions. The frequency distribution of disease scores and the LSI are presented in Table 48. The disease pressure was high at Raipur (6.6), Aduthurai (6.2) and Lonavala (6.0); Moderate disease pressure was noticed at Navsari (5.9), Nawagam (5.7), Karjat (5.4), Chatha (4.9), Rajendranagar (4.6), Chinsurah (4.2) and Bankura (3.0). Very low disease pressure was recorded at Titabar (1.1) and Maruteru (0.8). The disease screening was done under natural conditions at Aduthurai, Bankura, Chatha, Karjat, Lonavala, Maruteru, Nawagam and Rajendranagar and artificial inoculation at Chinsurah, Navasari, Titabar and Raipur (Table 48).

Table 48: Location severity index (LSI) and frequency distribution of sheath rot scores for NHSN entries, Kharif – 2019

Location/Frequency of score(0-9)												
Score	ADT	BNK	CHN	CHT	KJT	LNV	MTU	NVS	NWG	RNR	RPR	TTB
0	4	3	7	10	0	1	62	0	0	2	0	36
1	3	18	13	0	0	0	20	0	0	0	0	50
2	0	0	0	0	0	1	0	0	0	0	0	0
3	8	67	30	15	16	20	20	6	18	31	0	22
4	0	0	2	0	0	0	0	0	0	0	0	0
5	30	18	28	54	55	33	1	51	43	57	39	0
6	0	0	2	0	0	0	0	0	0	0	0	0
7	23	2	21	24	33	22	0	50	40	8	52	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	31	0	5	4	3	27	0	1	7	3	17	0
Total	99	108	108	107	107	104	103	108	108	101	108	108
LSI	6.2	3.0	4.2	4.9	5.4	6.0	0.8	5.9	5.7	4.6	6.6	1.1
Screening method	N	N	A	N	N	N	N	A	N	N	A	A

(N-Natural; A-Artificial)

The selection of promising entries was done based on the disease data of those locations where the disease pressure was moderate to very high. The promising entries with $SI \leq 5$ are presented in the Table 49. Some of the promising entries include IET # 28147, 28129, 28117, 28123, 28171 and 28134.

Table 49: Promising entries with low susceptibility index and high PI in NHSN to sheath rot, Kharif 2019

P.No.	IET No.	Location/Frequency of score (0-9)									SI	Total	<=3*	PI (<=3)**	<=5*	PI (<=5)**
		ADT	CHN	CHT	KJT	LNV	NVS	NWG	RNR	RPR						
45	28147	5	0	3	5	3	5	3	5	5	3.8	9	4	44	4	44
24	28129	-	5	3	3	-	5	3	3	5	3.9	7	4	57	4	57
9	28117	5	1	0	7	3	3	7	5	5	4.0	9	4	44	4	44
16	28123	7	3	3	3	3	5	3	3	7	4.1	9	6	67	6	67
8	MTU-1153 (RCV)	7	3	0	5	3	7	3	3	7	4.2	9	5	56	5	56
72	28171	1	0	7	3	5	5	5	3	9	4.2	9	4	44	4	44
30	28134	7	1	5	5	0	5	5	3	7	4.2	9	3	33	3	33
18	Rasi (LCV)	9	7	7	7	9	7	7	5	7	7.2	9	0	0	0	0
LSI		6.2	4.3	4.9	5.4	6.0	5.9	5.7	4.6	6.6						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ DSN

The DSN trial consisted of 151 entries including checks were screened at 11 locations across the country. The frequency distribution of disease scores and the LSI are presented in Table 50. The nursery was screened under natural conditions at all the locations except at Rajendranagar. The high disease pressure was recorded at Lonavala (6.9) and Raipur (6.7). Moderate disease pressure was recorded at Navasari (5.8), Karjat (5.7), Aduthurai (5.6), Nawagam (5.2), Cuttack (5.1), Pusa (4.6), Bankura (3.2) and Rajendranagar (3.1) and very low disease pressure was observed at Maruteru (0.9) during the season. The selection of promising entries were done based on the data of those locations where the disease pressure was moderate to high. The promising entries with $SI \leq 5$ are presented in the Table 51. Some of the promising lines were RMS-R-2, RMS-R-11, RP-Patho-3 and IET 25692.

Table 50: Location severity index (LSI) and frequency distribution of sheath rot scores for DSN entries, Kharif – 2019

Location/Frequency of score(0-9)											
Score	ADT	KJT	CTK	NVS	NWG	RNR	RPR	MTU	LVN	BNK	PSA
0	12	0	0	0	0	26	0	68	0	4	0
1	5	1	0	0	0	5	0	53	0	19	9
2	0	0	0	0	0	0	0	1	0	0	0
3	19	27	0	5	40	67	6	20	18	89	38
4	0	0	0	0	0	0	0	0	0	0	0
5	44	54	88	85	62	47	51	4	25	35	75
6	0	0	0	0	0	0	0	0	0	0	0
7	33	51	3	58	46	3	55	0	47	4	16
8	0	0	0	0	0	0	0	0	0	0	0
9	36	17	0	2	3	0	38	0	54	0	7
Total	149	150	91	150	151	148	150	146	144	151	145
LSI	5.6	5.7	5.1	5.8	5.2	3.1	6.7	0.9	6.9	3.2	4.6
Screening method	N		N	N	N	A	N	N		N	

(N-Natural; A-Artificial)

Table 51: Promising entries with low susceptibility index and high PI in DSN to sheath rot, Kharif 2019

P.No.	Designation	Location/Frequency of score (0-9)								SI	Total	<=3*	PI (<=3)**	<=5*	PI (<=5)**
		ADT	KJT	CTK	NVS	NWG	RPR	LVN	PSA						
98	RMS-R-2	0	5	-	5	5	3	3	1	3.1	7	4	57	7	100
107	RMS-R-11	1	1	-	5	5	7	3	3	3.6	7	4	57	6	86
55	RP-Patho-3	5	3	5	5	3	3	3	3	3.8	8	5	63	8	100
151	IET 25692	1	-	-	5	5	-	5	3	3.8	5	2	40	5	100
126	Phoghak	0	5	-	5	5	7	3	3	4.0	7	3	43	6	86
13	CR 4209-2	0	3	5	5	7	5	3	5	4.1	8	3	38	7	88
18	NWGR 11048	3	5	5	5	3	7	3	3	4.3	8	4	50	7	88
111	RMS-R-15	0	5	-	5	3	5	9	3	4.3	7	3	43	6	86
128	Gonalasha	0	3	-	5	3	9	5	5	4.3	7	3	43	6	86
124	Pankaj	0	3	-	5	5	7	3	7	4.3	7	3	43	5	71
139	T(N)1	9	7	-	7	7	5	9	7	7.3	7	0	0	1	14
LSI		5.7	5.8	5.1	5.8	5.2	6.7	6.9	4.7						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

❖ **GLUME DISCOLOURATION**➤ **NSN-1**

The National Screening Nursery (NSN-1) for grain discoloration was evaluated at four locations *viz.*, Chatha, Lonavala, Navasari and Nawagam which comprised of 353 entries. The frequency distribution of disease scores and the representative location severity index (LSI) are presented in the **Table 52**. The entries were screened under natural infection conditions. The disease pressure was high at Lonavala (LSI 6.5), moderate at Navasari (LSI 5.5) Nawagam (LSI 5.2) and Chatha (LSI 5.1). At Chatha only 98 entries were tested against GD. Hence, the data from Chatha was not considered for the selection of resistance entries. Some of the promising entries IET under NSN 1 for grain discoloration included IET27541, Tetep, Pusa 44, IET26767, IET27518, IET27528, IET28834, IET27703, IET27950, IET27621 and IET27438 (Table 53).

Table 52: Location severity index (LSI) and frequency distribution of Grain discoloration scores of NSN-1, Kharif2019

Score	Location/Frequency of GD score(0-9)			
	NWG	NVS	CHT	LNV
1	1	0	0	0
3	92	66	16	0
5	150	131	62	121
7	86	153	20	184
9	23	3	0	35
Total	352	353	98	340
LSI	5.2	5.5	5.1	6.5
Screening method	N	N	N	N

(N-Natural; A-Artificial)

Table 53: Promising entries with low susceptibility index (≤ 4) and high PI in NSN-1 to grain discoloration, Kharif 2019

P. No	IETNo	Location/Frequency of GD score (0-9)			SI	Total	$\leq 3^*$	PI (< 3) **	$\leq 5^*$	PI (< 5) **
		NWG	NVS	LNV						
151	27541	3	3	-	3.0	2	2	100	2	100
331	Tetep	3	3	-	3.0	2	2	100	2	100
46	Pusa 44)	3	3	5	3.7	3	2	67	3	100

P. No	IETNo	Location/Frequency of GD score (0-9)			SI	Total	<=3*	PI (<3) **	<=5*	PI (<5)**
		NWG	NVS	LNV						
51	26767	3	3	5	3.7	3	2	67	3	100
77	27518	3	3	5	3.7	3	2	67	3	100
85	27528	3	3	5	3.7	3	2	67	3	100
92	28834	3	3	5	3.7	3	2	67	3	100
177	27703	3	3	5	3.7	3	2	67	3	100
223	27950	3	3	5	3.7	3	2	67	3	100
236	27621	3	3	5	3.7	3	2	67	3	100
7	27438	3	5	-	4.0	2	1	50	2	100
LSI		5.2	5.5	6.5						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ NHSN

National Hybrid Screening Nursery (NHSN) consisting of 108 entries including checks were screened under natural conditions for glume discoloration at 4 locations. The frequency distribution of disease scores and location severity indices are presented in **Table 54**. The disease pressure was high at Lonavala (LSI 6.2), moderate at Navasari (LSI 5.5) and Nawagam (LSI 5.5); while it was low (<4) at Chatha (LSI 3.8).

Table 3: Location severity index (LSI) and frequency distribution of Grain discoloration scores of NHSN Kharif 2019

Score	Location/Frequency of GD score(0-9)			
	NWG	NVS	CHT	LNV
1	0	0	0	0
3	22	14	64	0
5	47	55	24	52
7	28	37	6	44
9	11	2	0	8
Total	108	108	94	104
LSI	5.5	5.5	3.8	6.2
Screening method	N	N	N	N

(N-Natural; A-Artificial)

Some of the promising entries under NHSN for grain discoloration included IET 27530, IET27518, IET27395, IET 27460, FL 478, IET26767, IET27732, Shabhagidhan, IET28835, IET26753 and IET27768 (**Table 55**).

Table 55: Promising entries with low susceptibility index and high PI in NHSN to grain discoloration, Kharif 2019

P. No.	IET No.	Location/Frequency of score (0-9)			SI	Total	<=3*	PI (<-3)**	<=5*	PI (<-5)**
		NWG	NVS	LNV						
76	27530	3	3	5	3.7	3	2	67	3	100
77	27518	3	3	5	3.7	3	2	67	3	100
6	27395	3	5	5	4.3	3	1	33	3	100
8	27460	3	5	5	4.3	3	1	33	3	100
45	FL 478	5	3	5	4.3	3	1	33	3	100
51	26767	3	5	5	4.3	3	1	33	3	100
58	27732	3	5	5	4.3	3	1	33	3	100
79	Shabhagidhan	3	5	5	4.3	3	1	33	3	100
93	28835	3	5	5	4.3	3	1	33	3	100
98	26753	3	5	5	4.3	3	1	33	3	100
108	27768	3	5	5	4.3	3	1	33	3	100
LSI		5.5	5.5	6.2						

(SI-Susceptibility Index;*No. of locations where the entry has scored ≤ 3 and ≤ 5 ;**Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

➤ DSN

Donor screening nursery (DSN) comprising of 151 entries including checks were tested against glume discolouration at 4 locations under natural infection conditions. The frequency distribution of disease scores and LSI are presented in Table 56. The disease pressure was very high at Lonavala (LSI 6.2); moderate at Navasari (LSI 5.5), Nawagam (LSI 5.3) and moderate at Chatha (LSI 4.1)

Table: Location severity index (LSI) and frequency distribution of Grain discoloration scores of DSN Kharif 2019

Score	Location/Frequency of score (0-9)			
	NWG	NVS	CHT	LNV
1	0	0	0	0
3	40	20	52	0
5	59	75	38	75
7	43	52	7	52

Score	Location/Frequency of score (0-9)			
	NWG	NVS	CHT	LNV
9	9	3	0	17
Total	151	150	97	144
LSI	5.3	5.5	4.1	6.2
Screening method	N	N	N	N

(N-Natural; A-Artificial)

The selection of promising entries was based on locations where diseases pressure was more and hence the data from 4 locations were considered for selection of promising entries. The best entries for grain discolouration included NWGR 11048, ISM-3G-4, HL18WS-23-30, RP-Bio Patho-4, NWGR 12016, KNM 7631, KNM 7632 and RMS-R-2 (Table 57)

Table 57: Promising entries with low susceptibility index (≤ 4) and high PI in DSN to grain discoloration, Kharif 2019

Designations	Location/Frequency of score (0-9)				SI	Total	$\leq 3^*$	PI (≤ 3)**	$\leq 5^*$	PI (≤ 5)**
	NWG	NVS	CHT	LNV						
NWGR 11048	3	3	3	5	3.5	4	3	75	4	100
ISM-3G-4	3	3	3	5	3.5	4	3	75	4	100
V-MSM 143	3	3	-	5	3.7	3	2	67	3	100
HL18WS-23-30	3	5	3	-	3.7	3	2	67	3	100
RP-Bio Patho-4	3	3	3	7	4.0	4	3	75	3	75
NWGR 12016	3	3	5	5	4.0	4	2	50	4	100
KNM 7631	5	3	3	5	4.0	4	2	50	4	100
KNM 7632	3	5	3	5	4.0	4	2	50	4	100
RMS-R-2	5	3	3	5	4.0	4	2	50	4	100
LSI	5.3	5.5	4.1	6.2						

(SI-Susceptibility Index; *No. of locations where the entry has scored ≤ 3 and ≤ 5 ; **Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

❖ BACTERIAL BLIGHT

➤ NSN-1

The National Screening Nursery-1 (NSN-1) consisted of 353 entries including checks. The entries were evaluated at 25 locations across the country. The entries were evaluated through artificial inoculation at all the locations except Jagtiyal and Sabour. The frequency distribution of the disease scores and location severity indices are presented in Table 58. The disease pressure was exceptionally high at Maruteru (LSI-8.4); high (LSI-6-8) at Jagtiyal (7.9), IIRR (7.3), Raipur (7.2), Navsari (6.6), Pattambi (6.6), Aduthurai (6.6), Pantnagar (6.3), Cuttack (6.3), Chiplima (6.3), Ludhiana (6.2), Nawagam (6.2) and Chinsurah (6.1); moderate (LSI-3-6) at Gangavathi (5.9), New Delhi (5.7), Masodha (5.6), Karjat (5.0), Chatha (4.8), Varanasi (4.7), Nellore (4.5), Patna (4.5), Titabar (3.8), Moncompu (3.7) and Sabour (3.0) and very low (LSI < 3) at Port Blair.

For selection of best entries, data of Port Blair was not considered as the disease pressure was very low (LSI-2.8). The data of Maruteru was also not considered as the disease pressure was shown as exceptionally high (LSI>8.4) where about 97% of the entries showed highly susceptible reaction and remaining showed moderate reaction. This looks overestimation of the disease score and needs reconfirmation. The promising entries with SI less than 4.5 and which exhibited a score of 5 at or more than 60% of the locations are presented in Table 59. Some of the promising entries which were on par or better than resistant check Improved Samba Mahsuri were IET # 27378, 28811, 28807, 28014, 27077, 28806 and 27294. Some of the other promising entries with SI less than 4.5 were IET # 28789, 28805, 27823, 28810 and 27637

➤ NSN-2

The National Screening Nursery-2 (NSN-2) consisted of 672 entries including checks. The entries were evaluated at 15 locations across the country. The entries were evaluated through artificial inoculation at all the locations. The frequency distribution of the disease scores and location severity indices are presented in Table 60. The disease pressure was high (LSI->6) at Maruteru (8.2), Pantnagar (7.4), IIRR (7.1), Cuttack (7.0), Gangavathi (6.8), Aduthurai (6.7), Raipur (6.7), Ludhiana (6.6), Pattambi (6.5) and Masodha (6.3); moderate (LSI-3-6) at Varanasi (5.3), Titabar (5.2), Chatha (4.4) and Patna (4.1) and very low (LSI <3) at Moncompu. For selection of promising entries, data of those locations were considered where, LSI was greater than 3. Accordingly, data of Moncompu was not considered. The promising entries with SI less than 5 and which exhibited a score of 5 at or more than 60% of the locations are presented in Table 61. Only one entry viz., IET 28503 was slightly superior than resistant check Improved Samba Mahsuri. Some of the highly promising entries were IET # 28751, 28635, 28585 and 28654. Other promising entries were IET # 28528, 28391, 28467, 28493, 28491, 28311, 28521, 28396, 28432, 28461, 28478, 28063, 28726, 28502, 28299, 28732 and 28543.

Table 58: Location severity index (LSI) and frequency distribution of bacterial blight scores of NSN 1, Kharif 2019

Score	Location/Frequency of scores (0-9)												
	ADT	CHN	CHP	CHT	CTK	GGV	IIRR	JGT	KJT	LDN	MNC	MSD	MTU
Inoculation	A	A	A	A	A	A	A	N	A	A	A	A	A
0	1	0	0	0	0	0	0	0	0	0	67	0	0
1	1	31	8	0	0	0	17	0	0	1	32	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	14	22	29	135	47	90	24	6	111	63	66	33	2
4	0	0	0	1	0	0	0	0	0	0	0	0	0
5	107	66	117	112	98	94	19	23	143	54	111	189	10
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	151	196	122	90	139	93	121	124	84	184	69	117	77
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	76	37	73	4	67	74	171	197	15	47	3	13	254
LSI	6.6	6.1	6.3	4.8	6.3	5.9	7.3	7.9	5	6.2	3.7	5.6	8.4
Total	350	352	349	342	351	351	352	350	353	349	348	352	343

Table contd..

Score	Location/Frequency of scores (0-9)											
	NDL	NLR	NVS	NWG	PNT	POB	PTB	PTN	RPR	SBR	TTB	VRN
Inoculation	A	A	A	A	A	A	A	A	A	N	A	A
0	0	0	0	0	10	0	0	2	0	118	0	0
1	21	34	1	0	29	143	0	0	0	39	11	0
2	0	0	0	0	0	0	0	0	0	1	0	0
3	0	116	14	21	46	97	15	89	5	70	195	136
4	0	0	0	0	0	0	0	91	0	0	0	0
5	190	114	52	142	60	59	98	115	44	55	141	140
6	0	0	0	0	0	0	0	0	0	4	0	0
7	110	66	267	151	48	25	173	56	220	35	3	63
8	0	0	0	0	0	0	0	0	0	0	0	0
9	32	19	19	38	159	3	64	0	83	31	0	12
LSI	5.7	4.5	6.6	6.2	6.3	2.8	6.6	4.5	7.2	3	3.8	4.7
Total	353	349	353	352	352	327	350	353	352	353	350	351

(N: Natural; Artificial)

Table 59: NSN 1 entries with low susceptibility index (SI ≤ 4.5) with score ≤ 5 to BB at or more than 60% of the locations

P. No.	Ent. No.	IET No.	Locations/Score (0-9)																				SI	*PI (≤3)	*PI (≤5)			
			ADT	CHN	CHP	CHT	CTK	GGV	IIRR	JGT	KJT	LDN	MNC	MSD	NDL	NLR	NVS	NWG	PNT	PTB	PTN	RPR				SBR	TTB	VRN
174	1316	27378	5	1	3	3	5	5	3	7	3	5	0	5	7	5	7	7	3	3	3	5	1	3	3	4.0	52.2	82.6
326	4830	28811	5	1	7	5	5	3	1	5	5	3	3	5	5	3	5	7	1	7	0	7	3	3	5	4.1	43.5	82.6
320	4824	28807	5	1	3	5	3	5	3	7	5	3	1	5	5	3	5	5	3	9	7	7	0	3	3	4.2	47.8	82.6
304	4808	28014	3	1	5	3	3	9	1	7	3	3	0	5	5	9	3	7	0	7	7	7	3	3	3	4.2	56.5	69.6
37	3401	27077	9	5	5	3	3	3	3	5	5	3	0	5	5	1	7	7	5	5	4	7	1	3	3	4.2	43.5	82.6
319	4823	28806	5	1	3	5	5	3	1	5	5	3	1	5	5	5	7	7	0	9	7	7	0	3	5	4.2	39.1	78.3
309	4813	27294	7	1	7	3	7	3	1	5	3	3	0	7	5	5	5	7	0	9	3	7	5	3	3	4.3	47.8	69.6
193	1338	28789	0	5	3	3	7	5	7	7	3	5	0	5	5	3	7	7	7	5	3	5	3	3	3	4.4	43.5	73.9
317	4821	28805	7	1	9	7	5	7	1	7	3	3	0	7	1	7	5	7	0	7	4	5	0	3	5	4.4	39.1	60.9
38	3402	27823	7	3	5	5	3	7	3	9	5	3	5	5	1	3	3	5	3	7	4	7	1	3	5	4.4	43.5	78.3
325	4829	28810	7	1	7	5	7	3	1	7	5	3	1	7	5	1	7	7	1	7	4	7	3	3	3	4.4	43.5	60.9
231	1501	27637	5	9	1	5	5	5	7	9	5	3	0	5	7	3	7	5	5	3	4	5	0	3	3	4.5	34.8	78.3
349	RP-BIO-226		7	1	5	5	3	3	3	7	3	3	3	3	9	5	1	7	1	5	5	3	9	3	5	4.3	52.2	78.3
342	TN1		7	7	9	7	9	9	9	7	7	7	5	9	5	9	9	9	9	7	4	9	3	5	7	7.3	4.3	21.7
LSI			6.6	6.1	6.3	4.8	6.3	5.9	7.3	7.9	5	6.2	3.7	5.6	5.7	4.5	6.6	6.2	6.3	6.6	4.5	7.2	3	3.8	4.7			

(SI-Susceptibility Index;*Promising index (PI) based on no. of locations where the entry had scored ≤ 3 and ≤ 5)

Table 60: Location severity index (LSI) and frequency distribution of bacterial blight scores of NSN 2, Kharif' 2019

Score	Location/Frequency of scores (0-9)														
	ADT	CHT	CTK	GGV	IIRR	LDN	MNC	MSD	MTU	PNT	PTB	PTN	RPR	TTB	VRN
Inoculation	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
0	0	0	0	0	0	0	302	0	0	4	0	26	0	0	0
1	1	1	2	1	15	0	45	0	0	20	0	0	3	0	0
2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
3	31	317	39	93	46	77	106	23	1	50	36	282	14	123	178
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	203	225	157	137	82	93	131	267	13	84	205	304	181	381	245
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	246	107	244	171	270	387	67	308	222	107	304	60	344	132	193
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	180	6	225	269	244	106	4	68	415	399	120	0	126	29	48
LSI	6.7	4.4	7.0	6.8	7.1	6.6	2.3	6.3	8.2	7.4	6.5	4.1	6.7	5.2	5.3
Total	661	657	667	671	657	663	655	666	651	664	665	672	668	665	664

(N: Natural; Artificial)

➤ **NSN-Hills**

The entries in NSNH were evaluated at 4 locations across the country. The entries were evaluated using artificial inoculation at all the four locations. The frequency distribution of the disease scores and location severity indices are presented in Table 62. At IIRR, the entries were evaluated under glass house condition. The disease pressure was very high (LSI >8) at IIRR and high (LSI-6-8) at Cuttack (7.5), Pantnagar (7.1) and Karjat (6.5). Data of all the four locations were considered for selection of promising entries. The promising entries with an SI less or equal to 6 and which showed a disease score of 5 at 50% locations or more are presented in Table 63. Only one entry (IET 28211) was highly promising and was on par with the resistant check, Improved Samba Mahsuri. Other moderately promising entries with SI ranging from 5.5-6 were IET # 27466 (TRC KS-20-114-B-B-37), 27468 (TRC BN -83-372-B-B-18), 27506 (TRC BN-188-145-B-B-18) and 28197 (VL 32463).

Table 61: NSN 2 entries with low susceptibility index (SI ≤5) with score ≤ 5 to BB at or more than 60% of the locations

P.No.	Ent. No.	IET No.	Locations/Score (0-9)														SI	*PI (≤3)	*PI (≤5)
			ADT	CHT	CTK	GGV	IIRR	LDN	MSD	MTU	PNT	PTB	PTN	RPR	TTB	VRN			
342	1609	28503	5	5	3	3	1	3	9	5	3	5	3	1	3	7	4.0	57.1	85.7
302	4231	28751	7	3	3	3	1	3	3	5	3	3	5	7	3	9	4.1	64.3	78.6
214	3905	28635	5	3	3	9	1	3	5	5	3	5	3	5	3	5	4.1	50.0	92.9
79	1917	28585	7	3	5	3	1	3	7	-	1	5	3	9	5	5	4.4	46.2	76.9
234	3925	28654	7	3	3	7	3	3	3	9	1	5	7	5	3	3	4.4	57.1	71.4
368	1635	28528	9	3	9	7	1	3	3	3	3	5	3	5	3	7	4.6	57.1	71.4
156	1209	28391	5	5	3	5	3	5	7	9	1	5	3	7	3	3	4.6	42.9	78.6
119	1434	28467	3	3	7	3	1	3	5	7	5	5	3	7	5	7	4.6	42.9	71.4
146	1462	28493	5	3	7	5	5	3	5	7	1	7	3	5	3	5	4.6	35.7	78.6
144	1460	28491	5	3	3	5	1	3	7	5	1	7	5	7	5	7	4.6	35.7	71.4
417	623	28311	5	5	5	5	3	5	5	7	5	3	5	5	3	3	4.6	28.6	92.9
361	1628	28521	9	3	7	7	3	3	3	7	3	3	3	7	3	5	4.7	57.1	64.3
162	1215	28396	5	5	3	5	3	3	5	7	3	7	3	5	7	5	4.7	35.7	78.6
201	1255	28432	-	3	5	9	3	3	5	7	3	5	5	5	5	-	4.8	33.3	83.3
111	1426	28461	7	3	3	5	3	3	5	9	7	3	3	5	5	7	4.9	42.9	71.4
131	1446	28478	9	3	7	3	3	3	7	7	3	5	5	5	3	5	4.9	42.9	71.4
601	4303	28063	3	7	3	9	5	7	5	7	3	5	3	5	3	3	4.9	42.9	71.4
276	4205	28726	5	5	3	9	1	3	7	7	3	7	5	7	3	3	4.9	42.9	64.3
341	1608	28502	5	3	7	7	3	7	7	5	3	5	3	3	3	9	5.0	42.9	64.3
405	610	28299	7	3	7	5	3	7	7	9	3	5	5	3	3	3	5.0	42.9	64.3
282	4211	28732	5	5	7	3	5	3	7	7	7	3	3	5	5	5	5.0	28.6	71.4
385	1653	28543	5	5	5	5	3	5	7	7	5	5	5	3	3	7	5.0	21.4	78.6
668	RP-BIO-226		5	-	3	3	-	3	3	7	1	7	5	3	3	5	4.0	58.3	83.3
661	TN1		7	7	9	9	7	9	9	9	9	9	3	9	7	7	7.9	7.1	7.1
LSI			6.7	4.4	7	6.8	7.1	6.6	6.3	8.2	7.4	6.5	4.1	6.7	5.2	5.3			

(SI-Susceptibility Index;*Promising index (PI) based on no. of locations where the entry had scored ≤3 and ≤5)

Table 62: Location severity index (LSI) and frequency distribution of bacterial blight scores of NSN Hills, Kharif 2019

Score	Location/Frequency of scores (0-9)			
	CTK	IIRR	KJT	PNT
Inoculation	A	A	A	A
0	0	0	0	0
1	0	1	0	1
2	0	0	0	0
3	4	0	1	7
4	0	0	0	0
5	15	3	37	33
6	0	0	0	0
7	46	11	71	21
8	0	0	0	0
9	53	99	9	58
Total	118	114	118	120
LSI	7.5	8.6	6.5	7.1

Table 63: NSN-Hills entries with low susceptibility index (SI ≤6) with score ≤ 5 to BB at or more than 50% of the locations

P. No.	E. No.	IET No.	Designation	Locations/Score (0-9)				SI	*PI (≤3)	*PI (≤5)
				CTK	IIRR	KJT	PNT			
65	2604	28211	HPR 3111	9	1	5	3	4.5	50.0	75.0
13	2203	27466	TRC KS-20-114-B-B-37	5	9	5	3	5.5	25.0	75.0
18	2208	27468	TRC BN -83-372-B-B-18	3	9	5	7	6.0	25.0	50.0
100	2703	27506	TRC BN-188-145-B-B-18	9	7	5	3	6.0	25.0	50.0
50	2311	28197	VL 32463	5	9	5	5	6.0	0.0	75.0
116	RP-Bio-226			3	9	5	1	4.5	50.0	75.0
109	TN 1			9	9	9	9	9.0	0.0	0.0
LSI				7.5	8.6	6.5	7.1			

(SI-Susceptibility Index;*Promising index (PI) based on no. of locations where the entry had scored ≤3 and ≤5)

➤ **NHSN**

The National Hybrid Screening Nursery (NHSN) consisted of 108 entries including different checks. The entries were evaluated at 21 locations across the country. The entries were evaluated using artificial inoculation at all the centres except at Arundhatinagar and Jagtiyal where the screening was done under natural condition. The frequency distribution of the disease scores and location severity indices are presented in Table 64. The disease pressure was high (LSI >6) at Maruteru (8.2), Jagtiyal (8.0), Pattambi (7.4), Gangavathi (7.2), Pantnagar (6.9), Karjat (6.7), Aduthurai (6.7), Nawagam (6.4), Raipur (6.4), Navsari (6.4), Ludhiana (6.3) and Chinsurah (6.2); moderate (LSI 3-6) at IIRR (6.0), Titabar (5.8), Masodha (5.8), New Delhi (5.7), Varanasi (5.0), Patna (4.1), Moncompu (3.7) and Chatha (3.3) and very low (LSI < 3) at Arundhatinagar.

For selection of best entries, data of Arundhatinagar was not considered as the disease pressure was very low (LSI-2.9). The promising entries with SI less than 5.5 and which exhibited a score of 5 at or more than 50% of the locations are presented in Table 65. None of the entries were on par or better than resistant check (Improved Samba Mahsuri). Some of the highly promising entries with an average SI less or equal to 5 were IET #28148, 28160 and 28143. Some of the promising entries which SI below 5.5 are IET # 28162, 28114, 28136, 28181, 28131, 28163, 28159, 28120 and 28164.

➤ **DSN**

The Donor Screening Nursery (DSN) consisted of 151 entries including different checks. The entries were evaluated at 22 locations across the country. The entries were evaluated using artificial inoculation at all the centres except at Jagtiyal where the screening was done under natural condition. The frequency distribution of the disease scores and location severity indices are presented in Table 66. The disease pressure was high (LSI > 6) at Jagtiyal (8.1), Maruteru (8.0), Gangavathi (7.4), Cuttack (7.1), Chiplima (7.0), Pattambi (6.8), Aduthurai (6.4), IIRR (6.4), Ludhiana (6.3), Pantnagar (6.2), Raipur (6.1) and Nawagam (6.1); moderate (LSI-3-6) at Navsari (6.0), Karjat (6.0), Masodha (5.9), Patna (5.8), New Delhi (5.8), Varanasi (5.0), Titabar (4.5), Moncompu (3.8) and Chatha (3.6) and very low (LSI <3) at Port Blair (2.8).

For selection of promising entries, the data of those locations were considered where the disease pressure was more than 3. Accordingly, the data of Port Blair was not considered for selection of promising entries. Only one entry (KNM 7787) was better than the resistant check, Improved Samba Mahsuri. Some of the other promising entries which showed an SI ranging from 4.5 to 5.5 were RP-Bio Patho-9, RP-Bio Patho-10, RP-Bio Patho-7, MSM-SB-52, ISM-2G-5412, KNM 7786, RP-Bio Patho-6, RMS-R-16, RMS-R-7, GSY-4-6, CR 4054-26-6-5, RP-Bio Patho-2, CR 4055-11-28-1, GSY-4-7, IET 25692 and RP-Bio Patho-3 (Table 67).

Table 64: Location severity index (LSI) and frequency distribution of bacterial blight scores of NHSN, Kharif' 2019

Score	Location/Frequency of scores (0-9)										
	ADT	ARD	CHN	CHT	GGV	IIRR	JGT	KJT	LDN	MNC	MSD
Inoculation	A	N	A	A	A	A	N	A	A	A	A
0	0	0	0	0	0	0	0	0	0	22	0
1	0	27	4	8	0	0	0	0	0	6	0
2	0	0	0	0	0	0	0	0	0	0	0
3	1	28	9	81	12	34	3	1	14	19	5
4	0	0	0	0	0	0	0	0	0	0	0
5	32	15	26	13	13	13	11	35	8	21	63
6	0	0	0	0	0	0	0	0	0	0	0
7	47	2	58	5	32	34	25	50	81	25	34
8	0	0	0	0	0	0	0	0	0	0	0
9	19	1	11	0	50	27	69	21	0	1	6
LSI	6.7	2.9	6.2	3.3	7.2	6.0	8.0	6.7	6.3	3.7	5.8
Total	99	73	108	107	107	108	108	107	103	94	108

Table contd..

Score	Location/Frequency of scores (0-9)									
	MTU	NDL	NVS	NWG	PNT	PTB	PTN	RPR	TTB	VRN
Inoculation	A	A	A	A	A	A	A	A	A	A
0	0	0	0	0	0	0	0	0	0	0
1	0	7	0	0	6	0	3	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	5	5	18	0	48	5	8	31
4	0	0	0	0	0	0	0	0	0	0
5	2	60	38	38	10	17	50	32	51	48
6	0	0	0	0	0	0	0	0	0	0
7	36	30	52	51	10	51	7	63	46	29
8	0	0	0	0	0	0	0	0	0	0
9	63	11	13	14	58	39	0	8	3	0
LSI	8.2	5.7	6.4	6.4	6.9	7.4	4.1	6.4	5.8	5.0
Total	101	108	108	108	102	107	108	108	108	108

(N: Natural; Artificial)

Table 65: NHSN entries with low susceptibility index (SI ≤5.5) with score ≤ 5 to BB at or more than 50% of the locations

P.No	E. No.	IET No.	Locations/Score (0-9)																				SI	*PI (≤3)	*PI (≤5)
			ADT	CHN	CHT	GGV	IIRR	JGT	KJT	LDN	MNC	MSD	MTU	NDL	NVS	NWG	PNT	PTB	PTN	RPR	TTB	VRN			
46	3127	28148	3	7	1	7	3	3	5	7	0	5	7	5	5	3	7	5	5	7	5	3	4.7	35.0	70.0
59	3209	28160	9	3	3	7	3	7	5	5	0	5	7	5	5	7	3	5	7	5	3	5	5.0	30.0	70.0
40	3121	28143	7	1	3	9	3	9	5	3	3	7	5	5	7	5	1	9	5	3	5	5	5.0	35.0	70.0
61	3211	28162	7	5	3	7	3	9	5	3	0	5	-	7	5	7	3	5	5	7	5	5	5.1	26.3	68.4
5	3005	28114	5	1	3	7	3	9	7	7	3	5	9	9	5	5	3	5	3	3	7	3	5.1	40.0	65.0
32	3113	28136	-	1	3	9	3	9	5	3	3	7	7	1	7	7	3	7	7	7	5	5	5.2	36.8	52.6
84	3306	28181	9	3	3	9	7	7	7	3	0	5	7	7	5	7	5	5	3	7	3	3	5.3	35.0	55.0
26	3107	28131	5	3	3	9	3	9	7	3	-	7	7	5	5	5	3	7	3	7	5	5	5.3	31.6	63.2
63	3213	28163	-	5	3	9	3	9	7	7	0	3	7	7	7	9	3	7	3	5	3	5	5.4	36.8	52.6
58	3208	28159	9	3	3	5	3	9	5	7	3	9	7	9	7	5	1	7	3	5	5	3	5.4	35.0	60.0
12	3012	28120	5	5	3	9	3	9	5	5	3	7	7	7	7	5	1	5	5	7	5	5	5.4	20.0	65.0
64	3214	28164	7	5	3	9	3	9	5	5	0	5	9	7	7	7	5	7	3	5	5	3	5.5	25.0	60.0
104	RP-BIO-226		5	1	3	3	3	3	5	3	5	3	5	5	3	7	1	5	3	3	3	5	3.7	60.0	95.0
97	TN1		7	7	3	9	9	9	9	7	7	9	9	1	9	9	9	9	3	9	9	5	7.4	15.0	20.0
LSI			6.7	6.2	3.3	7.2	6	8	6.7	6.3	3.7	5.8	8.2	5.7	6.4	6.4	6.9	7.4	4.1	6.4	5.8	5			

(SI-Susceptibility Index; *Promising index (PI) based on no. of locations where the entry had scored ≤3 and ≤5)

Table 66: Location severity index (LSI) and frequency distribution of bacterial blight scores of DSN, Kharif 2019

Score	Location/Frequency of scores (0-9)										
	ADT	CHP	CHT	CTK	GGV	IIRR	JGT	KJT	LDN	MNC	MSD
Inoculation	A	A	A	A	A	A	N	A	A	A	A
0	0	0	0	0	0	0	0	0	0	39	0
1	0	0	7	0	0	17	0	0	0	3	0
2	0	0	0	0	0	0	0	0	0	0	0
3	4	6	101	17	4	14	3	5	37	28	16
4	0	0	0	0	5	0	0	0	0	0	0
5	56	34	30	20	26	13	5	74	12	40	68
6	0	0	0	0	5	0	0	0	0	0	0
7	66	63	12	53	34	59	52	61	66	37	47
8	0	0	0	0	0	0	0	0	0	0	0
9	23	47	0	61	76	48	90	10	35	2	18
LSI	6.4	7	3.6	7.1	7.4	6.4	8.1	6	6.3	3.8	5.9
Total	149	150	150	151	150	151	150	150	150	149	149

Table contd.,

Score	Location/Frequency of scores (0-9)										
	MTU	NDL	NVS	NWG	PNT	POB	PTB	PTN	RPR	TTB	VRN
Inoculation	A	A	A	A	A	A	A	A	A	A	A
0	0	0	0	0	3	0	0	0	0	0	0
1	0	12	0	0	13	62	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	15	15	21	56	4	8	4	22	33
4	0	0	0	0	0	0	0	20	0	0	0
5	14	76	48	53	28	20	36	47	62	33	81
6	0	0	0	0	0	0	0	18	0	0	0
7	47	42	82	67	24	9	81	34	79	5	32
8	0	0	0	0	0	0	0	24	0	0	0
9	85	20	5	16	61	2	29	0	5	1	2
LSI	8	5.8	6	6.1	6.2	2.8	6.8	5.8	6.1	4.5	5
Total	146	150	150	151	150	149	150	151	150	61	148

(N: Natural; Artificial)

Table 67: DSN entries with low susceptibility index (SI ≤5.5) with score ≤ 5 to BB at or more than 45% of the locations

P.No.	Designations	Locations/Score (0-9)																				SI	*PI (≤3)	*PI (≤5)	
		ADT	CHP	CHT	CTK	GGV	IIRR	JGT	KJT	LDN	MNC	MSD	MTU	NDL	NVS	NWG	PNT	PTB	PTN	RPR	TTB				VRN
32	KNM 7787	5	9	3	3	5	7	7	5	3	0	5	7	1	3	7	3	3	4	5	3	3	4.3	47.6	76.2
73	RP-Bio Patho-9	7	5	3	3	9	1	9	5	3	0	5	5	1	5	3	1	7	7	5	-	5	4.5	40.0	75.0
74	RP-Bio Patho-10	7	5	5	3	7	1	9	5	3	0	5	5	5	3	3	0	7	6	7	-	5	4.6	35.0	70.0
71	RP-Bio Patho-7	5	7	3	7	7	1	9	5	3	0	5	7	7	5	3	0	5	5	7	5	5	4.8	28.6	66.7
34	MSM-SB-52	5	9	3	5	5	5	9	7	7	0	3	7	1	7	7	5	5	5	5	-	3	5.2	25.0	65.0
42	ISM-2G-5412	5	5	3	3	9	3	9	3	3	5	7	5	9	3	5	7	7	5	5	3	5	5.2	33.3	71.4
31	KNM 7786	5	9	5	3	9	5	7	5	3	0	5	7	7	5	7	3	5	4	7	-	3	5.2	25.0	65.0
70	RP-Bio Patho-6	5	7	5	9	9	3	9	5	3	0	7	7	5	3	5	0	7	4	7	5	7	5.3	23.8	57.1
112	RMS-R-16	5	9	3	7	5	3	5	3	7	5	5	9	5	7	5	1	7	6	7	3	-	5.4	25.0	60.0
103	RMS-R-7	5	7	3	9	7	5	9	5	5	0	5	7	7	5	7	3	5	8	5	3	3	5.4	23.8	61.9
119	GSY-4-6	5	5	3	9	5	1	9	7	5	3	7	7	5	5	7	1	9	3	7	5	5	5.4	23.8	61.9
6	CR 4054-26-6-5	7	9	1	3	9	3	7	5	3	3	3	9	5	9	3	3	7	8	7	-	5	5.5	40.0	55.0
66	RP-Bio Patho-2	7	7	3	7	9	1	7	5	3	5	9	5	1	7	7	1	7	7	7	5	5	5.5	23.8	47.6
8	CR 4055-11-28-1	5	7	3	3	5	7	7	9	3	7	5	7	5	5	5	3	5	7	7	5	5	5.5	19.0	61.9
120	GSY-4-7	5	7	3	7	9	1	7	5	7	0	9	7	7	3	9	1	7	4	7	-	5	5.5	25.0	45.0
151	IET 25692	5	-	-	9	-	7	-	-	-	0	-	-	-	5	7	5	-	6	-	-	-	5.5	12.5	50.0
67	RP-Bio Patho-3	5	7	3	9	9	7	7	5	7	0	5	7	7	7	5	3	7	5	5	3	3	5.5	23.8	52.4
146	RP-BIO-226	7	5	3	3	4	1	9	3	3	1	3	5	7	3	9	3	5	5	3	-	5	4.4	50.0	80.0
139	T(N)1	9	9	3	9	9	9	9	5	7	7	9	9	9	9	7	9	9	4	9	-	5	7.8	5.0	20.0
	LSI	6.4	7	3.6	7.1	7.4	6.4	8.1	6	6.3	3.8	5.9	8	5.8	6	6.1	6.2	6.8	5.8	6.1	4.5	5			

(SI-Susceptibility Index;*Promising index (PI) based on no. of locations where the entry had scored ≤3 and ≤5)

❖ **RICE TUNGRO DISEASE (RTD)**➤ **NSN-1**

The national screening nursery 1 (NSN-1) trial consisting of 353 entries including checks was proposed and conducted at 2 locations viz., Coimbatore and IIRR. At both the locations the nursery was evaluated by artificial inoculations with the aid of leafhopper transmission in the glass house. The frequency distribution of disease scores and location severity indices are presented in Table 68. The disease pressure was high at IIRR (LSI 6.4) and moderate at Coimbatore (LSI 4.9).

Table 68: Location severity index (LSI) and frequency distribution of rice tungro disease scores for NSN-1, Kharif, 2019

Score	Location/Frequency distribution of rice tungro disease scores (0-9 scale)	
	CBT	IIRR
1	0	0
3	95	15
5	185	103
7	72	233
9	1	0
Total	353	351
LSI	4.9	6.4
Screening method	A	A

(N- Natural; A- Artificial)

The entries performed better than the resistant check Vikramarya and showed resistance reaction to rice tungro disease are Pusa Basmati -1, IET 28836, IET 26420, IET 27384, and FBR 1-15 (Table 69).

Table 69: NSN-1 entries with low susceptibility index (SI ≤ 5) against rice tungro disease, Kharif, 2019

P. No.	IET No.	Location/Frequency of score (0-9)		SI	Total	<=3*	PI (<-3)**	<=5*	PI (<-5)**
		CBT	IIRR						
125	28836	3	3	3.0	2	2	100	2	100
1306	26420	3	3	3.0	2	2	100	2	100
1307	27384	3	3	3.0	2	2	100	2	100
4836	FBR 1-15 (DP)	3	3	3.0	2	2	100	2	100
Vikramarya	Vikramarya	3	3	3.0	2	2	100	2	100
T(N)1	T(N1)	5	7	6.0	2	0	0	1	50
LSI		4.9	6.4						

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3 and ≤5)

➤ **NSN-2**

The national screening nursery 2 (NSN-2) trial consisting of 672 entries including checks was evaluated only at IIRR. The disease pressure recorded was high with LSI 6.5. Out of 672 lines tested, 15 lines showed score 3, 133 lines with score 5 and rest of the entries were susceptible to the disease. Best performing lines included IET28326, IET28369, IET28443, IET27908, IET28656, IET28678, IET28688, IET28316, IET28274, IET28629, IET28702, IET28708, IET28712, Dubraj, and IET28820 in addition to the resistant checks Vikramarya and Nidhi (Table 70)

Table 70: NSN-2 entries with low susceptibility index ($SI \leq 3$) against rice tungro disease, Kharif, 2019

Ent. No.	IET No.	RTD score (0-9) at IIRR
5	28326	3
49	28369	3
92	28443	3
202	27908	3
236	28656	3
258	28678	3
269	28688	3
422	28316	3
443	28274	3
484	28629	3
524	28702	3
531	28708	3
536	28712	3
590	Dubraj (QC)	3
615	28820	3
662	Vikramarya	3
663	Nidhi	3

➤ **NSN-H**

One hundred and twenty entries were screened against rice tungro disease at IIRR under high disease pressure with LSI of 6.3. Out of which, only 2 lines (IET27461 and IET 26579) showed to be resistant for RTD.

➤ **NHSN**

The National Hybrid Screening Nursery (NHSN) consisted of 108 entries including checks. The entries were tested at two centers viz., Coimbatore and IIRR. The frequency distribution of disease scores and LSI are presented in Table 71. The disease pressure was high at IIRR (LSI 6.0) and Moderate at Coimbatore (LSI 5.7).

Table 71: Location severity index (LSI) and frequency distribution of rice tungro disease scores for NHSN, Kharif, 2019

Score	Location/Frequency of RTD score(0-9)	
	CBT	IIRR
1	0	0
3	6	3
4	0	0
5	60	49
7	40	55
9	2	0
Total	108	107
LSI	5.7	6.0
Screening method	A	A

(N- Natural; A- Artificial)

For the selection of promising entries both the locations were taken into consideration. The best entries which showed overall SI < 5 are listed in Table 72. The best entries are IET 28158, IET 28112, IET 28115 and IET 28116 along with check varieties Vikramarya and Nidhi.

Table 72: NHSN entries with low susceptibility index (SI ≤5) against rice tungro disease, Kharif, 2019

P. No.	Designation	IET No.	CBT	IIRR	SI
57	IHRT-M-3207	28158	3	5	4.0
99	Nidhi	Nidhi	5	3	4.0
2	IHRT-E-3002	28112	5	5	5.0
3	IHRT-E-3003	US-314 (NCH)	5	5	5.0
6	IHRT-E-3006	28115	5	5	5.0
7	IHRT-E-3007	28116	5	5	5.0
98	Vikramarya	Vikramarya	3	3	3.0

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3 and ≤5)

➤ DSN

Donor screening nursery (DSN) comprising of 151 entries including checks were tested at Coimbatore and IIRR. The frequency distribution of disease scores and LSI are presented in Table 73. The disease pressure was high at IIRR (LSI 6.2) and Coimbatore (LSI 6.4).

Table 73: Location severity index(LSI) and frequency distribution of RTD scores of DSN Kharif 2019

Score	Location/Frequency of score(0-9)	
	CBT	IIRR
1	0	0
3	9	11
5	37	41
7	93	99
9	10	0
Total	149	151
LSI	6.4	6.2
Screening method	A	A

(N- Natural; A- Artificial)

The DSN entries that showed a moderate level of resistance to rice tungro disease are listed in Table 74. The promising entries included are RP-Patho-12, RMS-R-8, RMS-R-12, RMS-R-13, RMS-R-15, RMS-R-16 and CB 15569

Table 74: DSN entries with low susceptibility index (SI ≤5) against rice tungro disease, Kharif, 2019

Designation	Location/Frequency of score (0-9)		SI	Total	≤3*	PI (<3)**	≤5*	PI (<5)**
	CBT	IIRR						
RP-Patho-12	3	3	3.0	2	2	100	2	100
Vikramarya	3	3	3.0	2	2	100	2	100
RMS-R-8	3	5	4.0	2	1	50	1	50
RMS-R-12	3	5	4.0	2	1	50	1	50
RMS-R-13	3	5	4.0	2	1	50	1	50
RMS-R-15	5	3	4.0	2	1	50	1	50
RMS-R-16	5	3	4.0	2	1	50	1	50
CB 15569	5	3	4.0	2	1	50	1	50
Nidhi	5	3	4.0	2	1	50	1	50
T(N)1	5	7	6.0	2	0	0	0	0
LSI	6.4	6.2						

(SI- Susceptibility Index; Promising Index (PI) based on percentage of locations the entry has scored ≤3 and ≤5)

➤ MULTIPLE DISEASE RESISTANCE

In NSN-1, a total of 13 entries had shown resistant/moderately resistant reaction to two or three diseases. One entry *i.e* IET # 27438 found promising against four diseases. This entry showed resistant reaction against NB and ShR while moderate resistant reaction against ShB and BS. Entries *viz.*, IET# 25212 (resistant against NB, moderate for ShB, ShR), 27077 (moderate reaction against NB, BS, BLB) and 26118 (moderate reaction against NB, ShB, BS) showed resistant/moderate reaction against three diseases. The remaining nine entries *viz.*, IET# 27736- (LB, ShR), 27743 (LB, NB), 27369 (LB, BS), 27781 (LB, ShB), 26684 (NB, ShB), 27280 (BS, ShR), 27378 (BLB, ShR), 28811 (LB, BLB) and 27637 (ShB, BLB) expressed resistant/moderate reaction against two diseases (Table 75)

Table 75: Multiple disease resistant lines in NSN-1, Kharif -2019

S.No	IET. No	Disease/Susceptible Index					
		LB	NB	ShB	BS	BLB	ShR
1	27438		3.4	5.0	4.9		3.1
2	25212 (R)		3.3	4.8			3.9
3	27077		3.8		4.2	4.2	
4	26118		3.8	5.0	4.8		
5	27736	3.9					3.9
6	27743	3.9	3.8				
7	27369	4.0			4.9		
8	27781	4.0		4.8			
9	26684		3.4	4.4			
10	27280				4.9		3.9
11	27378					4.0	4.0
12	28811	4.0				4.1	
13	27637			4.8		4.5	

(LB-Leaf Blast; NB-Neck blast; ShB-Sheath Blight; BS-Brown spot; BLB-Bacterial leaf blight; ShR – Sheath rot)

In NSN-2, IET # 28306 had shown high resistance to two diseases *viz.*, neck blast and sheath rot. In addition, IET # 28521 had shown high resistance to neck blast and moderate resistance to bacterial leaf blight. IET # 28732, 28301, 28304 shown resistance to neck blast and tolerance to sheath blight (Table 76).

Table 76: Multiple disease resistance in NSN-2, Kharif – 2019

S.No	IET. No	Disease/Susceptible Index			
		NB	ShR	BLB	ShB
1	28306	1.0	1.5		
2	28521	1.5		4.7	
3	28732	0.5			5.0
4	28301	2.0			4.8
5	28304	2.0			4.5

(NB-Neck blast; BS-Brown spot; BLB-Bacterial leaf blight; ShR – Sheath rot)

Under NSN-H, nine lines expressed resistant reaction to more than two diseases viz., IET # 26594 (moderately resistant to sheath blight, sheath rot and brown spot), 27466 (moderately resistant to neck blast, sheath blight and bacterial leaf blight). Seven entries viz., IET # 27465 (ShB, ShR), 27491 (LB, ShR), 28193 (LB, BS), 28211 (LB, BLB), 28212 (ShB, ShR), 28222 (LB, NB) and 28239 (NB, ShB) (Table 77).

Table 77: Multiple disease resistance in NSN-H, Kharif - 2019

S.No	IET. No	Disease/Susceptible Index					
		LB	NB	ShB	ShR	BS	BLB
1	26594			5.0	3.0	4.8	
2	27466		3.7	5.0			5.5
3	27465			5.0	4.0		
4	27491	4.8			4.0		
5	28193	4.6				4.7	
6	28211	4.8					4.5
7	28212			4.3	3.0		
8	28222	4.8	3.5				
9	28239		4.0	5.0			

(LB-Leaf blast; NB-Neck blast; ShB – Sheath blight; BS-Brown spot; BLB-Bacterial leaf blight; ShR – Sheath rot)

In NHSN, Out of 14 entries, 13 entries showed moderate/ resistant reaction to two diseases; except IET# 28148 expressed moderate resistance against three diseases (ShB, BS and BLB). Entries expressed moderate resistance or tolerance against two diseases are IET#28130 (LB, NB), 28115 (LB, RTD), 28117 (NB, ShR), 28129 (NB, ShR), 28154 (NB, ShB), 28160 (ShB, BLB), 28152 (ShB, BS), 28134 (BS, ShR) expressed moderate resistant reaction against two different diseases (Table 78).

Table 78: Multiple disease resistance in NHSN, Kharif – 2019

S.No	IET. No	Disease/Susceptible Index						
		LB	NB	ShB	BS	BLB	RTD	ShR
1	28148			5.2	4.3	4.7		
2	28130	3.9	4.0					
3	28115	3.7					5.0	
4	28117		3.4					4.0
5	28129		3.8					3.9
6	28154		3.8	5.4				
7	28141	3.9		5.3				
8	28160			5.3		5.0		
9	28152			5.4	4.9			
10	28134				4.8			4.2

(LB-Leaf blast; NB-Neck blast; ShB-Sheath blight; BS-Brown spot; BS-Brown spot; BLB-Bacterial leaf blight; ShR – Sheath rot; RTD- Rice tungro disease)

In DSN, CR 4209-2(moderate resistant to sheath blight, brown spot and sheath rot) and Phoghak (moderate resistant to neck blast, sheath blight and sheath rot) showed resistant reaction to three diseases. IET numbers showed moderate resistant reaction to two diseases were Gonalasha (sheath blight and sheath rot), HL18WS-20-4 (leaf blast and neck blast), IET 25692 (sheath blight and sheath rot), KNM 7787 (neck blast and bacterial leaf blight), RMS-R-11 (sheath blight and sheath rot), RMS-R-13 (neck blast and rice tungro virus), RMS-R-15 (RTD and sheath rot), RP-Bio Patho-10 (neck blast and BLB), RP-Bio Patho-7 (neck blast and BLB), RP-Patho-3(neck blast and sheath rot) and RP-Patho-9 (neck blast and sheath blight) (Table 79)

Table 79: Multiple disease resistance in DSN *Kharif* – 2019

S. No	IET. No	Disease/Susceptible Index						
		LB	NB	ShB	BS	BLB	RTD	ShR
1	CR 4209-2			4.9	4.6			4.1
2	Gonalasha			4.8				4.3
3	HL18WS-20-4	4.0	4.0					
4	IET 25692			4.1				3.8
5	KNM 7787		4.0			4.3		
7	Phoghak		3.3	4.6				4.0
8	RMS-R-11			4.9				3.6
9	RMS-R-13		4.0				4.0	
10	RMS-R-15						4.0	4.3
12	RP-Bio Patho-10		3.8			4.6		
13	RP-Bio Patho-7		3.7			4.8		
14	RP-Patho-3		3.8					3.8
15	RP-Patho-9		3.8	4.8				

(LB-Leaf blast; NB-Neck blast; ShB-Sheath blight; BS-Brown spot; BS-Brown spot; BLB-Bacterial leaf blight; ShR – Sheath rot; RTD- Rice tungro disease)

II. FIELD MONITORING OF VIRULENCE

1. *Pyricularia oryzae*

The experiment was conducted at 25 locations across India against *Pyricularia oryzae* during *Kharif* 2019. The aim of this experiment was to monitor virulence pattern in the population of rice blast pathogen. The nursery included twenty five cultivars consisting of near isogenic lines, international differentials, donors and commercial cultivars. The experiment was conducted at twenty five locations during the crop season to monitor the blast reaction on different host genotypes and is presented in Figure 1. The disease pressure was high (LSI 7.1, 6.8, 6.7, 6.5 and 6.1) at Coimbatore, Gudalur, Upper Shillong, Imphal and Cuttack. It was moderate (LSI 5.9 to 5.1) Lonovola, Gangavati, Almora, Ghaghraghat, Karjat, New Delhi, Nawagam and Navsari. It was low (LSI 4.7 to 2.5) at Jagityala, Mandya, Ponnampet, Jagdalpur, Hazaribagh, Pattambi, Mugad, IIRR, Ranchi, Rajendranagar, Khudwani and Malan. The data from these locations are presented in Table 80.

Raminad str-3, Tetep and Tadukan were resistant across the locations with SI 3.2, 3.5 and 3.5 respectively. Tetep was highly resistant at most of the locations about 17 locations that showed its potentiality as the best donors for resistance against blast disease. Tetep was susceptible at Coimbatore, Gudalur and Upper Shillong and moderately susceptible at Cuttack, Ghaghraghat and Gangavati. Raminad str-3 was susceptible at Coimbatore and Cuttack and also moderately susceptible at Imphal, Gudalur, Ghaghraghat and Karjat. Tadukan was showing resistant all the locations except Gangavati, Ghaghraghat, Coimbatore, Upper Shillong, Cuttack and Karjat. Zenith was highly susceptible at Gudalur and Upper Shillong; similarly NP-125 also highly susceptible at Coimbatore and Gudalur. The susceptible checks like HR-12 and Co-39 are showing susceptible reaction at most of the locations but HR-12 recorded moderately resistant reaction at Khudhwani and Co-39 also recorded low disease score at Ranchi, Karjat and Ghaghraghat. The resistant check Rasi was highly susceptible at Gudalur, Upper Shillong, Imphal, Almora, Nawagam, Cuttack, Gangavati, Mandy and Rajendranagar. IR 64 was showing susceptible reaction at Coimbatore, Lonavala, Imphal, Gudalur and Cuttack.

The difference in disease reaction score of susceptible and resistant checks reveals that a shift in the pathogen population. Cluster analysis of *Pyricularia oryzae* reaction on 25 different genotypes at 25 locations was done and is presented in Figure 2. The reaction pattern of genotypes at all the locations was grouped into six major groups at 60 percent similarity coefficient. The reaction pattern at Almora, Gudalur, Cuttack, Ghaghraghat, Karjat, Imphal, Ponnampet, Navasari, Coimbatore, Upper Shillong, Nawagam, Gangavati, Jagityal, Hazaribagh, Jagdalpur, Lonovola, New Delhi, IIRR, Mandya and Ranchi were in group one; Pattambi, Mugad, Malan, Khudhwani and Rajendranagar were in group two, three, four, five and six respectively.

Table 80: Reaction of rice differentials to *Pyricularia oryzae* at across the locations in India during *Kharif* -2019

Ent. No.	Differentials	CBT	GDL	USG	IMP	CTK	LNV	GGV	ALM	GHT	KJT	NDL	NWG	NVS	JGT	MND	PNP	JDP	HZB	PTB	MGD	IRR	RNC	RNR	KHU	MLN	SI	<=3*	<=5*	Total
	LSI	7.1	6.8	6.7	6.5	6.1	5.9	5.9	5.7	5.7	5.6	5.5	5.3	5.1	4.7	4.5	4.5	4.3	4.2	3.7	3.7	3.6	3.5	3.0	2.8	2.5				
	Screening Method	-	N	N	N	-	N	N/A	N	-	A	A	A	N/A	-	N/A	N	N	N	N	N	A	-	A	N/A	N/A				
12	Raminad -STR -3	7.0	5.0	4.0	6.0	7.0	3.0	3.0	1.0	5.0	5.0	0.0	4.0	3.0	3.5	0.5	4.5	2.0	2.5	3.0	3.0	1.0	1.3	1.5	2.0	1.0	3.2	15	22	25
22	Tetep	9.0	9.0	7.0	3.0	5.0	2.0	4.5	4.0	5.0	3.0	3.0	3.5	1.5	2.5	2.5	2.5	1.5	2.5	2.0	3.0	1.0	3.0	3.0	2.0	2.0	3.5	17	22	25
20	Tadukan	7.0	4.0	7.0	3.0	5.0	3.0	8.5	4.0	7.0	5.0	3.0	3.5	3.5	2.5	2.5	2.5	2.0	2.5	3.0	3.0	1.0	2.0	1.0	2.0	1.0	3.5	15	21	25
13	Zenith	3.0	7.0	7.0	5.0	5.0	5.0	4.5	5.0	6.5	5.0	3.0	4.5	5.5	4.5	1.0	4.5	0.5	2.5	4.0	3.0	2.0	3.0	2.0	3.0	2.0	3.9	11	21	25
14	NP - 125	8.0	3.0	9.0	6.5	5.0	4.5	5.0	1.0	5.0	5.0	5.0	3.0	3.0	4.0	1.0	4.5	5.0	3.0	3.0	5.0	1.0	3.3	1.5	3.0	1.0	3.9	11	22	25
11	C101 PKT	7.0	5.0	9.0	6.0	5.0	5.0	2.0	3.5	5.0	7.0	5.0	5.5	6.0	3.5	2.5	3.5	5.5	3.5	4.0	3.0	2.0	3.7	2.5	2.0	1.0	4.3	7	18	25
6	RIL - 29	8.0	5.0	4.0	7.0	7.0	5.5	5.0	4.0	5.0	6.5	5.0	5.0	5.0	4.5	3.5	3.5	4.0	3.5	3.5	3.0	3.0	2.0	1.0	3.0	2.0	4.3	6	20	25
7	<i>O. minuta</i>	9.0	7.0	4.0	6.0	5.0	8.0	8.0	4.5	5.0	6.0	3.0	5.5	5.0	4.5	2.5	4.0	3.5	2.5	4.0	3.0	3.0	2.3	3.0	2.0	1.5	4.5	9	18	25
10	A 57	6.0	6.0	9.0	7.0	7.0	4.5	2.5	4.5	7.0	6.5	5.0	6.5	6.0	2.5	2.5	4.5	4.0	2.5	4.0	3.0	4.0	4.3	2.5	2.0	1.0	4.6	8	16	25
4	C101 TTP	6.0	9.0	7.0	5.5	5.0	5.5	7.5	6.0	5.0	6.0	7.0	5.5	4.5	4.5	4.5	3.5	3.5	4.0	3.0	3.0	4.0	3.7	0.0	3.0	1.0	4.7	5	15	25
2	C101 A51	8.0	6.0	7.0	7.0	5.0	7.0	8.0	5.5	5.0	5.5	5.0	5.5	4.5	3.0	2.5	4.5	3.5	3.5	3.0	3.0	4.0	3.7	3.0	3.0	2.0	4.7	7	16	25
9	BL-245	3.0	6.0	8.0	5.5	7.0	5.0	2.5	6.0	5.0	7.0	7.0	5.5	6.5	3.5	7.5	5.0	4.5	4.0	4.0	3.0	3.0	3.7	2.5	2.0	1.0	4.7	7	15	25
21	IR - 64	9.0	7.0	0.0	8.5	7.0	9.0	8.5	6.5	5.0	3.5	5.0	4.5	4.5	3.5	3.5	4.0	2.5	3.0	4.0	4.0	4.0	2.7	3.5	4.0	1.5	4.7	5	18	25
1	C101 LAC	4.0	8.0	7.0	6.5	5.0	5.0	8.5	5.5	5.0	5.0	7.0	5.0	5.0	3.0	6.5	4.0	4.0	5.0	2.5	5.0	4.0	4.0	3.0	1.0	2.5	4.8	5	18	25
5	RIL - 10	5.0	7.0	8.0	7.5	5.0	5.0	5.0	7.0	5.0	7.0	5.0	3.0	3.5	5.0	6.5	3.5	4.5	4.5	3.0	5.0	5.0	4.3	3.5	2.0	1.5	4.9	4	19	25
16	Dular	9.0	3.0	8.0	6.5	5.0	4.0	4.0	9.0	7.0	7.0	7.0	5.5	4.5	6.5	1.0	5.5	6.0	3.5	3.0	5.0	1.0	1.3	1.0	2.0	6.0	4.9	7	13	25
8	BL-122	6.0	4.0	7.0	7.5	7.0	8.0	8.0	5.5	5.0	7.0	5.0	6.0	4.5	4.5	6.5	4.5	5.0	4.0	3.0	3.0	4.0	2.3	3.0	1.0	2.5	5.0	6	15	25
17	Kanto - 51	9.0	8.0	5.0	6.0	7.0	3.0	6.5	6.0	7.0	5.0	7.0	3.0	6.5	5.5	2.5	5.5	6.0	4.5	4.0	3.0	2.0	3.7	0.0	4.0	5.0	5.0	6	13	25
19	Calaro	7.0	7.0	8.0	6.0	5.0	9.0	6.0	5.5	7.0	5.0	7.0	6.0	5.5	5.5	6.5	3.5	2.5	4.0	5.0	5.0	4.0	4.3	1.0	3.0	4.0	5.3	3	12	25
18	Shi-tia-tao	7.0	9.0	2.0	7.5	7.0	7.5	4.0	9.0	7.0	5.0	7.0	5.5	6.0	5.0	8.5	4.5	3.5	8.5	4.0	2.0	7.0	4.7	0.0	3.0	5.0	5.6	4	12	25
24	Rasi	6.0	9.0	8.0	8.0	7.0	4.5	7.0	8.0	6.0	5.5	5.0	7.5	5.5	7.0	6.5	4.5	4.5	3.5	4.0	5.0	5.0	3.7	7.0	3.0	-	5.9	1	10	24
3	C104 PKT	9.0	9.0	8.0	7.5	5.0	8.5	7.5	8.0	5.0	6.5	7.0	5.0	5.0	5.0	7.5	5.5	5.5	6.0	3.5	3.0	4.0	4.7	6.0	4.0	2.5	5.9	2	11	25
15	USEN	9.0	9.0	8.0	7.0	7.0	9.0	4.5	8.0	7.0	5.0	7.0	7.5	6.0	6.0	8.5	5.5	6.5	4.0	4.0	3.0	5.0	4.3	7.0	3.0	5.0	6.2	2	9	25
25	Co - 39	9.0	9.0	7.0	7.5	9.0	9.0	8.5	7.5	5.0	5.0	9.0	9.0	7.5	9.0	7.0	6.5	8.5	9.0	6.5	5.0	6.0	4.3	9.0	6.0	-	7.5	0	4	24
23	HR - 12	8.0	9.0	9.0	8.0	9.0	9.0	9.0	9.0	6.0	5.5	9.0	8.0	8.5	8.0	9.0	8.5	8.5	8.5	6.5	6.0	9.0	6.7	7.5	4.0	6.0	7.8	0	1	25

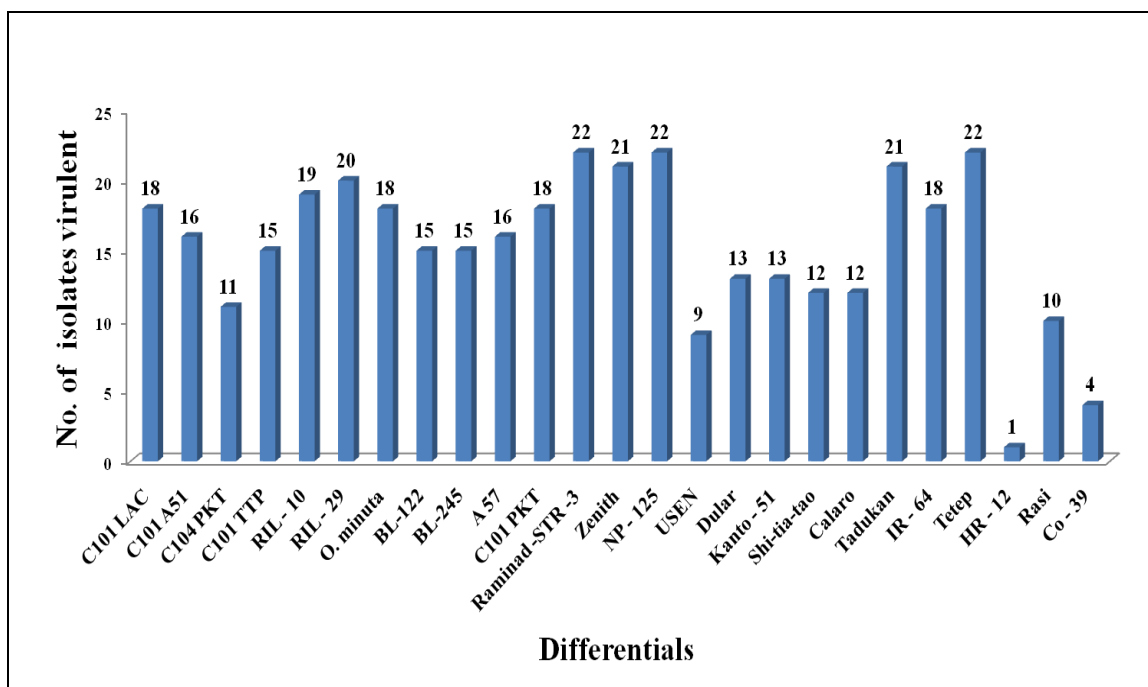


Figure 1: Differential reaction of hosts to rice blast pathogen (*Piricularia oryzae*) at different locations - Kharif 2019

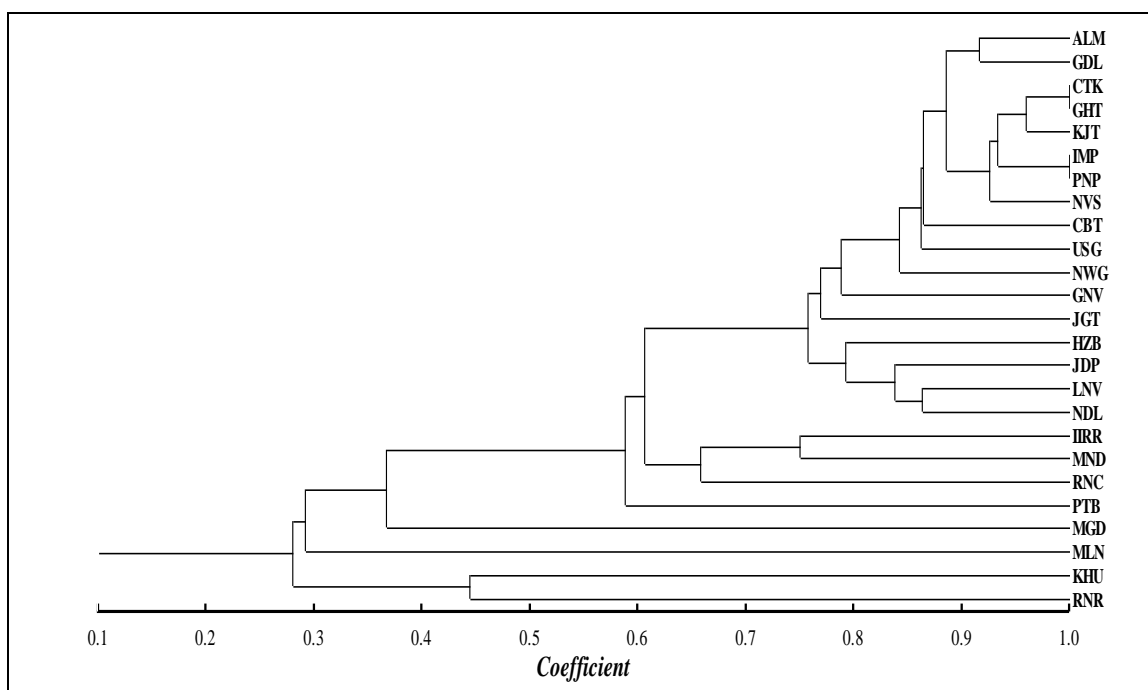


Figure 2: Dendrogram showing relatedness of different reactions of *P. oryzae* at different locations during Kharif -2019

2. *Xanthomonas oryzae* pv. *oryzae*

Trial on monitoring virulence of bacterial blight pathogen, *Xanthomonas oryzae* pv. *oryzae* was proposed at 26 hot spot location across India during *Kharif* season of 2019. Data was received from all the 26 locations. At Ludhiana, the trial was conducted with 10 different strains of *Xanthomonas oryzae* pv. *oryzae*. The rice differentials used in this trial consisted of twenty eight near isogenic lines (IRBB lines) possessing different bacterial blight resistant genes (singly) or various combination 5 BB resistance genes viz., *Xa4*, *xa5*, *Xa7*, *xa13* and *Xa21* in the background of rice cultivar IR 24. The differentials like DV 85, TN1 (susceptible check) and Improved Samba Mahsuri (RP Bio 226) (resistant check) were also included in the trial. The isolate from Maruteru, Arundhatinagar and Pattambi were extremely virulent and produced LSI (location severity index) of 6 or more. The isolates from Chiplima, Aduthurai, Gangavathi, New Delhi and Coimbatore were also categorized as highly virulent and the produced LSI between 5.7- 6. The MTU isolate was reported to be unique as it produced susceptible reaction on all the 31 differentials. The reaction pattern of this isolate should be re-confirmed. The isolate from Arundhatinagar also produced susceptible reactions (score >5) on 20 differentials and the reaction pattern of this isolate also should be re-confirmed. The isolates from Pattambi, Chiplima, Aduthurai, Gangavathi, New Delhi and Coimbatore produced susceptible reactions on 14-19 differentials. The isolates from Chatha, Karjat, Chinsurah, Faizabad, Raipur, Patna, Nawagam, Pantnagar, IIRR (collected from Warangal), Navsari, Rajendranagar and some isolates from Ludhiana (PbXo # 4, 5, 7, 8, 9, 10) were categorized as moderately virulent (LSI 4.3-5.5) and these isolates produced susceptible reactions on 8-18 differentials. The isolates from Sabour, Jagtiyal, Titabar, NRRI-Cuttack, Port Blair, Moncompu and some isolates from Ludhiana (PbXo # 1, 2, 3, 6) were categorized as less virulent (LSI <4.2) and these isolates produced susceptible reactions on 1-8 differentials. As far as performance of important genes is concerned, *Xa21* was found to be susceptible at 21 locations while *xa13* was found susceptible at 14 locations. Different 2 genes combinations (IRBB 50 to IRBB 55) showed susceptibility to 8-10 differentials. Gene combinations *Xa21* + *xa13* was found susceptible at 10 locations. Different 3 genes combinations (IRBB 56-IRBB 59; IRBB 61-IRBB 63) showed susceptibility to 3-8 differentials at different locations. Different 4 and 5 genes combinations (IRBB 60; IRBB 64-IRBB 66) showed susceptibility to 5-8 differentials at different locations (Table 81). Cluster analysis of *Xanthomonas oryzae* pv. *oryzae* reaction on different genotypes at various locations was done and is presented in Figure 3. The isolates belonging to different virulence categories (high virulence, moderate virulence and low virulence) very clearly formed separate groups (Figure 4).

Table 81: Reaction of rice differentials to *Xanthomonas oryzae* pv. *oryzae* at different locations during Kharif 2019

Differentials	Gene combinations	Highly virulent								Moderately virulent									
		MTU	AND	PTB	CHP	ADT	GGV	NDL	Coim	CHT	KJT	CHN	FZB	RPR	PTN	NWG	PbXo-9	PbXo-10	PNT
IRBB - 1	<i>Xa1</i>	8	7	9	9	5	9	5	7	6	6	7	6	9	4	7	7	7	9
IRBB - 3	<i>Xa3</i>	9	9	8	9	4	8	7	8	2	7	8	5	7	5	7	7	7	9
IRBB - 4	<i>Xa4</i>	9	5	7	8	5	6	7	6	5	7	5	5	9	6	8	7	7	9
IRBB - 5	<i>xa5</i>	9	3	7	8	6	4	5	5	7	7	6	5	7	5	7	7	7	8
IRBB - 7	<i>Xa7</i>	9	9	9	8	5	4	5	4	5	6	6	6	7	4	6	7	7	4
IRBB - 8	<i>xa8</i>	9	7	7	9	7	7	5	5	8	5	7	5	5	5	4	7	7	5
IRBB - 10	<i>Xa10</i>	8	9	5	9	7	6	5	6	5	6	9	7	9	6	6	7	7	9
IRBB - 11	<i>Xa11</i>	9	9	7	8	5	6	5	3	7	7	9	7	9	6	8	7	7	7
IRBB - 13	<i>xa13</i>	9	5	7	6	7	5	5	6	2	6	7	6	9	6	6	3	3	7
IRBB - 14	<i>Xa14</i>	9	9	7	7	3	7	9	7	6	6	9	5	9	5	6	7	7	9
IRBB - 21	<i>Xa21</i>	8	9	7	6	7	4	5	6	7	6	9	5	7	5	8	7	7	6
IRBB - 50	<i>Xa4+xa5</i>	8	9	7	8	5	8	5	6	6	4	5	6	3	4	4	7	7	3
IRBB - 51	<i>Xa4+xa13</i>	7	7	7	4	5	7	1	8	5	6	3	4	7	6	2	3	3	3
IRBB - 52	<i>Xa4+Xa21</i>	6	7	7	5	5	4	1	7	6	7	3	5	7	6	3	5	3	1
IRBB - 53	<i>xa5+xa13</i>	7	9	5	4	7	3	5	5	7	7	7	5	7	6	3	5	3	6
IRBB - 54	<i>xa5+Xa21</i>	7	9	5	6	4	6	5	8	4	6	3	5	3	4	3	3	3	4
IRBB - 55	<i>xa13+Xa21</i>	8	9	5	4	5	6	5	7	6	5	6	6	7	5	3	3	3	4
IRBB - 56	<i>Xa4+xa5+xa13</i>	6	7	5	4	8	6	7	5	5	6	3	6	3	4	3	3	3	3
IRBB - 57	<i>Xa4+xa5+Xa21</i>	7	9	5	5	8	6	5	4	5	5	4	5	1	6	3	3	5	1
IRBB - 58	<i>Xa4+xa13+Xa21</i>	6	5	4	3	7	4	5	3	5	4	3	5	3	5	2	3	3	9
IRBB - 59	<i>xa5+xa13+Xa21</i>	7	3	5	3	7	3	5	6	4	6	4	6	3	5	6	3	3	1
IRBB - 60	<i>Xa4+xa5+xa13+Xa21</i>	7	9	3	3	7	2	7	7	7	4	6	4	3	4	3	3	3	1
IRBB - 61	<i>Xa4 + xa5 + Xa7</i>	7	-	5	5	5	8	7	3	6	5	3	5	3	6	4	7	5	4
IRBB - 62	<i>Xa4 + Xa7 + Xa21</i>	7	5	5	6	7	8	5	7	5	4	3	4	1	5	6	3	3	1
IRBB - 63	<i>xa5 +Xa7 + xa13</i>	7	3	5	4	5	6	5	6	6	5	6	5	3	6	8	3	3	2
IRBB - 64	<i>Xa4 + xa5 + Xa7 + Xa21</i>	7	5	5	4	6	7	5	3	6	5	5	3	3	4	6	3	3	2
IRBB - 65	<i>Xa4 + Xa7 + xa13 + Xa21</i>	7	3	5	4	4	6	7	6	7	5	3	6	1	6	3	3	3	1
IRBB - 66	<i>Xa4 + xa5 + Xa7 + xa13 + Xa21</i>	7	7	3	3	4	4	7	5	6	4	3	4	3	5	2	3	3	6
DV - 85	-	7	7	5	5	9	6	9	4	6	5	4	7	5	5	6	7	7	7
ISM	<i>xa5+xa13+Xa21</i>	7	5	5	4	2	2	9	6	3	3	2	3	3	6	6	3	3	1
TN1	-	8	9	9	9	6	9	9	7	7	7	9	9	9	7	9	9	9	9
LSI		7.6	6.9	6.0	5.8	5.7	5.7	5.7	5.7	5.5	5.5	5.4	5.3	5.3	5.2	5.1	5.0	4.9	4.9
Min Score		6	3	3	3	2	2	1	3	2	3	2	3	1	4	2	3	3	1
Max Score		9	9	9	9	9	9	9	8	8	7	9	9	9	7	9	9	9	9
# entries > 5		31	20	14	15	15	20	11	19	18	17	15	12	15	13	17	14	13	14

Table 81: Reaction of rice differentials to *Xanthomonas oryzae* pv. *oryzae* at different locations during Kharif 2019

Differentials	Gene combination	Moderately virulent							Less virulent									
		PbXo-4	IIR	PbXo-5	NVS	PbXo-7	PbXo-8	RNR	PbXo-1	PbXo-6	SBR	JJT	TTB	PbXo-3	NRRI	PbXo-2	PBL	MCP
IRBB - 1	<i>Xa1</i>	7	9	7	7	7	7	3	7	7	5	6	7	7	7	5	3	4
IRBB - 3	<i>Xa3</i>	7	9	5	6	7	7	3	7	7	5	6	7	7	7	5	5	5
IRBB - 4	<i>Xa4</i>	7	7	7	7	7	3	4	5	5	6	5	7	3	5	3	3	2
IRBB - 5	<i>xa5</i>	5	5	7	5	7	3	7	5	3	9	4	7	3	3	3	3	4
IRBB - 7	<i>Xa7</i>	7	9	7	6	7	5	3	7	7	9	4	5	5	5	3	1	4
IRBB - 8	<i>xa8</i>	5	5	7	6	7	7	6	5	3	7	4	5	3	3	3	5	1
IRBB - 10	<i>Xa10</i>	7	9	7	5	7	7	5	7	7	5	6	6	7	5	3	7	3
IRBB - 11	<i>Xa11</i>	7	9	7	5	7	7	3	7	7	7	6	5	7	5	5	5	2
IRBB - 13	<i>xa13</i>	3	3	3	3	3	7	4	3	3	5	4	5	3	3	3	7	1
IRBB - 14	<i>Xa14</i>	7	9	7	4	7	7	6	7	7	5	5	7	7	3	5	5	4
IRBB - 21	<i>Xa21</i>	7	5	7	4	7	7	6	5	7	2	3	5	5	3	3	7	0
IRBB - 50	<i>Xa4+xa5</i>	3	5	5	5	5	1	4	3	3	3	4	5	3	3	3	1	0
IRBB - 51	<i>Xa4+xa13</i>	3	3	3	2	3	3	4	3	3	4	4	4	3	1	3	1	0
IRBB - 52	<i>Xa4+Xa21</i>	5	7	3	3	3	3	4	3	3	2	3	3	3	1	1	1	0
IRBB - 53	<i>xa5+xa13</i>	3	1	3	4	3	3	4	3	3	3	2	4	3	1	1	1	1
IRBB - 54	<i>xa5+Xa21</i>	7	3	7	4	3	3	5	3	3	3	4	3	3	1	1	1	0
IRBB - 55	<i>xa13+Xa21</i>	3	1	3	3	3	7	7	3	3	3	5	4	3	1	3	1	2
IRBB - 56	<i>Xa4+xa5+xa13</i>	3	1	1	4	1	3	4	1	3	3	3	3	3	3	1	3	3
IRBB - 57	<i>Xa4+xa5+Xa21</i>	5	1	3	3	3	3	3	3	3	2	3	2	5	1	3	1	1
IRBB - 58	<i>Xa4+xa13+Xa21</i>	3	1	1	2	3	3	3	3	3	1	2	3	3	1	3	3	0
IRBB - 59	<i>xa5+xa13+Xa21</i>	3	1	3	1	3	3	3	3	3	2	3	1	3	1	3	3	0
IRBB - 60	<i>Xa4+xa5+xa13+Xa21</i>	3	1	3	3	1	3	4	3	3	3	3	2	1	1	3	1	0
IRBB - 61	<i>Xa4 + xa5 + Xa7</i>	3	7	5	2	5	1	4	3	3	4	5	3	3	3	3	1	0
IRBB - 62	<i>Xa4 + Xa7 + Xa21</i>	3	5	3	5	1	3	3	3	3	3	4	3	3	3	3	1	0
IRBB - 63	<i>xa5 +Xa7 + xa13</i>	3	3	3	6	1	3	4	3	3	3	4	4	3	1	3	1	0
IRBB - 64	<i>Xa4 + xa5 + Xa7 + Xa21</i>	3	3	3	7	1	3	3	3	3	3	4	2	3	3	3	1	2
IRBB - 65	<i>Xa4 + Xa7 + xa13 + Xa21</i>	3	1	1	5	1	3	6	3	3	3	4	1	1	3	1	1	1
IRBB - 66	<i>Xa4 + xa5 + Xa7 + xa13 + Xa21</i>	3	1	1	3	1	3	3	3	3	2	2	1	1	3	1	1	0
DV - 85	-	3	7	7	7	9	3	7	3	3	5	3	3	3	5	3	3	1
ISM	<i>xa5+xa13+Xa21</i>	3	1	3	2	3	3	1	3	3	4	2	1	3	3	1	1	0
TN1	-	9	9	9	8	9	9	7	9	9	6	9	7	9	9	7		8
LSI		4.6	4.5	4.5	4.4	4.4	4.3	4.3	4.2	4.2	4.1	4.1	4.0	3.8	3.1	2.9	2.6	1.6
Min Score		3	1	1	1	1	1	1	1	3	1	2	1	1	1	1	1	0
Max Score		9	9	9	8	9	9	7	9	9	9	9	7	9	9	7	7	8
# entries > 5		10	11	12	9	12	10	8	7	8	6	5	7	6	3	1	3	1

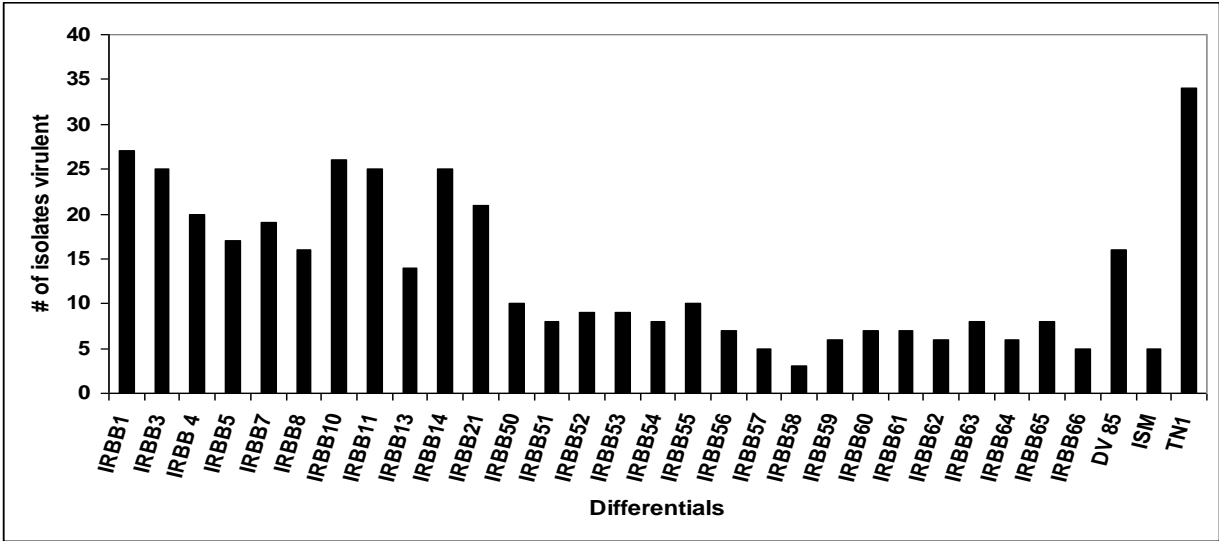


Figure 3: Number of *Xoo* isolates showing moderate to high virulence on different BB resistance genes and their combinations during Kharif 2019

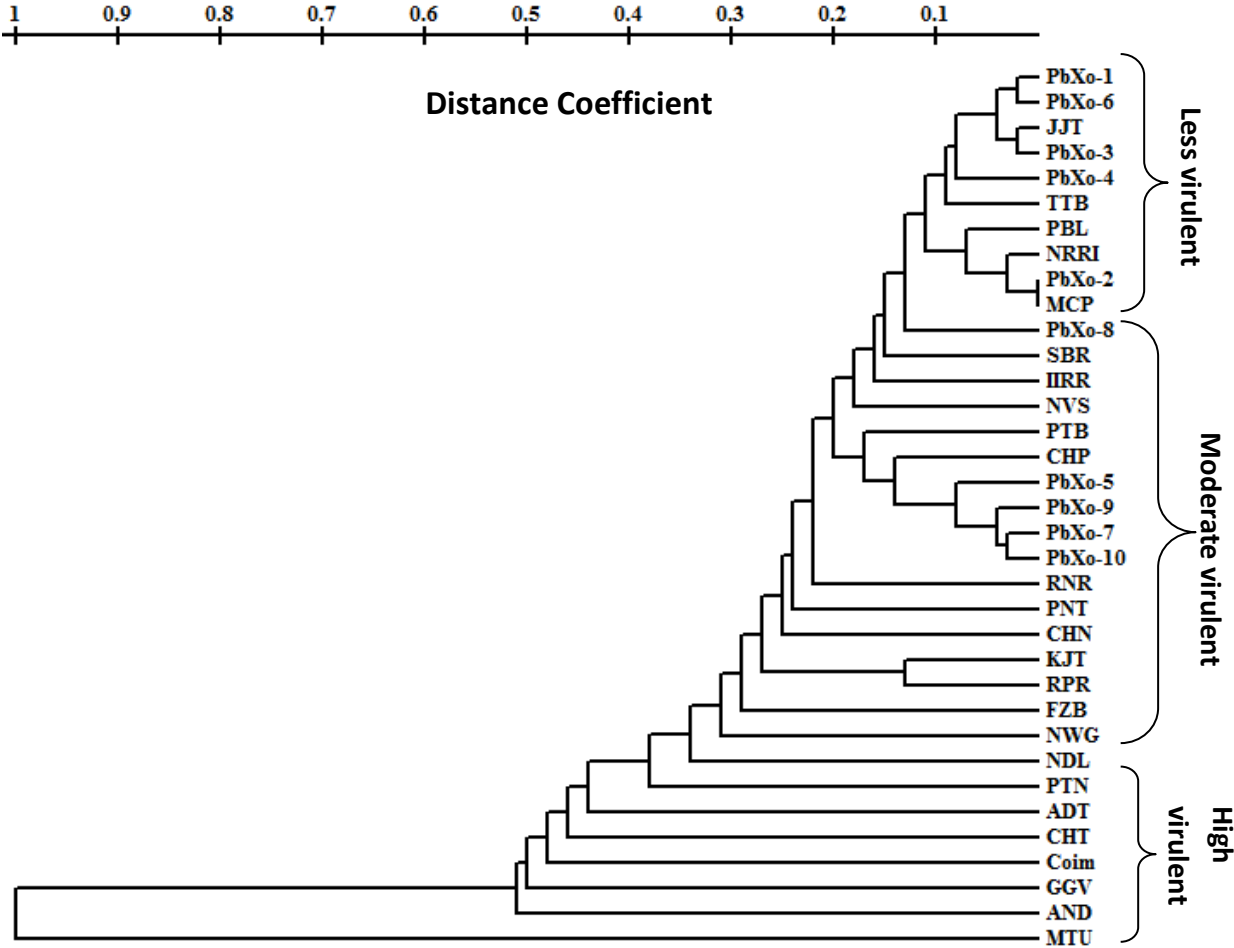


Figure 4: Dendrogram showing the relatedness of different *Xanthomonas oryzae* pv. *oryzae* isolates from various locations during Kharif 2019

III. DISEASE OBSERVATION NURSERY – *Kharif*-2019

Disease observation nursery (DON) trial was conducted at 10 locations with different sowing dates *viz.*, early, normal and late with respect to the respective locations with an aim to estimate the effect of such varied sowing/planting dates on the occurrence and severity of the disease in the respective endemic regions. It is generally known that the availability of susceptible host, virulent pathogen and prevalence of favorable weather condition play important role in the process of disease development. In this context the trial was formulated with susceptible variety to take up sowing in three different dates to collect the information on the incidence of the disease and also data was recorded as percent disease index of various rice diseases throughout the cropping period in a particular locality. Knowledge on the occurrence of particular disease on specific location based on susceptible host and time of sowing may help us to formulate the management strategy. The trial was proposed at 10 locations Chinsurah, Cuttack, Gangavathi, Kaul, Malan, Mandya, Maruteru, Moncompu, Nawagam, Pusa and Raipur. The data was received from 9 centres except from Cuttack. The salient findings of this study are presented on location-wise below.

Chinsurah: Three different sowing dates *viz.*, 27.05.19, 27.06.19 and 26.07.19 were followed as early, normal and late sowing periods respectively. The variety MTU 7029 was used to study the disease progress of different diseases in that region. The diseases that were prevalent in this centre were sheath blight, sheath rot, brown spot and bacterial leaf blight (BLB). The observations were taken from 30 DAT to 100 DAT. In general, the incidence of sheath blight disease was found early and tillering stages of the crop (30 to 70 DAT) and during the early and normal sowing periods (23 to 58.5% PDI and 16.5 to 32.5 % PDI respectively) and very less during the late sown crop *i.e.*, 1 to 5 % PDI. Sheath rot disease was present in the grain filling stage in all the sowing periods (80 to 100 DAT) and relatively more in the late sown crop (33.5 to 38.5% PDI) than when compared to the early (2 to 5% PDI) and normal sown crop (11 to 19% PDI). Similarly, brown spot disease was found to occur more in the tillering to grain filling stages (60 to 100 DAT) and more in the late sown crop (5.5 to 22.5% PDI) when compared to early sown crop (PDI - 1.0 to 5.5%) and normal sown crop (PDI - 1.5 to 9.0%). In the case of BLB, the disease was very less (2.5 and 5% PDI) and it was only during the early stages of the crop. The infected plants recovered with the age of the plants and did not show further symptoms (Table 82a).

Table 82a: Occurrence of different rice diseases in disease observation nursery at different test locations, *Kharif* – 2019 - Chinsurah

Location/ Date of sowing	DAT	Percent Disease Index											
		Sheath blight			Sheath rot			Brown spot			BLB		
		(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)
V- MTU 7029	30 DAT	23.0	16.5	1.0									
E: 27.05.19	40 DAT	27.5	19.0	2.0							2.5	-	-
N: 27.06.19	50 DAT	37.5	23.5	3.0							5.0	-	-

Location/ Date of sowing	DAT	Percent Disease Index											
		Sheath blight			Sheath rot			Brown spot			BLB		
		(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)
L: 26.07.19	60 DAT	47.5	27.5	5.0					1.5	5.5			
	70 DAT	58.5	32.5	5.0				1.0	2.0	10.0			
	80 DAT				2.0	11.0	33.5	2.5	4.5	16.5			
	90 DAT				4.0	16.5	38.0	4.0	5.5	22.5			
	100 DAT				5.0	19.0	-	5.5	9.0				

Pusa: Variety Pankaj was used for the purpose of studying the effect of sowing dates in the incidence and progress of brown spot disease of rice. The crop was sown on viz., 15.06.19 (early), 30.06.19 (normal) and 15.07.19 (late). The disease was found to initiate in the early stage of the crop (30DAT) and progress steadily during the entire duration of the crop. Late sown crops showed maximum incidence of the brown spot disease in Pusa (7.5 to 75% PDI) followed by early sown (2.5 to 42.5% PDI) and normal sown crop (1.5 to 35.20% PDI) (Table 82b).

Table 82b: Occurrence of different rice diseases in disease observation nursery at different test locations, Kharif – 2019 – Pusa

Location/ Date of sowing	Percent Disease Index			
	Pusa			
	Brown spot			
V/DOS	DAT	(E)	(N)	(L)
Pankaj (HS)				
E: 15-06-19	30 DAT	2.50	1.50	7.50
N: 30-06-19	40 DAT	5.50	2.75	13.00
L: 15-07-19	50 DAT	7.50	6.25	14.50
	60 DAT	14.00	11.00	22.50
	70 DAT	24.50	21.00	32.50
	80 DAT	32.50	26.50	41.00
	90 DAT	37.50	31.00	52.50
	100 DAT	40.00	33.00	62.50
	110 DAT	42.50	35.50	75.00

Malan: In case of the leaf blast disease of rice in Malan, the variety HPU 2216 was selected as the susceptible variety and the crop was sown relatively earlier i.e., 21.05.19 (early), 05.06.19 (normal) and 20.06.19 (late). The early sown crop was found to be relatively disease free (2.6 and 5.05% PDI) when compared to the normal (14.45 to 28.9% PDI) and late sown (6.96 to 34.2% PDI) crop. More availability of moisture during the early stages of the crops under the late sown conditions led to the more incidence of the disease. In the case of early sown conditions, initial stage of the crop was relatively dry and the crop matured when the humidity starts building up during late stages of the crop (Table 82c).

Table 82c: Occurrence of different rice diseases in disease observation nursery at different test locations, Kharif – 2019 - Malan

Location/ Date of sowing	Percent Disease Index			
	Malan			
	Blast			
V/DOS	DAT	(E)	(N)	(L)
V- HPU 2216	30 DAT			6.95
E: 21.05.19	40 DAT			18.5
N: 05.06.19	50 DAT		14.45	25.5
L: 20.06.19	60 DAT	2.6	20.5	34.2
	70 DAT	5.05	28.9	
	80 DAT			
	90 DAT			
	100 DAT			

Kaul: Different varieties were tested for different sowing dates which was not as per the technical programme finalized during the workshop. All the three cropping dates should have been planted for comparison, but has not been done in this case. The very purpose of comparing the disease severity during the different sowing periods has not been served with the conduct of this experiment. The cooperator is requested to explain this deviation from the finalized protocol for the conduct of DON experiments (Table 82d).

Table 82d: Occurrence of different rice diseases in disease observation nursery at different test locations, Kharif – 2019 - Kaul

Location/ Date of sowing	Percent Disease Index									
	Foot rot / Bakanae		Leaf and Neck Blast		Brown Spot		Sheath blight			
	DAT	(E)	(N)	(L)	Variety/DOS	(N)	Variety/DOS	DAT	(E)	(N)
V- PB 1121	30 DAT	15.95	10.5				V- HKR 126	30 DAT		
E: 07-06-19	40 DAT	-	23.5				E: 19-06-19	40 DAT		
N: 15-07-19	50 DAT	23.20					N: 25-06-19	50 DAT		
	60 DAT	34.60						60 DAT		
	70 DAT	30.95						70 DAT		
	80 DAT	28.55		33				80 DAT	29.5	31.0
	90 DAT	27.85						90 DAT	53.5	52.5
	100 DAT	21.85						100 DAT		
	110 DAT	17.50						110 DAT		
V- CSR 30	30 DAT	13.0	7.5		V- CSR 30		V- HKR 127	30 DAT		
E: 07-06-19	40 DAT	-	14		N: 21-06-19		E: 19-06-19	40 DAT		
N: 15-07-19	50 DAT	16.95			V- CSR 30		N: 25-06-19	50 DAT		
	60 DAT	21.75				4.5		60 DAT		
	70 DAT	19.95				5.5		70 DAT		
	80 DAT	17.10		37		8.5		80 DAT	24.5	24
	90 DAT	17.50				12.5		90 DAT	42.5	43
	100 DAT	14.00				4.5		100 DAT		
	110 DAT	12.65						110 DAT		

Gangavathi: Four major diseases including blast, brown spot, false smut and BLB were observed in all the sowing periods. Except false smut, the other three diseases were present in very less percentage (1 to 5.0 % PDI) in all the stages of the crop (30 to 90 DAT). However, the incidence of false smut was observed in the grain filling to early maturity stage (70 to 90 DAT) and in more scale 9.5 to 15 % PDI in the early sown crops followed by medium scale (8.5 to 12.5% PDI) and very less scale in the late sown crop (3 to 7% PDI) (Table 82e).

Table 82e: Occurrence of different rice diseases in disease observation nursery at different test locations, Kharif – 2019 - Gangavathi

Location/ Date of sowing	DAT	Percent Disease Index											
		Blast			Brown spot			False smut			BLB		
		(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)
V- MTU 7029	30 DAT	2.0	3.5	1.5	6.0	5.5	5.5				2.0	3.5	4.0
E: 20-07-2019	40 DAT	2.5	3.5	2.5	5.0	4.5	4.5				2.5	5.0	3.5
N: 05-08-2019	50 DAT	4.0	2.5	2.0	5.5	4.5	5.5				1.5	4.5	5.0
L: 20-08-2019	60 DAT	2.5	2.0	1.5	6.0	6.5	4.5				3.0	5.0	4.0
	70 DAT	5.0	1.5	1.5	6.5	6.5	5.5	9.5	8.5	3.0	2.5	3.5	2.5
	80 DAT	1.5	1.5	2.0	7.5	6.0	4.5	12	9.5	5.0	3.0	3.5	2.0
	90 DAT	1.0	1.5	1.5	5.0	3.5	4.0	15	12.5	7.0	2.5	3.0	2.5
	100 DAT	-	-	-	-	-	-	-	-	-	-	-	-

Mandya: Two varieties viz., MTU 1001 and IR - 64 were sown under three different sowing dates i.e, 08.07.19 (early), 30.07.19 (normal) and 18.09.19 (late) to study the effect on four different diseases viz., sheath blight, brown spot, leaf blast and neck blast. Overall among the two varieties tested, IR-64 showed better tolerance for the three diseases viz., brown spot, leaf blast and neck blast under all the sowing conditions when compared with the variety MTU 1001. The variety IR-64 was more susceptible to the sheath blight disease when compared to the variety MTU1001. Among the diseases, leaf blast was found only in the late sown crop and was found to be more in the MTU1001 variety (2.22 to 17.77% PDI) when compared with the variety IR-64 (2.22 to 8.88% PDI). Neck blast was found in crops sown in all the three sowing dates and the disease was observed to be more in the early sown crop of variety MTU1001 (15.55 and 17.85%) when compared to the same day sown crop of variety IR-64 (5.55 to 8.33% PDI). Sheath blight was more prevalent (maximum of 63.88 and 33.32% PDI) in the early sowing conditions in IR-64 and MTU1001 respectively. The disease was observed in all the stages of the crop, with the initial significant symptoms appearing during the 40 DAT in the variety MTU1001 and even earlier, i.e, 30 DAT in the case of variety IR-64 (Table 82f).

Table 82f: Occurrence of different rice diseases in disease observation nursery at different test locations, *Kharif* – 2019 – Mandya

Location/ Date of sowing	DAT	Percentage of Disease Severity											
		Sheath blight			Brown spot			Leaf blast			Neck Blast		
		(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)
Mandya													
MTU1001	30 DAT	0.00	0.00	0.00	0.00	0.00	3.85	0.00	0.00	2.22			
E: 08-07-2019	40 DAT	1.11	0.00	1.11	0.00	3.33	7.77	0.00	0.00	3.88			
N: 30-07-2019	50 DAT	3.33	3.33	3.33	1.11	7.77	13.33	0.00	0.00	6.66			
L: 18-09-2019	60 DAT	7.77	5.55	5.55	3.37	11.66	18.58	0.00	0.00	9.44			
	70 DAT	11.10	7.77	7.77	5.55	15.55	26.66	0.00	0.00	11.66			
	80 DAT	15.55	9.44	10.00	7.77	18.88	33.33	0.00	0.00	14.44			
	90 DAT	18.88	13.33	13.33	11.10	25.55	40.00	0.00	0.00	17.77			
	100 DAT	24.44	17.77	15.55	14.44	29.44	49.10	0.00	0.00	17.77	15.55	17.77	0.00
	110 DAT	33.32	24.44	17.77	17.77	35.55	58.33	0.00	0.00	-	17.85	31.10	8.88
IR-64	30 DAT	4.44	3.33	0.00	0.00	0.00	0.00	0.00	0.00	2.22			
E: 08-07-2019	40 DAT	8.89	6.66	2.22	0.00	0.00	0.00	0.00	0.00	3.33			
N: 30-07-2019	50 DAT	13.33	12.22	5.55	0.00	3.33	0.00	0.00	0.00	4.44			
L: 18-09-2019	60 DAT	22.22	17.78	7.77	0.00	6.66	3.33	0.00	0.00	6.66			
	70 DAT	31.11	25.55	10.00	1.11	11.11	5.55	0.00	0.00	6.66			
	80 DAT	38.89	31.11	12.22	3.33	15.55	10.00	0.00	0.00	7.77			
	90 DAT	46.67	35.00	14.44	5.55	18.89	13.33	0.00	0.00	8.88			
	100 DAT	55.00	38.33	16.66	7.77	26.66	16.66	0.00	0.00	8.88	5.55	9.44	0.00
	110 DAT	63.88	44.44	22.22	12.22	29.44	19.44				8.33	12.22	5.55

Maruteru: The Maruteru centre has tested two varieties viz., BPT5204 and Swarna with three different sowing dates i.e, 18.06.19 (early), 05.07.19 (normal) and 19.07.19 (late), for the variations in the incidence and severity of the three major diseases of the region viz., sheath blight, BLB and neck blast. In general the crop sown in the late season was relatively disease free during the late period of the crop for all the three diseases, except for BLB in case of BPT 5204 (42.78% PDI during 80DAT) and sheath blight in case of variety Swarna (53.83% in 60DAT and 46.91% PDI in 80DAT). Among the two varieties tested, the variety BPT5204 was found to be more susceptible to sheath blight in the normal sown conditions (78.60% PDI on 70DAT) when compared with the variety Swarna (72.97% PDI on 80DAT). Under the late sown conditions, both the varieties showed peak infection during 50-60 DAT (19.16% in BPT 5204 and 53.83% in Swarna). There was no fixed pattern of the disease development in the early and normal sowing conditions. However, the late sown crop (after 90DAT) was disease free in both the varieties later period of the crop.

In case of BLB disease, the both the varieties, BPT 5204 and Swarna, sown during normal sowing season were having highest incidence from 110 DAT (81.38 and 69.98% PDI). The variety BPT5204 showed more incidence of disease during the early (40.62% PDI) and late sown (42.78%) when compared to the variety Swarna (7.4% PDI). In case of neck blast the disease was more on both the varieties viz., Swarna (51.63% PDI) and BPT 5204 (45.05% PDI) sown during normal sowing time when compared to early sowing. Both the varieties that were sown late, totally free from neck blast during the cropping period (Table 82g).

Table 82g: Occurrence of different rice diseases in disease observation nursery at different test locations, Kharif – 2019 – Maruteru

Location/ Date of sowing	DAT	Percentage of Disease Index								
		Sheath blight			BLB			Neck Blast		
		(E)	(N)	(L)	(E)	(N)	(L)	(E)	(N)	(L)
Maruteru	30 DAT			0.00						
BPT 5204	40 DAT		0.00	13.47			0.00			
E: 18-06-2019	50 DAT	0.00	0.00	19.16			0.00			
N: 05-07-2019	60 DAT	9.06	24.19	15.97			0.00			0.00
L: 19-07-2019	70 DAT	27.50	78.60	1.91		0.00	31.85			
	80 DAT	-	46.13	1.44		0.00	42.78			0.00
	90 DAT	49.94	45.57		12.96	51.55			45.05	
	100 DAT	45.31	9.68		12.00	76.66				
	110 DAT	47.93	12.26		40.62	81.38		39.82	42.17	
Swarna	30 DAT			0.00						
E: 18-06-2019	40 DAT		0.00	30.69			0.00			
N: 05-07-2019	50 DAT	0.00	36.37	27.74			0.00			
L: 19-07-2019	60 DAT	44.67	46.43	53.83			0.00			0.00
	70 DAT	53.28	53.68	38.83		0.00	0.00			
	80 DAT	-	72.97	46.91		0.00	0.00			0.00
	90 DAT	65.99	50.17		0.00	31.67			38.76	
	100 DAT	59.89	52.54		0.00	68.44				
	110 DAT	55.76	38.52		7.40	69.98		41.71	51.63	

Moncompu: Four varieties viz., Pournami, Shreyas, Prathyasa and Uma were sown on different dates i.e, 07.06.19 (early), 25.06.19 (normal) and 26.08.19 (late) for the studies on the effect of the different periods of sowing on sheath blight and BLB intensity on rice. The results indicated that both sheath blight and BLB were prevalent in all the varieties tested, in all the stages of the crop and in all the three sowing periods. However, the intensity of the disease differed in different varieties sown during different periods. In the case of sheath blight disease, the variety Uma was more susceptible (maximum of 75.55% PDI) than the other varieties viz., Shreyas (37.78%), Prathyasa (33.33%) and Pournami (23.05%). In the case of the differences between the sowing periods, the variety Uma had highest infection (75.55 % PDI) only in the late sown crop when compared to very less severity in the normal (9.44% PDI) and early sown (16.66% PDI) crops. Further the disease reached a sudden peak in the late maturity stages i.e, 3.01% PDI at 50 DAT jumping to 75.55% PDI at 110 DAT, in the late sown crops. This was not the trend in the case of early sown (4.9% PDI at 50DAT to a maximum of 16.66% PDI at 110 DAT) and normal sown crops (3.67% PDI at 50 DAT to a maximum of 9.44% PDI at 110 DAT). This differing trend needs to be analyzed and correlated with the other biotic and abiotic factors. This sort of abnormal trend was not observed in the other three varieties, where the disease was progressing in a gradual manner. Further the higher incidence of disease in the case of early sown crop in all the three varieties differing from the variety Uma needs to be analyzed in relation to the prevalent predisposing factors favoring the disease.

In the case of BLB, the trend with the variety Uma, where in the disease peaked suddenly during the late stage of the crop (48.33% PDI at 110 DAT) when compared with the minimum of 2.38% PDI on 50 DAT. In contrast the disease increased in its severity gradually in the early (1.22 to 8.05% PDI) and normal (2.48 to 18.88% PDI) sown crops. In the case of other varieties too the severity of the disease was highest in the in the late sown crop and the increase in the disease was steep in case of all the sowing periods when approaching the maturity stage. This trend needs to be analyzed in relation to other factors (Table 82h).

Table 82h: Occurrence of different rice diseases in disease observation nursery at different test locations, Kharif – 2019 – Moncompu

Location/ Date of sowing		Percentage of Disease Index					
		Sheath blight			BLB		
	DAT	(E)	(N)	(L)	(E)	(N)	(L)
Pournami	30 DAT	0.00	0.00	0.00	0.00	2.20	0.00
MTU1001	40 DAT	0.00	0.00	0.00	0.00	1.68	0.00
E: 07-06-2019	50 DAT	4.76	2.50	2.69	1.89	4.31	2.15
N:25-06-2019	60 DAT	13.33	3.50	4.72	2.22	3.19	3.85
L: 26-08-2019	70 DAT	15.00	8.11	4.13	1.83	1.54	4.00
	80 DAT	15.55	3.89	2.73	5.92	2.70	4.90
	90 DAT	18.55	7.89	1.77	6.59	3.57	6.56
	100 DAT	17.55	14.16	0.00	11.74	13.05	8.89
	110 DAT	23.05	2.78	10.00	16.11	2.78	26.94
Shreyas	30 DAT	0.00	0.00	0.00	0.00	3.00	0.00
E: 07-06-2019	40 DAT	0.00	0.00	0.00	0.00	5.20	0.00
N:25-06-2019	50 DAT	3.31	6.67	6.56	4.47	3.36	2.21
L: 26-08-2019	60 DAT	17.44	3.72	1.16	3.11	2.90	4.25
	70 DAT	14.44	7.61	3.70	2.82	2.97	3.58
	80 DAT	13.33	4.98	2.11	7.87	2.83	5.13
	90 DAT	19.27	11.39	3.22	6.41	2.14	4.60
	100 DAT	19.67	10.83	0.28	11.83	16.90	9.72
	110 DAT	30.55	6.11	37.78	15.00	5.55	38.61
Prathyasa	30 DAT	0.00	0.00	0.00	0.00	3.64	0.00
E: 07-06-2019	40 DAT	0.00	0.00	0.00	0.00	3.05	0.00
N:25-06-2019	50 DAT	4.43	4.61	4.15	6.06	3.36	1.80
L: 26-08-2019	60 DAT	13.86	5.16	5.55	1.68	1.74	3.60
	70 DAT	15.55	4.83	5.11	2.06	3.74	4.44
	80 DAT	12.61	2.22	3.86	6.26	3.45	6.07
	90 DAT	14.44	9.19	2.78	8.45	4.00	5.78
	100 DAT	22.89	11.94	1.39	11.23	14.72	18.33
	110 DAT	31.11	16.94	33.33	15.27	18.89	31.22
Uma	30 DAT	0.00	0.00	0.00	0.00	4.62	0.00
E: 07-06-2019	40 DAT	0.00	0.00	0.00	0.00	2.48	0.00
N:25-06-2019	50 DAT	4.90	3.67	3.01	3.32	5.25	2.38
L: 26-08-2019	60 DAT	10.78	4.24	5.74	1.22	7.03	5.11
	70 DAT	13.05	5.27	4.06	1.25	7.35	5.45
	80 DAT	12.78	4.11	4.23	6.71	3.90	4.79
	90 DAT	12.95	4.44	1.49	6.73	7.20	6.53
	100 DAT	13.41	9.44	1.11	7.29	18.88	9.72
	110 DAT	16.66	9.44	75.55	8.05	14.44	48.33

Nawagam: Two varieties viz., Gurjari and P-203 were used as test varieties for the purpose of estimating the effects of sowing period viz., early (15.06.19), normal (01.07.19) and late (15.07.19) for the occurrence of sheath rot disease in Nawagam. In the case of variety Gurjari, it was observed that the incidence of the disease was relatively more in the late stages of the crop (80 to 100 DAT) in all the three different sowing periods i.e., early (20.56 to 36.11% PDI), normal (25 to 38.89% PDI) and late (35 to 42.23% PDI). However, the symptoms start to appear during the late tillering stage (60 DAT), except in case of the late sown crop where the disease was found to initiate even earlier (40DAT) and progresses gradually. Among the three sowing periods the incidence of sheath rot was found to be maximum in the late sown crop. The trend was similar in case variety P-203, with the initial symptoms starting to appear during about 70 DAT and progressing gradually. Further, the percentage disease index was relatively less in the case of the variety P-203 (1.11 to 28.24% PDI) when compared to the variety Gurjari (2.78 to 42.23%). Similar to the trend of early appearance in the late sown crop in the variety Gurjari, the disease appears early (40DAT) in this variety also and progresses gradually (Table 82i).

Table 82i: Occurrence of different rice diseases in disease observation nursery at different test locations, Kharif – 2019 – Nawagam

Location/ Date of sowing	Percent Disease Index			
	Nawagam			
	Sheath rot			
	DAT	(E)	(N)	(L)
Gurjari	30 DAT	0.00	0.00	0.00
E: 15-06-19	40 DAT	0.00	0.00	2.78
N: 01-07-19	50 DAT	0.00	2.78	13.89
L: 15-07-19	60 DAT	3.89	10.00	21.67
	70 DAT	15.00	19.45	28.89
	80 DAT	20.56	25.00	35.00
	90 DAT	31.67	33.33	40.56
	100 DAT	36.11	38.89	42.23
P-203	30 DAT	0.00	0.00	0.00
E: 15-06-19	40 DAT	0.00	0.00	1.11
N: 01-07-19	50 DAT	0.00	0.00	8.33
L: 15-07-19	60 DAT	0.00	2.78	14.44
	70 DAT	1.11	5.00	17.23
	80 DAT	6.67	10.00	19.45
	90 DAT	11.67	15.56	23.89
	100 DAT	15.56	22.23	28.34

Influence of weather parameters and date of sowing on sheath blight and neck blast disease intensity at various locations

To study the impact of weather parameters (temperature, relative humidity and rainfall) in the progress of the disease, the area under disease progress curve was measured and analysed. Accordingly, at the Mandya centre on leaf blast, sheath blight and brown spot diseases were analysed with the data obtained for two varieties viz., IR64 and MTU1001. The results indicated

that the leaf blast disease was more rapidly progressing in MTU1001 (738) when compared to IR64 (433). The progress was nil during the early and normal sowing conditions, and more in the late sown crop. However, sheath blight disease and the brown spot disease was observed to progress during all the three different sowing dates. The progress of brown spot disease was found to be more rapid in the variety MTU1001 (2199 maximum in late sown conditions) when compared to the variety IR64 (969 maximum under normal sown conditions), while it was reverse in the case of sheath blight disease, the variety IR64 had the maximum AUDPC of 2503 under early sown conditions when compared to 988 in MTU1001 under same condition. It was also observed that the sheath blight disease was more favoured by rainfall, maximum AUDPC (988 and 2503) in both the varieties viz., MTU1001 and IR64 respectively, was observed in the early sown crops with total rainfall 592.6mm. This may be due to the fact that rainfall would have helped the pathogen mycelia to spread more easily to the surrounding plants. In the case of brown spot disease, it appears that the excessive rainfall has washed off the leaf dwelling fungus and hence the occurrence of the disease has significantly reduced as the rainfall increased (Table 83a).

Table 83a: Disease Progression with respect to weather factors at Mandya

	AUDPC						Temperature		Relative Humidity		Rain fall (mm)
	Leaf Blast		Sheath blight		Brown spot						
	MTU 1001	IR 64	MTU 1001	IR 64	MTU 1001	IR 64	Maxi.	Mini.	Mor.	Eve	
Early	0	0	988	2503	522	239	30.6	18.6	90.5	79.9	592.6
Normal	0	0	694	1905	1300	969	30.8	18.6	91.0	77.1	479.7
Late	738	433	655	800	2199	586	29.8	18.0	91.0	76.2	238.1

Similar was the trend in the case of sheath rot disease in Nawagam centre. The AUDPC decreased as the rainfall increased even though the RH and temperature were almost similar in all the growing seasons. The maximum AUDPC was observed in the case of variety Gurjari (1639) in the late sown crop when the rainfall was the lowest (290.3mm) when compared to the lowest AUDPC (892) in the early sown crop and where the rainfall was highest (807.20mm). Similar was the trend with the other variety P203, though the AUDPC was significantly less (maximum 986 and minimum 272) when compared to the variety Gurjari (Table 83b).

Table 83b: Disease Progression with respect to weather factors at Nawagam

	AUDPC – Sheath rot		Temperature		Relative Humidity		Rain fall (mm)
	Gurjari	P 203	Maximum	Minimum	Morning	Evening	
Early	892	272	32.30	24.48	85.57	71.08	807.20
Normal	1100	445	32.13	23.91	85.32	69.97	449.20
Late	1639	986	32.36	22.89	83.14	65.67	290.30

The AUDPC of BLB was observed to differ among the four varieties tested at Moncompu centre. The AUDPC was highest (616) in the lowest rainfall season (normal sown with lowest rainfall (616.50mm) in the variety Uma, while it was reverse in the case of the other three varieties tested viz., Pournami, Shreyas and Prathyasa, where the AUDPC was found to be directly proportional to the intensity of the rainfall. However, all the four varieties showed a similar trend of increase in the AUDPC with the total rainfall. Among the different varieties, Uma had the highest AUDPC for BLB (616) and Shreyas for Sheath blight (1027) (Table 83c).

Table 83c: Disease Progression with respect to weather factors at Moncompu

Variety	AUDPC								Temperature		Relative Humidity		Rain fall (mm)
	BLB				Sheath blight				Maxi.	Mini.	Morning	Evening	
	V1	V2	V3	V4	V1	V2	V3	V4					
Early	382	440	434	305	963	1027	993	762	31.26	23.50	89.11	86.50	1473.90
Normal	325	406	453	616	414	483	464	359	33.00	22.75	88.75	84.50	614.50
Late	438	488	556	581	210	359	395	574	33.95	22.29	87.32	80.19	1063.80

(V1- Pournami; V2 – Shreyas; V3 – Prathyasa; V4 – Uma)

The AUDPC was in general very less in Gangavati for all the four diseases tested viz., blast (170), brownspot (360), false smut (318) and BLB (248), where even the rainfall was much below the centres (418.40 to 174.80mm). While the diseases blast (170), brown spot (360) and false smut (318) showed a clear trend of maximum AUDPC in maximum rainfall conditions, the BLB disease did not follow a standard pattern (Table 83d).

Table 83d: Disease Progression with respect to weather factors at Gangavati

	AUDPC				Temperature		Relative Humidity		Rain fall (mm)
	Blast	Brown spot	False smut	BLB	Maxi.	Mini.	Morning	Evening	
Early	170	360	318	148	30.10	21.45	83.36	53.37	418.40
Normal	135	325	263	248	29.89	20.49	86.64	51.90	375.20
Late	110	293	135	203	29.82	19.78	87.06	48.05	174.80

IV. DISEASE MANAGEMENT TRIALS

1. EVALUATION OF FUNGICIDES AGAINST LOCATION SPECIFIC DISEASES

The trial was formulated and conducted with an objective to evaluate new fungicidal molecules *viz.*, Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) and Prochloraz 45% EC (2.0 ml/l) against different disease of rice caused by fungi. Test molecules were compared with other standard fungicides *viz.*, tricyclazole 75% WP (0.6 g/l), azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC (1 ml/l), difenoconazole 25 EC (1.0 ml/l), hexaconazole 5% EC (2.0 ml/l) and propiconazole 25% EC (1.0 ml/l). All the check fungicides are recommended to manage the various rice diseases in India. Trail was conducted in endemic areas in all the agro-climatic zones. These molecules comprises of different formulations such as suspension concentrates (SC), suspo-emulsion (SE) and emulsifiable concentrates (EC). The trail was conducted during *Kharif*-2019 by using Randomised Block Design (RBD) as a statistical method with three or four replications in each centre.

The trial was proposed at 38 centres and conducted the experiment at 35 centres *viz.*, Aduthurai, Arundhatinagar, Bankura, Chatha, Chinsurah, Chiplima, Coimbatore, ICAR-IIRR, Cuttack (ICAR-NRRI), Faizabad (Masodha), Gangavati, Gerua, Ghaghraghat, Hazaribagh, Jagdalpur, Kaul, Lonavala, Ludhiana, Malan, Mandya, Maruteru, Moncompu, Navsari, Nawagam, Pantnagar, Pattambi, Ponnampet, Pusa, Raipur, Rajendranagar, Ranchi, Rewa, Sabour, Titabar and Varanasi across the rice growing regions in India. The experiment was conducted with locally popular disease susceptible rice varieties among the farmers. In general, sowings were taken up during June and July across the locations except in Aduthurai where sowing was done in the month of September. At Ludhiana sowing was done at early in the month of May. The details related to test variety used, date of sowing, date of transplanting, method of screening, date of initial symptoms observed, number of spray, spraying dates, disease observation and date of harvesting are mentioned in the Table 84. In general fungicides were sprayed immediately after noticing the initial symptoms at all the locations. Each fungicidal product were applied at the rate of two sprays with an intravel of 10-15 days in all the test centres except Aduthurai, Ghaghraghat, Jagdalpur and Titabar where various number of sprays were given. The fungicides were evaluated against leaf blast (10 locations), neck blast (eight locations), sheath blight (15 locations), sheath rot (five locations), brown spot (six locations) false smut (two locations) and grain discoloration (two locations).

Leaf blast: The fungicides were evaluated against leaf blast disease at ten locations across the rice growing region of the country. In all the centres uniformly two sprays of fungicides were applied except Ghagaraghat and Jagadalpur where three and four sprays were given, respectively. Disease severity was recorded at all the test locations. Besides, disease incidence was also observed at three locations *viz.*, Hazaribagh, Lonavala and Nawagam. The test fungicidal products were evaluated against the disease under natural incidence at six location except Coimbatore, IIRR, Nawagam and Rewa where through artificial inoculation.

Disease severity at test locations in check plots varied from 25.6% (Rewa) to 67.3% (Ghagaraghat). Severity on check plot was very high (>50%) at Ghagaraghat (67.3), Ponnampet (60.9%), Hazaribagh (53.9%), IIRR (52.1%) and; high (>30-50%) at Jagdalpur (45.0%), Lonavala (43.4%), Nawagam (38.6%), Coimbatore (36.3%) and Ranchi (35.9%) and moderate (20-29%) at Rewa (25.6%). Disease incidence at test locations in check plots varied from 62.1% (Rewa) to 86.1% (Nawagam).

All seven fungicidal treatments significantly reduced the disease severity and incidence at all test locations when compared to control. Test product *viz.*, Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) was significantly reduced the leaf blast severity at three locations *viz.*, Coimbatore, Lonavala and Rewa and incidence at one location (Nawagam). Besides, the same fungicide minimised the disease severity at two locations *viz.*, Coimbatore and Nawagam and disease incidence at two locations (Hazaribagh and Lonavala). The other combi-product azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) was found significantly reducing the disease severity at five locations *viz.*, Hazaribagh, ICAR-IIRR, Jagdalpur, Nawagam and Ponnampet and disease incidence at two locations (Hazaribagh and Lonavala). However, test product prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) showed low mean disease severity (18.0%) and disease incidence (32.3%) compared to other treatments from ten the test centres. Treatment (T4) azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) showed mean disease severity and incidence of 18.3% and 31.7% on par with new test molecule (Fig. 5 and Table 85).

In addition to these two products, other test product Prochloraz 45% EC (2.0 ml/l) (T2) and tricyclazole 75% WP (0.6g/l) (T3) also reduced the disease severity and incidence on par with the better products (T1 and T4) in different test locations. The grain yield data was recorded at all ten test locations and observed that all treated plots was superior to check plot (2945 Kg/ha). Treatment (T4) azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) was superior reducing leaf blast and increasing the mean yield (4011 Kg/ha). This is followed by prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) compared to the other treatments. These two treatments (T4 and T1) showed correlation between disease reduction and yield increase (Table 86).

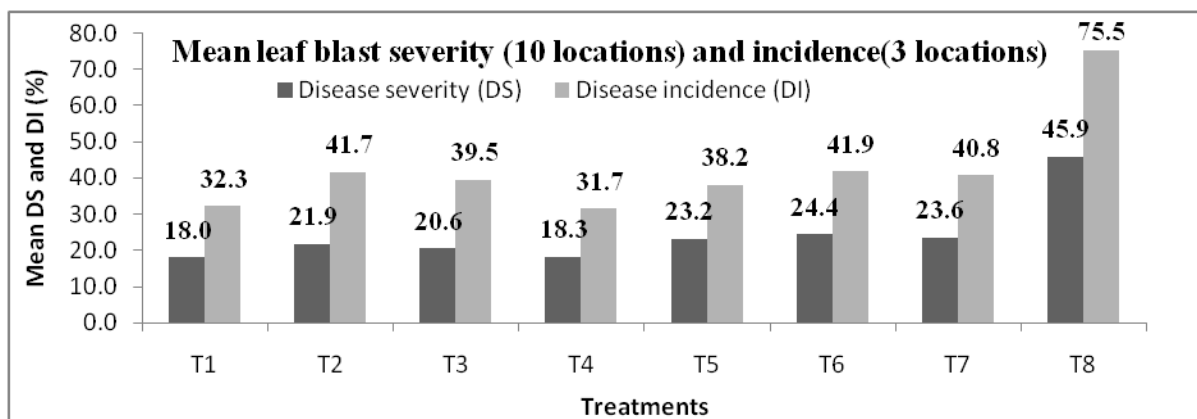


Figure 5: Effect of fungicides against leaf blast of rice, Kharif-2019

Table 1: Experimental details of fungicidal evaluation against location specific diseases of rice during, Kharif-2019

S. No	Location	Disease Recorded	Test Variety	Screening	Date of activities						
					Sowing/ Transplanting	Inoculation	Initial symptom	No of Spray	Spraying	Observation	Harvesting
1	Aduthurai	Brown spot; Sheath rot	BPT-5204	Natural	12.09.2019/ 14.10.2019	-	-	1	06.12.2019	-	23.01.2020
2	Arundhutanagar	Sheath blight	-	-	-	-	-	-	-	-	-
3	Bankura	Sheath blight	Swarna (MTU7029)	Artificial	25.06.2019/ 30.07.2019	16.09.2019	20.09.2019	2	27.09.2019 16.10.2019	20&27.09.2019 16&31.10.2019	19.11.2019
4	Chatha	Brown spot	Basmati-370	Natural	21.06.2019/ 29.07.2019	-	25.09.2019	2	27.09.2019 11.10.2019	-	10.12.2019
5	Coimbatore	Leaf blast	CO39	Artificial	05.10.2019/ 06.11.2019	28.11.2019; 01.12.2019	-	2	14.12.2019 20.12.2019	6.01.2020	21.01.2020
6	Chinsurah	Sheath blight	Swarna (MTU 7029)	Artificial	27.06.2019/ 30.07.2019	06.09.2019	15.09.2019	2	18.09.2019 26.09.2019	-	04.12.2019
		Sheath rot	Swarna (MTU 7029)	Artificial	26.07.2019/ 27.08.2019	24.10.2019	05.11.2019	2	08.11.2019 15.11.2019	-	02.12.2019
7	Chiplima	Sheath blight	-	Artificial	28.06.2019/ 25.07.2019	30.08.2019	12.09.2019	2	18.09.2019 03.10.2019	30.09.2019 17.10.2019	26.11.2019
8	Cuttack (ICAR-NRRI)	False smut	Moudamani	Natural	20.07.2019/ 12.08.2019	-	20.11.2019	-	01.11.2019 11.11.2019	28.11.2019	03.12.2019
		Sheath blight	Tapaswini	Artificial	29.07.2019/ 02.09.2019	01.10.2019	09.10.2019	2	19.10.2019 28.10.2019	02.11.2019 11.11.2019	20.12.2019
9	ICAR-IIRR	Leaf blast	HR-12	Artificial	13.06.2019/ 20.07.2019	15.08.2019; 20.08.2019	02.09.2019	2	02.09.2019 10.09.2019	27.09.2019 07.10.2019	26.10.2019
		Sheath blight	BPT-5204	Artificial	20.06.2019/ 24.07.2019	19.09.2019	21.09.2019	2	21.09.2019 01.10.2019	11.10.2019 25.10.2019	26.11.2019
10	Faizabad (Masodha)	Sheath blight	Pusa Basmati-1	Artificial	16.07.2019/ 14.08.2019	-	03.10.2019	2	12.10.2019 26.10.2019	24.10.2019 12.11.2019	01.12.2019
11	Gangavati	Sheath blight	GNV-10-89	Artificial	08.08.2019/ 07.09.2019	16.10.2019	20.10.2019	2	21.10.2019 06.11.2019	20.10.2019 05&21.11.2019	-
12	Gerua	Sheath blight	-	Artificial	09.08.2019/ 30.08.2019	04.10.2019	14.10.2019	2	22.10.2019 06.11.2019	-	04.12.2019
13	Ghagaraghat	Leaf blast; Neck blast	Jalprika	-	26/6/2019/ 31/7/2019	-	-	3	28.09.2019 29.10.2019 06.11.2019	25.08.2019	27.12.2019
14	Hazaribagh	Leaf blast	Co-39	Artificial	08.7.2019/ 26.07.2019	06.09.2019	10.09.2019	2	14.09.2019 30.09.2019	16.09.2019 01.10.2019	25.10.2019
15	Jagadapur	Leaf blast; Neck blast	Swarna	Natural	20.06.2019/ 27.07.2019	-	-	4	15&30.09.2019 15&30.10.2019	13&27.09.2019 13.10.2019	25.12.2019
16	Kaul	Neck blast	Basmati CSR 30	Natural	01.07.2019/ 26.07.2019	-	22.09.2019	2	01.20.2019 15.10.2019	LB:28.10.2019 NB:8.12.2019	10.11.2019
17	Lonavala	Leaf Blast	EK-70	Natural	-	-	-	-	-	-	23.10.2019
		Neck blast	EK-70	Natural	-	-	-	-	-	20.10.2019	23.10.2019
18	Ludhiana	Sheath blight	PR114	Artificial	27.05.2019/ 09.06.2019	-	-	2	09.09.2019	10.05.2019	20.10.2019

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S. No	Location	Disease Recorded	Test Variety	Screening	Date of activities						
					Sowing/ Transplanting	Inoculation	Initial symptom	No of Spray	Spraying	Observation	Harvesting
					27.06.2019				20.09.2019		
19	Malan	Neck blast	HPU 2216	Natural	18.06.2019/ 23.07.2019	-	-	2	09.09.2019 24.09.2019	21.10.2019	22.11.2019
20	Mandya	Sheath blight	MTU 1001	Artificial	14.08.2019/ 16.09.2019	30.10.2019	07.11.2019	2	09.11.2019 24.11.2019	-	31.12.2019
		Neck blast	MTU 1001	Natural	14.08.2019/ 16.09.2019	-	-	1	24.11.2019	31.12.2019	31.12.2019
21	Maruteru	Sheath blight	Swarna (MTU 7029)	Artificial	10.07.2019/ 07.08.2019	06.09.2019	13.09.2019	2	19.09.2019 03.10.2019	18&27.09.2019 07.11.2019	05.12.2019
		Neck blast	Swarna (MTU 7029)	Natural	-	-	-	-		30.11.2019	05.12.2019
22	Moncompu	Sheath blight and Grain discolouration	Uma (MO16)	Natural	06.06.2019/ 26.06.2019	-	20.08.2019	2	23.08.2019 09.07.2019	Shb:24.10.2019 GD:11.04.2019	11.06.2019
23	Navasari	Sheath rot	Jaya	Natural	24.06.2019/ 23.07.2019	-	08.09.2019	2	26.09.2019 07.10.2019	03.10.2019 15.10.2019	18.11.2019
24	Nawagam	Leaf blast; Sheath rot	Gurjari	Artificial	20.07.2019/ 28.08.2019	-	-	2	09.10.2019 24.09.2019	09.10.2019 24.09.2019 08.11.2019	02.12.2019
25	Pantnagar	Sheath blight	Pant Dhan-4	Artificial	17.06.2019 12.07.2019	12.09.2019	17.09.2019	2	20.09.2019 06.10.2019	25.09.2019	14.11.2019
26	Pattambi	Brown spot	Uma	Natural	22.07.2019/ 20.08.2019	-	08.11.2019	2	10.11.2019 18.11.2019	08.11.2019 .04.12.2019	11.12.2019
27	Ponnampet	Leaf blast	Intan	Natural	16.07.2019/ 20.08.2019	-	14.08.2019	2	23.09.2019 06.12.2019	21.10.2019	08.11.2019
		Neck blast	Intan	Natural		-	26.11.2019	2		02.01.2019	08.11.2019
28	Pusa	Brown spot	Pankaj (HS)	Natural	15.06.2019/ 10.07.2019	-	28.08.2019	2	06.08.2019 17.08.2019	-	-
29	Raipur	Sheath blight	Swarna	Artificial	02.07.2019/ 31.08.2019	06.10.2019	10.10.2019	2	10.10.2019 17.10.2019	27.10.2019	23.11.2019
30	Rajendranagar	Neck blast; shrt; GD	Tellahamsa	Artificial	05.07.2019/ 04.08.2019	27.09.2019	09.10.2019	2	10.10.2019 01.11.2019	30.10.2019 GD:19.11.2019	25.11.2019
31	Ranchi	Leaf blast; Neck blast	-	Natural	-	-	-	-	-	-	-
32	Rewa	Leaf blast	PS4	Artificial	05.07.2019/ 07.08.2019	25.08.2019	05.09.2019	2	16.09.2019 26.09.2019	30.09.2019 15.10.2019	25.11.2019
33	Sabour	Brown spot	Rajendra Mahsuri-1	Natural	26.06.2019/ 24.07.2019	-	22.10.2019	2	26.10.2019 10.11.2019	30.10.2019 15.11.2019	05.12.2019
34	Titabar	Sheath rot	Gitesh	Artificial	21.07.2019/ 21.08.2019	10.10.2019	20.10.2019	3	20&30.10.201 9 10.11.2019	20/10/2019	12-12-2019
35	Varanasi	False smut	RP Bio 226	Natural	28.06.2019/ 27.07.2019	-	10.10.2019	2	28.10.2019 11.11.2019	20.11.2019	22.11.2019

Table 85: Evaluation of fungicides against leaf blast disease severity and incidence of rice, Kharif- 2019

Treatment	Dose/ L	Leaf blast severity (%)											Leaf blast incidence (%)			
		CBT	GGT	HZB	IIRR	JDP	LNV	NWG	PNP	RCI	REW	Mean	HZB	LNV	NWG	Mean
T1- Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE	2 ml	9.0 (17.4)	19.1 (25.9)	19.9 (26.5)	24.1 (31.3)	27.2 (31.4)	21.5 (27.6)	15.9 (23.5)	19.5 (26.1)	11.5 (19.7)	12.4 (3.7)	18.0	16.0 (23.6)	19.2 (37.9)	61.6 (51.7)	32.3
T2- Prochloraz 45% EC	2 ml	11.5 (19.8)	22.1 (28.0)	32.2 (34.6)	31.6 (36.0)	26.1 (30.7)	24.3 (29.5)	19.2 (26.0)	25.7 (30.4)	9.1 (17.4)	16.7 (4.0)	21.9	30.0 (33.2)	28.4 (40.1)	66.8 (54.8)	41.7
T3- Tricyclazole 75% WP	0.6 g	9.5 (17.9)	9.5 (17.9)	22.8 (28.5)	23.1 (30.3)	27.8 (31.8)	36.1 (36.9)	25.1 (30.0)	23.8 (29.2)	13.8 (21.6)	14.2 (4.1)	20.6	20.7 (27.1)	22.8 (54.7)	75.0 (60.0)	39.5
T4- Azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC	1 ml	11.3 (19.6)	16.4 (23.8)	18.5 (25.4)	22.6 (25.5)	26.1 (30.7)	26.0 (30.6)	14.5 (22.4)	17.7 (24.8)	15.3 (23.0)	14.5 -	18.3	14.2 (22.1)	18.2 (42.8)	62.7 (52.4)	31.7
T5- Difenoconazole 25 EC	1ml	13.3 (21.3)	15.0 (22.8)	25.7 (30.4)	26.3 (32.1)	32.2 (34.6)	32.1 (34.5)	19.9 (26.5)	27.2 (31.3)	23.0 (28.6)	17.2 (3.9)	23.2	21.3 (27.5)	24.0 (49.5)	69.2 (56.3)	38.2
T6- Hexaconazole 5% EC	2 ml	18.5 (25.4)	13.7 (21.7)	24.5 (29.6)	25.3 (34.3)	27.8 (31.8)	33.7 (35.5)	28.7 (32.4)	31.8 (34.2)	26.1 (30.6)	13.8 (3.9)	24.4	21.2 (27.4)	24.3 (51.7)	80.2 (63.8)	41.9
T7- Propiconazole 25% EC	1 ml	16.5 (23.9)	12.5 (20.7)	26.0 (30.6)	25.7 (33.8)	30.6 (33.5)	29.4 (32.8)	22.3 (28.1)	29.7 (32.9)	17.9 (25.0)	25.6 (4.2)	23.6	22.4 (28.3)	24.8 (45.8)	75.2 (60.1)	40.8
T8- Control	-	36.3 (37.0)	67.3 (55.1)	53.9 (47.2)	52.1 (64.1)	45.0 (42.1)	43.4 (41.2)	38.6 (38.4)	60.9 (51.3)	35.9 (36.8)	25.6 (4.0)	45.9	78.2 (62.2)	62.1 (61.6)	86.1 (68.2)	75.5
General Mean		15.7	21.9	27.9	28.8	30.3	30.8	23.0	29.5	19.1	17.5	-	28.0	28.0	72.1	-
LSD @ 5% ($P=0.05$)		2.1	0.8	1.1	0.9	1.8	1.6	1.8	2.9	6.2	N/A	-	1.8	3.3	4.2	-
SE(m)		0.7	0.3	0.4	0.3	0.6	0.6	0.6	1.0	2.0	0.1	-	0.6	1.1	1.4	-
SE(d)		1.0	0.4	0.5	0.4	0.9	0.8	0.9	1.4	2.9	0.2	-	0.9	1.6	2.0	-
CV (%)		6.2	1.9	2.4	1.4	3.7	3.3	4.3	6.1	13.9	6.0	-	3.9	4.6	4.9	-
Transformation		AS	AS	AS	AS	AS	AS	AS	AS	AS	AS	-	AS	NT	AS	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; NT- No transformation)

Table 86: Effect of fungicides on grain yield with respect to leaf blast, Kharif-2019

Treatment	Dose/ L	Grain yield against leaf blast (Kg/Ha)										
		CBT	GGT	HZB	IIRR	JDP	LVN	NWG	PNP	RCI	REW	Mean
T1- Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE	2 ml	4248	1350	3451	4127	4988	2912	6545	3596	4011	4166	3939
T2- Prochloraz 45% EC	2 ml	4167	1104	2525	4273	5100	2629	6361	3307	4200	4036	3770
T3- Tricyclazole 75% WP	0.6 g	4238	2113	3243	4310	4758	2287	5999	3550	3933	4070	3850
T4- Azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC	1 ml	4198	1688	3657	4677	4820	2596	6789	3817	3733	4138	4011
T5- Difenoconazole 25 EC	1ml	4155	1825	3001	4430	4405	2482	6464	3180	3411	4112	3746
T6- Hexaconazole 5% EC	2 ml	4007	1825	2855	4273	4685	2374	5893	2973	3500	3911	3630
T7- Propiconazole 25% EC	1 ml	4049	1975	3011	4467	4510	2524	6198	3094	3678	4093	3760
T8- Control	-	3274	938	1979	3983	3783	1765	4524	2422	3233	3552	2945
General Mean		4042	1602	2965	4318	4631	2446	6096	3242	3712	4010	-
LSD @ 5% ($P=0.05$)		178	112	99	214	339	19	925	344	487	89	-
SE(m)		60	38	33	70	115	6	312	116	159	29	-
SE(d)		85	53	47	99	162	9	442	164	225	41	-
CV (%)		3.0	4.7	2.3	2.8	4.9	0.5	10.2	7.2	7.4	1.3	-

Neck blast: The trail was conducted at ten locations to know the efficacy of the test product against neck blast disease. Disease incidence was recorded at six centres and disease severity was noted at four centres *viz.*, Ghagaraghat, Kaul, Mandya and Rajendranagar. Grain yield data was recorded at all the locations except Kaul. Two sprays of fungicidal treatments were given at all the centres. The test fungicidal products were evaluated against neck blast under natural condition at all the centres. Disease incidence in control plot was very high (>50%) at Lonavala (79.8%), Malan (61.9%) Jagdalpur (55.6%), Ponnampet (53.8%) and Marateru (52.2%); and low (>20%) at Ranchi (19.0%). The severity on check plots was about 72.3% and 42.9% at Mandya and Kaul, respectively.

The performance of all the six fungicidal treatments was superior in reducing the neck blast incidence and severity at all the test locations compare to control (Mean DI: 53.7% and Mean DS: 55.3%). This trial showed statistically no significant difference among the treatments at Maruteru. Formulation prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) (T1) significantly reduced the incidence of the neck blast at two locations (Lonavala and Malan,) and on par with the best treatment at Jagdalpur (T2), Marateru (T3) and Ponnampet (T4). In addition to this, low mean disease incidence (24.6%) was observed from the plots where prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) applied followed by azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) (Fig.6 and Table 87). In respect to disease severity, tricyclazole 75% WP (0.6g) treatment (T3) significantly reduced the neck blast (16.0%) at all four test locations *viz.*, Ghagaraghat, Kaul, Mandya and Rajendranagar. Test product prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) spray was found second best in reducing the severity (20.5%).

The mean yield across the locations in check plot was 2631 Kg/ha. Among the eight fungicidal treatments, prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) sprayed plots gave highest mean yield (3991 Kg/ha) followed by azoxystrobin 11% + tebuconazole 18.3% w/w SC (1.5 g/l) (3936 Kg/ha) compared to other treatments (Table 88). The treatment T1 and T3 significantly increased the yield at all the test locations.

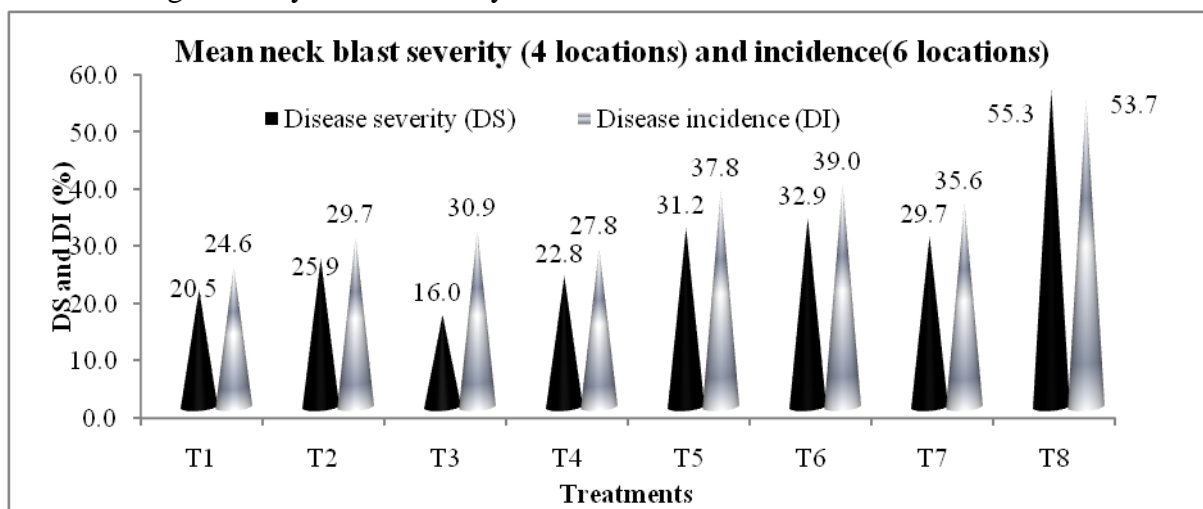


Figure 6: Effect of fungicides against neck blast of rice, Kharif-2019

Table 87: Evaluation of fungicides against neck blast severity and incidence of rice, Kharif- 2019

Treatments	Dose/L	Neck blast severity (%)					Neck blast incidence (%)						
		GGT	KUL	MND	RNR	Mean	JDP	LNV	MLN	MTU	PNP	RCI	Mean
T1- Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE	2 ml	14.7 (22.6)	16.1 (23.6)	9.6 (17.6)	33.6 (33.6)	20.5	33.9 (33.9)	34.1 (34.1)	15.2 (22.8)	41.4 (39.0)	16.0 (23.5)	7.0 (2.8)	24.6
T2- Prochloraz 45% EC	2 ml	15.5 (23.2)	20.9 (27.2)	16.3 (23.7)	43.6 (43.6)	25.9	32.9 (32.9)	41.0 (41.0)	32.4 (34.6)	46.7 (46.9)	19.7 (26.0)	5.7 (2.5)	29.7
T3- Tricyclazole 75% WP	0.6 g	8.2 (16.6)	11.9 (20.2)	6.7 (14.9)	29.2 (29.2)	16.0	35.9 (35.9)	65.3 (65.3)	18.4 (25.3)	39.8 (45.9)	17.8 (25.0)	8.0 (3.0)	30.9
T4- Azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC	1 ml	13.5 (21.5)	21.2 (27.3)	8.1 (16.2)	41.1 (41.1)	22.8	34.8 (34.8)	47.1 (47.1)	18.5 (25.4)	44.2 (38.8)	13.6 (22.0)	8.3 (3.0)	27.8
T5- Difenoconazole 25 EC	1ml	12.8 (20.9)	30.4 (33.4)	34.1 (35.6)	43.4 (43.4)	31.2	39.1 (39.1)	58.4 (58.4)	52.2 (46.2)	45.6 (44.8)	20.8 (28.1)	11.0 (3.4)	37.8
T6- Hexaconazole 5% EC	2 ml	11.9 (20.1)	27.8 (31.8)	46.7 (43.1)	42.5 (42.5)	32.9	35.6 (35.6)	62.2 (62.2)	56.3 (48.6)	43.2 (43.5)	22.0 (27.8)	14.7 (3.9)	39.0
T7- Propiconazole 25% EC	1 ml	10.1 (18.5)	20.3 (26.7)	37.8 (37.9)	45.5 (45.5)	29.7	36.8 (36.8)	51.8 (51.8)	44.1 (41.6)	44.2 (48.3)	25.2 (30.1)	11.3 (3.5)	35.6
T8- Control	-	60.4 (51.0)	42.9 (40.9)	72.3 (58.3)	54.2 (54.2)	55.3	55.6 (55.6)	79.8 (79.8)	61.9 (51.9)	52.2 (40.7)	53.8 (47.9)	19.0 (4.5)	53.7
General mean		18.4	23.9	28.9	41.6	29.3	38.1	55.0	37.4	44.7	23.6	10.6	34.9
LSD @ 5% ($P= 0.05$)		0.2	2.6	7.4	9.5	-	6.8	2.2	4.8	N/A	3.3	1.0	-
SE(m)		0.1	0.9	2.4	3.2	-	2.3	0.7	1.6	2.7	1.1	0.3	-
SE(d)		0.1	1.3	3.4	4.5	-	3.2	1.0	2.2	3.8	1.6	0.4	-
CV (%)		0.7	6.1	13.5	15.3	-	12.1	2.7	7.4	10.6	7.8	16.2	-
Transformation		AS	AS	AS	NT	-	NT	NT	AS	NT	AS	ST	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation; NT- No transformation)

Table 88: Effect of fungicides on grain yield with respect to neck blast, Kharif- 2019

Treatments	Dose/L	Grain yield against neck blast (Kg/Ha)									
		GGT	JDP	LNV	MLN	MND	MTU	PNP	RNR	RCI	Mean
T1- Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE	2 ml	1350	4988	2912	4757	4730	3700	3596	5879	4011	3991
T2- Prochloraz 45% EC	2 ml	1104	5100	2629	3413	3610	3574	3307	5680	4200	3624
T3- Tricyclazole 75% WP	0.6 g	2113	4758	2287	4248	4095	4493	3550	5951	3933	3936
T4- Azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC	1 ml	1688	4820	2596	3522	4285	5050	3817	5734	3733	3916
T5- Difenoconazole 25 EC	1ml	1825	4405	2482	2796	3216	4261	3180	6106	3411	3520
T6- Hexaconazole 5% EC	2 ml	1825	4685	2374	2505	3298	4976	2973	5273	3500	3490
T7- Propiconazole 25% EC	1 ml	1975	4510	2524	2651	3305	4715	3094	5876	3678	3592
T8- Control	-	938	3783	1765	1561	2826	2754	2422	4395	3233	2631
General Mean		1602	4631	2446	3182	3671	4190	3242	5612	3712	-
LSD @ 5% ($P=0.05$)		112	339	19	731	539	1351	344	644	487	-
SE(m)		38	115	6	239	176	456	116	217	159	-
SE(d)		53	162	9	338	249	645	164	307	225	-
CV (%)		4.7	4.9	0.5	13.0	8.3	21.8	7.2	7.7	7.4	-

Sheath blight: Fungicides were evaluated against sheath blight disease at 15 disease hot spot locations. The experiment was conducted under artificial inoculation at all the test locations except Arundhutinagar and Moncompu. Both disease severity and incidence was observed at five locations *viz.*, Bankura, Cuttack, Faizabad (Masodha), Ludhiana, Maruteru, and Pantnagar. All other ten locations only disease severity was observed during the experiment. Two sprays of fungicidal treatments were given at all the centres. Disease severity in check plots was varied between 43.1% (Ludhiana) and 95.8% (IIRR). Disease severity on untreated plot was very high (>50%) at IIRR (95.8%), Gangavathi (88.9%), Raipur (86.7%), Maruteru (78.6%), Bankura (75.0%), Faizabad (73.2%), Gerua (72.8%), Cuttack (72.6%), Mandya (71.8%), Chinsurah (71.7%), Pantnagar (66.6%), Moncompu (65.8%), Arundhutinagar (64.2%), Chiplima (56.1%); and high (30-50%) at Ludhiana (43.1%) and). Disease incidence varied between 51.5% (Faizabad) and 100% (Bankura). It was very high at Bankura (100%), Maruteru (96.0%), Ludhiana (92.1%), Pantnagar (77.8%), Cuttack (79.2%) and Faizabad (51.5%).

All fungicidal applications significantly reduced the sheath blight compared to control across the test locations. The combination fungicide azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) (T4) maximum reduced the severity at nine locations (Arundhutinagar, Chinchura, Chiplima, Gerua, IIRR, Ludhiana, Maruteru, NRRI and Pantnagar) and showed on par with best treatment (T2) at another two locations (Gangavathi, and Moncompu). Besides, treatments *viz.*, difenoconazole 25 EC (1.0 ml/l) and hexaconazole 5% EC (2.0 ml /l) significantly reduced the disease severity at three and two locations, respectively. The mean disease severity was low at azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (26.7%) treatment followed by difenoconazole 25 EC (1.0 ml/l) (32.5%) and hexaconazole 5% EC (2.0 ml /l) (32.7%) (Table 89).

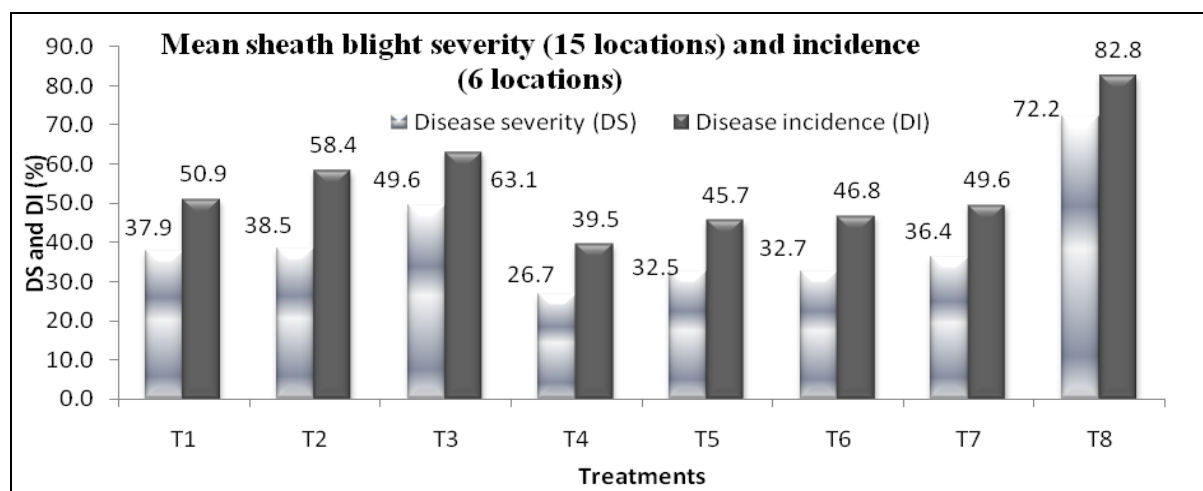


Figure 7: Effect of fungicides against sheath blight of rice, Kharif-2019

Combination fungicide azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0ml/l) significantly reduced the intensity at four locations (Ludhiana, Maruteru, NRRI and Pantnagar) and also showed low mean disease incidence. This was followed by difenoconazole 25 EC (1.0 ml/l) and hexaconazole 5% EC (2.0 ml /l) showed less disease incidence of 45.7%) and 46.8%, respectively (Fig.7 and Table 90).

Table 89: Evaluation of fungicides against sheath blight severity of rice, Kharif-2019

T. No	Dose/L	Sheath blight severity (%)															Mean
		ARD	BAN	CHN	CHP	FZB	GNV	GER	IIRR	LDN	MND	MTU	MNC	NRRI	PNT	RPR	
T1	2 ml	53.6 (47.0)	32.8 (34.9)	65.7 (54.1)	18.9 (25.7)	28.1 (32.0)	43.1 (41.0)	43.0 (41.0)	74.2 (59.5)	7.1 (15.4)	25.9 (30.5)	63.2 (52.8)	22.8 (28.3)	17.6 (24.8)	30.1 (33.2)	42.2 (40.3)	37.9
T2	2 ml	56.3 (48.6)	46.6 (43.0)	57.6 (49.4)	21.1 (27.3)	29.4 (32.8)	34.9 (36.1)	42.5 (40.7)	69.7 (56.6)	12.4 (20.6)	23.0 (28.6)	66.6 (54.9)	11.8 (19.3)	20.8 (27.0)	39.5 (38.9)	45.9 (42.6)	38.5
T3	0.6 g	60.0 (50.8)	53.3 (47.0)	66.9 (54.9)	26.3 (30.8)	36.5 (37.1)	64.0 (53.1)	46.0 (42.7)	73.6 (59.1)	17.3 (24.5)	54.1 (47.3)	70.3 (57.1)	21.3 (27.1)	44.0 (41.5)	42.1 (40.4)	68.9 (58.2)	49.6
T4	1 ml	35.7 (36.6)	48.9 (44.3)	23.4 (28.9)	11.5 (19.8)	25.7 (30.4)	35.1 (36.2)	34.5 (36.0)	23.3 (28.8)	5.2 (13.1)	34.8 (36.1)	39.5 (38.6)	13.6 (21.1)	16.4 (23.7)	28.3 (32.1)	25.2 (28.6)	26.7
T5	1ml	38.9 (38.5)	54.2 (47.4)	24.5 (29.6)	20.0 (26.5)	20.8 (27.1)	60.6 (51.1)	43.0 (41.0)	38.2 (38.1)	5.8 (13.9)	30.4 (33.4)	43.0 (40.7)	21.9 (27.9)	30.3 (33.3)	39.7 (39.1)	15.6 (23.1)	32.5
T6	2 ml	42.4 (40.6)	49.4 (44.7)	25.0 (30.0)	19.3 (26.0)	28.8 (32.4)	42.9 (40.9)	39.5 (38.9)	44.6 (41.8)	9.1 (17.6)	37.8 (37.9)	42.9 (40.9)	24.7 (28.8)	28.7 (32.3)	39.1 (38.7)	15.6 (23.0)	32.7
T7	1 ml	43.1 (41.0)	57.2 (49.2)	26.2 (30.8)	22.6 (28.3)	22.1 (28.0)	59.0 (50.1)	43.0 (41.0)	60.1 (50.8)	8.8 (17.3)	33.3 (35.2)	49.7 (44.8)	27.8 (31.7)	38.2 (38.1)	38.0 (38.0)	16.3 (23.8)	36.4
T8	Control	64.2 (53.3)	75.0 (60.0)	71.7 (57.8)	56.1 (46.7)	73.2 (58.8)	88.9 (70.5)	72.8 (58.5)	95.8 (71.5)	43.1 (41.0)	71.8 (58.2)	78.6 (62.5)	65.8 (54.3)	72.6 (51.1)	66.6 (54.7)	86.7 (69.4)	72.2
General Mean		49.3	52.2	45.1	24.5	33.1	53.6	45.5	60.0	13.6	38.9	56.7	26.2	33.6	40.4	39.5	-
LSD @ 5% ($P=0.05$)		3.6	9.4	1.9	4.4	3.1	5.5	1.6	7.1	1.6	5.4	9.3	9.2	8.2	2.3	18.1	-
SE(m)		1.2	3.2	0.6	1.4	1.0	1.8	0.5	2.3	0.5	1.8	3.1	3.1	2.8	0.8	5.9	-
SE(d)		1.7	4.5	0.9	2.0	1.5	2.5	0.8	3.3	0.7	2.5	4.4	4.4	3.9	1.1	8.3	-
CV (%)		5.5	13.6	3.0	8.7	5.9	6.6	2.6	7.9	4.4	7.9	12.8	20.9	16.4	3.3	26.5	-
Transformation		AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Table 90: Evaluation of fungicides against sheath blight incidence of rice, Kharif-2019

Treatments	Dose/L	Sheath blight incidence (%)						
		BAN	FZB	LDN	MTU	NRRI	PNT	Mean
T1- Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE	2 ml	100.0 (10.1)	31.4 (34.0)	32.7 (34.9)	77.5 (63.3)	26.8 (31.0)	37.3 (37.6)	50.9
T2- Prochloraz 45% EC	2 ml	100.0 (10.1)	32.5 (34.7)	61.4 (51.6)	74.0 (60.0)	30.4 (33.4)	52.2 (46.2)	58.4
T3- Tricyclazole 75% WP	0.6 g	100.0 (10.1)	38.8 (38.5)	65.1 (53.8)	75.2 (60.6)	48.2 (43.9)	51.1 (45.6)	63.1
T4- Azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC	1 ml	100.0 (10.1)	28.1 (32.0)	14.8 (22.6)	35.8 (36.5)	22.6 (28.2)	35.9 (36.8)	39.5
T5- Difenoconazole 25 EC	1ml	100.0 (10.1)	21.9 (27.9)	14.8 (22.5)	48.2 (43.9)	37.4 (37.6)	51.8 (46.0)	45.7
T6- Hexaconazole 5% EC	2 ml	100.0 (10.1)	30.2 (33.3)	26.1 (30.7)	39.1 (38.6)	34.3 (35.7)	51.0 (45.6)	46.8
T7- Propiconazole 25% EC	1 ml	100.0 (10.1)	23.0 (28.6)	27.7 (31.7)	53.6 (47.1)	41.0 (39.7)	52.0 (46.1)	49.6
T8- Control	-	100.0 (10.1)	51.5 (45.8)	92.1 (74.1)	96.0 (81.7)	79.2 (63.0)	77.8 (61.9)	82.8
General mean		100.0	32.2	41.8	62.4	40.0	51.1	54.6
LSD @ 5% ($P=0.05$)		N/A	2.5	3.7	13.4	7.2	2.2	-
SE(m)		0.0	0.8	1.2	4.5	2.4	0.7	-
SE(d)		0.0	1.2	1.7	6.4	3.5	1.0	-
CV (%)		0.0	4.9	5.2	16.8	12.5	2.8	-
Transformation		ST	AT	AT	AT	AT	AT	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Grain yield in the experimental plots were recorded at all the test locations. It was observed that grain yield was more in fungicide treated plots compared to check plot (3802 Kg/ha). Highest yield was recorded in the plots where azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0ml/l) sprayed (5444 Kg/ha) followed by hexaconazole 5% EC (2.0 ml /l) (5212 Kg/ha) and difenoconazole 25 EC (1.0 ml/l) (4816 Kg/ha) sprayed plots (Table 91).

Sheath rot: The fungicidal molecules were tested against sheath rot disease at six locations namely Aduthurai, Chinsurah, Nawagam, Navasari, Rajendranagar and Titabar. Both disease severity and incidence was recorded at Navasari, Nawagam and Titabar. Only disease severity was observed at Chinsurah and disease incidence was observed at Aduthurai and Rajendranagar. The test fungicidal products were evaluated against the disease under natural incidence at most of the locations except Chinsurah and Titabar. Uniformly two sprays of fungicides were applied in all the centres except Titabar where three sprays were given. Disease severity in check plots was very high (>50%) at Chinsurah (76.5%); high (30-50%) at Nawagam (42.9%), Titabar (40.5%) and Navasari (38.2%). Disease incidence in check plots was varied from 88% to 32%.

Table 91: Effect of fungicides on grain yield with respect to sheath blight, Kharif-2019

Treatments	Dose/L	Grain yield against sheath blight (Kg/Ha)															
		ARD	BAN	CHN	CHP	FZB	GNV	GER	IIRR	LDN	MND	MTU	MNC	NRRI	PNT	RPR	Mean
T1	2 ml	3313	4348	4668	5200	3275	5436	6053	3033	7489	4730	3700	3311	5264	6085	5915	4788
T2	2 ml	3073	5844	4743	4817	3113	5980	6265	3580	6744	3610	3574	3784	5040	5811	9127	5007
T3	0.6 g	2830	4170	4001	4378	2825	4567	6055	3033	6478	4095	4493	4150	3928	5757	9260	4668
T4	1 ml	3768	5197	6209	5450	3513	6257	6888	5120	7678	4285	5050	3763	5580	6148	6763	5444
T5	1ml	3565	3664	5742	5061	3838	4817	6008	3807	7489	3216	4261	3795	4350	5842	6785	4816
T6	2 ml	3520	4670	5826	5172	3288	5613	6650	4373	7639	3298	4976	3548	4676	5782	9150	5212
T7	1 ml	3350	3204	5735	4658	3725	4683	6090	3307	7272	3305	4715	3300	4290	5816	8967	4828
T8	-	2370	2734	3702	3350	2113	4130	5763	2320	5750	2826	2754	2654	3582	5221	7767	3802
General mean		3224	4229	5078	4761	3211	5185	6221	3572	7067	3671	4190	3538	4589	5808	7967	
LSD @ 5% ($P=0.05$)		487	1219	434	587	328	579	247	1104	600	539	1351	N/A	1203	161	N/A	
SE(m)		165	412	147	192	111	189	83	361	196	176	456	399	406	53	1674	
SE(d)		233	582	207	271	157	267	118	510	277	249	645	564	575	74	2368	
CV (%)		10.2	19.5	5.8	7.0	6.9	6.3	2.7	17.5	4.8	8.3	21.8	22.6	17.7	1.6	36.4	

Incidence was very high at Nawagam (88.0%); high at Navasari (45.3%), Titabar (48.3%), Aduthurai (37.1) and Rajendranagar (32.0%). All the fungicides significantly reduced the disease incidence and severity when compared to check and also increased the yield.

The new test product prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) (T1) and azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0ml/l) (T4) significantly reduced the sheath rot severity at each two locations. These two treatments (T1 and T4) showed minimum average disease severity (DS: 19.9% and 20.1%) from six test locations. Besides, T1 and T4 sprayed plots showed minimum average disease incidence of 30.6% and 30.5% respectively. However, these two products *viz.*, azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1 ml/l) and prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) were found better in reducing the disease severity as well as incidence on par with each other (Figure 8 and Table 92).

The mean yield across the experimental locations in check plot was 4190 Kg/ha. Among the treatments, azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1 ml/l) yielded more (5562 Kg/ha) followed by prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) (5485Kg/ha) when compare to other treatments (Table 94). These two treatment showed the correlation between disease reduction and yield increase.

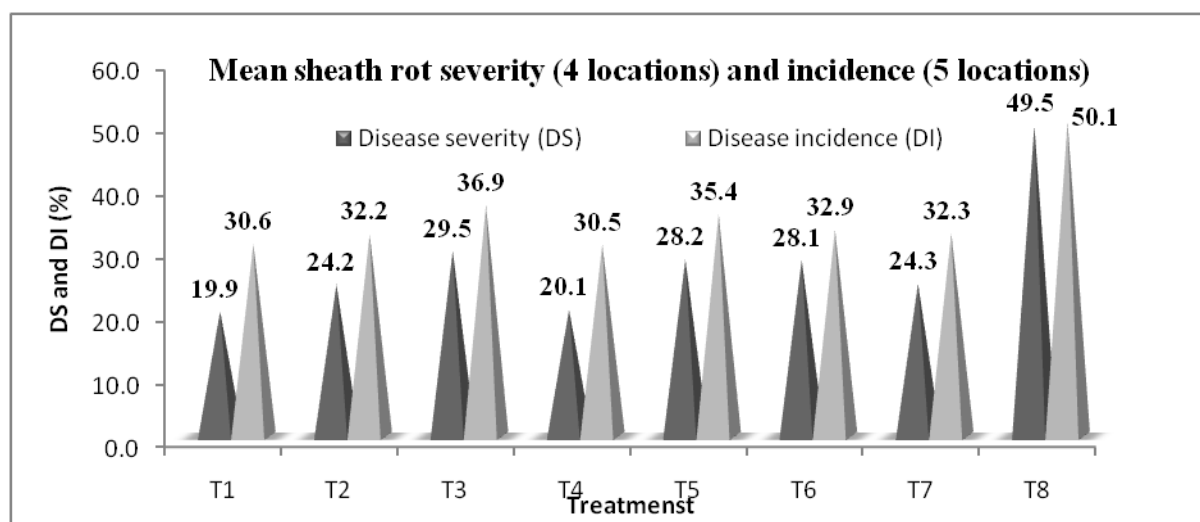


Figure 8: Effect of fungicides against sheath rot of rice, Kharif-2019

Brown spot: Fungicides were evaluated against brown spot at six different locations. Disease severity was recorded from five locations namely Aduthurai, Chatha, Hazaribagh, Pattambi, Pusa and Sabour. Only disease incidence was recorded at Hazaribagh and Sabour. Disease severity in control plot was very high (>50%) at Pusa (61.0%) and Pattambi (57.2%)); and high at Chatha (49.8%), Sabour (47.3%) Aduthurai (33.3%) and moderate at Hazaribagh (24.8%). The high disease incidence (67.9%) was noticed at Hazaribagh. Bio-efficacy of the fungicides was tested

under natural infection at all the centres except Hazaribagh where disease pressure was augmented with artificial inoculation.

All seven fungicidal treatments performed better in reducing the brown spot at all six centres compared to untreated control. Among all the treatment, hexaconazole 5%EC (2.0 ml/l) significantly reduced the disease severity at two locations (Chata and Patambi) and showed low mean severity (20.9%) compared to other treatments. Besides, propiconazole 25% EC (1.0 ml/l) and azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1 ml/l) also showed better in minimising the brown spot (Fig. 9 and Table 93). Regarding yield data, fungicide sprayed plots showed significantly higher yield compared to control plot (3162 Kg/ha). Highest mean yield (4659 Kg/ha) was obtained from the plots where azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) sprayed (Table 94).

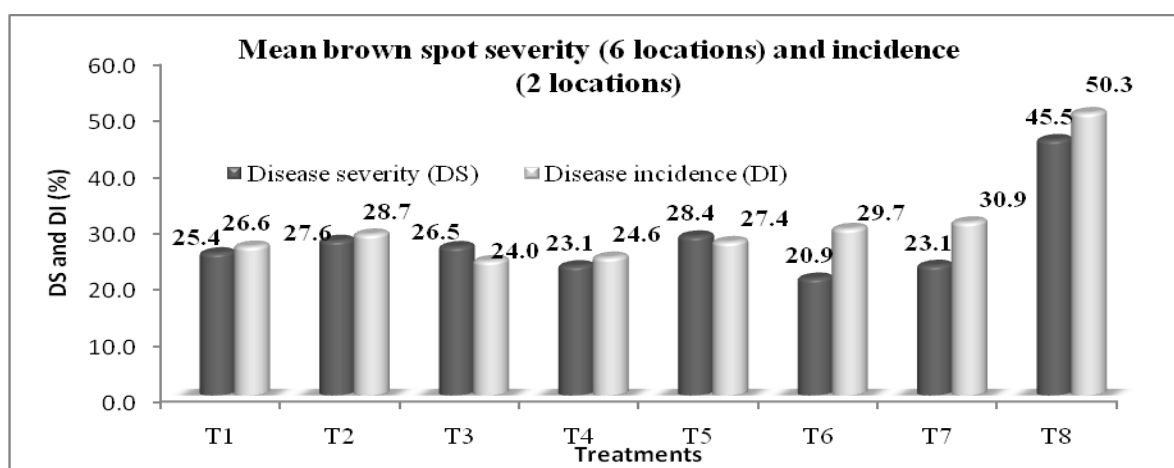


Figure 9: Effect of fungicides against brown spot of rice, Kharif-2019

False smut: Trail was conducted at Cuttack and Varanasi through natural incidence. Panicle and spikelet infection was observed from both the centres. Moderate level of panicle infection was noticed at NRRI (22.0%) and Varanasi (27.2%). This trail showed statistically no significant difference among the treatments in spikelet infection at both the centres. Azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) sprayed showed minimum panicle infection (12.7%) and spikelet infection (14.1) compare to other treatments (Table 95).

Grain discoloration: Experiment was conducted at Moncompu and Rajendranagar through natural incidence. Disease incidence and disease severity was observed at Moncompu and Rajendranagar, respectively. Low level of incidence (21.1%) and moderate severity (51.7%) was recorded in control plots. Azoxystrobin 18.2 % w/w + difenoconazole 11.4 % w/w SC (1.0 ml/l) sprayed plots showed less disease incidence and severity followed by prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE (2.0 ml/l) (Table 95).

Table 92: Evaluation of fungicides on sheath rot severity and incidence of rice, Kharif-2019

Treatments	Dose/ L	Sheath rot severity (%)					Sheath rot incidence (%)					
		CHN	NVS	NAW	TTB	Mean	ADT	NVS	NWA	RNR	TTB	Mean
T1- Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE	2 ml	28.3 (32.0)	16.6 (24.0)	15.8 (23.4)	18.8 (25.7)	19.9	20.3 (26.7)	26.5 (26.5)	60.8 (51.3)	24.2 (28.9)	21.5 (27.6)	30.6
T2- Prochloraz 45% EC	2 ml	35.6 (36.5)	23.1 (28.7)	20.8 (27.1)	17.3 (24.5)	24.2	13.8 (21.7)	35.1 (35.1)	70.4 (57.1)	22.2 (26.7)	19.5 (26.2)	32.2
T3- Tricyclazole 75% WP	0.6 g	49.5 (44.7)	25.7 (30.4)	32.5 (34.8)	10.3 (18.7)	29.5	29.6 (32.9)	38.0 (38.0)	78.2 (62.2)	24.7 (29.8)	13.8 (21.8)	36.9
T4- Azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC	1 ml	36.7 (37.2)	13.5 (21.5)	16.5 (23.9)	13.9 (21.9)	20.1	24.3 (29.5)	21.1 (21.1)	64.5 (53.4)	26.7 (30.6)	16.2 (23.7)	30.5
T5- Difenoconazole 25 EC	1ml	44.3 (41.7)	24.0 (29.3)	24.7 (29.7)	19.8 (26.4)	28.2	28.9 (32.5)	36.0 (36.0)	69.9 (56.8)	19.5 (22.7)	22.5 (28.3)	35.4
T6- Hexaconazole 5% EC	2 ml	41.7 (40.2)	15.1 (22.8)	34.4 (35.9)	21.1 (27.3)	28.1	13.6 (21.5)	25.7 (25.7)	82.3 (65.2)	17.8 (21.6)	25.3 (30.2)	32.9
T7- Propiconazole 25% EC	1 ml	40.3 (39.3)	21.8 (27.8)	26.1 (30.7)	9.1 (17.5)	24.3	22.9 (28.5)	32.1 (32.1)	75.0 (60.0)	19.5 (22.8)	12.3 (20.5)	32.3
T8- Control	-	76.5 (61.0)	38.2 (38.1)	42.9 (40.9)	40.5 (39.5)	49.5	37.1 (37.5)	45.3 (45.3)	88.0 (70.0)	32.0 (34.3)	48.3 (44.0)	50.1
General Mean		44.1	22.2	26.7	18.9	-	23.8	32.5	73.6	23.3	22.4	35.1
LSD @ 5% ($P=0.05$)		4.8	3.7	2.4	1.8	-	4.2	5.7	4.8	N/A	1.8	-
SE(m)		1.6	1.2	0.8	0.6	-	1.4	1.9	1.6	4.9	0.6	-
SE(d)		2.3	1.8	1.1	0.9	-	2.0	2.7	2.3	6.9	0.9	-
CV (%)		7.8	8.9	5.3	4.8	-	9.9	11.8	5.4	35.8	4.5	-
Transformation		AT	AT	AT	AT	-	AT	AT	AT	AT	AT	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Table 93: Evaluation of fungicides on brown spot severity and incidence of rice, *Kharif*-2019

Treatments	Dose/L	Brown spot disease severity (%)							BS- disease incidence (%)		
		ADT	CHT	HZB	PTB	PUS	SAB	Mean	HZB	SAB	Mean
T1- Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE	2 ml	15.1 (22.8)	40.8 (39.6)	10.4 (3.4)	42.7 (42.7)	10.0 (18.4)	33.2 (35.2)	25.4	30.8 (33.7)	22.3 (28.2)	26.6
T2- Prochloraz 45% EC	2 ml	10.5 (18.9)	41.3 (39.9)	19.2 (4.2)	46.9 (46.9)	20.3 (26.6)	27.4 (31.6)	27.6	38.6 (38.4)	18.8 (25.7)	28.7
T3- Tricyclazole 75% WP	0.6 g	23.9 (29.2)	33.7 (35.5)	17.2 (4.3)	54.5 (54.5)	11.9 (20.1)	17.6 (24.8)	26.5	36.1 (36.9)	11.8 (20.1)	24.0
T4- Azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC	1 ml	25.8 (30.4)	21.0 (27.2)	9.7 (4.3)	39.7 (39.7)	11.4 (19.7)	30.8 (33.7)	23.1	28.2 (32.0)	21.0 (27.3)	24.6
T5- Difenoconazole 25 EC	1ml	17.3 (24.5)	27.8 (31.8)	16.1 (3.3)	43.9 (43.9)	36.5 (37.1)	28.6 (32.3)	28.4	35.0 (36.3)	19.7 (26.3)	27.4
T6- Hexaconazole 5% EC	2 ml	12.9 (20.9)	13.3 (21.2)	16.2 (3.9)	33.9 (33.9)	13.1 (21.2)	35.8 (36.8)	20.9	35.2 (36.4)	24.2 (29.4)	29.7
T7- Propiconazole 25% EC	1 ml	16.5 (23.9)	15.5 (23.0)	15.6 (4.1)	43.0 (43.0)	9.1 (17.6)	39.1 (38.7)	23.1	35.5 (36.5)	26.3 (30.8)	30.9
T8- Control	-	33.3 (35.2)	49.8 (44.9)	24.8 (4.1)	57.2 (57.2)	61.0 (51.3)	47.3 (43.4)	45.5	67.9 (55.5)	32.7 (34.9)	50.3
General Mean		19.4	30.4	16.1	45.2	21.6	32.5	-	38.4	22.1	-
LSD @ 5% ($P=0.05$)		3.4	3.4	0.5	6.6	3.0	1.5	-	0.7	1.0	-
SE(m)		1.2	1.2	0.2	2.2	1.0	0.5	-	0.3	0.3	-
SE(d)		1.6	1.6	0.2	3.2	1.4	0.7	-	0.4	0.5	-
CV (%)		9.0	7.1	7.7	9.9	7.6	2.5	-	1.3	2.0	-
Transformation		AT	AT	ST	NT	AS	AS	-	AT	AT	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation; NT- No transformation)

Table 94: Effect of fungicides on grain yield with respect to sheath rot and brown spot, Kharif-2019

Treatments	Dose/ L	Grain yield against sheath rot (%)							Grain yield against brown spot (%)						
		ADT	CHN	NVS	NWG	RNR	TTB	Mean	ADT	CHT	HZB	PTB	PSA	SBR	Mean
T1- Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE	2 ml	5388	4792	5967	6545	5879	4340	5485	5388	2480	4248	5363	3917	4517	4318
T2- Prochloraz 45% EC	2 ml	6388	4590	5293	6361	5680	4360	5445	6388	2423	3259	5000	2950	5933	4325
T3- Tricyclazole 75% WP	0.6 g	5413	3972	5063	5999	5951	4570	5161	5413	2750	3312	4975	3566	6067	4347
T4- Azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC	1 ml	5788	4444	6288	6789	5734	4330	5562	5788	3060	4495	5195	3734	5683	4659
T5- Difenoconazole 25 EC	1ml	5350	4111	5170	6464	6106	4270	5245	5350	2840	3965	5338	2654	5783	4322
T6- Hexaconazole 5% EC	2 ml	6200	4250	6059	5893	5273	4275	5325	6200	3370	3935	5015	3014	4417	4325
T7- Propiconazole 25% EC	1 ml	5375	4403	5385	6198	5876	5530	5461	5375	3250	3647	4963	4065	4017	4219
T8- Control	-	4975	3208	4205	4524	4395	3835	4190	4975	1830	2457	3938	2008	3767	3162
General Mean		5609	4221	5428	6096	5612	4439	5234	5609	2750	3665	4973	3238	5023	-
LSD @ 5% ($P=0.05$)		432	484	758	925	644	836	-	432	389	81	669	348	229	-
SE(m)		146	163	256	312	217	282	-	146	131	27	226	118	75	-
SE(d)		206	231	362	442	307	399	-	206	186	39	319	166	106	-
CV (%)		5.2	7.7	9.4	10.2	7.7	12.7	-	5.2	9.5	1.5	9.1	7.3	2.6	-

Table 95: Evaluation of fungicides on false smut and grain discoloration of rice, Kharif-2019

Treatments	Dose /L	False smut									Grain discoloration				
		Panicle infection (%)			Spikelet infection (%)			Yield (Kg/Ha)			DI (%)		DS (%)		Yield (Kg/Ha)
		NRRI	VNS	Mean	NRRI	VNS	Mean	NRRI	VNS	Mean	MNC	RNR	MNC	RNR	Mean
T1- Prochloraz 23.5% w/w + tricyclazole 20.0% w/w SE	2 ml	11.7	16.0	13.8	1.2	22.6	11.9	5100	5450	5275	10.6	15.6	3311	5879	4595
T2- Prochloraz 45% EC	2 ml	10.9	18.5	14.7	1.0	24.4	12.7	6567	5450	6008	9.7	16.1	3784	5680	4732
T3- Tricyclazole 75% WP	0.6 g	13.8	20.4	17.1	2.7	33.2	18.0	4567	5050	4808	9.1	22.5	4150	5951	5050
T4- Azoxystrobin 18.2 % w/w + difenoconazole 11.4% w/w SC	1 ml	11.3	14.3	12.8	1.0	20.7	10.8	5933	5550	5742	9.0	16.7	3763	5734	4748
T5- Difenoconazole 25 EC	1ml	12.9	20.3	16.6	1.5	26.6	14.0	4567	5125	4846	10.0	28.9	3795	6106	4950
T6- Hexaconazole 5% EC	2 ml	13.6	23.7	18.6	1.5	27.8	14.6	4467	5050	4758	11.2	22.8	3548	5273	4410
T7- Propiconazole 25% EC	1 ml	12.6	19.8	16.2	1.4	25.8	13.6	4200	5375	4788	10.0	22.2	3300	5876	4588
T8- Control	-	22.0	27.2	24.6	3.1	33.2	18.1	3367	4875	4121	21.1	51.7	2654	4395	3524
General Mean		13.6	20.0	-	1.7	26.8	-	4845	5240	-	11.3	24.6	3538	5612	-
C.D.		0.4	N/A	-	N/A	N/A	-	N/A	N/A	-	0.3	9.1	N/A	644	-
SE(m)		0.1	2.3	-	0.1	3.4	-	711	321	-	0.1	3.1	399	217	-
SE(d)		0.2	3.2	-	0.2	4.7	-	1006	455	-	0.1	4.4	564	307	-
C.V.		5.6	17.2	-	16.1	21.8	-	25.4	12.3	-	5.8	21.5	22.6	7.7	-
Transformation		ST	AT	-	ST	AT	-	-	-	-	ST	AT	-	-	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

2. INTEGRATED DISEASE MANAGEMENT, *Kharif* -2019

To study the effect of Integrated Disease Management (IDM) practices on the incidence of different diseases in rice, the trials were proposed at about eighteen locations i.e., Arundhutinagar, Chiplima (CHP) Faizabad (FZB), Gerua, Hazaribagh (HZB), IIRR, Jagdalpur (JDP), Lonavala, Malan (MLN), Mandya (MND), Maruteru (MTU), Moncompu (MNC), NRRI, Pantnagar (PNT), Pattambi (PTB), Ponnampet (PNP), Rewa (REW), Titabar (TTB), and it was conducted at fourteen locations. The layout suggested was RBD with 3 replications adopting a net plot size of 5 x 2 m and a spacing of 15 x 15 cm. Locally popular variety was suggested for the trial. The fertilizers recommended were (N:P: K: Zn-120:60:40:25)-Apply fertilizer @ 120 kg N/ha, 60kg P₂O₅/ha and 40 K₂O/ha. Apply entire P and K and ½ N as basal dose and the remaining ½N at maximum tillering stage. Apply additional 25% N at booting stage. Apply ZnSO₄ @ 25 kg/ha as basal dose.

The different components for IDM trial are

T1	Seed treatment with bio-control agent (10 g/kg seeds) (Bio-control agent formulation was supplied by ICAR-NRRI).
T2	Seed treatment with bio-control agent + one application of bio-control agent at 15-20 DAT (10 g/litre)
T3	Seed treatment with bio-control agent + one application of propiconazole (1 g/litre) at booting stage
T4	Seed treatment with bio-control agent + one application of bio-control agent at 15-20 DAT (10 g/litre) + One blanket application of propiconazole (1 g/litre) at booting stage
T5	Seed treatment with carbendazim (2 g/kg) + one blanket application of combination fungicide (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage
T6	Control (No seed treatment, No spraying of bio-control agent or any fungicide)

The experiments were conducted in randomized block design under natural condition in hot spot locations. If the disease is not occurring naturally, artificial inoculation was done. The details on the trial conducted in different locations are presented in Table 96.

Effect of integrated management practices against severity of leaf blast of rice - *Kharif*, 2019

Jagdalpur, Hazaribagh, Malan, Ponnampet and Rewa centres conducted the study to analyze the effects of the IDM treatments on the disease severity of leaf blast in rice. Among the three centres tested, PNP showed maximum disease severity (59.94% DS) in control followed by Jagdalpur (58.89% DS), Hazaribagh (52.82% DS), Malan (31% DS) and Rewa (14.3% DS). Among the different treatments, the seed treatment with carbendazim (2 g/kg) + one blanket application of combination fungicide (Trifloxystrobin 25% + Tebuconazole 50%) @ 0.4 g/l at booting stage (T5) was found to be very effective, giving the maximum reduction percentage disease over control (80.61% DS) Table 97.

Table 96: Experimental details of IDM for the management of rice diseases, Kharif-2019

S. No	Location	Disease Recorded	Test Variety	Screening	Date of activities					
					Sowing/ Transplanting	Inoculation	Initial symptom	Spraying Date	Observation	Harvesting
1	Chiplima	Sheath blight	Swarna	Artificial	18.07.2019 22.08.2019	21.09.2019	30.09.2019	16.10.2019	30.10.2019 11.11.2019	19.12.2019
2	Faizabad	Sheath blight	Pusa Basmati 1	Artificial	29.06.2019 27.07.2019	24.09.2019	01.10.2019	28.09.2019 06.10.2019	05.10.2019	08.11.2019
3	Hazaribagh	Leaf blast	CO-39	Artificial	08.07.2019 26.07.2019	06.09.2019	10.09.2019	14.09.2019	13.09.2019 27.09.2019	25.10.2019
4	Jagdapur	Leaf blast, Neck blast	Swarna	Natural	20.06.2019 29.07.2019	-	10.09.2019	28.09.2019 14.09.2019	26/09/19 11/10/19	28.12.2019
5	Malan	Leaf blast, Neck blast	HPU 2216	Natural	11.07.2019 14.08.2019	-	05.09.2019	24.09.2019 25.09.2019	05.10.2019	29.11.2019
6	Mandya	Sheath blight	Jyothi	Artificial/ Natural	14.08.2019 16.09.2019	27.10.2019	03.11.2019	13.11.2019	08.11.2019 29.11.2019	25.12.2019
7	Moncompu	Sheath blight	UMA (MO 16)	Natural	03.09.2019 24.09.2019	-	30.11.2019	02.12.2019	03.01.2020	14.01.2020
8	Maruteru	Sheath blight	Swarna (MTU-7029)	Artificial	10.07.2019 07.08.2019	11.09.2019	18.09.2019	11.10.2019	07.09.2019 28.09.2019 26.10.2019	05.12.2019
		BLB	Krishnaveni (MTU-2077)	Artificial	10.07.2019 23.08.2019	01.10.2019	07.10.2019	28.10.2019	05.11.2019 22.11.2019 07.12.2019	19.12.2019
9	Pantnagar	Sheath blight	Pant Dhan-4	Natural	15.07.2019 07.08.2019	-	10.10.2019	15.10.2019	14.10.2019 26.10.2019	25.11.2019
10	Pattambi	Sheath blight	Jyothi	Natural	22.07.2019 21.08.2019	-	25.09.2019	01.10.2019	25.09.2019 15.11.2019	02.12.2019
11	Ponnampet	Leaf blast Neck blast	Intan	Natural	16-07-2019 20-08-2019	-	14.08.2019-LB 26.11.2019-NB	11.09.2019 03.10.2019	21-10-2019 02-01-2020	08.01.2020
12	Rewa	Leaf blast	PS4	Artificial	24.07.2019 08.08.2019	26.08.2019	07.09.2019	30.09.2019	05.10.2019 15.10.2019	26.11.2019
13	Titabar	Sheath rot	Gitesh	Artificial	06.07.2019 08.08.2019	10.10.2019	22.10.2019	22.10.2019	01-11-2019 11-11-2019 21-11-2019	12.12.2019

However, the effectivity among the treatments was found to differ among the centres, in case of Ponnampet, seed treatment with *Trichoderma* followed by application at 15-20 DAS (T2) was found to have significant effect on the suppression of the disease severity (63.46% reduction of DS over control) and is comparable with the chemical treatment T5. It was observed that one spray of propiconazole at the booting stage along with the treatment T2 did not have any significant effect in suppressing the disease severity (60.21% reduction of DS over control) when compared with T2 alone (63.46% reduction of DS over control). In the case of Jagdalpur centre with second high disease severity among the centres, treatment T5 was the most effective in percentage decrease disease severity over control (28.30%) followed by T4 (23.58%). The trend was similar in the case of Hazaribagh, where the treatment T4 was most successful in percentage decrease disease severity over control (67.55%) after the chemical control T5 (80.61%) and other treatments with bioagent T3 and T2 were also found to be effective (56.52 and 43.27% respectively). The highest increase in the percentage of grain yield over control was as expectedly observed in the chemical alone treatment with maximum decrease in the disease, 80.61% in the case of T5 in Hazaribagh. However, among the integrated treatment with bioagents and propiconazole, the treatment T4 in the Hazaribagh centre was found to be having the highest increase in grain yield percentage (67.55%) followed by T3 and T4 in the same centre (67.55 and 56.52% respectively). In the case of PNP, all the bioagents treatments (T1-T4) were found to be on par with each other, indicating that propiconazole spray did not have any significant effect on the yield of the plant (Table 97).

Effect of integrated management practices against severity of neck blast and grain yield at different locations - Kharif, 2019

Three centres viz., MLN, JDP and PNP conducted IDM trials on the effect of the bioagents along with chemicals for the management of neck blast disease in rice. Among the three centres PNP and JDP were found to have maximum disease in the control plots (53.70 and 52.16% disease index). MLN had significantly less disease (21% DI) when compared to the other two centres. Among the five treatments, the chemical treatment, T5 was found to be most effective (72.58 and 70.05 % decrease of disease index over control). However, in the case of JDP and PNP, the treatment T4 (seed treatment followed by field application of bioagent and spray of propiconazole) was found to be near (33.33 and 65.74% reduction in PDI over control respectively) to the effect of chemical alone treatment, T5 (35.70 and 72.58% reduction in PDI over control respectively). PNP centre reported the maximum suppression of disease over control (68.48%) in the bioagent alone treatment applied as seed treatment followed by the foliar application on 15-20 DAT (treatment T2). With respect to the increase in grain yield of the crop over control, the PNP centre showed maximum increase (56.97%) in the treatment T5 followed. The treatments with bioagent alone (T1 and T2) and an additional spray of propiconazole with the bioagent (T3 and T4) were on par with each other. However, in the case of JDP, the additional spray of propiconazole with the bioagent (T4 and T3) had significantly increased the percentage suppression of disease over control (33.33 and 28.69% respectively) and increased the percentage grain yield over control (21.55 and 18.25% respectively) when compared with (T2 and T1), the bioagents alone treatments, percentage suppression of disease over control (16.53 and 13.4% respectively) and the percentage grain yield over control (8.84 and 4.39% respectively) (Table 98).

Table 97: Effect of integrated management practices against severity of leaf blast and grain yield - Kharif, 2019

Treatment	Leaf blast								
	JDP			HZB			MLN		
	DS (%)	% decrease over control (DS)	% increase in Grain Yield (Kg/ha)	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)
T1 = ST with Bio-control agent @ (10 g/kg)	50.00 (45.17)	15.09	4.39	35.72 (36.69)	32.37	43.03	25.50 (30.28)	17.74	7.50
T2 = T1 + bio-control agent at 15-20 DAT	49.44 (43.54)	16.04	8.84	29.96 (33.17)	43.27	52.21	23.00 (28.56)	25.81	19.56
T3 = T1 + one spray of propiconazole at booting stage	46.11 (37.19)	21.70	18.25	22.96 (28.62)	56.52	67.15	20.20* (26.67)	34.84	21.47
T4 = T2 + one spray of propiconazole at booting stage	45.00 (34.77)	23.58	21.55	17.14 (24.44)	67.55	82.23	24.00 (29.24)	22.58	20.00
T5 = ST with carbendazim (2 g/kg) + spray of (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage	42.22* (33.53)	28.30	28.05	10.24* (18.65)	80.61	97.97	22.90 (28.58)	26.13	23.97
T6 = control	58.89 (52.15)	-	-	52.82 (46.60)	-	-	31.00 (33.83)	-	-
C.V (%)	8.69	-	4.03	1.61	-	1.02	6.18	-	8.95
LSD @ 5% ($P=0.05$)	5.37	-	251	0.75	-	48.0	3.32	-	127
Transformation	AT	-		AT	-		AT	-	

(* - Best treatment; DS – Disease Severity; Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Table 97: Effect of IDM practices against severity of leaf blast and grain yield - Kharif, 2019

Treatment	Leaf blast					
	PNP			REW		
	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)
T1 = ST with Bio-control agent @ (10 g/kg)	30.33 (33.33)	49.41	35.48	11.2 (3.34)	21.7	6.92
T2 = T1 + bio-control agent at 15-20 DAT	21.90 (27.80)	63.46	40.98	9.6 (3.10)	32.9	8.86
T3 = T1 + one spray of propiconazole at booting stage	33.50 (35.30)	44.11	35.36	9.2 (3.02)	36.4	11.53
T4 = T2 + one spray of propiconazole at booting stage	23.85 (29.21)	60.21	37.48	8.9 (2.98)	37.8	13.76
T5 = ST with carbendazim (2 g/kg) + spray of (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage	19.78* (26.30)	67.01	56.97	7.9* (2.80)	45.5	16.50
T6 = Control	59.94 (50.72)	-	-	14.3 (3.78)	-	-
C.V (%)	7.18	-	8.80	3.61	-	1.90
LSD @ 5% ($P=0.05$)	3.60	-	443	0.20	-	142
Transformation	AT	-	-	ST	-	-

(* - Best treatment; DS – Disease Severity; Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Table 98: Effect of integrated management practices against severity of neck blast and grain yield at different locations - Kharif, 2019

Treatment	Neck Blast								
	MLN			JDP			PNP		
	DI (%)	% decrease over control	% increase in Grain Yield (Kg/ha)	DI (%)	% decrease over control	% increase in Grain Yield (Kg/ha)	DI (%)	% decrease over control	% increase in Grain Yield (Kg/ha)
T1 = ST with Bio-control agent @ (10 g/kg)	18.50 (25.33)	11.90	7.50	45.17 (42.20)	13.40	4.39	22.88 (28.51)	57.40	35.48
T2 = T1 + bio-control agent at 15-20 DAT	17.60 (24.79)	16.19	19.56	43.54 (41.26)	16.53	8.84	16.93 (24.08)	68.48	40.98
T3 = T1 + one spray of propiconazole at booting stage	14.50 (22.15)	30.95	21.47	37.19 (37.55)	28.69	18.25	24.35 (29.55)	54.66	35.36
T4 = T2 + one spray of propiconazole at booting stage	18.00 (24.98)	14.29	20.00	34.78 (36.09)	33.33	21.55	18.40 (25.38)	65.74	37.48
T5 = ST with carbendazim (2 g/kg) + spray of (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage	4.40* (11.97)	79.05	23.97	33.54* (35.31)	35.70	28.05	14.73* (22.32)	72.58	56.97
T6 = Control	21.00 (27.23)	-	-	52.16 (46.22)	-	-	53.70 (47.10)	-	-
C.V (%)	12.59	-	8.95	5.32	-	4.03	9.99	-	8.80
LSD @ 5% ($P=0.05$)	5.2	-	127	3.18	-	251	4.44	-	443
Transformation	AT	-	-	AT	-	-	AT	-	-

(* - Best treatment; DI – Disease Incidence; Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Effect of integrated management practices against severity of sheath blight and grain yield at different locations - Kharif, 2019

A total of seven centres viz., Chiplima, Faizabad, Mandya, Maruteru, Moncompu, Pantnagar and Pattambi conducted the IDM trials to study the effect of the bioagent and standard chemical application to study their effect on the severity and incidence on the sheath blight disease of rice. Among the different centres, Maruteru had the highest PDI in the control plots (79.61%) followed by Mandya (73.33), Faizabad (68.50), Pattambi (66.00%), Pantnagar (65.24%), Moncompu (61.94%), Chiplima (46.94%). The standard chemical treatment, seed treatment with carbendazim @2g/kg of seeds plus spray of 0.4g/l of trifloxystrobin 25%+ tebuconazole 50% (T5) resulted in the most effective decrease in the PDI percentage over control. The treatment where seeds are treated with the biocontrol agent @10g/kg followed by application of the bioagent at 15-20DAT and one spray of propiconazole at the booting stage (T4) was the most effective after T5, the Moncompu centre at 74.35% decrease in PDI over control followed by Faizabad (67.78%), Mandya (60.60%) and Maruteru (54.29%). Faizabad centre reported the maximum suppression of disease over control (36.10%) in the bioagent alone treatment applied as seed treatment followed by the foliar application on 15-20 DAT (treatment T2), followed by Moncompu (33.86%) (Table 99).

With respect to the increase in the percentage of increase in the grain yield over control, in general there was no direct effect of the bioagents in the grain yield increase and the decrease in the disease especially in the case of Maruteru, Moncompu, Pantnagar and Pattambi centres. This trend was unique to the sheath blight disease. However, as an exception, the treatment T3 and T4 in the Faizabad centre showed significant increase in the percentage of increase in grain yield over control (52.17% and 60.22% respectively) which is above even the chemical alone treatment T5 (53.76%) (Table 99).

Effect of integrated management practices against severity of Brown spot disease of rice

Hazaribagh centre has conducted the trial on use of bioagents along with the chemicals. At this location, the disease severity was 21.3% and disease incidence was 54.42% in control treatment. Among the different treatments, the chemical only treatment T5, was found to be the most effective in reducing the disease over control (61.89%) followed by the treatment T4, where in the bioagents were applied as seed treatment followed by foliar spray and spray of combi product (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage (48.10%). Bioagent alone applied as seed treatment followed by application on 15-20 DAT was able to suppress the disease to about 27.95% over control. Though both the disease severity and index were less in the brown spot The general increase in the percentage grain yield over was significantly in all the bioagent and propiconazole spray treatments (T1 to T4) with the highest in T4 (60.24) followed by T3 (54.16). The chemical alone treatment T5 gave the highest increase in grain yield percentage (89.01%) over control (Table 100).

Table 99: Effect of integrated management practices against severity of sheath blight and grain yield at different locations - Kharif, 2019

Treatment	CHP			FZB			MND		
	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)	DS (%)	% decrease over control (DS)	% increase in Grain Yield (Kg/ha)	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)
T1 = ST with Bio-control agent @ (10 g/kg)	39.72 (38.99)	15.38	8.03	54.60 (47.62)	20.29	12.90	57.78 (49.51)	21.21	13.31
T2 = T1 + bio-control agent at 15-20 DAT	35.28 (36.30)	24.84	14.81	43.77 (41.40)	36.10	29.03	48.89 (44.34)	33.33	20.42
T3 = T1 + one spray of propiconazole at booting stage	27.78 (31.62)	40.82	23.47	28.30 (32.09)	58.69	52.17	43.33 (41.15)	40.91	20.23
T4 = T2 + one spray of propiconazole at booting stage	25.56 (30.23)	45.56	28.39	22.07* (27.97)	67.78	60.22	28.89 (32.38)	60.60	29.69
T5 = ST with carbendazim (2 g/kg) + spray of (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage	14.72* (22.47)	68.64	46.31	26.00 (30.61)	62.04	53.76	21.11* (27.38)	71.21	46.63
T6 = Control	46.94 (43.22)	-	-	68.50 (55.86)	-	-	73.33 (59.08)	-	-
C.V (%)	12.94	-	8.18	5.36	-	7.12	9.69	-	9.00
LSD @ 5% ($P=0.05$)	6.59	-	500	3.17	-	336	6.17	-	441
Transformation	AT	-	-	AT	-	-	AT	-	-

(* - Best treatment; DS – Disease Severity; Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Table 99: Effect of integrated management practices against severity of sheath blight and grain yield at different locations - Kharif, 2019

Treatment	MTU			MNC		
	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)
T1 = ST with Bio-control agent @ (10 g/kg)	47.03 (43.24)	40.92	4.66	43.75 (41.39)	29.37	7.89
T2 = T1 + bio-control agent at 15-20 DAT	58.43 (49.96)	26.60	11.26	40.97 (49.69)	33.86	18.42
T3 = T1 + one spray of propiconazole at booting stage	52.22 (46.30)	34.41	2.96	33.89 (34.51)	45.29	17.11
T4 = T2 + one spray of propiconazole at booting stage	36.39 (36.94)	54.29	7.86	15.27 (22.88)	75.35	23.68
T5 = ST with carbendazim (2 g/kg) + spray of (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage	34.34* (35.29)	56.86	51.41	14.30* (21.35)	76.91	39.58
T6 = Control	79.61 (63.27)	-	-	61.94 (52.01)	-	-
C.V (%)	21.51	-	23.39	15.78	-	16.92
LSD @ 5% ($P=0.05$)	14.85	-	1170	8.43	-	569
Transformation	AT	-	-	AT	-	-

(* - Best treatment; DS – Disease Severity; Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Table 99: Effect of integrated management practices against severity of sheath blight and grain yield at different locations - Kharif, 2019

Treatment	PNT			PTB		
	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)
T1 = ST with Bio-control agent @ (10 g/kg)	60.74	6.91	0.35	65.52 (54.16)	0.73	5.48
T2 = T1 + bio-control agent at 15-20 DAT	54.07	17.12	1.27	68.8 (55.60)	4.24	5.12
T3 = T1 + one spray of propiconazole at booting stage	38.69	40.69	6.89	48.6 (43.83)	26.36	6.16
T4 = T2 + one spray of propiconazole at booting stage	35.89	44.98	9.17	47.73* (43.66)	27.68	4.11
T5 = ST with carbendazim (2 g/kg) + spray of (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage	32.70*	49.88	10.73	53.30 (46.71)	19.24	5.15
T6 = Control	65.24	-	-	66.00 (52.44)	-	-
C.V (%)	4.08	-	1.55	7.62	-	10.64
LSD @ 5% ($P=0.05$)	2.94	-	133	5.71	-	590
Transformation	-	-	-	AT	-	-

(* - Best treatment; DS – Disease Severity; Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Effect of integrated management practices against severity of sheath rot

Titabar centre conducted the trails on the integrated management of sheath rot using bioagent along with the chemicals. The centre has reported a maximum disease severity of 38.77% and 40.50% of disease incidence in the control plots. The chemical alone treatment was the most effective in reducing about 76.61% of the disease over control. However the treatment T4 with the bioagents applied twice as seed treatment followed by application as foliar spray on 15-20 DAT and a foliar application of propiconazole at booting stage was also found to be very effective in suppressing the disease to the tune of 71.76% over control. The bioagent alone treatment T2, was able to suppress the disease to the tune of 46.35% over control. The percentage disease suppression in the case of sheath rot of rice by the above treatments did not directly affect the percentage increase in the grain yield of rice in the respective treatments. The maximum percentage increase in the grain yield over control was observed in the chemical alone treatment T5 (20.84) followed by other treatments T4 and T3 (17.20 and 16.89% respectively). The bioagents alone treatments (T1 and T2) were on par with the treatments T3 and T4 (Table 100).

Effect of integrated management practices against severity of Bacterial leaf blight

Only Maruteru centre had conducted the trial on the management of BLB in rice using the bioagent supplied along with the standard chemical practices. The centre has reported high disease severity and it was observed that none of the treatments had controlled the disease satisfactorily. In control treatment 78.43% of disease incidence and 94.78% of disease severity was recorded. The maximum percent decrease in disease severity over control (9.21%) was observed in the case of treatment T4. The values were too low to consider them any significant for an effective disease control strategy. The bioagent alone treatment, T2 was able to suppress the disease to the tune of about 3.81% over control. Lack of effectivity of any of the five treatments to suppress the percentage disease index and severity over control resulted in only a maximum of 23.37% increase in the grain yield over control in treatment T4 and is on par with the chemical alone treatment T5 (22.91%). The other treatments (T1 to T3) were on par with each in the increase of grain (Table 100).

Table 100: Effect of integrated management practices against severity of brown spot, sheath rot and Bacterial leaf blight - Kharif, 2019

Treatment	Brown spot				Sheath rot				BLB			
	HZB				TTB				MTU			
	DI (%)	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)	DI (%)	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)	DI (%)	DS (%)	% decrease over control	% increase in Grain Yield (Kg/ha)
T1 = ST with Bio-control agent @ (10 g/kg)	29.00 (32.57)	17.13 (4.13)	19.52	23.08	33.30 (35.22)	26.50 (30.96)	31.65	14.35	71.38 (57.95)	89.33 (71.03)	5.75	14.78
T2 = T1 + bio-control agent at 15-20 DAT	25.83 (30.53)	15.34 (3.91)	27.95	34.00	27.80 (31.79)	20.80 (27.11)	46.35	15.90	77.49 (61.82)	91.17 (72.74)	3.81	13.82
T3 = T1 + one spray of propiconazole at booting stage	19.91 (26.48)	13.34 (3.65)	37.32	54.16	23.50 (28.97)	15.30 (23.01)	60.54	16.89	67.21 (55.65)	88.22 (69.99)	6.92	7.31
T4 = T2 + one spray of propiconazole at booting stage	18.17 (25.22)	11.05 (3.32)	48.10	60.24	14.40 (24.25)	10.95 (19.28)	71.76	17.20	66.90* (54.92)	86.05 (68.17)	9.21	23.37
T5 = ST with carbendazim (2 g/kg) + spray of (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage	14.78* (22.60)	8.11 (2.85)	61.89	89.01	12.50* (20.66)	9.07 (17.50)	76.61	20.84	67.57 (55.49)	86.35 (68.67)	8.89	22.91
T6 = Control	54.42 (47.52)	21.30 (4.61)	-	-	40.50 (39.50)	38.77 (38.49)	-	-	78.43 (62.50)	94.78 (76.89)	-	-
C.V (%)	1.16	2.16	-	1.25	8.83	3.40	-	3.14	4.10	2.70	-	11.67
LSD @ 5% ($P=0.05$)	0.53	0.12	-	66.65	7.72	1.33	-	207	1.85	2.89	-	607.40
Transformation	AT	ST	-	-	AT	AT	-	-	AT	AT	-	-

(* - Best treatment; DI – Disease Incidence; DS – Disease Severity; Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

TRIAL NO: 14 SPECIAL TRIAL ON THE EVALUATION OF ESSENTIAL OILS AGAINST RICE DISEASES

. The overuse of fungicides for the management of major rice diseases is a matter of concern and alternative or complementary protection practices are important and need of the hour to reduce the use of pesticides for achieving a sustainable environment. Last year results of this trial suggest that, the oils were not effective against bacterial blight and hence this year, this trial was proposed only for the management of fungal diseases. The trial was laid out with ten treatments and a control viz., T1 - Citronella oil @ 2.0ml/l; T2- Eucalyptus oil @ 2.0ml/l; T3- Cedar wood oil@ 2.0ml/l; T4- Nirgundi oil@ 2.0ml/l; T5-Lemon grass oil@2.0ml/l; T6-Clove oil@2.0ml/l; T7-Neem essential oil@2.0ml/l; T8-Emulsifier@2.0ml/l; T9-Carbendazim@0.6g/l and T10-Control. The trial was proposed at different hot spot locations for different rice diseases viz., 8 locations for leaf blast; 9 locations for sheath blight and 5 locations for brown spot. In *Kharif* 2019, essential oils were tested for their performance at 17 different locations i.e., against leaf blast at 3 locations (Hazaribagh, Jagdalpur and Mandya), against neck blast at 2 locations (Jagdalpur, Malan, Lonavala); against sheath blight at 8 locations (Chinsurah, Chiplima, IIRR, Ludhiana, Maruteru, Masodha (Faizabad), Moncompu, Raipur); against brown spot at Sabour and against false smut at Maruteru and Pantnagar. Data was not received from Karjat, Nellore (Leaf blast), Pantnagar (Sheath blight); Hazaribagh, Mugad, Pusa and Ranchi (Brown spot). The trial details are presented in Table 101. Trial on leaf blast was conducted under artificial and natural disease pressure; trial on sheath blight was conducted under artificial disease pressure; trial on brown spot was conducted under natural disease pressure and trial on false smut was conducted both under natural and artificial disease pressure.

Effect of essential oils against leaf and neck blast disease at different locations

Trial on leaf blast was conducted at Hazaribagh and Mandya; on neck blast at Malan and Lonavala; on both leaf and neck blast the trial was conducted at Jagdalpur. Leaf blast and neck blast was recorded in terms of disease severity at all locations. Leaf blast severity was very high at Hazaribagh (78.73%), Jagdalpur (60.74%); and high at Mandya (49.14%). With respect to neck blast, very high disease severity of 60.27%, 51.30%, and 50.59% was recorded at all the three locations viz., Lonavala, Malan and Jagdalpur respectively. Among the different essential oils tested for their efficacy against leaf blast at Jagdalpur and Mandya, application of two sprays of Neem oil @ 2 ml/l (T7) effectively reduced the leaf blast severity and per cent of disease reduction was varied from 41.21% to 37.80% compared to control. Similarly, the same treatment recorded high grain yield (JDP – 4603 kg/ha; MND - 4404 kg/ha). At Hazaribagh, application of two sprays of Clove oil @ 2 ml/l (T6) significantly reduced the disease severity from 78.73% to 42.63% and increased the grain yield from 1984 kg/ha to 3244 kg/ha. The fungicide treatment (T9 - Carbendazim @0.6g/l) performed well in all the three locations in reducing the disease severity (Table 102). With respect to neck blast, application of Neem oil @ 2.0ml/l (T7) significantly reduced the neck blast disease severity at Jagdalpur (DS - 27.01%; Control - 50.59%) and Malan (DS - 43.50%; Control - 51.30%). The same treatment significantly increased the grain yield compared to control (JDP = T6 – 4603 kg/ha; Control – 3320 kg/ha; MLN = T6 – 2538 kg/ha; Control – 1440 kg/ha). At Lonavala, except Carbendazim @0.6g/l (T9), all the other treatments did not show much difference in reducing the disease severity (Table 103).

Table 101: Experimental details of Special trial on essential oils for the management of rice diseases, Kharif-2019

S. No	Location	Disease Recorded	Test Variety	Screening	Date of activities					
					Sowing/ Transplanting	Inoculation	Initial symptom	Spraying	Observation	Harvesting
1	Chinsurah	Sheath Blight	Swarna (MTU 7029)	Artificial	27.06.2019 02.08.2019	06.09.2019	15.09.2019	18.09.2019 26.09.2019	18.10.2019	04.12.2019
2	Chiplima	Sheath Blight	Swarna	Artificial	28.06.2019 25.07.2019	21.09.2019	-	24.09.2019 01.10.2019	04.11.2019	26.11.2019
3	Faizabad	Sheath Blight	Pusa Basmati-1	Artificial	29.06.2019; 27.07.2019	24.09.2019	01.10.2019	28.09.2019; 06.10.2019	05.10.2019	08.11.2019
4	Hazaribag	Leaf Blast	C0-39	Artificial	09.07.2019; 27.07.2019	06.09.2019	08.09.2019	08.09.2019 16.09.2019	19.09.2019	25.10.2019
5	IIRR	Sheath Blight	TN 1	Artificial	24.07.19	07.10.19	10.10.2019	17.10.2019	21.10.2019	26.11.2019
6	Jagdulpur	Leaf blast Neck blast	Swarna	Natural	20.06.2019; 25.07.2019	-	30.08.2019	28.09.2019; 14.10.2019;	26.09.2019	29.12.2019
7	Lonavala	Neck blast	EK-70	Natural	15.06.2019; 22.07.2019	-	16.09.2019	14.09.2019 24.09.2019	12.09.2019	25.10.2019
8	Ludhiana	Sheath Blight	PR114	Artificial	27.05. 2019; 27.06.2019	02.09.2019	05.09.2019	04.09.2019; 14.09.2019	05.09.2019	20.10.2019
9	Malan	Neck Blast	HPU 2216	Natural	18.06.2019; 23.07.2019	-	-	09.09.2019; 16.09.2019	05.11.2019	20.11.2019
11	Mandya	Leaf blast	MTU1001	Artificial	14.08.2019; 16.09.2019	-	10.10.2019	16.10.2019; 23.10.2019	15.10.2019	05.01.2020
12	Maruteru	False smut	Swarna (MTU-7029)	Artificial- ShB Natural - FS	10.07.2019; 07.08.2019	17.09.2019	20.09.2019	21.09.2019; 03.10.2019	20.10.2019 19.11.2019	09.12.2019
13	Moncompu	Sheath blight	UMA(MO 16)	Natural	03.09/2019; 24.09.2019	-	08.10.2019	10.10.2019; 22.10.2019	03.01.2020	14.01.2020
14	Pantnagar	False Smut	Pant Dhan-4	Artificial	22.06.2019; 19.07.2019	12.10.2019	20.10.2019	21.10.2019; 28.10.2019	04.11.2019	15.11.2019
15	Chiplima	Sheath blight	Swarna	Artificial	28.06.2019; 25.07.2019	21.09.2019	-	24.09.2019; 01.10.2019	14.10.2019; 04.11.2019	26.11.2019
16	Sabour	Brown spot	Rajendra Sweta	Natural	26.06.2019; 25.07.2019	-	22.09.2019	25.09.2019; 10.10.2019	28.09.2019	28.11.2019
17	Raipur	Sheath blight	Swarna	Artificial	02.07.2019; 31.08.2019	09.10.2019	13.10.2019	13.10.2019; 19.10.2019	30.10.2019	23.11.2019
18	Pusa	Brown spot	Pankaj (HS)	Natural	15.06.2019; 10.07.2019	.	-	-	-	-

Table 102: Effect of essential oils against Leaf blast and grain yield at different locations *Kharif*, 2019

T. No	Treatment	Leaf blast								
		HZB			JDP			MND		
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	44.43 (41.79)	43.57	3032	51.85	14.64	3710	31.36	36.18	3740
T 2	Eucalyptus oil @2.0ml/l	46.86 (43.18)	40.48	2866	48.89	19.51	3850	29.88	39.19	4256
T 3	Cedar wood oil @2.0ml/l	52.47 (46.40)	33.35	2580	42.96	29.27	4497	33.83	31.16	4344
T 4	Nirgundi oil @2.0ml/l	48.11 (43.90)	38.90	2726	50.37	17.07	3763	28.64	41.72	4253
T 5	Lemon grass oil @2.0ml/l	48.27 (43.99)	38.69	2458	45.19	25.60	4293	30.37	38.20	4246
T 6	Clove oil @2.0ml/l	42.63 (40.75)	45.85	3244	48.15	20.73	3867	31.60	35.69	4022
T 7	Neem oil @2.0ml/l	49.60 (44.75)	37.00	2697	37.78	37.80	4603	28.89	41.21	4404
T 8	Emulsifier @2.0ml/l	55.54 (48.16)	29.46	2087	47.41	21.95	4033	30.86	37.20	4619
T 9	Carbendazim @0.6g/l	39.28 (38.79)	50.11	3405	36.30	40.24	5013	28.15	42.71	4808
T10	Control	78.73 (62.58)	-	1984	60.74	-	3320	49.14	-	3514
	C.V (%)	2.3	-	1.51	4.0	-	1.87	3.33	-	5.13
	LSD @ 5% ($P=0.05$)	1.79	-	70.12	3.22	-	131	1.97	-	371
	Transformation	AT	-		-	-	-	-	--	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Table 103: Effect of essential oils against Neck blast and grain yield at different AICRIP locations, Kharif, 2019

T. No	Treatment	Neck Blast								
		JDP			MLN			LNV		
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	41.59 (40.14)	17.78	3710	46.10	10.14	2401	57.20	5.09	1772
T 2	Eucalyptus oil @2.0ml/l	36.15 (36.94)	28.53	3850	44.03	14.23	2229	54.78	9.11	1825
T 3	Cedar wood oil @2.0ml/l	28.62 (32.33)	43.41	4497	47.17	7.99	2023	58.21	3.42	1732
T 4	Nirgundi oil @2.0ml/l	38.85 (38.54)	23.19	3763	47.97	6.43	2058	55.95	7.16	1839
T 5	Lemon grass oil @2.0ml/l	29.73 (33.03)	41.23	4293	44.33	13.65	2675	56.20	6.75	1744
T 6	Clove oil @2.0ml/l	33.60 (35.41)	33.58	3867	44.30	13.65	2298	57.87	3.98	1600
T 7	Neem oil @2.0ml/l	27.01 (31.30)	46.61	4603	43.50	15.20	2538	55.79	7.43	1922
T 8	Emulsifier @2.0ml/l	32.06 (34.46)	36.61	4033	47.70	7.02	2023	59.70	0.95	1837
T 9	Carbendazim @0.6g/l	26.28 (30.83)	48.04	5013	33.10	35.48	3052	45.00	25.34	2325
T10	Control	50.59 (45.32)	-	3320	51.30	-	1440	60.27	-	1737
	C.V (%)	2.94	-	1.87	11.79	-	14.59	2.11	-	1.17
	LSD @ 5% ($P=0.05$)	1.80	-	131	9.08	-	569	2.03	-	36
	Transformation	AT	-	-	-	-	-	-	-	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Effect of essential oils against sheath blight disease at different locations

Trial on the effect of essential oils for the management of sheath blight disease severity was conducted at Chinsurah, Chiplima, IIRR, Ludhiana, Maruteru, Masodha (Faizabad), Moncompu, Raipur and Sabour. Disease severity was very high at IIRR (96.12%), Maruteru (76.59%), Raipur (75.55%), Moncompu (72.96%), Masodha (71.10%), Chinsurah (70.37%); high at Chiplima (47.03%) and moderate at Ludhiana (35.60%). Among the different essential oils tested, spraying of Neem oil @2.0ml/l (T7) was effective in reducing the disease severity at Chinsurah and Ludhiana. The percentage of disease reduction was varied between 18.05% and 23.57% compared to control and similarly the grain yield was also increased compared to control (CHN – 4900 kg/ha; LDN – 7133 kg/ha). Spraying of Citronella oil @2.0ml/l (T1) was effective in reducing the disease severity at Chiplima (DS - 30.00%) compared to control (47.03%) and increased the grain yield from 4711 kg/ha to 5578 kg/ha. At Maruteru spraying of Nirgundi oil @2.0ml/l (T4) reduced the disease severity from 76.59% to 28.95%. At IIRR and Raipur, T6 (Clove oil@ 2.0ml/l) treatment effectively reduced the disease severity compared to control treatment (IIRR = T6 - 49.52%; Control - 96.12%; RPR = T6 - 65.92%; Control - 75.55%). The disease reduction percentage was varied from 12.75% (RPR) to 48.48% (IIRR). With respect to grain yield, there was no significant difference among the treatments. At Moncompu spraying of Lemon grass oil @2.0ml/l (T5) effectively reduced the disease wherein percentage of disease reduction was 83.00% and grain yield was 3367 kg/ha. At Masodha, spraying of Cedar wood oil @2.0ml/l (T3) was effectively reduced the disease with 48.36% disease reduction and increased the grain yield from 2233 kg/ha to 3217 kg/ha (Table 104).

Effect of essential oils against brown spot and false smut disease at different locations

The trial for the management of brown spot was conducted at Sabour under natural disease pressure. The disease severity was moderate (31.39%). Among the tested oils, Citronella oil @2.0ml/l (T1) significantly reduced the disease severity from 31.39% to 11.37% with the percentage reduction of 63.78%. The same treatment increased the grain yield from 3983 kg/ha to 6200 kg/ha. At Maruteru and Pantnagar essential oils were tested against false smut disease. At Maruteru, spraying of Citronella oil @2.0ml/l (T1) significantly reduced the percentage from 16.31% to 9.93% and increased the yield from 3442 kg/ha to 4220 kg/ha. At Pantnagar, maximum of 11.20% disease reduction was recorded with Neem oil @2.0ml/l (T7) but there was no significant difference in the grain yield with respect to different treatments (Table 105).

Table 104: Effect of essential oils against sheath blight and grain yield - Kharif, 2019

T. No	Treatment	Sheath blight											
		CHN			CHP			IIRR			LDN		
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	64.71 (53.54)	8.03	4000	30.00 (33.06)	36.21	5578	53.21 (46.82)	44.64	2463	31.9 (34.38)	10.38	6522
T 2	Eucalyptus oil @2.0ml/l	68.00 (55.53)	3.35	4000	41.48 (40.06)	11.79	5089	69.89 (56.96)	27.29	2283	27.9 (31.86)	21.70	6911
T 3	Cedar wood oil @2.0ml/l	66.27 (54.47)	5.83	3900	35.56 (36.52)	24.40	5333	66.51 (54.62)	30.81	2497	30.4 (33.42)	14.59	7044
T 4	Nirgundi oil @2.0ml/l	66.67 (54.73)	5.26	3933	38.15 (38.08)	18.89	5311	69.95 (56.75)	27.22	2343	29.3 (32.76)	17.67	7156
T 5	Lemon grass oil @2.0ml/l	67.03 (54.94)	4.73	4167	41.85 (40.27)	11.01	5000	60.85 (51.26)	36.69	1970	34.9 (36.21)	1.96	6961
T 6	Clove oil @2.0ml/l	69.43 (56.41)	1.32	4100	40.74 (39.57)	13.37	5133	49.52 (44.72)	48.48	1923	32.1 (34.46)	10.00	6778
T 7	Neem oil @2.0ml/l	57.67 (49.39)	18.05	4900	37.78 (37.89)	19.68	5267	60.04 (50.85)	37.53	2057	27.2 (31.45)	23.57	7133
T 8	Emulsifier @2.0ml/l	70.63 (57.16)	-0.38	3433	44.07 (41.57)	6.29	4756	64.21 (53.25)	33.19	1980	26.6 (31.03)	25.34	7083
T 9	Carbendazim @0.6g/l	26.83 (31.17)	61.87	5767	24.81 (29.73)	47.24	6067	36.68 (46.82)	61.84	2463	15.2 (22.96)	57.25	8217
T10	Control	70.37 (57.00)	-	3517	47.03 (43.28)	-	4711	96.12 (56.96)	44.64	2283	35.6 (36.63)	-	6539
	C.V (%)	1.98	-	8.38	9.67	-	8.07	5.95	-	10.08	5.17	-	3.9
	LSD @ 5% (P= 0.05)	1.77	-	600	6.30	-	722	5.38	-	398	2.88	-	470
	Transformation	AT	-	-	AT	-	-	AT	-	-	AT	-	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Table 104: Effect of essential oils against sheath blight and grain yield - Kharif, 2019

T. No	Treatment	Sheath blight												
		MTU				MSD (FZB)			MNC			RPR		
		Disease Severity (%)	Disease Incidence (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	47.99 (48.65)	56.35 (44.21)	37.34	4220	37.5 (37.72)	47.33	3100	37.03 (37.19)	49.25	3367	69.62 (57.08)	7.85	8800
T 2	Eucalyptus oil @2.0ml/l	48.08 (47.49)	54.31 (43.53)	37.22	4200	41.8 (40.24)	41.28	2950	17.59 (24.65)	75.89	2833	70.73 (58.04)	6.38	8556
T 3	Cedar wood oil @2.0ml/l	51.81 (47.67)	54.64 (43.64)	32.35	3827	36.7 (37.28)	48.36	3217	32.03 (33.99)	56.10	3067	70.36 (57.04)	6.87	8766
T 4	Nirgundi oil @2.0ml/l	28.95 (33.15)	32.00 (34.68)	62.20	4580	40.0 (39.21)	43.76	2833	40.55 (39.50)	44.42	3233	71.85 (59.04)	4.90	8850
T 5	Lemon grass oil @2.0ml/l	52.84 (55.04)	65.77 (47.97)	31.01	4210	41.3 (39.95)	41.98	2850	12.40 (20.05)	83.00	3367	72.59 (58.65)	3.92	8983
T 6	Clove oil @2.0ml/l	56.66 (55.71)	68.16 (48.27)	26.02	3763	45.2 (42.23)	36.45	2800	33.70 (35.37)	53.81	2700	65.92 (54.51)	12.75	8400
T 7	Neem oil @2.0ml/l	51.29 (46.00)	51.76 (42.68)	33.03	4015	46.8 (43.15)	34.20	2750	11.48 (19.59)	84.27	3400	69.62 (56.64)	7.85	8216
T 8	Emulsifier @2.0ml/l	41.57 (45.58)	51.27 (42.36)	45.72	4289	50.4 (45.23)	29.10	2633	29.07 (32.46)	60.16	2867	68.14 (55.65)	9.81	8366
T 9	Carbendazim @0.6g/l	46.15 (43.03)	46.61 (40.96)	39.74	4311	29.7 (32.99)	58.20	3667	15.18 (22.93)	79.19	2900	13.73 (21.93)	81.83	9006
T10	Control	76.59 (75.76)	91.15 (61.13)	-	3442	71.1 (57.53)	-	2233	72.96 (58.68)	-	2200	75.55 (60.73)	-	7150
	C.V (%)	15.19	19.32	-	15.23	4.01	-	5.68	17.32	-	11.89	11.52	-	3.59
	LSD @ 5% ($P=0.05$)	11.77	16.50	-	715	2.85	-	283	9.63	-	610	10.65	-	524
	Transformation	AT	AT	-		AT	-		AT	-		AT	-	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation)

Table 105: Effect of essential oils against severity of Brown spot and False smut - Kharif, 2019

T. No	Treatment	Brown spot			False smut					
		SBR			MTU			PNT		
		Disease Severity (%)	% decrease over control	Grain Yield (Kg/ha)	% of infected panicles/m ²	% decrease over control	Grain Yield (Kg/ha)	% of infected panicles/m ²	% decrease over control	Grain Yield (Kg/ha)
T 1	Citronella oil @2.0ml/l	11.37 (19.67)	63.78	6200	9.93 (3.12)	39.12	4220	31.19 (33.94)	3.02	5525
T 2	Eucalyptus oil @2.0ml/l	14.77 (22.57)	52.94	5767	9.78 (3.10)	40.04	4200	30.20 (33.32)	6.10	5569
T 3	Cedar wood oil @2.0ml/l	18.72 (25.62)	40.34	5467	13.15 (3.61)	19.37	3827	30.80 (33.70)	4.22	5593
T 4	Nirgundi oil @2.0ml/l	20.74 (27.08)	33.89	5250	10.00 (3.14)	38.69	4580	30.53 (33.53)	5.06	5550
T 5	Lemon grass oil @2.0ml/l	13.39 (21.45)	57.33	6033	13.23 (3.56)	18.88	4210	30.01 (33.20)	6.70	5575
T 6	Clove oil @2.0ml/l	24.51 (29.65)	21.90	4783	13.40 (3.64)	17.84	3763	30.42 (33.46)	5.42	5530
T 7	Neem oil @2.0ml/l	25.51 (30.33)	18.70	4450	16.31 (4.02)	0.00	4015	28.56 (32.29)	11.20	5554
T 8	Emulsifier @2.0ml/l	27.43 (31.56)	12.58	4267	15.91 (3.98)	2.45	4289	30.01 (33.20)	6.69	5577
T 9	Carbendazim @0.6g/l	14.53 (22.39)	53.71	5683	6.97 (2.64)	57.27	4311	21.20 (27.40)	34.07	6095
T10	Control	31.39 (34.06)	-	3983	16.31 (4.04)	-	3442	32.16 (34.52)	-	5428
	C.V (%)	2.42	-	2.86	14.53	-	15.23	2.42	-	2.09
	LSD @ 5% (<i>P</i> = 0.05)	1.09	-	254	0.86	-	715	1.36	-	200
	Transformation	AT	-	-	ST	-	-	AT	-	-

(Figures in the parenthesis indicate transformed means; AT- Arc sine transformation; ST- Square root transformation)

Annexure I**Weather conditions at test locations where Plant Pathology Coordinated Trials were conducted, Kharif-2019**

S. No	Location/ Details		Weather data from May-2019 to January-2020								
1	Aduthurai		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		0	0	2	7	11	11	8	10	-
	Rainfall (mm)		0	0.8	21.2	92.8	251.2	226.7	286.7	247.3	-
	Temp. (°C)	Maximum	37.2	36	34.5	34.8	51	32.0	31.6	29.5	-
		Minimum	27.3	26.7	25.2	24.6	35.9	23.9	22.9	21.2	-
	RH (%)	Morning	87	85	87	83	128	94.5	97	98	-
		Evening	51	57	51	53	86	73	100	92	-
2	Almora		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		-	7	14	19	6	3	-	-	-
	Rainfall (mm)		-	53.45	114.25	252.95	46.25	16.5	-	-	-
	Temp. (°C)	Maximum	-	30.225	29.32	28.62	29.05	27.3	-	-	-
		Minimum	-	16.34	19.15	20.26	19.075	11.1	-	-	-
	RH (%)	Morning	-	77.04	89.86	92.12	92.67	92.8	-	-	-
		Evening	-	47.86	64.08	70.38	60.7	48.52	-	-	-
3	Arundhutinagar	No Data									
4	Bankura	No Data									
5	Chatha		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		-	4	11	8	7	3	3	-	-
	Rainfall (mm)		-	24.2	322.8	172.7	168.2	30.6	77.4	-	-
	Temp. (°C)	Maximum	-	40.5	34.7	33.7	33	29.4	24	-	-
		Minimum	-	24.1	26.3	25.9	24.6	17.2	13	-	-
	RH (%)	Morning	-	50	81	87	89	87	90	-	-
		Evening	-	29	60	65	66	53	50	-	-
6	Chinsurah		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		6	9	17	23	22	11	2	1	-
	Rainfall (mm)		124	74.4	183.6	285.6	162.2	121.3	87.3	9	-
	Temp. (°C)	Maximum	37.38	37.21	35.7	34.63	34.31	32.27	30.26	26.09	-
		Minimum	27.26	25.13	24.45	24.31	24.37	21.69	11	11.17	-
	RH (%)	Morning	89.84	90.5	92.03	90.9	89.07	93.03	95.3	94.26	-
		Evening	58.1	65.63	71.42	71.97	72.47	70.62	59.63	54.16	-
7	Chiplima		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		0	7	10	9	5	0	0	1	-
	Rainfall (mm)		0	217.8	241.3	357.9	116.5	0	0	0.4	-
	Temp. (°C)	Maximum	39.7	34.9	31.9	31.6	33	32.3	28.8	30	-
		Minimum	23.2	24.6	24	24.7	23.5	20.4	14.3	9.5	-
	RH (%)	Morning	76	82	90	90	87	88	90	94	-
		Evening	48	66	73	78	69	62	69	42	-
8	Coimbatore		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		6	0	1	6	9	13	5	6	-

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S. No	Location/ Details		Weather data from May-2019 to January-2020								
	Rainfall (mm)		63	0	40	299.5	38.7	314.7	83.6	59.9	-
	Temp. (°C)	Maximum	35.1	33.1	31	28	29	30.5	29.6	29.3	-
		Minimum	21.8	22.3	21.4	21.2	21.4	21.9	21.5	22.3	-
	RH (%)	Morning	88.5	75.8	82.6	83	77.13	89.3	79.2	83.2	-
		Evening	-	-	-	-	-	-	-	-	-
9	Cuttack		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		3	7	6	14	14	9	1	-	-
	Rainfall (mm)		190	197	488.3	522	529	746.8	6.4	-	-
	Temp. (°C)	Maximum	37.4	34.4	32.3	31.9	31.7	31.5	29.6	-	-
		Minimum	25.9	26.3	25.6	25.5	25.1	24.1	20.5	-	-
	RH (%)	Morning	89.1	83.9	88.7	89	93.8	92.8	90.5	-	-
		Evening	63.7	65.8	72.7	81.2	79.6	69.7	59.4	-	-
10	Faizabad (Masodha)		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		-	1	6	5	6	4	-	-	-
	Rainfall (mm)		-	24.00	396.50	44.10	217.00	179.60	-	-	-
	Temp. (°C)	Maximum	-	38.9	33.6	32.8	32.6	28.9	-	-	-
		Minimum	-	26.8	26.0	26.3	25.8	22.5	-	-	-
	RH (%)	Morning	-	74.6	88.5	84.3	90.3	94.1	-	-	-
		Evening	-	42.2	75.0	77.9	78.5	83.1	-	-	-
11	Gangavati		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		1	7	9	5	14	12	1	2	-
	Rainfall (mm)		7.60	45.20	57.00	37.90	251.40	160.90	6.10	6.3	-
	Temp. (°C)	Maximum	38.64	34.83	32.19	29.87	29.73	30.58	30.00	28.71	-
		Minimum	24.41	24.43	23.58	22.51	22.80	21.90	19.56	17.58	-
	RH (%)	Morning	49.77	60.58	66.93	70.32	77.36	90.08	82.62	87.98	-
		Evening	19.19	33.92	42.99	47.22	58.32	55.82	45.51	40.73	-
12	Gerua	No Data	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
13	Ghaghraghat		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		–	–	03	18	15	01	-	02	-
	Rainfall (mm)		–	–	53.4	250.40	424.4	5.6	-	24.00	-
	Temp. (°C)	Maximum	41.48	41.48	32.80	32.32	30.47	30.61	28.73	21.48	-
		Minimum	25.87	28.10	26.39	25.65	24.57	19.71	15.93	9.13	-
	RH (%)	Morning	-	-	-	-	-	-	-	-	-
		Evening	-	-	-	-	-	-	-	-	-
14	Gudalur		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		19	21	30	26	17	15	6	3	-
	Rainfall (mm)		324	845	732	753	316	268	41	23	-
	Temp. (°C)	Maximum	28.5	23.2	21.9	22.3	25.7	26	25.6	25.2	-
		Minimum	18.3	16.8	17	16.8	16.9	16.5	15.1	14.3	-
	RH (%)	Morning	92.8	98.1	98.3	98.5	95.3	93.6	91.2	90.4	-
		Evening	81	91.3	92.5	91.7	78.5	74.7	68.2	65.8	-

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15	Hazaribagh		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		4	8	19	19	15	17	0	2	-
	Rainfall (mm)		11.6	100.1	302	169.3	267.7	174.2	0	14.2	-
	Temp. (°C)	Maximum	38.8	36.8	30.8	29.9	29.5	27.8	26.3	21.8	-
		Minimum	22.6	24.3	22.1	21.9	21.2	17.5	11.1	7.2	-
	RH (%)	Morning	49.7	65.5	83.3	82.8	85.4	83.4	81.8	86.1	-
		Evening	32.4	49.4	78.1	77.1	74	69.6	52.5	55.3	-
16	IIRR		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		1	5	8	12	14	12	0	1	-
	Rainfall (mm)		9.0	85.0	60.6	190.8	318.8	129	0.0	8.8	-
	Temp. (°C)	Maximum	41.2	36.8	32.0	29.8	29.7	30	29.9	27.8	-
		Minimum	21.3	20.0	18.3	17.4	16.7	16.6	17.7	15.8	-
	RH (%)	Morning	59.0	81.0	83.3	88.1	93.1	92.9	90.3	91.7	-
		Evening	29.0	48.0	58.1	68	69.9	70.5	49.4	52	-
17	Imphal		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		17	20	26	16	21	13	6	2	-
	Rainfall (mm)		87.1	181.4	202.6	62.9	253.7	159.8	38.7	13.6	-
	Temp. (°C)	Maximum	33.2	34	35	34.4	32.5	30.4	29.7	25	-
		Minimum	17.6	19	20.2	21.2	19.5	17.6	9.4	2.5	-
	RH (%)	Morning	81.2	87.4	89.4	87.1	90.6	93.8	93.5	92.6	-
		Evening	54.7	66.1	70.9	67.5	68	67.3	56.2	46.4	-
18	Jagadalspur		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		5	9	21	22	16	11	0	0	-
	Rainfall (mm)		89.8	221	622.5	582.2	499	237.8	0.4	5.8	-
	Temp. (°C)	Maximum	38.1	34.8	28.9	28.7	29.4	30.2	29.5	28.1	-
		Minimum	23.7	24.6	22.6	22.4	22.5	20.9	14.8	12.8	-
	RH (%)	Morning	72	80	93	94	94	96	97	97	-
		Evening	37	55	78	77	75	67	46	42	-
19	Jagtial	No Data	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
20	Karjat		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		0	11	27	25	25	13	1	0	-
	Rainfall (mm)		0	536.80	1901.80	1075.50	1267.40	289.30	2.60	0	-
	Temp. (°C)	Maximum	39.4	34.79	29.65	29.60	29.10	32.29	33.61	32.75	-
		Minimum	24.5	25.91	24.22	24.43	23.61	22.61	20.94	19.13	-
	RH (%)	Morning	74.8	81.23	91.37	90.70	92.20	90.53	90.13	88.81	-
		Evening	33.8	62.27	86.73	82.47	85.63	67.70	49.10	42.71	-
21	Kaul		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		0	2	0	0	0	0	0	2	
	Rainfall (mm)		0	152.6	0	0	0	0	0	152.6	
	Temp. (°C)	Maximum	39.6	32.4	32.3	31.1	26.7	17.2	39.6	32.4	
		Minimum	19.5	25	23.5	16.5	11.4	4.8	19.5	25	

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	RH (%)	Morning	65	91	94	94	90	93	65	91	
		Evening	30	77	73	49	47	64	30	77	
22	Khudwani		Apr -19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
	Rainy days (No.)		11	11	9	8	6	0	4	13	-
	Rainfall (mm)		44.8	89	104	104.8	117.8	0	32.6	300.9	-
	Temp. (°C)	Maximum	21.88	23.2	26.03	30.46	29.36	30.75	21.93	8.95	-
		Minimum	7.11	8.19	10.72	16.46	16.2	12.2	5.95	2.21	-
	RH (%)	Morning	75.56	74.32	73.33	77.12	83.93	73.76	87.9	91.26	-
		Evening	52.6	54.54	57.76	50.41	58.83	44	54.61	57.23	-
23	Lonavala		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		-	19	30	31	29	11	1	-	-
	Rainfall (mm)		-	60.1.2	2718	1762.8	1359	190	0.2	-	-
	Temp. (°C)	Maximum	-	28.8	29	30	30.2	31	29.6	-	-
		Minimum	-	19.4	20	20	19	20	15.6	-	-
	RH (%)	Morning	-	94.8	95.7	94.7	90.4	83	79.8	-	-
		Evening	-	86.6	93.2	89.2	77.9	77.7	55	-	-
24	Ludhiana		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		3	2	10	8	8	0	2	-	-
	Rainfall (mm)		20	29.9	218.4	331.4	264.8	0	35.2	-	-
	Temp. (°C)	Maximum	38	40.4	34	33.8	33.1	30.6	25.6	-	-
		Minimum	22.1	26.8	26.7	26.1	25.5	18.4	13.4	-	-
	RH (%)	Morning	52	55	79	85	86	90	90	-	-
		Evening	22	30	64	67	68	46	47	-	-
25	Malan		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		2	4	15	12	6	1	1	-	-
	Rainfall (mm)		33.4	25.6	438.5	407.1	203.7	18.4	8.4	-	-
	Temp. (°C)	Maximum	33.1	35.3	31.1	30.2	30.1	24.8	23.5	-	-
		Minimum	15.9	18.2	18.6	16.2	15	13.9	13.8	-	-
	RH (%)	Morning	76.6	78.8	81.6	81.5	81.4	77.7	77.4	-	-
		Evening	70	75.3	74	77.5	75.8	69.5	70	-	-
26	Mandya		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		7	3	2	13	6	15	1	0	-
	Rainfall (mm)		134.3	40.4	14.2	120.2	129.6	331.2	16.9	2	-
	Temp. (°C)	Maximum	35.5	36	33	28.9	31.3	31.4	30.9	27.8	-
		Minimum	23.5	22.8	21.5	18.7	19	18.8	18.2	17.3	-
	RH (%)	Morning	81	88	86	88	91	93	90	91	-
		Evening	53	56	61	85	79	77	75	77	-
27	Maruteru		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		Nil	4	12	11	12	12	Nil	Nil	-
	Rainfall (mm)		Nil	42.1	297.3	142.3	259.9	181.8	Nil	Nil	-
	Temp. (°C)	Maximum	36.1	35	31.77	30.39	31.42	31.16	30.95	29.73	-

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		Minimum	23.5	21.63	21.52	21.73	21.62	22.61	22.61	23.42	-
	RH (%)	Morning	85.7	82.8	86.84	86.39	88.07	86.94	83.29	82.26	-
		Evening	45.47	50.67	60.32	66.74	71.9	68.03	60.39	69.26	-
28	Moncompu		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		3	19	19	22	21	23	14	2	-
	Rainfall (mm)		11.4	470.8	324.3	587.8	282	693.5	98.7	160	-
	Temp. (°C)	Maximum	33.82	32.55	31.09	30.16	29.34	32.6	33.13	34	-
		Minimum	24.33	24.03	23.63	23.42	23.82	22.3	22.2	22.3	-
	RH (%)	Morning	78.9	83.73	84.32	92.1	91.77	89.1	90.9	87.3	-
		Evening	70.3	84.4	85.39	87.3	87.43	85.6	84.4	80.1	-
29	Mugad		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		1	10	23	19	12	16	3	-	-
	Rainfall (mm)		19.4	168.2	369.2	811	124.6	455.4	105	-	-
30	Navsari		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		0	7	15	17	20	4	3	0	-
	Rainfall (mm)		0	262	491	535	750	95	37	0	-
	Temp. (°C)	Maximum	34.7	33.5	31.4	29.9	30.9	33.4	33.2	31	-
		Minimum	24.3	25.4	24.2	23.5	22.9	21.5	19.1	15.8	-
	RH (%)	Morning	85	91.5	94.4	96	95.9	87.8	91	85	-
		Evening	61.9	77	87.1	87.4	87.9	68.3	63.8	62.1	-
31	Nawagam		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		0	4	5	15	15	2	0	0	-
	Rainfall (mm)		0	103.4	120.2	458.2	207.2	46	0	0	-
	Temp. (°C)	Maximum	41.8	38.8	34.8	31.1	31.6	33.4	32.0	27.5	-
		Minimum	20.6	26.1	26.5	25.4	25.2	21.9	20.2	14.4	-
	RH (%)	Morning	65	73	76	90	89	82	79	75	-
		Evening	21	47	64	76	81	58	55	40	-
32	Nellore		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		-	1	6	5	7	10	8	7	2
	Rainfall (mm)		-	6.4	15.2	81.9	185.4	330.2	166.8	158	29.6
	Temp. (°C)	Maximum	-	38.9	37.2	33	33.2	31.7	30.1	28.5	29.1
		Minimum	-	28.9	28.8	25.9	25.2	24.2	24.5	22.7	21.8
	RH (%)	Morning	-	60.8	66.9	72.5	83.6	84.1	86.4	89.4	93.5
		Evening	-	45.5	54.2	57.3	62.7	72.8	71.2	71.3	73.4
33	New Delhi		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		7	3	12	10	4	1	1	-	-
	Rainfall (mm)		45.4	31.2	283.3	246.1	17.6	41	4.8	-	-
	Temp. (°C)	Maximum	40.1	54.2	35.7	33.4	34	31.7	27.28	-	-
		Minimum	23.9	28	27.5	26.5	25.6	18.3	14.5	-	-
	RH (%)	Morning	62.2	64.6	80.6	89.1	87.8	87	87	-	-
		Evening	36.3	40.9	66.2	68.1	63.1	50.3	64	-	-

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34	Pantnagar		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		0	6	17	15	8	0	1	-	-
	Rainfall (mm)		0.00	257.00	239.50	332.30	290.60	0.00	29.20	-	-
	Temp. (°C)	Maximum	72.40	37.00	32.30	32.00	31.60	30.90	28.00	-	-
		Minimum	20.90	37.00	25.90	25.50	24.30	18.60	13.40	-	-
	RH (%)	Morning	56.00	69.90	85.20	88.20	89.30	89.40	90.20	-	-
		Evening	20.00	43.90	69.40	69.40	67.40	50.90	47.70	-	-
35	Patna		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
36	Pattambi		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		4	16	23	24	16	19	4	1	-
	Rainfall (mm)		82.5	342.6	560.9	1090.3	386.6	455.1	48.6	6	-
	Temp. (°C)	Maximum	34.9	31.7	29.8	29.3	30.7	31.6	32.3	31.9	-
		Minimum	23.4	22.3	21.5	21.1	21.8	21	21.1	20.8	-
	RH (%)	Morning	82.8	93.1	95.4	95.8	93.3	89.1	89.5	80.1	-
		Evening	55.4	72.3	77.1	79.9	70.4	70.5	60.6	53.7	-
37	Ponnampet		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		5	17	25	24	20	16	0	1	-
	Rainfall (mm)		60.40	263.40	623.30	1795.90	496.70	229.40	0.00	33.00	
38	Portblair		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
39	Pusa		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		-	4.00	13.00	7.00	12.00	1.00	0.00	-	-
	Rainfall (mm)		-	35.00	354.00	171.70	403.00	6.60	0.00	-	-
	Temp. (°C)	Maximum	-	37.50	33.10	34.30	31.40	29.30	26.31	-	-
		Minimum	-	26.50	26.10	26.80	23.20	22.10	20.10	-	-
	RH (%)	Morning	-	80	88	89	91	92	93	-	-
		Evening	-	59	73	75	80	82	60	-	-
40	Raipur		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		-	-	-	-	-	-	-	-	-
	Rainfall (mm)		10.6	75.8	211.5	301.6	451.1	81.6	0	0.8	-
	Temp. (°C)	Maximum	42.9	40.5	32.4	30.4	31	30.6	30.2	27.6	-
		Minimum	27.5	28.2	25.6	25.2	24.9	23	17.2	13.8	-
	RH (%)	Morning	46	67	86	91	91	91	90	86	-
		Evening	19	39	70	77	74	65	94	40	-
41	Rajendranagar		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
	Rainy days (No.)		1	5	8	12	14	12	0	1	-
	Rainfall (mm)		9.0	85.0	60.6	190.8	318.8	129	0.0	8.8	-
	Temp. (°C)	Maximum	41.2	36.8	32.0	29.8	29.7	30	29.9	27.8	-
		Minimum	21.3	20.0	18.3	17.4	16.7	16.6	17.7	15.8	-
	RH (%)	Morning	59.0	81.0	83.3	88.1	93.1	92.9	90.3	91.7	-
		Evening	29.0	48.0	58.1	68	69.9	70.5	49.4	52	-
42	Ranchi		May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20

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			May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
43	Rewa										
	Rainy days (No.)		3	2	15	19	17	3	0	1	-
	Rainfall (mm)		6	40.6	364.4	517.2	335.6	42.8	0	30.6	-
	Temp. (°C)	Maximum	43.3	42.3	34.9	33.2	32.7	30.9	30.5	22.7	-
		Minimum	22.4	26.9	25.5	25.8	24.9	20.1	14.4	9.8	-
	RH (%)	Morning	34	40	73	84	86	84	71	75	-
		Evening	17	25	57	71	77	67	55	59	-
44	Sabour										
	Rainy days (No.)		4	4	18	12	16	4	0	2	-
	Rainfall (mm)		15.3	45.3	24.72	5.46	23.2	5.85	0	1.8	-
	Temp. (°C)	Maximum	41.8	41.5	38.2	36.6	36.4	32.8	30.5	27.5	-
		Minimum	19.6	20	23.2	25	21.6	18.8	13.5	9.2	-
	RH (%)	Morning	89	87	98	92	92	100	92	94	-
		Evening	60.4	66	86	84	92	92	83	81	-
45	Titabar										
	Rainy days (No.)		16.0	18.0	17.0	23.0	15.0	22.0	0.0	0.0	-
	Rainfall (mm)		357.7	266.4	397.8	182.8	348.4	167.6	0.0	0.0	-
	Temp. (°C)	Maximum	28.8	33.1	32.4	34.0	32.1	30.1	28.4	23.8	-
		Minimum	20.8	24.0	24.1	23.9	22.3	20.1	15.4	8.6	-
	RH (%)	Morning	90.0	92.5	90.3	92.0	95.1	94.8	95.0	93.0	-
		Evening	81.0	76.1	80.0	72.0	75.6	78.5	71.5	63.0	-
46	Umiam (Barapani)										
	Rainy days (No.)		14	18	19	14	23	11	4	3	-
	Rainfall (mm)		203.3	380.4	396.7	290.6	429.7	259.1	33.2	24.8	-
	Temp. (°C)	Maximum	28.1	28.1	27.9	29.6	27.1	25.1	24.2	20.5	-
		Minimum	18	19.9	20.4	20.6	19.3	16.1	12.8	6.9	-
	RH (%)	Morning	83.5	87.3	89.2	84.4	92.7	92.4	87.2	85.9	-
		Evening	69	78.9	79.8	74.6	86.3	78.4	66.3	58.9	-
47	Upper Shillong										
	Rainy days (No.)		20	25	28	17	25	16	5	-	-
	Rainfall (mm)		238	317.2	534.1	187.9	220	259.6	34.1	-	-
	Temp. (°C)	Maximum	28.2	29.2	28.1	29.5	29.2	24.8	24.2	-	-
		Minimum	12.5	15	16.1	16.4	13.5	10.1	7.6	-	-
	RH (%)	Morning	100	100	100	98	98	100	100	-	-
		Evening	44	57	58	58	61	47	24	-	-
48	Varanasi										
	Rainy days (No.)		0	4	11	14	13	3	0	2	-
	Rainfall (mm)		0	26.6	296.2	244.7	756	42.8	0	36.6	-
	Temp. (°C)	Maximum	45	46.3	38.4	34.8	34.6	33.2	31.6	28	-
		Minimum	20.8	21.8	20.8	22.4	19.4	16	19	3.2	-
	RH (%)	Morning	73	71	98	97	98	97	96	97	-
		Evening	46	70	98	92	98	93	67	92	-
49	Wangbal										
			May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20

(No data indicates weather data was not received from the respective locations)

Annexure - II

Details on the locations where Coordinated Pathology Screening trials were conducted during, *Kharif 2019*

S. No.	Location	Latitude (North)	Longitude (East)	Elevation (m. from MSL)	Ecosystem	Sowing (Year, 2019)	Fertilizer Basal - NPK (Kg/ha)	Fertilizer top dressing (Kg/ha)
1	Aduthurai	10° N	79°E	19.5 m	Irrigated	13-09-2019	37.5:50:25	112.5:0:25 (NPK)
2	Almora	29°36'N	79°40'E	1250 m	Upland	31-07-2019	60:60:40 20kg/ha	40 N
3	Arundatinagar	22°56'N	91°10'E	12.6 m	Irrigated	02-07-2019	-	-
4	Barapani (Umiam)	25.6820 N	91.9149 E	958.61 m	Rainfed lowland	10.07.2019	-	-
5	Bankura	23°24' N	87°05'E	84 m	Upland (Rainfed)	26-07-2019	NPK @ 120:50:30 Kg/ha (Basal 10:26:26 18Kg+SSP 9Kg+Urea 10Kg;	1st top dressing at 21 DAT urea10Kg-and 2nd top dressing at 42 DAT urea 10 Kg
6	Chatha	32°40'N	74°18'E	293 m	Irrigated	23-07-2019	N:P:K::30:20:10	10+10kg N/ha (1st and 2nd top dressing)
7	Chinsurah	22°52'N	88°24'E	8.62 m	Irrigated	23-07-2019	60:50:30	60 N
8	Chiplima	20°21'N	80°55'E	178.8 m	Irrigated	20-07-2019	80:40:40 40:40:20	15:0:15 (25 DAP) 15:0:0 (45 DAP)
9	Coimbatore	11° N	77°E	409 m	Irrigated	10-10-2019	45:0:4	45 N and 4P
10	Cuttack (NRRI)	20°23'N	85°17'E	36 m	Irrigated Shallow lowland	20-07-2019	120	-
11	Faizabad (Masodha)	26°47'N	82°12'E	113 m	Irrigated	18-07-2019	60:60:60	60 kg/h (20DAP)
12	Gangavati	15°43'N	76°53'E	419 m	Irrigated	08-08-2019	250:75:75	75N
13	Gerua	26°14'N	91°33'E	49 m	Rainfed lowland	-	-	-
14	Ghaghrahat	27°50'N	81°20'E	112 m	Rainfed lowland	19-07-2019	100:60:20	-
15	Gudalur	11°30'N	76°30'E	409 m	Irrigated	29-08-2019	Urea 15 kg for entire uniform blast nursery bed; 10g/pot (RTD)	-
16	Hazaribagh	23° 95'91'' N	85° 37'20'' E	614 m	Upland	14-08-2019	N:P2O5:K2O = 50:50:50	50+50 N
17	IIRR	17°19' N	78°23'E	542 m	Irrigated	15-06-2019	60:60:40 kg/ha	40 N
18	Imphal	24°45' N	93°54' E	774 m	Rainfed lowland	12-07-2019	80:60:40 NPK	40 N
19	Jagadapur	19°05' N	81°57'E	556 m	Upland/ Irrigated	16-08-2019	60:60:60	30:30:0 (NPK)
20	Jagtial	18.830713	78.959899	264 m	Irrigated	21-07-2019	120 Nitrogen	(40+40)
21	Karjat	18°55' N	73°15'E	51.7 m	Rainfed lowland	23-07-2019	-	70N
22	Kaul	29°51'N	76°39'E	230.7 m	Irrigated	19-06-2019	22.5 N + 57.5 P2O5 + 25 Zinc sulphate/ha	57.5+57.5 N in two splits
23	Khudwani	33.73°N	75.15°E	1601 m	Irrigated	05-08-2019	60: 60: 30 (NPK)	60 N
24	Lonavala	18.9°N	73.5°E	622m	Rainfed	19.08.2019	120:50:50	60N

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S. No.	Location	Latitude (North)	Longitude (East)	Elevation (m. from MSL)	Ecosystem	Sowing (Year, 2019)	Fertilizer Basal - NPK (Kg/ha)	Fertilizer top dressing (Kg/ha)
					lowland		60:50:50	
25	Ludhiana	30°90'N	75°85'E	262 m	Irrigated	25-07-2019	Urea 37kg/Acre	Urea 74kg/acre
26	Malan	32°1'N	76.2°E	950 m	Upland	07-08-2019	120:40:40 60:40:40	60N
27	Mandya	12°36'N	76°15'E	694.64 m	Irrigated	30-08-2019	150:50:50 75:50:50	75:0:0
28	Maruteru	16°38'N	81°44'E	5m	Irrigated	18-07-2019	150:40:40 50:40:20	50:0:0 (NPK) 50:0:20
29	Moncompu	9°51'N	76°5'E	10 m	Irrigated	09-09-2019	120:45:45 Kg/ha 1/2N,1/2P&K	15DAP-1/4N, 1/4P&K, 40DAP-1/4N, 1/4P&K
30	Mugad	50° 26' N	74°54'50"E	697 m	Rainfed drill sown low land	06-10-2019	63 : 50 : 50 NPK kg/ha	33 kg N/ha
31	Navsari	20°57'N	72°29'E	10 m	Irrigated	17-07-2019	75:50:0	75N
32	Nawagam	22°48'N	71°38'E	32.4 m	Irrigated	20-07-2019	120:30:0 60 N + 30 P ₂ O ₅ .	60 N + 20 ZnSO ₄
33	Nellore	14°27'N	79°59'E	20 m	Irrigated	21-09-2019	-	32 24 16 kg/acre NPK
34	New Delhi	28°08'N	77°12'E	216 m	Irrigated	17-07-2019	N:P:K 60:60:40 Kg per ha	20 kg N per ha
35	Pantnagar	29°N	79°30'E	343.84 m	Irrigated	09-07-2019	60:60:40-15Kg (ZnSO ₄)	60N +5.0 (ZnSO ₄)
36	Patna	25°13.25ft	84°14.405ft.	77 m	Upland/Irrigated	27-07-2019	120:60:40	60N
37	Pattambi	10°48'N	76°12'E	25.35 m	Upland/Rainfed Lowland	25-07-2019	120:30:30 80:30:15	40:0:15 (NPK)
38	Ponnampet	12°29'N	75°56'E	856 m	Rainfed Lowland	31/07/2019	75:75:90 37.5:75:45	37.5 N:0:45
39	Portblair	6°14'N	92°94'E	5 m	Rainfed lowland	-	-	-
40	Pusa	25.98 N	85.67 E	51.8 m	Irrigated	23-07-2019	40:40:20	40N:40N
41	Raipur	21° 16'N	81°36'E	681 m	Irrigated	20-07-2019	60Kg N	60N
42	Rajendranagar	17° 19'N	78°23'E	542 m	Irrigated	15-07-2019	180:60:40 45:60:40	135N IN 3 Splits
43	Ranchi							
44	Rewa	24°30'N	81°15'E	360 m	Upland Irrigated	23-07-2019	80:60:40	60N
45	Sabour	25° 23'N	87°07'E	37.19m	Rainfed lowland	18-07-2019	40:40:20	20N
46	Titabar	26°N	93°E	99 m	Lowland	29-07-2019	60:20:40	20 kg N 2
47	Upper Shillong	25° 30'122"N	91° 48'413" E	1675 msl	Rainfed lowland	24-07-2019	120N:40P:40 60 kg N ,40 Kg P ,40 Kg K at Nursery	60 kg N at Nursery
48	Varanasi	25°20'N	23°03'E	75.7 m	Irrigated	30-07-2019	120:60:60	30N
49	Wangbal	24°8'N	94'E	781 m	Irrigated	-	-	-

Annexure – III (Abbreviations)

Name of the centre	Code	Details	Code
Aduthurai	ADT	(-)	Data not available
Almora	ALM	A	Artificial Inoculation
Arundhatinagar	ARD	AVTs	Advanced variety trails
Bankura	BAN	BLB	Bacterial leaf blight
Chatha	CHT	BS	Brown spot
Chinsurah	CHN	CV	Co-efficient of variation
Chiplima	CHP	DSN	Donor Screening Nursery
Coimbatore	CBT	FS	False Smut
Cuttack (NRRRI)	CTK	GD	Glume discoloration
Gangavati	GNV	GSN	Germplasm Screening Nursery
Gerua	GER	IC No.	Indigenous collection Number
Ghagrahat	GGT	IET No.	Initial Evaluation Trail Number
Gudalur	GDL	IVTs	Initial variety trails
Hazaribagh	HZB	LB	Leaf blast
Imphal	IMP	LSD	Least significant difference
Indian Institute of Rice Research	IIRR	LSI	Location Severity Index
Jagadapur	JDP	MSL	Mean sea level
Jagtial	JGT	N	Natural Infection
Karjat	KJT	NB	Neck blast
Kaul	KUL	NdB	Node blast
Kudhwani	KHD	NHSN	National Hybrid Screening Nursery
Lonavala	LVN	NSN-1	National Screening Nursery 1
Ludhiana	LDN	NSN -2	National Screening Nursery 2
Malan	MLN	NSN-H	National Screening Nursery- Hills
Mandya	MND	PI	Promising index
Maruteru	MTU	RTD	Rice Tungro Disease
Masodha (Faizabad)	MSD	RTV	Rice Tungro Virus
Moncompu	MNC	SE	Standard error
Mugad	MGD	ShB	Sheath blight
Navsari	NVS	ShR	Sheath rot
Nawagam	NWG	SI	Susceptibility Index
Nellore	NLR	StR	Stem rot
New Delhi (IARI)	NDL		
Pantnagar	PNT		
Patna	PTN		
Pattambi	PTB		
Ponnampet	PNP		
Portblair	POB		
Pusa	PSA		
Raipur	RPR		
Rajendranagar	RNR		
Ranchi	RNC		
Rewa	REW		
Sabour	SBR		
Titabar	TTB		
Umiam (Barapani)	UMM		
Upper Shillong	USG		
Varanasi	VRN		
Wangbal	WGL		

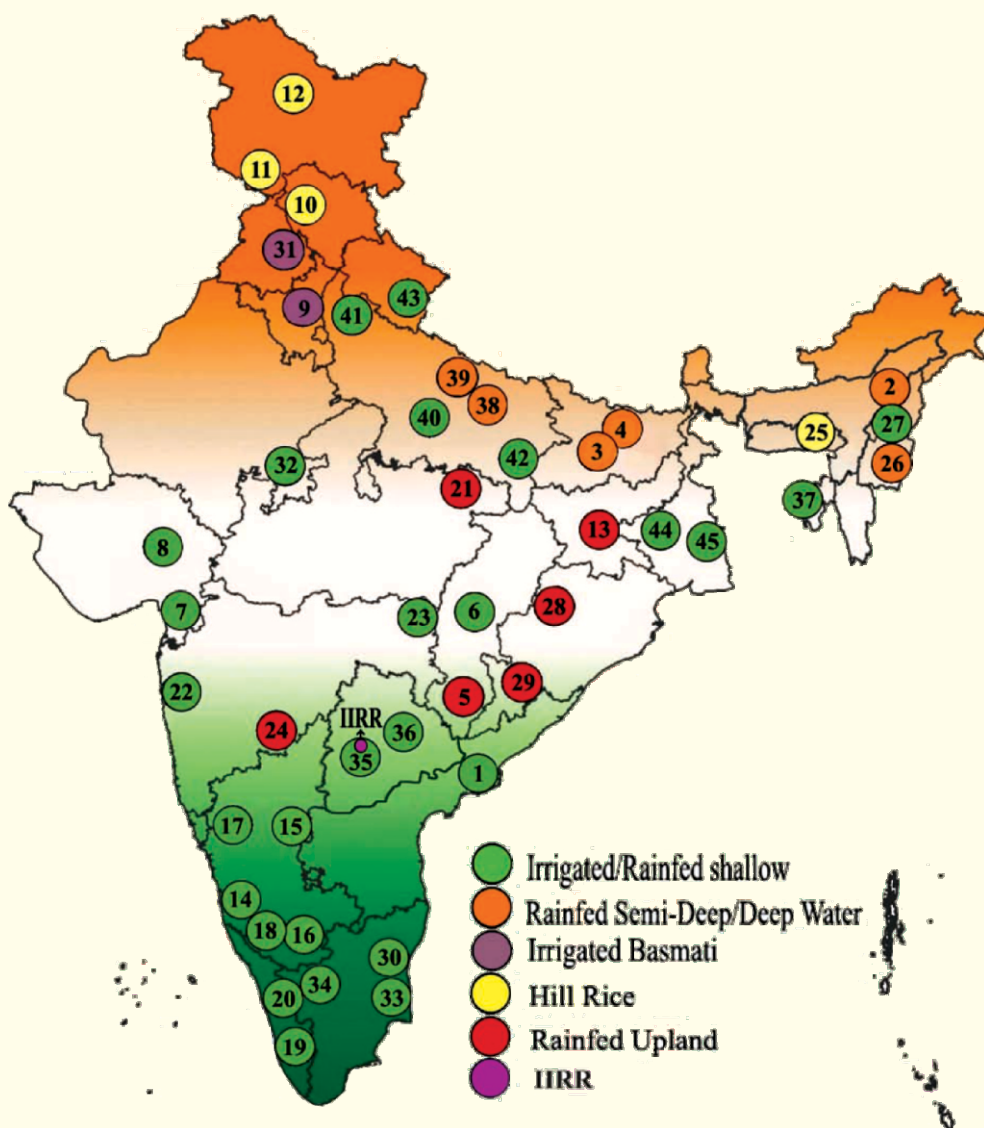
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