# PROGRESS REPORT 2017

## Vol. 2

# CROP PROTECTION

## (ENTOMOLOGY AND PLANT PATHOLOGY)

## All India Coordinated
## Rice Improvement Project

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**Correct citation: Indian Institute of Rice Research, 2018**
**Progress Report, 2017, Vol.2, Crop Protection**
**(Entomology, Plant Pathology)**
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# PREFACE

Ensuring profitable production and productivity of rice in diverse ecosystems is the key to achieve food security of the country as well as sustainable livelihood of farmers**.** Multi-disciplinary evaluation of varietal, crop production and crop protection technologies across locations has been continued under the All India Coordinated Rice Improvement Project (AICRIP) to strengthen rice farmers with suitable technologies resulting in higher levels of rice production and productivity with optimum use of inputs. Comprehensive research efforts of about 400 scientists belonging to ICAR - Indian Institute of Rice Research, 45 funded and more than hundred voluntary centres belonging to State Agricultural Universities as well as Departments of Agriculture, ICAR Institutes and Private Undertakings contribute towards this direction.

This volume reports the salient findings of experimental trials in entomology and plant pathology carried out during 2017. The crop protection programme of AICRIP mainly targets development of holistic, eco-friendly and cost effective IPM strategies with adequate socio-economic gains for rice farmers. Emphasis is on bio-intensive IPM components such as host plant resistance, ecological engineering and biodiversity and use of only safe chemicals. Our ultimate goal is to evolve an IPM package with optimum resource use for insect pest, disease and weed management.

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..

(S.R. Voleti)

Director (Acting)

April 2018

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**TRIALS**

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# SUMMARY

All India Coordinated Entomology Program was organized and conducted during *kharif* 2017 with seven major studies encompassing various aspects of rice Entomology involving 363 experiments (87.9%) that were carried out at 41 locations (32 funded+9 voluntary) in 23 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.

**Host plant resistance studies** comprised of seven screening trials involving 1728 entries consisting of 1398 pre-breeding lines, 114 hybrids,16 cultivars, 62 germplasm accessions and124 check varieties. These entries were evaluated against 13 insect pests in 236 valid tests (50 greenhouse reactions+186 field reactions). The results of these tests identified 74 entries (4.28%) as promising against various insect pests. Of these, 22 entries (29.73%) were under retesting.

Evaluation of 105 entries in **Planthopper Screening trial (PHS)** against the two planthoppers BPH and WBPH in 8 greenhouse and 7 field tests indicated that 9 breeding lines *viz*., BPT 2411, BPT 2611, BPT 2776, BPT 2787, JGL 24497, MTU 1245 (MTU 2139-7-1-1-1), RP 5995 Bphk17-5, IR 73382-80-9-3-13-2-2-1-3-B (HWR-16) and RP 5690-20-6-3-2-1 as promising in 5-9 valid tests.

Evaluation of 60 entries in **Gall midge screening trial (GMS)** in two greenhouse and 8 field tests against 10 populations of gall midge (which includes five identified biotypes) helped in identification of 10 lines that were promising in 3-4 of the 10 tests across all the populations. Of these, WGL1191 and WGL1196 were promising in four valid tests.

In **Gall midge special screening trial (GMSS)** 85 donors were evaluated in 8 valid tests against gall midge populations. ASD 7, KAKAI (K 1417), Sudu Hondarawala, AC6248, PTB 12, WGL 1127, WGL 1145 and IET 19782 were identified as promising in 4-5 of the 8 valid tests. All these lines were under retesting.

Field evaluation of 20 entries replicated thrice in a randomised block design against rice leaf folder in **Leaf Folder Screening Trial (LFST)** at 18 locations in 11 valid field tests revealed that 14 entries were promising in 2-6 valid field tests. A nomination from Nawagam, NWGR-13017 was found promising in 6 valid field tests while seven entries i.e., HPR 2613, HPR 2617, HWR 3, NWGR- 9080, NWGR-13108, Mahisagar and MP 209 were found promising in 4 valid field tests. HPR 2873, HWR 24, RP 5587-B-B-B-51 and MP 11 were found promising in 3 valid field tests while Varundhan and RP 5588-B-B-B-B-76 were found promising in 2 valid field tests.

In **Stem borer screening trial (SBST),** evaluation of 56 entries in 30 field tests identified 3 entries *viz.*, CN 2069, IIRR-BIO-SB-5 and IIRR-BIO-SB-3 as promising in 4-5 of the 30 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 gave good grain yield despite damage.

Evaluation of 25 entries under **Multiple Resistance Screening Trial (MRST)** in 10 greenhouse and 50 field tests against 10 insect pests helped in identification of 3 entries *viz.*, CR 2711-149, Dhanrasi and KNM 113 as promising in 7-9 tests of the 60 tests against 1-4 pests. The MRI varied from 7-36 with a PPR of 1.17-6.0. Of the 3 entries, KNM113 was in the third year of testing.

**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** was constituted with 364 entries (340 AVT entries along with 10 insect checks and 14 disease checks) and evaluation at 20 locations identified 3 entries *viz.*, IET nos 26263, 25970 and Pooja (RP) as promising in four of the 30 valid tests against 2-3 pests. **NSN 2** trial was constituted with 753 entries and evaluated at 14 locations against 8 insect pests identified six entries *viz.*, 26674, 27071, 27193, 27206, 27070 and PTB 33 as promising in 7-9 tests of the 30 valid tests against 3-4 pests. **NSN- Hills** trial was constituted with 109 entries and evaluated at 8 locations in 17 tests against 9 insect pests and none of them were promising against major insect pests. **NHSN** trial was constituted with 151 entries and evaluated at 14 locations against 8 insect pests and identified IET Nos 26537, 26544, 26503, 26527, NDR 259, PTB33 and RP 2068-18-3-5 as promising in 4-6 tests of the 26 valid tests.

**2.2 Insect biotype studies** comprising of three trials 1) Gall midge biotype monitoring trial (**GMBT**), 2) Gall midge population monitoring (**GMPM**) and Planthopper special screening trial (**PHSS**) were conducted to monitor the virulence pattern of gall midge and brown planthopper populations.

Evaluation of the gene differentials in **GMBT** trial in 2 greenhouse and 8 field tests against 6 different biotypes and one population of gall midge identified Aganni (*Gm8*), INRC 3021(*Gm8*) and W1263 (*Gm1*) as promising in 5-6 of the 10 tests. The results suggest that *Gm8* and *Gm1* hold promise across locations. In **GMPM** trial evaluation of the gene differentials through single female progeny testing at Warangal suggested low virulence against Aganni.

In **Planthopper Special Screening Trial (PHSS)**, 16 gene differentials with primary sources of resistance were evaluated against brown planthopper across eleven locations in standard seed box screening test. Two gene differentials *viz.*, PTB 33 with *bph2*+*Bph3*+unknown factors and RP 2068-18-3-5 with *Bph33(t)* gene were promising in 10 and 8 locations, respectively. Rathu Heenati with *Bph3*+*Bph17* genes and T 12 with *bph7* gene performed better in 6 and 4 locations, respectively with a damage score of <5. Two gene differentials *viz.*, Swarnalatha with *Bph 6* gene and Babawee with *bph 4* gene registered promising reaction at three locations whereas ASD 7 with *bph2* and Pokkali with *bph9* genes showed low damage at two locations.

**2.3. Chemical Control studies** consisted of two trials *viz.*, Pesticide compatibility trial (PCT) and Botanical Insecticide Evaluation Trial (BIET) carried out during *Kharif* 2017.

**Pesticide compatibility trial (PCT)** was carried out with the objective of evaluating the compatibility of newer insecticide and fungicide formulations as tank mix against major insect pests and diseases of rice and consequent impact on grain yield, at 24 centres during *kharif* 2017. There were no significant differences in the performance of the two newer insecticide formulations spinetoram+methoxy-fenozide and triflumezopyrim in their proven efficacy when applied alone or in combination with fungicides. Individually spinetoram+methoxyfenozide performed better against stem borer and leaf folder, while triflumezopyrim showed superior efficacy against plant and leafhoppers. Insecticide treatments applied alone and its combination with fungicides were superior to remaining treatments including control in terms of yield. Overall, the results revealed that there was no adverse impact on the efficacy of either of the insecticides when applied with fungicides or vice versa confirming the compatibility of the chemicals when used as tank mix in the field.

**Botanical Insecticide Evaluation Trial (BIET)** was carried out at 30 locations across the country to evaluate the efficacy of four essential oils, neemazal and recommended insecticides, dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield during *kharif* 2017. Based on the performance of the treatments in controlling the pest damage at various locations, the botanicals-cedarwood and eucalyptus oils were found effective in reducing damage by stem borer. In case of gall midge camphor oil showed efficacy in reducing silver shoot damage. Dinotefuran was the most effective treatment in reducing the populations of plant and leafhoppers, while all the essential oil treatments were moderately effective. Against leaf folder, performance of lemon grass oil was superior,while cedarwood oil was effective in reducing the damage by gundhi bug. Eucalyptus oil was found effective against cut worm and the efficacy was comparable with rynaxypyr. Botanical formulations were found moderately effective in reducing damage by hispa and whorl maggot. Impact of essential oils on natural enemies revealed that treatments were relatively safer to mirid bug than spiders. Highest grain yield of 4276.5 kg/ha was recorded in rynaxypyr treatment. Among botancal formulations, cedar wood oil recorded the highest yield of 3879.9 kg/ha.

**Ecological studies** consisted of one trial on **Effect of planting dates on insect pest incidence (EPDP)** conducted at 20 locations during *Kharif* 2017. In general, the pest incidence was low to moderate in different dates of planting across locations. Stem borer damage was reported from 15 locations, of which highest dead heart damage was observed in late planting at Pusa (30.81% DH) followed by Titabar (23.57% DH). Highest white ear damage was also observed in late planting at Jagdalpur (48.24% WE) followed by Pusa (34.78% WE) and Nawagam (26.25% WE). Gall midge damage was reported from 8 locations with highest damage in late planting at Titabar (15.56% SS) and Sakoli (11.81% SS). Among the foliage feeders, leaf folder incidence was reported from 18 locations, of which highest damage of 22.93% DL was observed in late planting at Titabar followed by Bapatla (16.85% DL). Whorl maggot incidence was reported from 6 locations with highest damage at Malan in normal planting (13.28% DL). Caseworm damage was recorded in 3 locations with highest damage at Titabar in late planting (22.67%

DL). Among the plant and leaf hoppers, BPH was reported from 9 locations with highest population at Chiplima in late planting (70 hoppers/5 hills) and Gangavathi (69.6 hoppers/5 hills). WBPH population was observed in 8 locations with higher numbers at Gangavathi in late planting (87/5 hills) followed by normal planting (84/ 5 hills). Low population of GLH was observed at 9 locations. Minor pests such as horned caterpillar at Navasari, rice skipper and grasshopper incidence at Khudwani and thrips at Jagdalpur were observed in all the three plantings.

**Biocontrol and Biodiversity 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).

**Ecological engineering for pest management** was taken up in six locations with a combination of interventions such as organic manuring, alleyways, spacing management, water management and growing of flowering plants on bunds. The results also indicated that water management along with ecological engineering can significantly reduce hopper population at Warangal (7.45/hill) when compared to farmers practice (154.37/hill). Such interventions increased the natural enemy populations like mirids, spiders and coccinellids and increased egg parasitisation across the locations. The benefit cost was also significantly higher with ecological engineering (1.38) when compared to Farmers practice (0.60).

**Bio intensive pest management trial** was initiated to explore the feasibility of biointensive 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 (6.19 %) Raipur (7.51%) and Titabar (0.52 %) as compared to farmers practice where it was 15.97, 13.88 and 13.42 % respectively. In Ludhiana and IIRR the pest incidence was on par as compared to Farmers' practice. White ear damage at IIRR was 9.51 % in BIPM plots as compared to10.56 % in FP plots. Similarly at Ludhiana population of BPH was 18.17 and 20.71per hill in BIPM and Farmers practice. The natural enemies were higher in BIPM plots in all locations. In Hyderabad after three years of these trial, higher yields were obtained in BIPM plots (4250 kg/ha) compared to 3156 kg/ha indicating a period of three years for stabilization of yields in organic practices. The results also indicated an increase in natural enemy population in the organic BIPM plots.

**Integrated Pest Management Studies** involved two trials**, i) Yield Loss Estimation Trial (YLET)** and **ii) Integrated Pest Management special trial (IPMS).**

**Yield loss estimation trial** was conducted at 6 locations for stem borer and 3 locations for leaf folder during *Kharif* 2017. Regression analysis revealed a significant negative relationship between per cent white ears and grain yield at Coimbatore, Chinsurah and Pantnagar. Pooled analysis of white ears vs natural logarithm of grain yield revealed a significant regression ($R^2$ = 0.5335). Based on this model, per cent reduction in grain yield was predicted to be 23.7% for 10% white ears, 41.7% reduction for 20% white ears, 74.1% reduction for 50% white ears and more than 88.5% for 80% or more white ears. A significant negative relationship was observed between leaf folder damaged leaves and grain yield at

Ludhiana ($R^2$=0.3589; P<0.00001; n=133) with a reduction of 1.27 g for every 10% increase in the leaf folder damaged leaves.

**Integrated Pest Management special (IPMs)** trial was carried out in a participatory mode in farmers' fields' at 17 locations during *kharif* 2017 with the main aim of managing all the pests including insects, diseases and weeds in a holistic way by providing a basket of options to the farmers. Across the locations, adoption of IPM practices resulted in low incidence of weeds, insect pests, and diseases in IPM plots compared to FP plots. Weed population and weed biomass recorded at all the locations were considerably reduced by two to five times in IPM implemented plots compared to farmers practices and resulted in significantly higher grain yields. Low incidence of BPH in IPM plots was observed at Chinsurah (5 hoppers/5 hills), and Warangal (33 hoppers/5 hills) as compared to FP plots (86 and 386 hoppers/5 hills, respectively). Stem borer damage was found low in IPM plots at Chinsurah (2.78% WE), Jagdalpur (6.5% DH), Raipur (2.9% WE) and Titabar (1.23%) compared to farmer practices plots. Damage by leaf feeding insects like leaf folder, whorl maggot, hispa, thrips, caseworm and armyworm was also lower in IPM plots than FP plots across the locations. Similarly, in plots where IPM practices were followed had significantly less units of Area under disease progress curve (AUDPC) when compared with the farmers practices. Grain yield was significantly high in IPM plots at majority of locations resulting in high BC ratio due to higher returns and low cost of cultivation.

**Assessment of insect populations throughout the year using light traps** in 29 locations revealed that stem borers and planthoppers, mainly BPH continued to be the most widespread pest in terms of numbers as well as spread across the zones except Northern hills (Zone-I). Compared to the previous year catches, there was a substantial increase in the populations of stem borers (upto a maximum of 5940/week in 16 SW), GLH (upto a maximum of 96494/week in 40 SW), BPH (70357/week in 40 SW), and WBPH (29455/week during 15 SW) across locations. The leaf folder catches were slightly lower compared to that of last year, however it was reported from 24 locations. Maximum number of insect species (including pests and natural enemies) were recorded at Moncompu (15) followed by Raipur (14), and Jagdalpur (13), while eleven species were recorded at Coimbatore, Karaikal, and Maruteru.

## INTRODUCTION

Insect pest scenario in rice continues to be dynamic and of immense significance. Changing climate and its concomitant effect on cropping systems add to cultivation woes of the rice farmers particularly in tackling the changing pest profiles. However, few pests such as planthoppers, stem borer, and leaf folder have consistently posed serious challenges in rice cultivation. Some less significant pests such as hispa, caseworm, swarming caterpillar, cutworms etc. due to their suddenness of occurrence and spread, have resulted in panic actions by rice farmers to protect their crops at any cost.

The pest survey reports (PSR) regularly compiled at fortnightly interval under the All India Coordinated Rice Improvement Project (AICRIP) Entomology programme, bear a testimony to the farmers situations. During 2017, brown plant hopper incidence resulted in hopper burn in isolated patches at Tekkali and Amudalavalasa (A.P.), Ludhiana and Fathehgarh Sahib (Punjab), Samba (Jammu&Kashmir), and Kanke (Jharkhand). At Ragolu and Mandya white backed planthopper also occurred in severe form. Severe incidence of leaf folder was observed at Coimbatore at maximum tillering and panicle emergence stage, while it was also severe in Nellore, Karaikal, and Pattambi. At later stages, leaf mite and thrips caused considerable damage at Coimbatore and Karaikal. Grasshoppers caused 25-60 per cent damage at Tiruvur, Tamil Nadu, while Caseworm caused significant damage at Mandya. In certain pockets of Mandya and Mysore, army worm occurred in severe form. Panicle mite incidence was moderate to severe in parts of coastal Andhra Pradesh and Telangana. Root knot and white tip nematodes were reported from parts of Malan. Severe damage by black beetle and high incidence of chaffer beetles was also reported from isolated pockets of Malan. Snails and Root knot nematode was reported in moderate to severe form from Chatha of Jammu and Kashmir.

In order to surmount problems caused by these multifarious pest situations, concerted efforts are being continued under AICRIP. The main aim is to find eco-friendly and viable solutions for managing the pests in a cost effective way by the farmers in rice fields. Host plant resistance (HPR) screening programme targeting development of resistant varieties against planthoppers and gall midge receives major focus. Under the HPR studies, screening of nominated entries and germplasm accessions from different states was carried out to incorporate desirable multiple pest resistant traits into elite high yielding entries or for further utilization in enhancement of genetic potential.

Since botanicals are potential environment friendly alternatives to conventional pesticides, chemical control studies include evaluation of performance of botanicals against major rice pests. Their role as an important component of organic rice farming is also being examined. Even though chemical pesticides are to be used as last resort, efforts are being made to screen effective newer insecticide molecules for their compatibility with fungicides because farmers still find these chemicals as their saviour while dealing with pest outbreaks or pest caused emergency situations.

Changing climate scenario worldwide has shown enough evidence of its impact on altering the pest profiles across the rice ecosystems of the country. Hence, ecological studies are undertaken to have a relook at the changing pest dynamics under varying planting scenarios in rice fields. Similarly generation of reliable data on a consistent basis is a pre-requisite for quantification of yield loss due to insect pests. Field trials at different centres assist in assimilating valuable information on pest losses for better understanding and developing effective pest management solutions.

Investigation into the rice ecosystem functions and services with emphasis on the role of diverse natural enemy populations *vis a vis* pests is essential for timely human interventions. Ecological engineering for the management of planthoppers is one of the innovative and natural strategies designed to protect rice crop with minimum damage to environment. The promising outcome of the efforts so far will further help in devising safe and even income generating means of pest management for the farmers. Biointensive pest management studies are the broader efforts to integrate all the eco-friendly inputs of pest management to enable rice farmers rely as much less on chemical pesticides.

Adoption of Integrated Pest Management (IPM) in farmers fields will be practical only when it can address tackling of pest problems in a practically holistic and economical way. Special IPM trials are being carried out across locations in farmers field situations with diverse pest scenario to work out realistic solutions for the farmers. In this regard, multidisciplinary efforts with inputs from Entomology, Plant Pathology and Agronomy researchers and farmer participatory approach have provided way for effective validation of location specific IPM practices.

Short and long term assessment of pest populations through light trap catches have also been continued for better understanding of pest population dynamics in relation to weather factors during the year as prerequisites for pest forecasting.

The following report highlights the significant findings from the glass house evaluations and field trials carried out at IIRR and its cooperating centres under AICRIP during 2017.

# 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 multilocational evaluation of breeding lines against insect pests from various National Screening Nurseries 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* 2017. In all, 1728 entries were evaluated at 40 locations against 13 insect pests and 74 entries (4.28%) 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**".

**Planthopper Screening Trial (PHS)**

The trial was constituted with 105 entries comprising of 16 breeding lines developed at RRU, ANGRAU, Bapatla; 9 breeding lines developed at TNAU, Coimbatore; 15 breeding lines developed at RARS, PJTSAU, Jagtiyal; 4 breeding lines developed at APRRI, ANGRAU, Maruteru; 18 breeding lines developed at RARS, PJTSAU; Warangal, 26 breeding lines and 2 mutants 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, four entries were under retesting. The entries were evaluated at 12 locations in 15 tests against brown planthopper (BPH), whitebacked planthopper (WBPH) and mixed populations of planthoppers under both field and greenhouse conditions.

Evaluation of entries in 6 greenhouse and 2 field tests against brown planthopper, 2 greenhouse tests against whitebacked planthopper and 5 field tests against mixed populations of planthoppers revealed that 9 breeding lines *viz.*, BPT 2411, BPT 2611, BPT 2776, BPT 2787, JGL 24497, MTU 1245 (MTU 2139-7-1-1-1), RP 5995Bphk17-5, IR 73382-80-9-3-13-2-2-1-3-B (HWR-16) and RP 5690-20-6-3-2-1 as promising in 5-9 tests **(Table 2.1)**. BPT 2611 and MTU 1245 (MTU 2139-7-1-1-1) performed better in second year of retesting. The susceptible check TN1 recorded damage score in the range of 8.8-9.0 in these valid tests. The universal checks viz., PTB 33 and MO1 performed well in 13 and 7 tests respectively. The other check line, RP 2068-18-3-5 carrying gall midge resistance gm3 gene and identified as a new donor check line for BPH performed better in 8 tests.

Mixed populations of brown planthopper and whitebacked planthopper were present in Gangavathi, Nawagam, Pantnagar, Warangal and Maruteru. Data on BPH and WBPH populations at Gangavathi (WBPH 1.5 to 2.0 times more) and Nawagam (WBPH 4.7 times more) revealed predominance of WBPH over BPH. BPH was predominant throughout the crop season at Pantnagar (BPH 3.5-8 times more) and

Warangal (BPH 3-7 times more than WBPH). At Kaul and Rajendranagar, only BPH population was present whereas in Nawagam only WBPH population was present.

Evaluation of the 105 entries against the two planthoppers BPH and WBPH in 8 greenhouse and 7 field tests indicated 12 entries (including three checks) as promising in 5-13 tests.

**ii) Gall midge screening trial (GMS)** The objective of this trial is to evaluate the breeding lines specifically bred for gall midge resistance. Gall midge trial was constituted with 60 entries (54 breeding lines nominated from research stations at Jagtial, Kunaram, Rudrur, Warangal, Sindewahi and, IIRR, and six checks) and evaluated at 13 locations across the country. The valid data from 10 locations were considered for analysis for various biotypes/populations and the results are discussed as under:

JGL 30292, SKL 07-11-177-50-65-60-267, SKL 07-11-177-50-84-12-40, SKL 07-16-87-38-12-154-118, WGL1151, WGL1191, WGL1196 recorded nil damage at both IIRR and CHP for GMB1. At Cuttack, none of the test entries recorded nil damage for GMB 2 except Abhaya. IET 24238, IET 25550, IET 25575, IET 25638, RP 2068-18-3-5, Aganni and Kavya had nil damage at Ranchi for biotype 3. Only KNM 1623 recorded nil damage for GMB4 at Sakoli. None of the test lines were promising at Warangal for GMB 4 M. SKL 07-13-316-8-31-65-44 and WGL1196 were promising for GMB 5 at Pattambi and Moncompu (<10% DP). At Maruteru, JGL 28454, JGL 28921, RDR 1160 and Kavya showed nil damage. JGL 28639, JGL 30292, WGL1191 recorded nil damage against Nellore population.

*Overall reaction***:** Evaluation of 60 entries in two greenhouse and 8 field tests against 10 populations of gall midge (five identified biotypes) helped in identification of 10 lines that were promising in 3-4 of the 10 tests **(Table 2.2)** across all the populations. Of these, WGL1191 and WGL1196 were promising in four tests. IET 25550, JGL 28454, JGL 30292, SKL 07-11-177-50-65-60-267, SKL 07-11-177-50-84-12-40, SKL 07-13-316-8-31-65-44, SKL 07-16-87-38-12-154-118 and IET 24238 were promising in 3 tests.

**iii) Gall midge special screening trial (GMSS)**

This trial constituted with 85 donors (including gene pyramided lines along with check varieties) was carried out in the 11 locations to identify new sources of resistance to gall midge biotypes/populations. The valid data from the eight locations were considered and the results are discussed biotype wise at each of the locations tested:

Evaluation of the entries for GMB1 identified 36 entries with nil damage at IIRR. At Cuttack, 12 lines *viz.*, ASD 7, Kakai (K 1417), ARC 6248, PTB 26, PTB 32, IC 332045, RP 6145GMK17-3 had nil damage for GMB 2. CAUR-1, W1263, KAKAI (K 1417), Sinna sivappu, Sudu Hondarawala, PTB 12, IET 19792 and IET 20141 had nil damage for biotype 3 at both Jagtial and Ranchi. WGL 1143 WGL 1145 WGL 1146 and WGL 1147 were promising against GMB4 at Sakoli.

**Table 2.1 Performance of most promising entries against planthoppers, PHS, *kharif* 2017**

| Entry No. | Designation | Cross Combination | Brown Planthopper | | | | | | | | Whitebacked planthopper | | Planthoppers | | | | | No of promising tests (NPT) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | IIRR | CBT | CTC | LDN | MND | PNT | KUL | RNR | IIRR | CBT | GNV | MTU | WGL | NWG | PNT | BPH | BPH | WBPH | PH | Total |
| | | | Greenhouse reaction | | | | | | 90 DT | 78 DT | Greenhouse Reaction | | 110 DT | 94 DT | 88-90 DT | 62 DT | 46 DT | GR | FR | GR | FR | |
| | | | Damage score | | | | | | No./10h | DS | DS | DS | DS | DS | DS | No./10hills | | 6 | 2 | 2 | 5 | 15 |
| 1 | BPT 2411 | BPT 5204/ BPT 4358 | 7.8 | 7.0 | 9.0 | 7.4 | 9.0 | 8.4 | 194 | 7.0 | 4.7 | 8.3 | 3.0 | 3.0 | 5.0 | 46 | 160 | 0 | 0 | 1 | 4 | **5** |
| 6 | BPT 2611* | IR 64 /Lalnakanda | 8.1 | 6.8 | 9.0 | 2.7 | 5.0 | 8.0 | 150 | 3.0 | 5.0 | 5.3 | 3.0 | 3.0 | 5.0 | 47 | 150 | 2 | 2 | 1 | 4 | **9** |
| 12 | BPT 2776 | BPT 2231/NLR 145 | 9.0 | 6.3 | 7.0 | 3.7 | 9.0 | 8.8 | 184 | 7.0 | 4.1 | 8.9 | 3.0 | 3.0 | 3.0 | 90 | 153 | 1 | 0 | 1 | 4 | **6** |
| 13 | BPT 2787 | | 7.5 | 3.0 | 9.0 | 4.2 | 9.0 | 9.0 | 204 | 3.0 | 4.6 | 7.8 | 3.0 | 7.0 | 3.0 | 45 | 178 | 2 | 1 | 1 | 2 | **6** |
| 28 | JGL 24497 | JGL3855/ Annada | 2.4 | 5.1 | 5.0 | 2.6 | 7.0 | 6.0 | 226 | 5.0 | 1.7 | 4.8 | 9.0 | 9.0 | 9.0 | NG | 136 | 3 | 0 | 2 | 1 | **6** |
| 48 | MTU 1245* (MTU 2139-7-1-1-1*) | MTU 1061/ TKM 6 | 8.8 | 6.8 | 3.0 | 8.1 | 9.0 | 7.0 | 271 | 3.0 | 5.6 | 7.2 | 3.0 | 5.0 | 3.0 | 78 | 167 | 1 | 1 | 0 | 3 | **5** |
| 91 | RP 5995 Bphk 17-5 | RPHR-1005 BPH-18 | 8.7 | 2.8 | 7.0 | 2.2 | 5.0 | 2.4 | 224 | 9.0 | 4.1 | 5.5 | 3.0 | 7.0 | 7.0 | 94 | 204 | 4 | 0 | 1 | 1 | **6** |
| 93 | IR 73382-80-9-3-13-2-2-1-3-B (HWR-16) | | 5.9 | 5.1 | 9.0 | 3.5 | 9.0 | 2.2 | 223 | 3.0 | 4.0 | 5.1 | 9.0 | 7.0 | 5.0 | NG | 185 | 2 | 1 | 1 | 1 | **5** |
| 97 | RP 5690-20-6-3-2-1 | Sonamahsuri/ SR 26-B | 4.8 | 5.5 | 5.0 | 2.3 | 5.0 | 1.7 | 201 | 3.0 | 2.3 | 7.6 | 5.0 | 5.0 | 3.0 | NG | 161 | 5 | 1 | 1 | 2 | **9** |
| 20 | PTB 33 | R check | 0.5 | 3.9 | 3.0 | 1.7 | 1.0 | 2.1 | 79 | 3.0 | 4.7? | 4.3? | 3.0 | 5? | 3.0 | 120 | 186 | 6 | 2 | 2 | 3 | **13** |
| 30 | MO 1 | R check | 4.0 | 6.3 | 3.0 | 5.0 | 9.0 | 9.0 | 176 | 7.0 | 1.7 | 3.1 | 3.0 | 9.0 | 3.0 | 119 | 187 | 3 | 0 | 2 | 2 | **7** |
| 40 | RP 2068-18-3-5 | R. check | 2.8 | 4.2 | 3.0 | 1.6 | 7.0 | 1.4 | 282 | 7.0 | 6.4 | 6.8 | 3.0 | 3.0 | 3.0 | 126 | 207 | 5 | 0 | 0 | 3 | **8** |
| Promising level | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 3.0 | 150 | 3.0 | 5.0 | 5.0 | 3.0 | 5.0 | 5.0 | 40 | 160 | | | | | |
| No. of promising entries | | | 16 | 7 | 18 | 27 | 11 | 10 | 8 | 25 | 24 | 8 | 34 | 17 | 31 | 5 | 12 | | | | | |

*-Entry under retesting. Data from Aduthurai was not considered for analysis due to low pest pressure

IC 576897, Sudu Hondarawala, PTB 12, RP 6125GMK17-1, WGL 1127, WGL 1145 in the second year of testing recorded nil damage at Warangal for biotype 4M. Though, all the entries were susceptible at Pattambi, 16 entries recorded nil damage at Moncompu for biotype 5.

*Overall reaction*: Evaluation of 85 donors in 8 valid tests against gall midge populations identified 8 donors *viz*., ASD 7, KAKAI (K 1417), Sudu Hondrawala, AC6248, PTB 12, WGL 1127, WGL 1145 and IET 19792 as promising in 4-5 of the 8 tests. All these lines were under retesting **(Table 2.3)**.

**Table 2.2 Reaction of most promising entries against gall midge populations in GMS, *kharif* 2017**

| Entry No. | Designation | GMB1 | | GMB2 | GMB3 | GMB4 | GMB4M | GMB5 | | GMB | | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | IIRR | CHP | CTC | RCI | SKL | WGL | PTB | MNC | MTU | NLR | NPT |
| | | GH | 30DT | GH | 50DT | 50DT | 50DT | 50DT | 50DT | 50DT | 50DT | |
| | | %DP | %DP | %SS | %DP | %DP | %DP | %DP | %SS | %DP | %DP | 10 |
| 51 | WGL1191 | 0 | 0 | 100 | 35 | 95 | 100 | 61.9 | 0 | 75 | 0 | **4** |
| 53 | WGL1196 | 0 | 0 | 100 | 40 | 55 | 95 | 9.5 | 0 | 40 | 40 | **4** |
| 56 | IET 25550 | 100 | 0 | 90 | 0 | 100 | 100 | 52.4 | 0 | 94.4 | 14.3 | **3** |
| 12 | JGL 28454 | NT | 0 | 60 | 10 | 25 | 85 | 57.1 | 0 | 0 | NT | **3** |
| 22 | JGL 30292 | 0 | 0 | 60 | 15 | 80 | 94.7 | 52.4 | 4.5 | 66.7 | 0 | **3** |
| 25 | SKL 07-11-177-50-65-60-267 | 0 | 0 | 60 | 35 | 20 | 95 | 38.1 | 0 | 15.8 | 9.5 | **3** |
| 26 | SKL 07-11-177-50-84-12-40 | 0 | 0 | 20 | 35 | 25 | 94.7 | 28.6 | 0 | 5.3 | 14.3 | **3** |
| 28 | SKL 07-13-316-8-31-65-44 | 0 | 10 | 60 | 20 | 40 | 95 | 9.5 | 0 | 10.5 | 30 | **3** |
| 29 | SKL 07-16-87-38-12-154-118 | 0 | 0 | 70 | 20 | 15 | 100 | 28.6 | 0 | 10 | 15 | **3** |
| 1 | IET 24238 | NT | 0 | 70 | 30 | 45 | 95 | 19 | 0 | 0 | 18.2 | **3** |
| | Checks | | | | | | | | | | | |
| 30 | Kavya | 0 | 0 | 60 | 0 | 40 | 90 | 33.3 | 0 | 0 | 30 | **5** |
| 20 | Aganni | 0 | 0 | 70 | 0 | 20 | 65 | 28.6 | 0 | 5 | 5 | **4** |
| 60 | RP 2068-18-3-5 | 0 | 0 | 70 | 0 | 90 | 90 | 57.1 | 0 | 80 | NT | **4** |
| 40 | Abhaya | 0 | 10 | 0 | 35 | 5 | 30 | 23.8 | 0 | 5.6 | NT | **3** |
| Total tested | | 40 | 57 | 60 | 60 | 59 | 59 | 60 | 60 | 59 | 50 | |
| Avg. in the trial | | 45.4 | 7.4 | 69.1 | 25.6 | 71.6 | 89.8 | 51.1 | 2.2 | 53.8 | 19.5 | |
| Avg. damage in the TN1 | | 100.0 | 35.0 | 80.0 | 62.5 | 97.5 | 91.9 | 81.0 | 4.0 | 100.0 | 18.4 | |
| Promising level | | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | |
| No. promising | | 16 | 29 | 1 | 6 | 1 | 0 | 1 | 27 | 5 | 3 | |

Data from Jagdalpur, Ragolu and Jagtial was not considered for analysis due to insufficient pest pressure

**Table 2.3 Reaction of donors against gall midge populations in GMSS, *kharif* 2017**

| Entry No. | Designation | GMB1 | GMB2 | GMB3 | | GMB4 | GMB4M | GMB5 | | Overall NPT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | IIRR | CTC | JGT | RCI | SKL | WGL | PTB | MNC | |
| | | GH | GH | 50DT | 50DT | 50DT | 50DT | 50DT | 30DT | |
| | | %DP | %SS | %DP | %DP | %DP | %DP | %DP | %SS | 8 |
| 44 | KAKAI (K 1417) * | 0.0 | 0.0 | 0.0 | 0.0 | 60.0 | 11.1 | 42.9 | 0.0 | **5** |
| 47 | PTB 12* | 0.0 | 30.0 | 0.0 | 0.0 | 30.0 | 0.0 | 28.6 | 0.0 | **5** |
| 43 | ASD 7* | 0.0 | 0.0 | 20.0 | 0.0 | 90.0 | 33.3 | 38.1 | 0.0 | **4** |
| 46 | SUDU HONDARAWALA* | 0.0 | 27.0 | 0.0 | 0.0 | 30.0 | 0.0 | 33.3 | 2.0 | **4** |
| 49 | ARC 6248* | 0.0 | 0.0 | 68.4 | 0.0 | 95.0 | 10.5 | 38.1 | 0.0 | **4** |
| 71 | WGL 1127* | 0.0 | 0.0 | 0.0 | 30.0 | 15.0 | 0.0 | 57.1 | 5.1 | **4** |
| 76 | WGL 1145* | 0.0 | 70.0 | 0.0 | 30.0 | 0.0 | 0.0 | 76.2 | 5.7 | **4** |
| 83 | IET 19792* | 0.0 | 60.0 | 0.0 | 0.0 | 30.0 | 85.0 | 28.6 | 0.0 | **4** |
| Total tested | | 81 | 84 | 84 | 85 | 84 | 85 | 85 | 85 | |
| Average in the trial | | 42.6 | 45.9 | 38.5 | 18.7 | 70.7 | 44.1 | 54.2 | 4.0 | |
| Average damage in TN1 | | 100.0 | 86.5 | 68.4 | 64.5 | 100.0 | 97.5 | 69.1 | 7.6 | |
| Promising level | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| No. promising | | 36 | 12 | 24 | 29 | 4 | 6 | 0 | 16 | |

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

**Leaf folder screening trial (LFST)**

This field evaluation trial was constituted with 20 entries consisting of six nominations from Rice & Wheat Research station, CSK HP Agricultural University, Malan, four nominations from Main Rice Research Station, Anand Agricultural University, Nawagam, six nominations from IIRR along with susceptible check (TN1) and resistant check (W 1263). During *Kharif* 2017, the trial was conducted at 18 locations with 20 entries replicated thrice in a randomised block design. Data analysis revealed 14 entries as promising in 2-6 valid tests out of 11 valid tests **(Table.2.4)**. The average damage in the trial ranged between 8.7 and 37.8% while maximum damage varied from 13.7 to 65.2% in various locations. A nomination from Nawagam, NWGR-13017 was found promising in 6 valid field tests while resistant check, W 1263 was found promising in 5 out of 11 valid field tests. Seven entries *viz.*, HPR 2613, HPR 2617, HWR 3, NWGR- 9080, NWGR-13108, Mahisagar and MP 209 were found promising in 4 valid field tests. HPR 2873, HWR 24, RP 5587-B-B-B-51 and MP 11 were found promising in 3 valid field tests while Varun dhan and RP 5588-B-B-B-B-76 were found promising in 2 out of 11 valid field tests.

*Field evaluation of 20 entries replicated thrice in a randomised block design against rice leaf folder in **Leaf Folder Screening Trial (LFST)** at 18 locations in 11 valid field tests revealed that 14 entries were promising in 2-6 valid field tests. A nomination from Nawagam, NWGR-13017 was found promising in 6 valid field tests while seven entries i.e., HPR 2613, HPR 2617, HWR 3, NWGR- 9080, NWGR-13108, Mahisagar and MP 209 were found promising in 4 valid field tests. HPR 2873, HWR 24, RP 5587-B-B-B-51 and MP 11 were found promising in 3 valid field tests while Varundhan and RP 5588-B-B-B-B-76 were found promising in 2 valid field tests.*

**Table 2.4 Promising entries identified against Leaf folder in LFST, *Kharif* 2017**

| Designation | Parentage | PTB | NVS | KUL | CHT | CHN | KBP | LDN | MLN | NLR | NWG | RNR | NPT (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 60 DT | 80 DT | 60 DT | 85 DT | 97 DT | 30 DT | 60 DT | 80 DT | 80 DT | 60 DT | 58 DT | |
| NWGR-13017 | SK-20/ IET-19297 | 14.8 | 17.3 | 17.1 | 28.2 | 21.1 | 10.3 | 29.8 | 13.6 | 5.6 | 9.6 | 5.8 | **6** |
| W 1263 | Resistant check | 12.8 | 5.2 | 15.1 | 23.7 | 26.6 | 13.7 | 17.9 | 17.7 | 6.6 | 13.0 | 13.8 | **5** |
| HPR 2613 | MLN2098-1-6 216/HPR 2362 | 22.9 | 11.2 | 17.7 | 59.4 | 23.1 | 11.6 | 16.6 | 8.8 | 14.4 | 14.7 | 7.6 | **4** |
| HPR 2617 | MLN 2042-6-1-1-1 (TS 29/IR 64) | 19.5 | 9.4 | 15.7 | 57.9 | 34.4 | 11.5 | 25 | 8.7 | 12.3 | 10.7 | 7.9 | **4** |
| HWR 3 | IR 71037-9-7-B | 14.5 | 17.1 | 14.9 | 27.5 | 44.7 | 11.6 | 20.4 | 8.4 | 15.8 | NG | 7.5 | **4** |
| NWGR-9080 | GR-7/ NWGR-99038 | 24.3 | 18.9 | 17.6 | 23.9 | 62.9 | 10.1 | 26.9 | 11.7 | 17.3 | 9.6 | 7.3 | **4** |
| NWGR-13108 | GR-4 / NWGR- 99115 | 20.3 | 19.2 | 17.4 | 35.1 | 26.6 | 9.9 | 26.5 | 13.9 | 16.6 | 9.9 | 7.6 | **4** |
| Mahisagar | CN-540 / IR-50 | 28.8 | 17.2 | 17.4 | 33.9 | 28.5 | 9.5 | 18.6 | 14.0 | 13.0 | 9.8 | 11.8 | **4** |
| MP 209 | TN1/W 1263 | 16.2 | 10.9 | 17.7 | 31.2 | 35.4 | 10.1 | 18.4 | 18.7 | 19.4 | 9.4 | 12.8 | **4** |
| HPR-2873 | HPR 2143/AC 19146/VL 30425 | 21.8 | 16.1 | 13.4 | 37.2 | 29.4 | 11.6 | 24.9 | 8.6 | 12.9 | 14.9 | 6.3 | **3** |
| HWR 24 | IR 73382-7-12-1-1-3-B | 21.0 | 11.7 | 17.0 | 32.9 | 46.0 | 10.4 | 28.6 | 12.6 | 15.1 | 6.7 | 7.1 | **3** |
| RP 5587-B-B-B-51 | IR 64/ O. glaberrima | 12.6 | 20.3 | 16.6 | 31.4 | 54.5 | 10.7 | 27.8 | 9.9 | 13.9 | 12.4 | 10.5 | **3** |
| MP 11 | TN1/W 1263 | 20.4 | 7.4 | 17.7 | 29.0 | 34.2 | 9.4 | 19.4 | 10.7 | 16.5 | 12 | 10.9 | **3** |
| Varun dhan | Pure line selection from Junjen - 4 | 18.6 | 20.8 | 12.1 | 37.7 | 30.7 | 11.2 | 18.2 | 9.2 | 12.1 | 12.9 | 11.1 | **2** |
| RP 5588-B-B-B-B-76 | IR 64/ O. glaberrima | 11.8 | NG | 17.1 | 33.4 | 65.2 | 10.8 | 20.9 | 21 | 14.2 | 10.9 | 4.4 | **2** |
| Total entries tested | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | |
| Avg. damage in TN1 | | 18.9 | 15 | 19.8 | 25.1 | 52.2 | 10.9 | 40.8 | 10.5 | 14.4 | 17.3 | 3.7 | |
| Avg. damage in Trial | | 19.3 | 16.5 | 16.4 | 36.2 | 37.8 | 10.9 | 22.4 | 11.9 | 13.8 | 11.5 | 8.7 | |
| Promising level | | 20 | 20 | 10 | 25 | 25 | 10 | 20 | 10 | 10 | 10 | 10 | |
| No. Promising | | 10 | 14 | 0 | 2 | 2 | 4 | 7 | 8 | 2 | 7 | 1 | |

Data from Gangavathi, Iroseimba,Jagdalpur,Karaikal, Khudwani and Masodha was not considered due to low pest pressure.
Data from Arundhuthinagarcould not be included for analysis due to late receipt

**v) Stem borer screening trial (SBST)**

Stem borer Screening trial (SBST) initiated in 2015 was continued in kharif 2017, with 56 entries specifically bred for stem borer tolerance from IIRR, along with nominations from Jagtial, Chinsurah and Cuttack. The trial was carried out at 10 locations. To ensure effective screening of the material two plantings were taken up as per the technical programme. To identify the tolerant lines, observations were recorded on dead heart at vegetative phase and white ear damage, grain yield in the infested plant and the larval survival in the stubbles at harvest. Keeping in view the level of pest incidence at locations the promising level for each observation at a location was fixed so as to identify the best performing entries. The results of the evaluation are discussed below.

*Dead heart damage***:** The dead heart damage in the trial varied from 0-63.9% with an average damage of 21.5% DH across 4 locations in 9 tests. Evaluation of entries for dead heart damage in two staggered sowings identified RP 5588-B-B-B-B-45, IIRR-BIO-SB-5, IIRR-BIO-SB-3, BK 39-179, BK 49-42 and RP 5893-181-28-6-5-8-B-B-2-2 with nil damage at Pantnagar.

*White ear damage***:** The white ear damage across 6 locations in 9 tests varied from 0-30.6% with a mean of 11.9%WE. Evaluation of entries identified, IIRR-BIO-SB-2, CN 2069 and BK 49-42 as promising in 1-2 tests of the 9 tests with <5% WE damage. The mean larval survival per entry across locations varied from 0-5.7 larvae/hill.

*Grain yield***:** RP 5588-B-B-B-B-159-2, IIRR-BIO-SB-5, IIRR-BIO-SB-3 and CN 2069 were found promising with >18g/hill in 3 of the 12 tests for grain yield /hill.

*Overall reaction: Evaluation of entries in 30 field tests identified 3 entries viz., CN 2069, IIRR-BIO-SB-5 and IIRR-BIO-SB-3 promising in 4-5 of the 30 tests in terms of low dead hearts, white ear damage and high grain yield. These entries have consistently yielded high despite stem borer damage since the last two years suggesting that recovery resistance and tolerance could be the mechanism for better grain yield* **(Table 2.5)**.

**Table 2.5 Reaction of promising entries against stem borer in SBST, *kharif* 2017**

| Entry No. | Designation | Number of promising tests | | | |
|---|---|---|---|---|---|
| | | DH(%) | WE(%) | GY(g/hill) | Overall NPT |
| | | 9 | 9 | 12 | 30 |
| 11 | IIRR-BIO-SB-5* | 1 | 0 | 3 | 4 |
| 17 | IIRR-BIO-SB-3* | 1 | 0 | 3 | 4 |
| 19 | CN 2069* | 0 | 2 | 3 | 5 |

*Entry under retesting; No data was received from Bapatla due to lack of pest incidence.
SBDH data from CHN, MNC, MSD & RNR; SBWE data from MSD, GGT, RNR-not considered due to low pest pressure.

**vi) Multiple resistance screening trial (MRST)**

The trial included evaluation of 25 entries consisting of 4 promising entries from pest specific trials, 17 popular cultivars and 3 insect resistant and a susceptible check against 10 insect pests at 31 locations. The details of the reaction of entries is available in **Screening Nurseries- Diseases and Insect pests Vol II.** The valid data from various locations are discussed pest wise.

**BPH**: CR 2711-149, IR 65482-7-216-1-2-B and RP 2068-13-5 were promising ( DS<3.0) in 2-4 of the 7 greenhouse tests.

**WBPH**: IR 65482-7-216-1-2-B and CR 2711-149 were promising in one greenhouse test at IIRR of the 2 tests.

**Mixed population of planthoppers**: RP 2068-18-3-5, Swarna Sub 1 and Co50 had a DS<3.0 exhibiting field tolerance at MTU, WGL and GGV for mixed population of planthoppers.

**Gall midge:** KNM113, W1263 and Sahbagidhan were promising in 3-4 tests of the 9 tests against gall midge. Of these KNM113 was under retesting.

**Stem borer**: Evaluation of entries against stem borer at vegetative phase for dead heart damage in 5 valid tests and at reproductive phase for white ear damage in 16 valid tests identified Bahadur, Dhanrasi, as promising in 5 of the 21 tests.

**Foliage feeders:** CR 2711-149, Co 50, Dhanrasi, W1263, Pushyami, Swarna Sub 1 recorded <10 % DL in one test of the 8 valid tests. None of the entries were promising for gundhi bug, grasshopper, case worm damage and rice hispa. RP Bio 226 had < 10 % DL by whorl maggot in 2 of the 3 tests at 30 DAT.

*Overall reaction: Evaluation of 25 entries in 10 greenhouse and 50 field tests against 10 insect pests helped in identification of 3 entries viz., CR 2711-149 Dhanrasi and KNM 113 as promising in 7-9 tests of the 60 tests against 1-4 pests. The MRI varied from 7-36 with a PPR of 1.17-6.0* ***(Table 2.6)****. Of the 3 entries, KNM113 was in the third year of testing. The check lines W1263 and RP2068-18-3-5 had an MRI of 2.33 and 1.17, respectively.*

**vii) National Screening Nurseries**

National Screening Nurseries (NSN) comprised of 4 trials, National Screening Nursery 1(NSN1), National Screening Nursery 2(NSN2), National Screening Nursery – Hills (NSN hills) and National Hybrid Screening Nursery (NHSN). **NSN1** was constituted with 364 entries (340 AVT entries along with 10 insect checks and 14 disease checks) and evaluated at 20 locations. **NSN 2** trial was constituted with 753 entries (729 entries from IVT trials, 10 insect and 14 disease checks) and evaluated at 14 locations against 8 insect pests. **NSN- Hills** trial was constituted with 109 entries (85 hill entries + 10 insect check lines and 14 disease checks) and evaluated at 8 locations in 17 tests against 9 insect pests. Data on Stem borer from Chatha and Ludhiana, on Leaffolder from Chatha and Khudwani were not considered for analysis. **NHSN** trial was constituted with 151 entries (113 hybrids + 10 insect + 14 disease checks). The entries were evaluated at 14 locations against 8 insect pests. The valid data in each trial are discussed pest wise:

**Brown planthopper**:

*NSN1*: None of the entries showed consistent performance across locations against BPH.

**Table 2.6 Performance of the most promising cultures against insect pests in MRST, *kharif* 2017**

| Entry No. | Designation | Number of promising tests | | | | | | | | | | | | Overall NPT | Number of Pests (P) | MRI | PPR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BPH | WBPH | Bph +Wbph | GM | SBDH | SBWE | LF | RH | WM | CW | GB | GRH | TESTS (T) | | P X T | |
| | | 7 | 2 | 5 | 9 | 5 | 16 | 8 | 1 | 3 | 1 | 2 | 1 | 60 | 10 | 600 | |
| 1 | CR 2711-149* | 4 | 1 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 9 | 4 | 36 | 6.00 |
| 6 | Dhanrasi* | 0 | 0 | 2 | 0 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 8 | 2 | 16 | 2.67 |
| 11 | KNM 113* | 0 | 0 | 1 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 1 | 7 | 1.17 |
| | Checks | | | | | | | | | | | | | | | | |
| 15 | W1263 | 0 | 0 | 2 | 3 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 7 | 2 | 14 | 2.33 |
| 10 | RP 2068-13-5 | 3 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 1 | 7 | 1.17 |

Per cent promising reaction (PPR)= MRI of test entryX 100/Total MRI

Data from RCI, RGL, CTC for GM; from GNV,KJT, LDN, NCR, SKL, RCI & RNR for SBDH; from JDP, KBP, NLR, NVR & WGL for LF; from JDP for GLH & BPH; from RCI, CHT, SKL for SBWE; from SHN,MSD, MTU & PSA for LF have not been considered for analysis due to low pest pressure.

**Table 2.7 Performance of the most promising cultures against insect pests in NSN1, *kharif* 2017**

| Sl. No. | IET No | DESIGNATION | Cross | Number of promising tests ( NPT) | | | | | | | | | Overall NPT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | BPH | WBPH | BPH + WBPH | GM | SBDH | SBWE | LF | RT | WM | |
| | | | | 4 | 2 | 5 | 5 | 3 | 4 | 5 | 1 | 1 | 30 |
| 84 | 26263 | MTU 1239 (MTU II 369-72-4-1-1-1) | MTU1075/BM 71 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 4 |
| 165 | 25970 | RP 5594-410-27-3-2 | MTU1010 /RPHR1005 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 4 |
| 294 | | Pooja (RP) | | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 4 |
| | | Checks | | | | | | | | | | | |
| 359 | | PTB-33 | | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 5 |
| 361 | | RP 2068-18-3-5 | | 2 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 5 |

Data from RGL, RNR, MSD, GNV, SKL, TTB, WGL for SBDH ; MNC , CHP, GGT, MSD, LDN, SKL for SBWE;LFDL for MNC, JDP, MSD, GNV, PSA & WGL not included for analysis due to low pest pressure.

**Valid insect pest reaction data for NSN1 from following locations considered for the analysis- Should this be in tabular form?**

| Pest | Locations | | | | |
|---|---|---|---|---|---|
| BPH | IIRR | LDN | CBT | KUL | |
| WBPH | IIRR | CBT | | | |
| BPH+WBPH | MTU | GNV (DS) | GNV(No./10h) | PNT | WGL |
| GM | IIRR | CHP | SKL | TTB | WGL |
| SBDH | PNT | PSA | RGL | | |
| SBWE | RNR | PNT | NWG | PSA | |
| LF | LDN | NWG(DL) | NWG(DS) | PNT | WGL |
| RT | JDP | | | | |
| WM | JDP | | | | |

**Table 2.8 Performance of most promising cultures against insect pests in NSN2, *kharif* 2017**

| Entry No. | IET. No. | Number of promising tests (NPT) | | | | | | | | | | Overall NPT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BPH | WBPH | WBPH+BPH | GM | SBDH | SBWE | LF | RH | WM | RT | |
| | | 4 | 2 | 4 | 3 | 3 | 6 | 4 | 1 | 2 | 1 | 30 |
| 30 | 26674 | 0 | 0 | 1 | 0 | 2 | 4 | 1 | 0 | 0 | 0 | 8 |
| 330 | 27071 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 0 | 1 | 0 | 8 |
| 593 | 27193 | 0 | 0 | 2 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 7 |
| 607 | 27206 | 0 | 0 | 2 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 7 |
| 329 | 27070 | 0 | 0 | 1 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 7 |
| | Check | | | | | | | | | | | |
| 748 | PTB-33 | 2 | 0 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 0 | 9 |

Data from JDP on BPH; from CHN for SBDH; from JDP for GM; from GNV for LF; from JDP for GLH not considered for analysis due to low pest pressure.

**Valid insect pest reaction data for NSN2 from following locations considered for the analysis Should this be in tabular form?**

| Pest | Locations | | | | | |
|---|---|---|---|---|---|---|
| BPH | IIRR | CBT | LDN | MND | | |
| WBPH | IIRR | CBT | | | | |
| BPH+WBPH | GNV | MTU | GNV | PNT | | |
| GM | IIRR | CHP | MNC | | | |
| SBDH | CHP | PNT | NVS | | | |
| SBWE | CHP | GGT | GNV | CHN | MNC | NVS |
| LF | MNC | PNT | MNC | NVS | | |
| RH | MLN | | | | | |
| WM | JDP | MLN | | | | |
| RT | JDP | | | | | |

*NSN2 :* None of the entries were tolerant to BPH.

*NSN hills*: IET No 26565 was promising in 2 of the 4 greenhouse tests.

*NHSN:* IET No 26551 was promising in greenhouse reaction at Pantnagar and Mandya of the 4 tests.

**White- backed planthopper**:
*NSN1*: None of the test entries were promising for WBPH.

*NSN2 :* None of the entries were tolerant to WBPH.

*NSN hills*: IET 26583 and 26594 were promising in one of the 2 tests in greenhouse evaluation.

*NHSN:* IET Nos 26464, 26469, 26466, 26544, NDR 359, IR 64 and MO1 were promising in one of the 2 tests at IIRR with a DS of 3.0.

**Planthoppers**:

*NSN1*: Field tolerance for mixed populations of planthoppers was exhibited by IET Nos 25970, 26752 and Pooja in 2 of the 5 tests. The ratio of BPH to WBPH was 1:2.3 at Maruteru, 0.55:1 at Gangavati, 6.1:1 at Pantnagar and 1.8:1 at Warangal.

*NSN2:* Field tolerance to mixed population of planthoppers was identified in 8 entries viz., IET nos 26661, 26966, 26825, 26837, 27193, 27206, 27243 and 27272 at both Gangavathi and Maruteru with a DS of 1.

*NSN hills*: None of the entries were promising against planthoppers in the field evaluation at Maruteru though few entries supported low population at Pantnagar

*NHSN:* None of the test hybrids were promising against planthoppers in the field evaluation at Maruteru and Pantnagar.

**Gall midge**:
*NSN1*: IET Nos 25970, 25994, 25749, CR Dhan 201 (NC) and 25613 recorded nil damage against GMB1 in 2 of the 5 tests. Aganni and W1263 were promising in 3 tests.

*NSN2:* None of the test entries were promising.

*NSN hills*: IET Nos 26593, 26598, 26603, 26609 were found resistant in greenhouse reaction at IIRR (GMB1) apart from the six standard checks.

*NHSN:* IET Nos 26527, 26537, 26544 and 26550 were promising for gall midge in both the tests at IIRR and Pattambi (<10%DP). W1263 and IET 26488 (NHSN 45) recorded nil damage at Pattambi.

**Stem borer (SB)**:
*NSN1*: IET Nos 26347 recorded nil dead heart damage in 2 of the 3 tests at vegetative phase. IET Nos 26263, 25521, 26373, 26746, 27280, Swarnadhan were promising in 2 of the 4 valid tests for white ear damage.

*NSN2:* IET Nos 26674, 25882, 26715, 27151 were promising at vegetative phase for dead heart damage in 2 of the 3 tests. IET Nos 26674, 26655, 26656, 26675, 26677, 26734, 25882, 25881, 25883, 26725, 26732, 27095, 27147 were promising in 3-4 of the 6 tests for white ear damage. However, these lines need to be further tested under greenhouse conditions for validation of the reactions.

*NSN hills*: IET 26557 and IET 26605 recorded <6% white ear damage at Ludhiana and Pantnagar. This needs to be verified under infested conditions.

*NHSN:* US-312 (NCH) had <10% DH damage at CHN and PNT. IET No 26503 and Swarnadhan were found promising in 2 of the four tests though >30 % white ear damage was reported from Nawagam in both the entries.

**Leaf folder**:
*NSN1*: MO1 was the only entry with nil damage in 1 test of the 5 valid tests.

*NSN2* : IET nos 27070, US 314 (HC) and 26778 had nil damage in 3 of the 4 ests.

*NHSN* : IET Nos 26470, 26485, 26511, 26510, 26493, 26527, 26544 recorded <7 % DL in one of the four tests.

**Whorl maggot**:
*NSN1*: None of the entries were promising.

*NSN2:* IET Nos 27108, 27065 and 27071 recorded <10% DL in field evaluation at Jagdalpur and Malan.

*NSN hills*: None of them were promising at Malan.

*NHSN:* None of the entries were promising.

**Rice thrips:**
*NSN1*: None of the entries were promising.

*NSN2*: Shobini (NC) had a DS of 2.2 at Jagdalpur.

**Blue beetle**
*NHSN:* None of the test hybrids were promising at Pattambi.

**Rice hispa**
*NSN Hills:* At Malan, efforts were made to evaluate the hill entries for hispa damage. All the 109 entries were surrounded by 60 mesh white nylon net. Field collected rice hispa adults were starved for 8 h and then released @ 2500 adults per 40 sq. m area at 78 DAT. The average damage in the trial was 31.7 % DL (Max. 84.7% DL and Min. 12.0% DL). IET Nos 26557, 26578, 26590, 24207 and VL Dhan 65 had <15 % DL.

**Case worm**
*NHSN :* At Pattambi, IET No 26544 and BPT 5204 recorded zero damage at 30 DAT.

**Gundhi bug**

*NSN Hills :* IET Nos 26562 and 26569 had nil damage at Chatha.

NHSN: None of the entries were promising

*Overall reaction*

***NSN1:*** *Evaluation of 364 entries at 20 locations in 6 greenhouse and 24 field tests against 7 insect pests identified 3 entries viz.,IET nos 26263, 25970 and Pooja (RP) as promising in 4 tests of the 30 valid tests against 2-3pests. PTB 33 and RP 2068-18-3-5 were promising in 5 tests* ***(Table 2.7)****.*

***NSN2:*** *Evaluation of 753 entries in 7 greenhouse and 23 field tests against 8 pests in 30 valid tests identified six entries viz., IET Nos. 26674, 27071, 27193, 27206, 27070 and PTB-33 as promising in 7-9 tests of the 30 valid tests against 3-4 pests* ***(Table 2.8)****.*

***NSN-Hills****: Evaluation of NSN hills in 7 greenhouse, 1 net house and 9 field tests across 8 locations against 8 pests identified IET 26565, 26594 and 26605 as promising in 2 of the 17 tests against 2 pests. None of the entries have resistance to any major pests.*

***NHSN:*** *Evaluation of hybrids along with checks in 8 greenhouse and 18 field tests against 9 pests identified IET Nos 26537, 26544, 26503, 26527, NDR 359, PTB 33 and RP 2068-18-3-5 as promising in 4-6tests of the 26 valid tests* ***(Table 2.9)****.*

**Table 2.9 Performance of the most promising hybrids against insect pests in NHSN, *Kharif* 2017.**

| Entry No. | IET No. | Designation | Number of promising tests (NPT) | | | | | | | | | | | Overall NPT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BPH | WBPH | BPH + WBPH | GMB | SBDH | SBWE | LF | WM | CW | BB | GB | |
| | | | 6 | 2 | 2 | 2 | 2 | 4 | 4 | 1 | 1 | 1 | 1 | 26 |
| 81 | 26537 | PHI-17102 | 1 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | **5** |
| 94 | 26544 | NPH-2899 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | **5** |
| 46 | 26503 | NK-24215 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | **4** |
| 72 | 26527 | Indam-200-040 | 0 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | **4** |
| 78 | - | NDR-359 (NCV) Checks | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | **4** |
| 132 | | PTB-33 | 4 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | **6** |
| 134 | | RP 2068-18-3-5 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | **4** |

**Valid NHSN insect pest reaction data from following locations considered for the analysis**

| Pest | Locations | | | | | |
|---|---|---|---|---|---|---|
| BPH | IIRR | CBT | MND | LDN | PNT | KUL |
| WBPH | IIRR | CBT | | | | |
| BPH+WBPH | PNT | MTU | | | | |
| GM | IIRR | PTB | | | | |
| SBDH | CHN | PNT | | | | |
| SBWE | CHN | LDN | NWG | PNT | | |
| LF | LDN | NWG | PNT | MNC | | |
| CW | PTB | | | | | |
| WM | PTB | | | | | |
| BB | PTB | | | | | |
| GB | REW | | | | | |

Data from MNC on GM; from RPR, LDN, RNR on SBDH; from RPR, RNR on SBWE; from PTB on LF not included 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 through Insect biotype studies comprising of three trials 1) Gall midge biotype monitoring trial (GMBT), 2) Gall midge population monitoring (GMPM) and 3)Planthopper screening trial (PHSS). The results of the observed virulence pattern of gall midge populations during *kharif* 2017 are discussed trial wise.

**Gall midge biotype monitoring trial (GMBT)**

Gall midge biotype trial was constituted with a set of gene differentials categorized into 5 groups and carried out at 15 locations. The results of the evaluation are summarized in **(Table 2.10)** and discussed as under.

*Biotype 1:* This biotype is characterized by the reaction pattern R-R-R-R-S. The populations at IIRR and Jagdalpur followed this pattern of expression while Duokang1 and BG308-2 showed susceptibility at IIRR.

*Biotype 2*: At Cuttack, Unlike last year, group 2, 3 and 4 differentials showed susceptibility this year except for Phalguna, ARC5984, Abhaya and INRC 3021 (*Gm8*) which were resistant.

*Biotype 3*: The reaction of the gall midge populations at Jagtial and Ranchi conformed to the typical pattern of R-S-R-R-S for biotype 3 except for susceptibility of RP 2068-18-3-5 at both the locations.

*Biotype 4M*: Aganni (with *Gm8*) exhibited <5% plant damage when evaluated against biotype 4M at Warangal. INRC 3021 (with *Gm8*) exhibited <5% plant damage when evaluated at Maruteru.

**Other populations:** All the differentials exhibited susceptibility to gall midge populations at Sakoli and Pattambi. *Gm1* and *Gm8* genes hold promise against populations at Moncompu earlier designated as Biotype 5.

*Overall reaction: Evaluation of the gene differentials in 2 greenhouse and 8 field tests against 6 different biotypes and one population of gall midge identified Aganni (Gm8 ) , INRC 3021( Gm8) and W1263 (Gm1) as promising in 5-6 of the 10 tests. The results suggest that Gm8 and Gm1 hold promise across locations.*

**Gall midge population monitoring (GMPM)**

The virulence pattern of the gall midge populations, is monitored through progeny testing of a single gall midge female in GMPM trial. This year the trial was conducted on three differentials, W1263 (*Gm1*), RP2068-18-3-5 (*gm3*), Aganni (*Gm8*) along with TN1 variety at Warangal. 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 trial could be carried out only at Warangal and the results are summarized below.

*Warangal:* Two hundred and fifty females were collected from the light source and infested singly, of these 124 females (49.6%) were virulent. 1.73% females

were virulent on Aganni, 4.42% on RP 2068-18-3-5, 6.62 % on W1263 and 20.15 % on TN1. Sex ratio varied from 0.35-0.41 females for every male.

*Evaluation of the gene differentials through single female progeny testing at Warangal, suggested low virulence on Aganni which is similar to the trend observed in the last two years.*

**Table 2.10 Reaction of gene differentials to gall midge populations in GMBT, kharif 2017**

| Group | Entry No. | Differential | Gene | GMB1 | | GMB2 | GMB3 | | GMB4M | GMB4 | GMB5 | GMB 5 | GMB? | Overall NPT | Promising against biotypes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | IIRR | JDP | CTC | JGT | RCI | WGL | SKL | PTB | MNC | MTU | | |
| | | | | GH | 50DT | GH | 50DT | 50DT | 50DT | 50DT | 50DT | 30DT | 50DT | | |
| | | | | %DP | %DP | %SS | %DP | %DP | %DP | %DP | %DP | %SS | %DP | 10 | |
| I | 1 | KAVYA | *Gm1* | 0.0 | 0.0 | 75.0 | 0.0 | 0.0 | 84.2 | 40.0 | 14.3 | 0.0 | 80.0 | 5 | 1,3,5 |
| | 2 | W1263 | *Gm1* | 0.0 | 0.0 | 61.5 | 0.0 | 0.0 | 80.0 | 45.0 | 66.7 | 0.0 | 21.1 | 5 | 1,3,6 |
| | 3 | ARC 6605 | *(?)* | 0.0 | 0.0 | 8.0 | 0.0 | 0.0 | 70.0 | 80.0 | 100.0 | 0.0 | 66.7 | 5 | 1,2,3,5 |
| II | 4 | PHALGUNA | *Gm2* | 0.0 | 0.0 | 0.0 | 75.0 | 20.0 | 60.0 | 100.0 | 100.0 | 18.7 | 71.4 | 3 | 1,2 |
| | 5 | ARC 5984 | *Gm5* | 0.0 | 0.0 | 0.0 | 25.0 | 50.0 | 65.0 | 85.0 | 77.2 | 2.2 | 85.0 | 3 | 1,2,5 |
| | 6 | DUKONG 1 | *Gm6* | 60.0 | 0.0 | 50.0 | 50.0 | 0.0 | 80.0 | 100.0 | 100.0 | 5.6 | 68.4 | 2 | 1,5 |
| | 7 | RP 2333-156-8 | *Gm7* | 10.0 | 0.0 | 50.0 | 45.0 | 35.0 | 65.0 | 100.0 | 100.0 | 11.5 | 55.0 | 1 | 1 |
| | 8 | MADHURI L 9 | *Gm9* | 0.0 | 0.0 | 45.0 | 20.0 | 0.0 | 80.0 | 65.0 | 71.4 | 0.0 | 65.0 | 4 | 1,3,5 |
| | 9 | BG 380-2 | *Gm10* | 63.6 | 10.0 | 72.0 | 80.0 | 0.0 | 90.0 | 100.0 | 85.7 | 4.0 | RD | 1 | |
| III | 10 | MR 1523 | *Gm11* | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 80.0 | 100.0 | 100.0 | 14.8 | 75.0 | 4 | 1,3 |
| IV | 11 | RP 2068-18-3-5 | *gm3* | 0.0 | 10.0 | 90.0 | 55.0 | 30.0 | 85.0 | 70.0 | 100.0 | 12.6 | 55.0 | 1 | |
| | 12 | ABHAYA | *Gm4* | 0.0 | 20.0 | 77.7 | 20.0 | 0.0 | 45.0 | 85.0 | 85.7 | 7.5 | 78.9 | 2 | 1,2,3 |
| | 13 | INRC 3021 | *Gm8* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 15.0 | 15.0 | 100.0 | 0.0 | 5.0 | 6 | 1,2,3,4M,5 |
| | 14 | AGANNI | *Gm8* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 | 15.0 | 100.0 | 0.0 | 15.0 | 6 | 1,2,3,4M,5 |
| | 15 | INRC 15888 | *Gm8* | 0.0 | 0.0 | 100.0 | 0.0 | 20.0 | 73.7 | 40.0 | 77.2 | 0.0 | 15.0 | 4 | |
| V | 16 | B 95-1 | *none* | 57.1 | 40.0 | 50.0 | 40.0 | 50.0 | 94.4 | 100.0 | 90.5 | 15.5 | 80.0 | | |
| | 17 | TN1 | *none* | 100.0 | 50.0 | 100.0 | 85.0 | 65.0 | 100.0 | 100.0 | 100.0 | 10.9 | RD | | |
| Total tested | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 15 | | |
| Average. in the trial | | | | 17.1 | 7.6 | 51.7 | 29.1 | 15.9 | 69 | 72.9 | 86.4 | 6.1 | 55.8 | | |
| Damage in TN1 | | | | 100 | 50 | 100 | 85 | 65 | 100 | 100 | 100 | 10.9 | RD | | |
| Promising level | | | | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | | |
| Entries with nil damage | | | | 12 | 12 | 4 | 7 | 10 | 1 | 0 | 0 | 7 | 1 | | |

Pest incidence was low at Chiplima, Nellore, Ragolu and Iroishemba.

**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, Cuttack, Gangavathi, Ludhiana, Mandya, Maruteru, New Delhi, Pantnagar and Rajendranagar in the greenhouse in standard seedbox screening test (SSST) with 2-3 replications. The special screening tests *viz.*, days to wilt to know the tolerance mechanism was conducted at Coimbatore and Pantnagar. Feeding preference test by measuring honeydew excretion was carried out at Maruteru and Pantnagar, while nymphal survival and egg hatching tests were done at Pantnagar.

Two gene differentials *viz.*, PTB 33 with *bph2*+*Bph3*+unknown factors and RP 2068-18-3-5 with *Bph33(t)* gene were promising in 10 and 8 locations respectively out of 11 locations. Rathu Heenati with *Bph3*+*Bph17* genes and T 12 with *bph7* gene performed better in 6 and 4 locations respectively with a damage score of <5. T12 performed better at Aduthurai, Ludhiana, Maruteru and New Delhi whereas Rathu Heenati was promising at Coimbatore, Cuttack, Gangavathi, Ludhiana, Mandya and Maruteru. Two of the gene differentials registered promising reaction at three locations *viz.*, Swarnalatha with Bph 6 gene at Aduthurai, Ludhiana, Maruteru and Babawee with bph 4 gene at IIRR, Ludhiana and Rajendranagar. Two other gene differentials showed low damage at two locations only viz., ASD 7 with *bph2* at Coimbatore and Maruteru and Pokkali with *bph9* gene at Coimbatore and Ludhiana. Chinsaba with *bph 8* gene performed better at one location i.e. at Maruteru. Seven gene differentials *viz.*, IR 36 with bph2 gene, IR 64 with *Bph1*+ gene, IR 65482-7-216-1-2-B with *Bph 18* gene, IR71033-121-15 with *Bph 20/21* gene, Milyang 63, OM 4498 and MUT NS 1 with unknown genetics, were not effective at any of the test locations.

At Pantnagar, lowest nymphal survival was observed in RP 2068-18-3-5 and T 12 followed by PTB 33 and Rathu Heenati. RP 2068-18-3-5 did not wilt, while PTB 33 wilted after 24.4 days. Unhatched eggs were high in RP 2068-18-3-5 followed by Swarnalata, IR 65482-7-216-1-2-B and PTB 33. Honeydew excretion was lowest in ASD7 followed by PTB 33 and RP 2068-18-3-5(Table 2.11a).

**Table 2.11 Reaction of most promising gene differentials against BPH in PHSS, *kharif* 2017**

| Entry No. | DESIGNATION | Gene | Damage Score at Locations | | | | | | | | | | | NPT (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | IIRR | ADT | CBT | CTC | GNV | LDN | MND | MTU | NDL | PNT | RNR | |
| 2 | Babawee (ACC 8978) | *bph4* | 4.7 | 8.8 | 6.1 | 5.7 | 9.0 | 4.8 | 9.0 | 7.3 | 8.4 | 7.8 | 4.9 | **3** |
| 14 | Ptb33 | *bph2+Bph3+* | 1.7 | 5.5 | 3.9 | 1.0 | 1.0 | 2.0 | 1.0 | 0.1 | 2.7 | 3.0 | 3.9 | **10** |
| 16 | Rathu Heenati (ACC 11730) | *Bph3+Bph 17* | 6.9 | 6.9 | 4.2 | 3.7 | 3.0 | 2.2 | 3.0 | 4.5 | 6.6 | 7.6 | 7.0 | **6** |
| 17 | RP 2068-18-3-5 | *Bph33(t)* | 0.4 | 0.7 | 6.2 | 1.0 | 9.0 | 2.0 | 9.0 | 3.2 | 2.3 | 1.4 | 3.1 | **8** |
| 18 | Swarnalatha (ACC 33964) | *Bph6* | 8.2 | 3.3 | 5.3 | 8.3 | 7.0 | 3.3 | 9.0 | 1.1 | 7.7 | 6.6 | 8.3 | **3** |
| 19 | T 12 (ACC 56989) | *bph7* | 8.7 | 3.0 | 7.7 | 5.7 | 9.0 | 1.4 | 9.0 | 0.2 | 3.9 | 8.8 | 5.1 | **4** |

**Table: 2.11a Special Screening techniques to know mechanisms of resistance**

| PHSS NO | Designation | Pantnagar | | | |
|---|---|---|---|---|---|
| | | Days to wilting | Nymphal survival (%) | Honeydew area ($mm^2$) | Unhatched eggs (%) |
| 1 | ASD 7 (ACC 6303) | 12.6 | 82 | 625 | 26.87 |
| 2 | Babawee (ACC 8978) | 20.6 | 76 | 65.6 | 26.89 |
| 3 | Chinsaba (ACC 33016) | 12.4 | 76 | 934 | 26.98 |
| 4 | IR 36 | 17.8 | 62 | 593.2 | 21.67 |
| 5 | TN1 | 15.6 | 70 | 1221.4 | 25.77 |
| 6 | IR 64 | 12.6 | 52 | 1203.8 | 26.54 |
| 7 | IR 65482-7-216-1-2-B | 16 | 78 | 565.2 | 29.61 |
| 8 | IR71033-121-15 | 12 | 62 | 897.2 | 25.33 |
| 9 | Milyang 63 | 11.6 | 54 | 696.8 | 23.16 |
| 10 | TN1 | 6.6 | 68 | 779.6 | 27.52 |
| 11 | MUT NS 1 | 6.8 | 50 | 602.6 | 25.90 |
| 12 | OM 4498 | NG | NG | 631 | 24.66 |
| 13 | Pokkali | 10.8 | 50 | 688.4 | 24.55 |
| 14 | Ptb33 | 24.4 | 46 | 138.2 | 29.41 |
| 15 | TN1 | NG | NG | 472 | NG |
| 16 | Rathu Heenati (ACC 11730) | 14.4 | 48 | 174.6 | 21.67 |
| 17 | RP 2068-18-3-5 | | 40 | 79.4 | 31.95 |
| 18 | Swarnalatha (ACC 33964) | 8.8 | 62 | 203 | 31.18 |
| 19 | T 12 (ACC 56989) | 17.8 | 40 | 105 | 23.32 |
| 20 | TN1 | 9.8 | 58 | 633.8 | 24.99 |

The data from Maruteru and Coimbatore was not considered as it is not suitable for analysis.

## 2.3. Chemical Control Studies

Management of insect pests through use of chemicals continues to be an integral component of rice pest management. However, farmers always would like to save time, labour and money while undertaking pesticide application measures. Since they have to manage situations with simultaneous occurrence of both pests and diseases, they resort to application of pesticide mixtures. So, as and when efficacy of a newer molecule is established as an insecticide or fungicide there is a need to generate requisite information on the its compatibility with other chemicals when applied as tank mix in field. Similarly, there is also a constant need to look out for safe and eco-friendly products of plant origin as alternatives to chemical pesticides in the context of safety to human health and environment. Hence, chemical control studies included two trials as described under:

**Pesticide Compatibility Trial (PCT)**

During 2017, the compatibility of two newer insecticides belonging to different groups *viz.*, spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC supplied by Dow Agrosciences Ltd and triflumezopyrim (DPX RAB 55 106 SC), a product of Dupont India Ltd.. with fungicides was evaluated based on their efficacy when applied as tank-mix in the field. The fungicides consisted of hexaconazole and tricyclazole supplied by Rallies India Ltd. During Kharif 2017, the trial was carried out at 24 locations *viz.*, Coimbatore, Chinsurah, Chiplima, Gangavathi, Kurumbapet, Karaikal, Kaul, Jagdalpur, Ludhiana, Malan, Mandya, Maruteru, New Delhi, Navsari, Nawagam, Pantnagar, Pusa, Nellore, Pattambi, Ragolu, Raipur, Rajendranagar, Sakoli and Titabar.

| Sl. No. | Location | Date of sowing | Date of planting | Date of harvesting | No of applications | Times of application (DAT) |
|---|---|---|---|---|---|---|
| 1 | Bapatla | 12-08-2017 | 15-09-2017 | 06-01-2018 | 2 | 35 & 60 |
| 2 | Chinsurah | 28-07-2017 | 22-08-2017 | | 3 | 25,45 & 81 |
| 3 | Coimbatore | 10-06-2017 | 10-07-2017 | 15-11-2017 | 3 | 17,30 & 60 |
| 4 | Chiplima | 28-07-2017 | 28-08-2017 | 06-12-2017 | 3 | 20,50 & 65 |
| 5 | Masodha | 08-07-2017 | 08-08-2017 | 29-11-2017 | 2 | 18 & 45 |
| 6 | Gangavathi | 21-07-2017 | 12-09-2017 | 04-01-2018 | 4 | 15,30,45 & 75 |
| 7 | Karjat | 08-06-2017 | 21-07-2017 | 30-10-2017 | 1 | 50 |
| 8 | Karaikal | 12-07-2017 | 09-08-2017 | 26-10-2017 | 1 | 45 |
| 9 | Kaul | | 20-07-2017 | 06-11-2017 | 1 | 45 |
| 10 | Ludhiana | 18-05-2017 | 19-06-2017 | 20-10-2017 | 2 | 55 & 70 |
| 11 | Malan | 20-06-2017 | 18-07-2017 | 29-10-2017 | 2 | 25 & 55 |
| 12 | Mandya | 21-08-2017 | 09-07-2017 | 01-02-2018 | 2 | 45 & 70 |
| 13 | Maruteru | 23-06-2017 | 20-07-2017 | 17-11-2017 | 2 | 18 & 55 |
| 14 | Navsari | 05-07-2017 | 03-08-2017 | 07-11-2017 | 2 | 15 & 50 |
| 15 | Nawagam | 14-07-2017 | 31-08-2017 | 15-12-2017 | 2 | 45 & 65 |
| 16 | Nellore | 22-08-2017 | 25-09-2017 | | 1 | 65 |
| 17 | New Delhi | 19-06-2017 | 19-07-2017 | 28-10-2017 | 3 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 18 | Puducherry | 18-10-2017 | 03-11-2017 | 26-12-2017 | | |
| 19 | Pantnagar | 23-06-2017 | 26-07-2017 | 14-11-2027 | 3 | 15,40,65 & 80 |
| 20 | Pattambi | 07-07-2017 | 25-07-2017 | 01-11-2017 | 3 | 15,45 & 60 |
| 21 | Pusa | 01-07-2017 | 17-07-2017 | 26-11-2017 | 2 | 10 & 55 |
| 22 | Raipur | 03-07-2017 | 11-08-2017 | 07-12-2017 | 3 | 45,60 & 80 |
| 23 | Ragolu | 06-07-2017 | 06-08-2017 | 25-11-2017 | 3 | 15,45 & 70 |
| 24 | Rajendranagar | 07-07-2017 | 01-08-2017 | 17-11-2017 | 2 | 15 & 45 |
| 25 | Ranchi | 09-07-2017 | 29-07-2017 | 06-12-2017 | 5 | 15,30,45,60 & 90 |
| 26 | Sakoli | 29-06-2017 | 25-07-2017 | 27-11-2017 | 4 | 15,40,70 & 90 |
| 27 | Titabar | 07-07-2017 | 07-08-2017 | 24-11-2017 | 5 | 15,30,45,50 & 65 |

**Treatments**

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

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

**Results**

**Insect pest infestation** (**Table 2.12**)

The **stem borer** infestation at vegetative stage across 14 locations was recorded up to a maximum of 36.9% DH, while mean infestation ranged from 5.7 to 12.4% DH across treatments including control. There were significant differences among the pesticide treatments at 10 locations. The infestation in insecticides alone and combination treatments (5.7 to 8.1% DH) was lower than that in fungicide alone treatments (8.9 and 9.6% DH %) and control (12.4% DH). The differences in efficacy between the insecticides and their combinations with fungicides were not significant. At heading stage, there were significant differences among the treatments at 9 locations. The white ear incidence was significantly lower in spinetoram+methoxyfenozide treatment and its combinations (7.1 to 7.5% WE), while triflumezopyrim treatment alone and in combination fared on par with

fungicide treatments (9.3 to 10.7% WE). All the treatments were significantly superior to control (17.0% WE). Overall, against stem borer, the performance of spinetoram+methoxyfenozide was superior to that of triflumezopyrim, when applied alone or in combination with fungicides.

The **gall midge** incidence was recorded up to 55.8% SS across 4 locations. All the insecticide treatments were at par (9.6 to 13.3% SS) while fungicide treatments were at par with control (14.4 to 18.6 % SS).

**Leaf folder** incidence was recorded upto a maximum of 69.3% DL at PattambiPATTAMBIPattambi, while in the remaining locations, the damage ranged between 0.6 and 24.6% DL. The mean infestation across locations varied from 6.3 to 11.2% DL in pesticide treatments compared to 14.2% DL in control. Spinetoram+methoxyfenozide treatment performance both alone and in combination with fungicides was significantly superior to that of remaining treatments. (bring the leaf folder table before BPH)

**Brown planthopper** populations were recorded at 12 locations and very high infestation was recorded up to 2616.7 hopper/10 hills at Maruteru followed by a maximum of 925.3 hoppers/10 hills at New Delhi. The mean infestation across locations ranged from 26.9 to 126.5 hoppers per 10 hills. The hopper population was significantly lower in triflumezopyrim treatment alone and in combination with fungicides (26.9 to 29.6 hoppers/10 hills) compared to spinetoram+methoxyfenozide treatments (112.7 to 126.5 hoppers/10 hills). The fungicides alone treatments also showed significantly hopper populations on par with control (88.2 to 100.4 hoppers/10 hills). The efficacy of triflumezopyrim when applied individually was at par also in combination with fungicides. The **white backed planthopper** population was recorded in 9 locations and maximum incidence up to 153.0 hoppers/10 hills was observed at Maruteru and Navsari. As observed in the case of BPH, application of triflumezopyrim individually as well as in combination with fungicides showed significantly lower mean WBPH population (23.4 to 24.3 hoppers/10 hills) than spinetoram+methoxyfenozide (32.9 to 35.0 hoppers/10 hills). The fungicides applied alone (31.3 and 31.6 hoppers/10 hills) were at par with spinetoram+methoxyfenozide, however all pesticide treatments were superior to untreated control (47.4 hoppers/10 hills).

The **green leafhopper (GLH)** incidence was recorded up to 15.7 hoppers/10 hills, at Coimbatore and Sakoli. All the insecticide treatments were at par (5.2 to 7.4 hoppers/10 hills) while fungicide treatments were at par with control (10.2 to 11.3 hoppers/10 hills).

**Disease incidence (Table 2.13)**

**Blast** disease was recorded at three locations. At Chiplima and Gangavathi, **leaf blast** disease severity was recorded upto 78.0% and 33.2%, respectively and there were significant differences among treatments including control after the application of pesticide treatments. The blast severity was significantly lower in the fungicide applications applied alone as well as in combination with insecticides (9.4 to 18.0%) compared to insecticide treatments alone (20.0 and 22.0.0%) and control (28.3%). Among the two fungicides, tricyclazole performed

significantly superior (9.0 to 9.4%) to hexaconazole (15.7 to 18.0%) in reducing blast incidence. However, there were no significant differences in performance of both fungicides when used alone or in combination with insecticides. **Neck blast** was observed at Ragolu and Rajendranagar. The trends in performance of the fungicides were similar and tricyclazole (7.1 to 9.7%) which performed significantly better than hexaconazole (16.0 to 17.3%) and control (20.7%) in reducing neck blast incidence. **Sheath rot** incidence was observed at Rajendranagar. Ranging from 7.5 to 25.2% in fungicide treatments compared to 30.0% in control. The insecticide treatments showed 22.3 and 22.8% severity.

**Sheath blight** incidence was observed at 8 locations. At Pattambi disease severity was observed up to 80.0% while at five locations *viz*., Ragolu, Raipur, Faizabad, Gangavathi and Kaul, it ranged between 4.2 to 64.3%. At all these locations there were significant differences among the treatments including control after application of treatments. Across locations, the hexaconazole treatment in combination with triflumezopyrim was the most superior treatment showing least disease severity of 21.2 followed by hexaconazole treatment applied alone (22.8%) and hexaconazole-spinetoram+methoxyfenozide combination (23.4%). The tricyclazole and insecticide treatments showed a range of 29.1 to 35.7% disease severity, while the control plot showed the highest disease severity (37.4%).

**Grain yield (Table 2.14)**

There were significant differences in grain yield among different treatments at 24 locations. The mean grain yield data across the locations revealed that all insecticide treatments were at par with grain yield ranging narrowly from 4062 to 4196 kg/ha (21.4 to 23.9% IOC). They were significantly superior to fungicide treatments applied alone (3879 and 3895 kg/ha with 17.7 and 18.0% IOC, respectively). All pesticide treatments used alone or in combination yielded significantly higher than control (3194 kg/ha).

*Pesticide compatibility trial was carried out with the objective of evaluating the compatibility of newer insecticide and fungicide formulations as tank mix against major insect pests and diseases of rice and consequent impact on grain yield, at 24 centres during kharif 2017. There were no significant differences in the performance of the two newer insecticide formulations spinetoram+methoxy-fenozide and triflumezopyrim in their proven efficacy when applied alone or in combination with fungicides. Individually spinetoram+methoxyfenozide performed better against stem borer and leaf folder, while triflumezopyrim showed superior efficacy against plant and leafhoppers. Insecticide treatments applied alone and its combination with fungicides were superior to remaining treatments including control in terms of yield. Overall, the results revealed that there was no adverse impact on the efficacy of either of the insecticides when applied with fungicides or vice versa confirming the compatibility of the chemicals when used as tank mix in the field.*

**Table: 2.12 Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Stem Borer Damage (%Deadhearts) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CBT | | CHN | | CHP | | MSD | | KBP | |
| | | | | | 27DT | 48DT | 30DT | 50DT | 56DT | 76DT | 30DT | 50DT | 30DT | 50DT |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 2.2a | 1.4a | 1.6a | 1.4a | 2.2a | 2a | 5.9b | 3b | 22.9a | 12a |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 5.7a | 3.0a | 11.7c | 8.8b | 4.4b | 5.2b | 4.7ab | 0.6a | 32a | 9.7a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 7.2a | 6.4b | 13.3c | 14.4c | 5.3b | 5.8b | 10.6c | 11.9c | 32.4a | 12.6a |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 5.6a | 11.8b | 11.3c | 13.0c | 6.2b | 6.2b | 10.8c | 12.6c | 26.3a | 10.5a |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 7.1a | 5.9ab | 3.9b | 2.7a | 2.5a | 2.5a | 4.1ab | 2.4b | 20.2a | 10.0a |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 2.1a | 1.9a | 3.3ab | 3a | 1.8a | 1.8a | 5.9b | 3b | 19.4a | 9.2a |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 8a | 3.5a | 14c | 16.1c | 5.5b | 6.6b | 3.1a | 0.6a | 20.3a | 8.7a |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 5.5a | 3.9a | 13.2c | 13.8c | 5.6b | 5.9b | 3.6a | 1.2a | 12.8a | 8.7a |
| 9 | Untreated control | Water | Water spray | | 6.4a | 7.7b | 20d | 21.7d | 8.4c | 9.8c | 22.5d | 36.9d | 20.4a | 8.5a |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Stem Borer Damage (%Deadhearts) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LDN | | | NVS | | NWG | PNT | | PSA | | PTB |
| | | | | | 68DT | 83DT | 93DT | 30DT | 50DT | 50DT | 30DT | 50DT | 30DT | 50DT | 50DT |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 1.9a | 2.4a | 1.6a | 3.5a | 4.2a | 5.9b | 6.2a | 11.5a | 8.7b | 9.4b | 2.3a |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 3.0a | 4.3b | 3.3a | 6.8bc | 7.6bc | 11.4c | 9.2a | 17a | 6.7ab | 9.1b | 3.6a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 3.6a | 5.1b | 3.4b | 9.5c | 10.1d | 4.3ab | 5.9a | 17.6a | 9.9b | 10.8b | 8.3b |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 4.1a | 5.0b | 3.6b | 10.3d | 10.8d | 7.5b | 3.1a | 13.9a | 7.4b | 9.2b | 1.7a |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxy-fenozide 30%+ Hexaconazole | - | 0.75+2.0 | 2.5a | 3.2a | 1.5a | 4.3a | 5.2ab | 3.3a | 4.8aa | 13.6a | 4a | 1.7a | 2.1a |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxy-fenozide 30%+ Tricyclazole | - | 0.75+0.6 | 2.7a | 3.2a | 1.8a | 5.8b | 6.2b | 5.7b | 8.1a | 15.3a | 9.9b | 10.5b | 2.6a |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 3.6a | 4.8b | 3.1b | 7.4bc | 8.4c | 10.4c | 6.6a | 14.8a | 9.4b | 11.6b | 1.3a |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 3.9a | 4.3b | 3.7b | 8c | 9c | 12.3c | 3.5a | 15.7a | 7.4b | 9.2b | 0a |
| 9 | Untreated control | Water | Water spray | | 6.8a | 7.2c | 8.3c | 14.3e | 18.8e | 16.1d | 6.1a | 12a | 8b | 5.5a | 11.6b |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Stem Borer Damage (%Deadhearts) | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | RPR | | SKL | | | | | TTB | | |
| | | | | | 30DT | 50DT | 43DT | 51 T | 81DT | 94DT | 102DT | 30DT | 50DT | |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 13.2a | 15.2a | 12.1a | 6a | 4.2a | 7.1a | 5.7a | 1.4a | 1.2a | **5.9a** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 15.2a | 18.5a | 13.5a | 8.6a | 2.7a | 6.4a | 8.0a | 1.3a | 1.4a | **8.1b** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 12.7a | 19.6a | 11a | 8.2a | 5.8a | 7.6a | 10.1a | 1.5a | 2.0a | **9.6b** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 13.1a | 20a | 9a | 8.8a | 6.3a | 5.5a | 11.5a | 1.1a | 1.2a | **8.9b** |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 11.8a | 14.7a | 8.8a | 5.3a | 3.9a | 8.1a | 10.9a | 0.6a | 0.6a | **5.7a** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 13.7a | 16a | 12.8a | 6.2a | 4.5a | 4.7a | 5.5a | 0.8a | 0.0a | **6.2a** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 12.5a | 13.9a | 11a | 8a | 2.7a | 11.3a | 7.5a | 0.9a | 0.6a | **7.9b** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 12.5a | 18.2a | 12.6a | 8.6a | 4.3a | 6a | 6.8a | 1.0a | 0.7a | **7.4b** |
| 9 | Untreated control | Water | Water spray | | 12.8a | 22.4a | 10a | 10.4a | 6.6a | 6.4a | 12.4a | 5.8a | 7.3b | **12.4c** |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Stem Borer Damage (%White ears) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CBT | CHN | CHP | FZB | KJT | LDN | MND | NVS | NWG |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 3.2a | 1.8a | 3.0b | 3.9a | 3.0a | 1.6a | 0.2a | 5.6a | 14.2a |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 3.6a | 13.3b | 7.8c | 1.3a | 5.9a | 3.0a | 1.1a | 8.7b | 20.6a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 8.2a | 18.8b | 7.1c | 12.5b | 3.5a | 3.8a | 2.0a | 10.2b | 14.3a |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 7.2a | 18.2b | 7.7c | 12.8b | 5.2a | 3.6a | 1.8a | 12.2c | 13.3a |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 7.3a | 2.7a | 2.8ab | 2.6a | 2.5a | 2.2a | 0.2a | 6.6a | 14.4a |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 4.9a | 3.0a | 1.9a | 3.4a | 2.4a | 2.2a | 0.2a | 8.1b | 15.7a |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 4.4a | 16.7b | 7.3c | 0.7a | 6.6a | 3.7a | 0.9a | 9.4b | 20.8b |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 3.7a | 19.7b | 6.3c | 1.3a | 5.3a | 3.6a | 1.2a | 9.5bd | 22.4b |
| 9 | Untreated control | Water | Water spray | | 10.2a | 30.7c | 13.2d | 49.4b | 5.5a | 8.8b | 5.1b | 20.8 | 33.2c |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Stem Borer Damage (%White ears) | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PNT | PSA | PTB | RGL | RNR | RPR | SKL | |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 9.6a | 9.0b | 20.7a | 11.7a | 2.8a | 16.1a | 9.4a | **7.2a** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 10.1a | 8.0b | 18.3a | 10.6a | 8.0a | 21.1a | 7.6a | **9.3ab** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 8.2a | 12.7c | 17.2a | 11.7a | 11.6b | 16.9a | 10.7a | **10.6b** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 11.8a | 10.4c | 16.1a | 7.9a | 11.2b | 19.2a | 11.8a | **10.7b** |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 10.2a | 1.1a | 19.1a | 10.9a | 5.9a | 16.1a | 9.7a | **7.1a** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 12.5a | 11.0c | 17.0a | 9.7a | 4.1a | 16.0a | 7.9a | **7.5a** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 10.0a | 12.7c | 22.6a | 11.8a | 6.8a | 18.7a | 7.5a | **10.0b** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 10.1a | 10.4c | 17.0a | 10.5aa | 6.2a | 15.9a | 6.4a | **9.3ab** |
| 9 | Untreated control | Water | Water spray | | 12.3a | 10.4c | 21.5a | 13.3a | 9.3b | 17.0a | 10.9a | **17.0c** |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Gall Midge (%Silver Shoots) | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CBT | CHP | | PTB | SKL | | |
| | | | | | 48DT | 56DT | 76DT | 30DT | 59DT | 85DT | |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 2.9a | 9.1b | 4.3c | 41.2b | 15.4a | 6.9ab | **13.3b** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 4.1a | 6.9a | 2.1b | 23.2a | 16.0a | 6.6ab | **9.8a** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 3.9a | 8.2a | 2.2b | 35.7b | 18.4a | 8.9b | **12.9b** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 4.2a | 9.1b | 3.5b | 46.2c | 17.4a | 10.6b | **15.2bc** |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 5.1a | 10.2b | 3.4b | 45.2c | 15.1a | 7.2ab | **14.4bc** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 5.7a | 9.0b | 2.9b | 40.2b | 12.4a | 6.9ab | **12.8b** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 2.6a | 6.5a | 2.1a | 31.2a | 15.7a | 6.5ab | **10.8a** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 2.8a | 5.0a | 1.6a | 29.3a | 15.3a | 3.9a | **9.6a** |
| 9 | Untreated control | Water | Water spray | | 8.4a | 13.9c | 9.3d | 55.5c | 15.4a | 9.4b | **18.6c** |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Brown Planthopper(No./10hills) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BPT | | GNV | | | | KUL | | | |
| | | | | | 37DT | 64DT | 43DT | 46DT | 67DT | 70DT | 54DT | 57DT | 80DT | 83DT |
| 1 | Spinetoram6%+methoxyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 36.0b | 35.0a | 8.7a | 16.3a | 15.7a | 13.7a | 30.0a | 32.7b | 129.3b | 135.7b |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 32.3b | 34.3a | 13.0a | 15.3a | 12.7a | 14.7a | 29.3a | 15.0a | 23.3a | 52.0a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 39.3c | 43.3b | 11.0a | 15.7a | 15.7a | 16.7a | 33.0a | 41.7c | 129.3b | 134.7b |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 40.3c | 42.3b | 13.7a | 14.7a | 13.0a | 13.0a | 36.7a | 28.3b | 122.7b | 144.3b |
| 5 | Spinetoram 6% + methoxyfenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 34.7b | 42.3b | 14.3a | 12.3a | 13.3a | 15.7a | 31.7a | 29.7b | 126.3b | 149.0b |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 39.3c | 32.0a | 15.0a | 9.7a | 17.3a | 14.7a | 28.0a | 34.0b | 116.0 | 118.3b |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 27.3a | 33.7a | 11.7a | 11.7a | 15.7a | 12.7a | 30.3a | 12.3a | 20.7a | 52.7a |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 28.3a | 34.3a | 13.7a | 13.0a | 15.7a | 12.7a | 29.3a | 13.3a | 21.3a | 50.3a |
| 9 | Untreated control | Water | Water spray | | 47.0d | 51.3c | 14.7a | 12.0a | 13.3a | 11.3a | 30.0a | 34.0b | 137.0b | 148.7b |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formul a-tion | g or ml per litre of spray fluid | Brown Planthopper(No./10hills) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LDN | | | | MND | MTU | | NDL | | | |
| | | | | | 58DT | 63DT | 84DT | 89DT | | 50DT | 70DT | 30DT | 50DT | 60DT | 70DT | 80DT |
| 1 | Spinetoram6%+metho xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 12.3a | 9.7b | 19.7c | 22.3b | 13.3b | 59.3a | 2259.7b | 7.3a | 8.7a | 38.0b | 273.7b | 592.3b |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 13.7a | 5.3a | 7.0a | 11.0a | 2.0a | 13.0a | 6.3a | 9.7a | 3.7a | 24.3a | 70.0a | 8.7a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 13.3a | 11.7c | 19.0bc | 25.0b | 48.7c | 37.3a | 837.7b | 6.7a | 8.7a | 42.0b | 429.7c | 925.3c |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 13.7a | 11.0c | 18.7bc | 23.0b | 46.3c | 58.3a | 1008.3b | 5.3a | 5.7a | 19.0a | 180.0b | 825.7c |
| 5 | Spinetoram 6% + methoxyfenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 13.3a | 10.7c | 15.7b | 26.3b | 6.0a | 39.0a | 2616.7b | 3.0a | 3.0a | 40.0b | 163.7b | 910.0c |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 13.7a | 11.0c | 14.7 | 22.3b | 7.7a | 57.3a | 2240.0b | 9.0a | 8.0a | 33.7b | 378.0c | 768.7c |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 13.0a | 7.0a | 6.7a | 10.0a | 1.0a | 30.0a | 9.0a | 5.0a | 2.3a | 11.7a | 87.7a | 48.0a |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim+Tricyclazole | - | 0.48+0.6 | 13.7a | 8.0b | 7.0a | 11.3a | 1.7a | 28.3a | 4.7a | 7.0a | 4.3a | 16.0a | 87.7a | 2.3a |
| 9 | Untreated control | Water | Water spray | | 12.7a | 16.0d | 30.0d | 25.0b | 55.3c | 45.0a | 1536.7b | 9.7a | 33.0b | 52.3b | 144.3b | 660.3b |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Brown Planthopper(No./10hills) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | NVS | | | | PNT | | | |
| | | | | | 50DT | 55DT | 70DT | 75DT | 43DT | 51DT | 56DT | 63DT |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 10.7a | 4.3c | 11.7a | 5.0c | 16.3a | 40.0b | 44.3a | 35.0a |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 10.3a | 1.0a | 12.3a | 1.7a | 29.7a | 35.0ab | 47.7a | 27.7a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 9.7a | 7.0d | 12.7a | 7.3d | 19.3a | 38.7b | 36.7a | 27.3a |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 10.3a | 7.7d | 12.0a | 8.0d | 28.3a | 49.7c | 42.0a | 33.3a |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 9.7a | 5.0d | 12.7a | 5.7c | 21.3a | 36.7b | 49.7a | 30.7a |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 10.0a | 5.7d | 12.3a | 6.3c | 26.0a | 47.7c | 41.7a | 27.7a |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 9.7a | 1.7a | 11.7a | 2.3a | 19.3a | 26.3a | 39.0a | 28.7a |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 10.7a | 2.7b | 12.3a | 3.3b | 22.7a | 32.7ab | 37.3a | 26.7a |
| 9 | Untreated control | Water | Water spray | | 10.0a | 11.3e | 13.0a | 14.3e | 22.0a | 42.3b | 43.0a | 29.7a |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Brown Planthopper(No./10hills) | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | RGL | | RPR | | SKL | | | | |
| | | | | | 76DT | 81DT | 50DT | 70DT | 43DT | 73DT | 79DT | 94DT | |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 62.0a | 80.0a | 8.0a | 83.3a | 6.7a | 20.3a | 7.3a | 28.3a | **112.7c** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 73.3a | 69.3a | 8.7a | 74.7a | 5.7a | 20.3a | 5.0a | 24.0a | **27.4a** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 56.0a | 72.0a | 8.7a | 89.3b | 6.3a | 20.7a | 14.0b | 27.3a | **90.7b** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 64.7a | 72.0a | 8.0a | 92.7b | 5.3a | 21.3a | 14.7b | 27.0a | **88.2b** |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 70.0a | 70.7a | 8.7a | 81.3a | 5.3a | 21.3a | 6.3a | 23.3a | **126.5c** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 69.3a | 72.0a | 8.7a | 85.3a | 6.7a | 21.0a | 5.3a | 21.7a | **118.4c** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 68.7a | 58.0a | 8.7a | 73.3a | 5.7a | 20.3a | 4.7a | 28.0a | **29.6a** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 64.0a | 66.7a | 8.7a | 75.3a | 5.3a | 20.7a | 5.0a | 22.0a | **26.9a** |
| 9 | Untreated control | Water | Water spray | | 76.7a | 78.0a | 9.3a | 119.3c | 5.3a | 21.7a | 17.0b | 20.7a | **100.4bc** |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formulation | g or ml per litre of spray fluid | Whitebacked Planthopper(No./10hills) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BPT | | GNV | | | | LDN | | | |
| | | | | | 37 DT | 64DT | 43DT | 46DT | 67DT | 70DT | 58DT | 63DT | 84DT | 89DT |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 28.0b | 3.0b | 59.0a | 21.3a | 17.7a | 20.3a | 38.3a | 31.0b | 38.3c | 32.3b |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 29.7b | 0.7a | 62.7a | 18.3a | 14.3a | 18.0a | 36.7a | 9.7a | 16.7a | 8.7a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 29.0b | 0.3a | 52.0a | 25.0a | 18.3a | 16.0a | 40.0a | 33.3b | 38.3c | 32.7b |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 27.0b | 4.3c | 61.3a | 20.7a | 17.7a | 16.3a | 40.0a | 35.0b | 38.3c | 33.3b |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 26.3b | 3.0b | 67.0a | 22.0a | 14.3a | 20.3a | 38.3a | 28.3b | 33.3c | 28.3b |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 34.0c | 0.3a | 56.0a | 17.0a | 19.3a | 18.7a | 38.3a | 31.0b | 33.7c | 29.0b |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 24.0a | 2.7b | 54.7a | 22.7a | 19.7a | 16.7a | 40.0a | 12.3a | 16.7a | 11.7a |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 25.7a | 1.3a | 66.3a | 23.0a | 14.0a | 13.0a | 40.0a | 13.0a | 17.0a | 13.0a |
| 9 | Untreated control | Water | Water spray | | 40.7c | 8.3d | 61.7a | 16.0a | 19.7a | 13.0a | 36.7a | 51.7c | 26.7b | 33.3b |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formulation | g or ml per litre of spray fluid | Whitebacked Planthopper(No./10hills) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MTU | NDL | NVS | | | | NWG | | | |
| | | | | | 70DT | 30DT | 50DT | 55DT | 70DT | 75DT | 4DT | 6DT | 47DT | 57DT |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 103.3b | 8.7a | 10.7a | 4.0c | 12.7a | 5.0c | 98.7a | 38.7b | 60.0b | 42.7a |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 0.3a | 7.0a | 10.0a | 1.3c | 13.3a | 2.0a | 96.0a | 17.3a | 28.0a | 42.7a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 99.0b | 5.0a | 10.3a | 8.0e | 13.0a | 8.3d | 90.7a | 14.7a | 41.3a | 49.3a |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 80.3b | 5.3a | 11.0a | 9.0e | 12.3a | 9.7d | 92.0a | 17.3a | 38.7a | 46.7a |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 153.0b | 9.3a | 11.3a | 5.3d | 13.7a | 5.7c | 85.3a | 57.3b | 81.3c | 50.7a |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 144.3b | 9.7a | 11.0a | 6.3d | 12.7a | 6.3c | 74.7a | 41.3b | 70.7c | 48.0a |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 8.3a | 8.7a | 10.3a | 2.0b | 13.0a | 3.0b | 94.7a | 18.7a | 40.0a | 52.0a |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 0.0a | 11.0a | 10.0a | 2.7b | 13.3a | 3.7b | 94.7a | 13.3a | 34.7a | 54.7a |
| 9 | Untreated control | Water | Water spray | | 96.7b | 9.0a | 10.7a | 12.0f | 13.7a | 14.3e | 146.7b | 150.7c | 153.3d | 130.7b |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Whitebacked Planthopper(No./10hills) | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PNR | SKL | | | | | | |
| | | | | | 63DT | 43DT | 49DT | 73DT | 79DT | 94DT | 100DT | |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 1.3a | 143.0a | 15.0a | 20.0a | 9.0b | 13.3a | 11.7a | **32.9b** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 0.7a | 136.3a | 14.0a | 21.7a | 5.7a | 10.3a | 9.0a | **23.4a** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 0.7a | 146.7a | 14.0a | 21.3a | 17.3c | 10.3a | 18.7b | **31.6b** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 1.7a | 145.0a | 15.3a | 20.0a | 16.7c | 11.0a | 19.0b | **31.3b** |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 0.3a | 124.7a | 16.7a | 22.0a | 6.7a | 9.7a | 10.3a | **35.0b** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 2.3a | 127.7a | 16.7a | 20.3a | 7.3a | 11.3a | 13.3a | **33.4b** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 2.0a | 125.0a | 13.7a | 19.0a | 5.0a | 9.3a | 11.0a | **24.3a** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 0.7a | 123.0a | 15.7a | 21.7a | 5.0a | 9.3a | 10.0a | **24.1a** |
| 9 | Untreated control | Water | Water spray | | 6.3a | 139.3a | 15.0a | 22.0a | 23.0d | 9.3a | 20.3b | **47.4c** |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Leaffolder(%Damaged Leaves) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MSD | | KJT | | KBP | KUL | | | LDN | | | |
| | | | | | 30DT | 50DT | 30DT | 50DT | 30DT | 54DT | 65DT | 80DT | 57DT | 67DT | 83DT | 93DT |
| 1 | Spinetoram6%+methoxy-fenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 3.4c | 2.3c | 9.9a | 8.9a | 10.7b | 5.6a | 5.6a | 4.9ab | 9.7a | 5.2a | 5.4a | 3.6a |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 2.5b | 1.8a | 8.1a | 14.2a | 12.8b | 5.5a | 5.8a | 5.8b | 9.3a | 7.1b | 7.6 | 7.7c |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 3.4b | 2.9c | 7.0a | 23.8a | 11.9b | 5.1a | 7.8a | 7.8b | 10.1a | 7.4b | 9.6c | 8.9d |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 3.7b | 3.4c | 8.8a | 15.8a | 5.0a | 4.8a | 6.3a | 5.6b | 9.5a | 7.1b | 10.0c | 8.3d |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 2.1b | 2.2b | 8.6a | 12.6a | 8.1a | 4.6a | 5.7a | 3.7a | 9.2a | 5.8ab | 5.8ab | 4.6b |
| 6 | Spinetoram 6% + methoxy-fenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 2.1b | 2.3b | 9.6a | 13.5a | 11.7b | 5.5a | 6.0a | 4.2ab | 8.9a | 5.6ab | 6.0b | 4.7b |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 0.9a | 1.1a | 8.2a | 11.1a | 10.7b | 5.9a | 6.9a | 5.5b | 9.9a | 6.3ab | 6.8b | 6.2c |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 1.6a | 2.1b | 9.8a | 25.0a | 14.3b | 6.0a | 6.6a | 6.3b | 10.1a | 6.6b | 6.7b | 6.3c |
| 9 | Untreated control | Water | Water spray | | 8.7d | 9.0d | 8.2a | 21.5a | 6.6a | 5.4a | 6.4a | 5.7b | 10.0a | 16.4c | 18.0d | 20.1e |

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

**Table: 2.12 (Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Leaffolder(%Damaged Leaves) | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MLN | | MTU | NVS | NWG | | PTB | | | |
| | | | | | 42DT | 72DT | 70DT | 50DT | 45DT | 60DT | 5 DT | 45DT | 60DT | |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 6.2a | 8.6a | 7.2a | 7.7a | 7.3a | 7.5a | 9.7a | 0.6a | 13.0a | **6.6a** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 7.2a | 7.4a | 5.3a | 10.3b | 11.2b | 9.8b | 7.4a | 1.5ab | 57.7b | **9.5b** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 6.5a | 6.8a | 6.8a | 13.7cd | 7.4a | 7.0a | 14.7a | 1.9ab | 69.3b | **11.2bc** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 6.3a | 9.0a | 7.0a | 15.0d | 7.2a | 6.9a | 11.8a | 3.1b | 67.1b | **10.4b** |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxy-fenozide 30%+ Hexaconazole | - | 0.75+2.0 | 6.4a | 8.8a | 7.6a | 8.8ab | 7.7a | 8.0a | 9.4a | 1.1a | 7.1a | **6.3a** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxy-fenozide 30%+ Tricyclazole | - | 0.75+0.6 | 6.9a | 8.8a | 6.7a | 9.5b | 7.3a | 7.3a | 11.2a | 2.0ab | 7.3a | **6.8a** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 6.2a | 8.8a | 9.4a | 10.2b | 11.2b | 10.2b | 12.9a | 2.3ab | 66.8b | **10.0b** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 6.3a | 6.8a | 6.4a | 12.2c | 10.9b | 10.2b | 13.0a | 1.7ab | 65.1b | **10.8b** |
| 9 | Untreated control | Water | Water spray | | 21.1b | 24.6b | 6.3a | 23.7e | 14.2c | 14.1c | 11.4a | 5.4c | 51.1b | **14.2c** |

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

**Table: 2.12(Contd…) Insect Pest Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Green Leafhopper(No./10hills) | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CBT | | | | SKL | | | |
| | | | | | 27DT | 30DT | 48DT | 51DT | 49DT | 79DT | 100DT | |
| 1 | Spinetoram6%+methoxyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 9.0a | 6.3b | 5.3a | 1.0a | 8.0a | 3.7a | 7.7a | **5.7a** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 10.7a | 5.7b | 5.7a | 1.0a | 7.7a | 3.7a | 6.7a | **5.2a** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 10.0a | 8.3b | 7.7a | 5.3a | 10.0a | 15.7c | 14.3b | **11.3b** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 8.0a | 8.3b | 8.3a | 6.7a | 8.7a | 9.7b | 14.0b | **10.2b** |
| 5 | Spinetoram 6% + methoxyfenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 7.7a | 8.0b | 6.0a | 4.0a | 9.3a | 3.7a | 9.7a | **7.4a** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 6.7a | 2.3a | 8.3a | 4.0a | 7.0a | 3.3a | 8.7a | **5.7a** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 9.3a | 6.3b | 6.7a | 2.0a | 9.3a | 3.0a | 9.3a | **6.6a** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 7.0a | 4.0a | 8.7a | 4.0a | 10.3b | 2.7a | 8.3a | **6.3a** |
| 9 | Untreated control | Water | Water spray | | 9.3a | 8.3b | 6.7a | 5.3a | 10.0b | 11.7c | 15.7b | **11.1b** |

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

**Table: 2.13 Disease Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Blast | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CHP | | GNV | | | | SKL | | | | |
| | | | | | 60DT | 75DT | 43DT | 60DT | 61DT | 70DT | 54DT | 73DT | 84DT | 94DT | |
| 1 | Spinetoram6%+methoxyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 56.3e | 46.7d | 27.8a | 25.3bc | 24.0b | 24.7c | 60.3a | 28.0a | 39.0a | 29.0a | **22.0cd** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 29.3cd | 38.3c | 27.8a | 29.3b | 29.9c | 30.8d | 58.3a | 29.0a | 35.0a | 28.0a | **20.0c** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 28.0c | 24.3b | 23.0a | 21.8b | 25.1bc | 21.4c | 48.3a | 26.0a | 34.7a | 26.0a | **15.7b** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 11.0a | 13.0a | 24.1a | 12.7a | 13.3a | 6.3b | 49.7a | 24.3a | 34.3a | 30.3a | **9.4a** |
| 5 | Spinetoram 6% + methoxyfenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 29.0c | 26.7b | 23.3a | 22.6b | 24.9bc | 24.8c | 51.0a | 27.0a | 30.3a | 24.0a | **16.4b** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 13.3ab | 11.0a | 21.5a | 12.3a | 13.2a | 5.4b | 52.3a | 25.7a | 28.7a | 24.0a | **9.0a** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 38.3d | 33.0c | 22.9a | 22.6b | 24.2b | 24.9c | 55.0a | 25.7a | 32.0a | 25.0a | **18.0b** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 18.3b | 15.3a | 23.0a | 9.9a | 11.4a | 2.6a | 57.7a | 25.3a | 31.0a | 23.0a | **9.4a** |
| 9 | Untreated control | Water | Water spray | | 78.0f | 59.7e | 31.8b | 32.6c | 33.2c | 32.5d | 57.0a | 26.0a | 39.7a | 27.3a | **28.3d** |

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

**Table: 2.13 (Contd…) Disease Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Neck blast | | Mean | Sheath rot |
|---|---|---|---|---|---|---|---|---|
| | | | | | RGL | RNR | | RNR |
| | | | | | Pre-harvest | 90DT | | |
| 1 | Spinetoram6%+methoxyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 11.7a | 25.4b | **18.5b** | **22.8b** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 10.6a | 23.5b | **17.1b** | **22.3b** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 11.7a | 20.4b | **16.0b** | **11.6a** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 7.6a | 6.7b | **7.1a** | **25.2bc** |
| 5 | Spinetoram 6% + methoxyfenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 10.9a | 22.6b | **16.7b** | **9.0a** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 10.0a | 9.5a | **9.7a** | **23.2b** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 11.8a | 22.9b | **17.3b** | **7.5a** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 10.5a | 9.3a | **9.9a** | **19.7b** |
| 9 | Untreated control | Water | Water spray | | 13.3a | 28.0b | **20.7b** | **30.0c** |

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

**Table: 2.13 (Contd…) Disease Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Sheath Blight | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MSD | | GNV | | | | KUL | LDN | MTU | |
| | | | | | 50DT | 55DT | 43DT | 60DT | 61DT | 68DT | 65DT | 58DT | 50DT | 70DT |
| 1 | Spinetoram6%+methoxyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 16.9a | 35.4e | 31.1a | 31.6b | 29.5b | 31.1b | 36.5b | 19.7c | 26.7a | 40.7a |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 19.6a | 33.3e | 31.3a | 31.4b | 31.4b | 31.5b | 37.0b | 7.0a | 10.3a | 18.0a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 20.3a | 19.0b | 30.9a | 14.4a | 23.8a | 7.6a | 18.8a | 19.0c | 10.0a | 15.3a |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 20.3a | 29.3de | 30.6a | 29.5b | 33.2b | 32.5b | 33.9b | 18.7c | 14.7a | 47.0a |
| 5 | Spinetoram 6% + methoxyfenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 17.1a | 16.0ab | 29.6a | 12.1a | 21.9a | 5.8a | 17.3a | 15.7bc | 10.7a | 49.3a |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 20.3a | 25.0c | 31.5a | 31.8b | 33.8b | 33.3b | 34.1b | 14.7b | 17.0a | 54.3a |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 16.5a | 15.4a | 31.5a | 12.6a | 18.0a | 5.1a | 16.5a | 6.7a | 6.3a | 12.7a |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 18.5a | 26.1cd | 32.3a | 31.2b | 32.8b | 32.4b | 32.0b | 7.0a | 19.7a | 18.7a |
| 9 | Untreated control | Water | Water spray | | 20.7a | 42.9f | 30.2a | 34.7b | 33.9b | 33.8b | 38.6b | 30.0d | 18.0a | 19.3a |

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

**Table: 2.13 (Contd…) Disease Incidence in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Sheath Blight | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PTB | | RGL | | | RPR | |
| | | | | | 45DT | 60DT | 48DT | 55DT | 81DT | 68DT | |
| 1 | Spinetoram6%+methoxyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 48.3a | 65.0b | 19.9ab | 59.9c | 40.4a | 38.7a | **35.7c** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 53.3a | 70.0b | 17.7ab | 64.3c | 40.9a | 40.0a | **33.6bc** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 58.3a | 26.7a | 24.2b | 4.2a | 32.2a | 40.0a | **22.8a** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 66.7a | 28.3a | 18.9ab | 9.2a | 45.6a | 34.8a | **30.8b** |
| 5 | Spinetoram 6% + methoxyfenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 48.3a | 23.3a | 15.2ab | 9.4a | 40.8a | 42.2a | **23.4a** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 60.0a | 23.3a | 19.3ab | 52.5c | 46.4a | 37.8a | **33.4b** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 63.3a | 28.3a | 13.9a | 20.6b | 33.8a | 38.1a | **21.2a** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 45.0a | 16.7a | 19.6ab | 53.6c | 41.4a | 38.6a | **29.1ab** |
| 9 | Untreated control | Water | Water spray | | 60.0a | 80.0b | 21.8b | 48.5c | 44.2a | 41.9a | **37.4c** |

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

**Table: 2.14 Grain yield in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Grain Yield(Kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BPT | CBT | CHN | CHP | MSD | GNV | KJT | KBP |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 4724a | 5302a | 5033a | 4975b | 3025bc | 6367b | 3464a | 4100ab |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 3801c | 5024a | 3733b | 4740c | 3067bc | 8867a | 2640a | 4400a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 3428d | 4353b | 3033bc | 4465e | 2933c | 6567b | 2680a | 4167ab |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 3597d | 4213b | 2889c | 4602d | 2667d | 6767b | 2751a | 4367a |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 3420d | 5177a | 4567a | 5033b | 3400a | 7433ab | 2529a | 3533b |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 3369e | 5028a | 4556a | 5190a | 3150b | 7267b | 2318a | 4350a |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 4509b | 4998a | 2967c | 4642e | 3525a | 7900ab | 3222a | 4683a |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 3529d | 5046a | 2611cd | 4798c | 3200b | 8600a | 2873a | 4183ab |
| 9 | Untreated control | Water | Water spray | | 3083f | 3902c | 2067d | 3408f | 2017e | 4600c | 2140a | 3683b |

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

**Table: 2.14(Contd…) Grain yield in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Grain Yield(Kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LUD | MLN | MND | MTU | NDL | NVS | NWG | PNT |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 6486ab | 5112b | 4153a | 1398a | 2833b | 3772a | 2598a | 1405a |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 6108b | 5508ab | 3960a | 1816a | 3283b | 3532b | 2161b | 1471a |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 6606a | 5472ab | 3800a | 1411a | 4650ab | 3198c | 2456ab | 1518a |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 6174b | 5076b | 3813a | 1802a | 4542ab | 3104cd | 2613a | 1339a |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 7044a | 4752b | 4467a | 1447a | 3183b | 3695ab | 2667a | 1333a |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 6256b | 4752b | 4560a | 1733a | 3667b | 3618ab | 2187b | 1606a |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 6483a | 5220ab | 4067a | 1875a | 4417ab | 3435b | 2165b | 1241a |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 6222b | 5832a | 4133a | 2086a | 5500a | 3318c | 2772a | 1318a |
| 9 | Untreated control | Water | Water spray | | 5287c | 2952c | 2733b | 1586a | 4583a | 2932d | 1985b | 1525a |

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

**Table: 2.14 (Contd…) Grain yield in different treatments, PCT, *Kharif* 2017**

| Sl. No. | Trade Name | Common Name | % a.i. formula-tion | g or ml per litre of spray fluid | Grain Yield(Kg/ha) | | | | | | | Mean | % IOC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PSA | PTB | RGL | RNR | RPR | SKL | TTB | | |
| 1 | Spinetoram6%+metho-xyfenozide 30% | Spinetoram 6% + methoxyfenozide 30% | 36 | 0.75 | 5778b | 2048a | 6943b | 3083a | 6050a | 1874a | 4337b | **4124a** | **22.6** |
| 2 | DPX-RAB 55 | Triflumezopyrim | 106 | 0.48 | 5139bc | 1415b | 7332ab | 3032a | 5858ab | 2448a | 4100c | **4062a** | **21.4** |
| 3 | Contaf Plus | Hexaconazole | 5 | 2 | 6375a | 1482b | 7123ab | 2883a | 5650b | 1357b | 3987c | **3895a** | **18.0** |
| 4 | Mantis 75 WP | Tricyclazole | 75 | 0.6 | 6125b | 1598b | 6719b | 2994a | 5792ab | 1479b | 4200b | **3879a** | **17.7** |
| 5 | Spinetoram 6% + methoxy-fenozide 30%+Contaf | Spinetoram 6% + methoxyfenozide 30%+ Hexaconazole | - | 0.75+2.0 | 6708a | 2048a | 6854b | 2933a | 6100a | 1848a | 4620a | **4121a** | **22.5** |
| 6 | Spinetoram 6% + methoxyfenozide 30%+ Baan | Spinetoram 6% + methoxyfenozide 30%+ Tricyclazole | - | 0.75+0.6 | 6306a | 1965a | 6544b | 2690ab | 5883ab | 2185a | 4520a | **4074a** | **21.6** |
| 7 | DPX-RAB 55+Contaf | Triflumezopyrim +Hexaconazole | - | 0.48+2.0 | 6903a | 1565b | 7549a | 2953a | 6054ab | 1837a | 4303b | **4196a** | **23.9** |
| 8 | DPX-RAB 55+Baan | Triflumezopyrim + Tricyclazole | - | 0.48+0.6 | 6694a | 1449b | 7718a | 2353b | 5938ab | 2131a | 4195b | **4196a** | **23.9** |
| 9 | Untreated control | Water | Water spray | | 4917c | 1415b | 6670b | 2479b | 5138f | 917b | 3433d | **3194b** | |

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

**ii) Botanical Insecticides Evaluation Trial (BIET)**

Use of plant extracts or botanicals is one of the earliest practices in control of insect pests of crops. Botanicals can play a key role in management of rice pests as they are eco-friendly, safe, renewable and cost effective. Integration of botanicals in rice IPM will reduce pesticide load in environment, prevent insecticide resistance and help in conserving natural enemy populations. Earlier efforts under AICRIP were mainly focussed on evaluation of efficacy of various insecticides against insect pests. Hence, it was felt essential to re-look at the efficacy of some of commercially available botanical formulations against major pests of rice to identify the effective botanical with an aim to integrate in rice IPM. So, the trial with commercially available botanical formulations initiated last year was continued during *kharif* 2017 with inclusion of few plant essential oils to evaluate their relative efficacy at recommended doses against major insect pests at 20 locations.

Essential oils derived from various parts of aromatic plants are known to posses effective antibiotic and insecticidal properties since ages. These oils were used in treatment of various diseases of humans, animals and plants and also for repelling insects in storage and home gradens. Efficacy of these oils was very well established aginst musquitoes as repellents. Keeping their insecticidal properties in view, preliminary studies were conducted at IIRR for two years i.e., 2014-15 and 2015-16 to know their efficacy against rice pests. Among several essential oils evaluated, camphor, cedar wood, lemongrass, eucaluptus, laevender, oregano and rosemary oils wer found effective in reducing the damage caused by brown plant hopper, yellow stem orer, leaf folder under field trials. Based on the efficacy and cost four oils mentioned in tehnical programme were selected and included in the present BIET trial under AICRIP.

| Sl. No. | Location | Date of sowing | Date of planting | Date of harvesting | No of applications | Times of application (DAT) |
|---|---|---|---|---|---|---|
| 1 | Bapatla | 12-08-2017 | 15-09-2017 | 06-01-2018 | 2 | 35 & 60 |
| 2 | Chinsurah | 16-06-2017 | 26-07-2017 | 23-11-2017 | 3 | 15,30 & 50 |
| 3 | Coimbatore | 10-06-2017 | 10-07-2017 | 17-11-2017 | 3 | 17,30 & 60 |
| 4 | Chiplima | 28-07-2017 | 28-08-2017 | 08-12-2017 | 3 | 20,50 & 65 |
| 5 | Chatha | 05-06-2017 | 01-07-2017 | 04-11-2017 | 5 | 15,25,40,55 & 75 |
| 6 | Gangavathi | 21-07-2017 | 05-09-2017 | 04-01-2018 | 4 | 30,58 & 78 |
| 7 | Iroishemba | 08-07-2017 | 08-08-2017 | 12-12-2017 | 1 | 25 |
| 8 | Jagdalpur | 07-07-2017 | 03-08-2017 | 15-12-2017 | 3 | 15,35 & 50 |
| 9 | Khudwani | 11-05-2017 | 10-06-2017 | 08-10-2017 | 1 | 60 |
| 10 | Karjat | 08-06-2017 | 21-07-2017 | 30-10-2017 | 1 | 50 |
| 11 | Karaikal | 12-07-2017 | 09-08-2017 | 27-10-2017 | 1 | 45 |
| 12 | Kaul | 11-06-2017 | 20-07-2017 | 06-11-2017 | 3 | 55,63 & 78 |
| 13 | Ludhiana | 18-05-2017 | 19-06-2017 | 20-10-2017 | 2 | 55 & 70 |
| 14 | Malan | 20-06-2017 | 18-07-2017 | 29-10-2017 | 2 | 25 & 55 |
| 15 | Masodha | 08-07-2017 | 08-08-2017 | 29-11-2017 | 4 | 17,30,43 & 53 |
| 16 | Maruteru | 23-06-2017 | 20-07-2017 | 13-11-2017 | 2 | 18 & 48 |
| 17 | Navsari | 05-07-2017 | 03-08-2017 | 07-11-2017 | 2 | 50 & 61 |
| 18 | Nellore | 22-08-2017 | 25-09-2017 | yet to harvest | 1 | 46 |
| 19 | New Delhi | 19-06-2017 | 20-07-2017 | 11-12-2017 | 2 | 26 &53 |
| 20 | Puducherry | 09-08-2017 | 14-09-2017 | 26-12-2017 | 2 | 34 & 54 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 21 | Pattambi | 07-07-2017 | 25-07-2017 | 01-11-2017 | 2 | 15 & 40 |
| 22 | Pusa | 01-07-2017 | 21-07-2017 | 25-11-2017 | 2 | 10,30 & 50 |
| 23 | Raipur | 03-07-2017 | 10-08-2017 | 01-12-2017 | 3 | 43,55 & 75 |
| 24 | Ragolu | 06-07-2017 | 06-08-2017 | 25-11-2017 | 3 | 15,41 & 70 |
| 25 | Ranchi | 27-06-2017 | 18-07-2017 | 26-12-2017 | 6 | 25,40,70,80,90 & 105 |
| 26 | Rewa | 02-07-2017 | 28-08-2017 | 10-11-2017 | 1 | 35 |
| 27 | Sakoli | 29-06-2017 | 26-07-2017 | 27-11-2017 | 4 | 15,40,70 & 90 |
| 28 | Titabar | 09-07-2017 | 10-08-2017 | 04-12-2017 | 1 | 15 |

Treatments:
Four plant essential oils *viz.*, Camphor oil, Cedar wood oil, Eucalyptus oil and Lemon grass oil @ 1000 ml/ha were compared for their efficacy with effective commercial neem formulation, Neemazal and commonly recommended insecticides – dinotefuran 20 SG @ 40 g a.i./ha and rynaxypyr 20 SC @ 30 g a.i./ha along with untreated control (only water spray). There were eight treatments replicated thrice and laid out in Randomized Complete Block Design (RCBD). Spray applications of the treatments were done based on pest incidence exceeding the economic threshold level at 15 days interval. All the treatments were applied as high volume sprays @ 500 litres of spray fluid/ha.

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

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

**Results**

**Pest Infestation (Table 2.15)**:

Stem borer infestation during vegetative stage ranged from 1.1to 23.4% dead hearts (DH) in the insecticide treatments and 1.7-18.2% in essential oil treatments across 15 locations with minimum damage of 4.4 and maximum of 19.6% DH in untreated control, during 28 to108 DAT. There were significant differences in stem borer damage (DH) among the treatments at 13 locations. Rynaxypyr treatment recorded the lowest mean damage of 4.3% while essential oil treatments showed mean DH infestation between 6.8 and 7.6% across the locations compared to 11.1% in untreated control. Botanical insecticide

treatments were significantly superior to control at 12 locations. Among the oils, eucalyptus oil treatment showed highest efficacy with 6.7% DH when compared to other oils.

White ears (WE) damage at heading stage in various treatments ranged from 1.3 to 29.7% against 5.9 to 38.8% in control across 16 centres. There were significant differences among treatments in white ear damage at 10 locations. Mean WE infestation ranged from 8.5-9.2% in essential oil treatments compared to 6.2-7.4% in insecticide treatments and 14.3% in control. Overall, eucalyptus and cedar wood oils were found to be superior in reducing stem borer damage compared to other botanical treatments along with insecticide, rynaxypyr at both vegetative and reproductive phases.

Gall midge occurrence was reported from 7 centres of which Pattambi recorded highest damage ranging from 22.2 to 37.2% SS across treatments and 42.2% in control at 50 DAT. At other locations, the SS damage varied from 1.6 to 37.2 in treatments and 5.6 to 42.2% in control. There were significant differences in the efficacy of essential oils among the treatments at 5 locations. The lowest mean infestation was recorded in Camphor oil (10.4%) and the efficacy was on par with insecticides in all centres except Chiplima and significantly superior to control (15.6%).

Brown planthopper incidence was very high at Maruteru centre (66.7-3168.3 hoppers/10hills) during 40 to 70 DAT followed by New Delhi centre with population of 44.2-316.1 hoppers/10 hills during 70 to 90 DAT in untreated control. Across the 10 locations, dinotefuran was found to be the most effective treatment with mean population of 36.8/10 hills and was significantly superior to control (193.4). Mean BPH population in essential oil treatments ranged between64.9-102.1hoppers/10hills. All botanical treatments significantly reduced BPH populations and camphor oil showed superior efficacy.

White backed planthopper populations were observed at 6 locations, and Gangavathi recorded the highest populations ranging from 73.3-175.3/10 hills across the treatments at 40 DAT followed by Maruteru (28.3-121.6). The populations of hoppers varied from10.67 to 243.3/10 hills across other centres in control. Dinotefuran was the most effective treatment in reducing WBPH populations (16.8 hoppers/10 hills). Essential oil treatments also showed significant efficacy against the hoppers with mean population of 29.2-35.3 hoppers/10 hills and significantly superior to that of control (51.74hoppers/10 hills).

Green leafhopper incidence was high at Ranchi (29.0-77.0 hoppers/10hills) during 79-82 DAT among the 7 centres. Dinotefuran was the most effective treatment with mean population of 13.1 hoppers/10 hills and superior to control (21.1). There were significant differences in hopper populations among the treatments at 4 locations. All the botanical treatments also showed significant efficacy against the hoppers (15.3-17.5/10hills) when compared to control (21.1).

Leaf folder damage was recorded from 14 locations and highest leaf damage was recorded in Ranchi centre (72.6-78.6%) followed by Malan with 37.2-41.5% during 47-88 days after planting. There were significant differences in leaf damage among the treatments at 9 locations. Dinotefuran was the most effective

treatment showing mean leaf damage of 9.7%. Among the oils, lemongrass oil recorded lowest infestation (12-0% DL) in comparison to 18-7% DL in untreated control.

Whorl maggot infestation was recorded at 8 centres, of which high foliage damage was noticed in Malan ranging from 13.5-28.7% in treatments and 46.9% in control at 47 DAT. The lowest mean damage was recorded in rynaxypyr treatment (5.7%). A mean damage range of 7.0-7.7% was noticed in essential oil treatments less than that of control (10.2%).

Hispa damage was observed at 2 centres *viz.*, Karaikal, and Ranchi. Highest damage of more than 50% was recorded in Ranchi, however none of the treatments were found effective against the pest at 33 DAT and all were at par. Dinotefuron was the most effective treatment with 36.0% mean leaf damage. Essential oil treatments showing 30.0-38.1% mean leaf damage were superior to control with 40.7%.

Gundhi bug incidence was observed in Navsari and Rewa locations. Both essential oil and insecticide treatments were found effective in reducing mean damage by the bug (8.5-11.6%) at both centres when compared to 18.2% in control. Among botanicals, cedarwood oil recorded the lowest damage of 9.1%.

Cutworm infestation was reported from Iriosemba and Pattambi centres at 45 DAT with damage range of 6.3-13.9% in treatments and 8.6-16.0% in control. Eucalyptus oil recorded the lowest mean damage of 10.0% comparable with rynaxypyr (9.7%) and better than control (11.7%)

Natural enemies: The populations of mirid bug, an important natural enemy of BPH, were recorded in 4 centres. High populations of 31.3-157.0 mirid bugs/10 hills was recorded in Kaul centre followed by Maruteru with 21.33-88.67 bugs in treatments as against 120.0-128.0 in control. There were no significant differences in mirid populations among treatments in Maruteru centre at 42, 50 and 70 DAT. Low population of mirid bugs was recorded in dinotefuran treatment (11.0/10hills) indicating that the insecticide is not very safe to predators. Comparatively higher populations in of the predator was noticed in essential oil treatments (18.1-23.7/10hills) when compared to 36.3 in control indicating that all botanicals are safe to the mirid bug.

Spider populations were recorded in 8 locations, of which Ludhiana reported more spider numbers (10.3-28.3/10hills) compared to other locations (1.0-13.3/10hills). Mean spider population in essential oil treatments ranged from 8.3-8.7/10 hills as compared to 11.2 in control signifying that botanical treatments are relatively safer to spiders.

**Grain Yield (Table 2.16)**:
There were significant differences in grain yield among the treatments including control at 20 locations out of total 26 locations. Based on mean yield of these locations, rynaxypyr recorded the highest grain yield of 4276.5kg/ha with 28.0% increase over control (IOC) followed by dinotefuran with 4186.9kg/ha (25.3% IOC). Among the botanicals, cedar wood oil treatment recorded highest yield of 3879.7 kg/ha (16.1% IOC) on par with others with a range of 3786.7-3825.3

kg/ha (range of 13.3-14.2% IOC. All the treatments yielded significantly higher than Control (3340.97 kg/ha).

*Botanical Insecticide Evaluation Trial (BIET) was carried out at 30 locations across the country to evaluate the efficacy of four essential oils, neemazal and recommended insecticides, dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield during kharif 2017. Based on the performance of the treatments in controlling the pest damage at various locations, the botanicals-cedarwood and eucalyptus oils were found effective in reducing damage by stem borer. In case of gall midge camphor oil showed efficacy in reducing silver shoot damage. Dinotefuran was the most effective treatment in reducing the populations of plant and leafhoppers, while all the essential oil treatments were moderately effective. Against leaf folder, performance of lemongrass oil was was superior, while cedarwood oil was effective in reducing the damage by Gundhi bug. Eucalyptus oil was found effective against cut worm and the efficacy was comparable with rynaxypyr. Botanical formulations were found moderately effective in reducing damage by hispa and whorl maggot. Impact of essential oils on natural enemies revealed that treatments were relatively safer to mirid bug than spiders. Highest grain yield of 4276.5 kg/ha was recorded in rynaxypyr treatment. Among botancal formulations, cedar wood oil recorded the highest yield of 3879.7 kg/ha.*

**Table 2.15 Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Stem Borer Damage (%Dead Hearts) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CBT | | CHN | | CHP | | IRS | KBP | | KRK | | KJT | |
| | | | 28DT | 50DT | 30DT | 50DT | 56DT | 70DT | 30DT | 30DT | 50DT | 30DT | 50DT | 30DT | 50DT |
| 1 | Camphor oil | 1000 | 3.5a | 4.2a | 11.1bcd | 9.6b | 5.4abc | 4.9bc | 3.8ab | 14.1a | 9.4a | 2.6a | 4.1ab | 9.8ab | 4.0ab |
| 2 | Cedar wood oil | 1000 | 4.8a | 5.3a | 12.2ac | 9.3b | 5.1abc | 4.3bc | 4.2ab | 20.8a | 11.1a | 4.0a | 5.8ab | 9.8ab | 2.3cd |
| 3 | Eucalyptus oil | 1000 | 4.4a | 6.5a | 9.9cd | 6.8c | 6.1ab | 6.4b | 3.4ab | 11.6a | 10.0a | 3.3a | 3.5ab | 9.6bc | 4.0cd |
| 4 | Lemon grass oil | 1000 | 3.8a | 7.6a | 14.5a | 10.4b | 4.8bc | 4.2bc | 4.4ab | 14.6a | 7.2a | 3.2a | 6.7ab | 9.9ab | 3.1bc |
| 5 | Neem azal | 1000 | 4.5a | 5.6a | 8.2de | 5.8c | 6.5ab | 6.3b | 2.3b | 13.2a | 7.7a | 0.7a | 2.1ab | 9.7b | 2.2cd |
| 6 | Dinotefuran | 200 | 4.4a | 6.3a | 8.8cd | 5.2c | 3.6c | 3.6c | 4.6ab | 23.4a | 9.5a | 4.7a | 1.1b | 10.2ab | 1.3de |
| 7 | Rynaxypyr | 150 | 2.5a | 3.3a | 4.9e | 2.6d | 1.7d | 1.6d | 2.5b | 21.0a | 8.7a | 3.5a | 4.4ab | 8.6c | 0.8e |
| 8 | Untreated Control | Water | 6.4a | 10.5a | 16.2a | 15.7a | 7.6a | 9.6a | 5.6a | 16.5a | 9.3a | 4.4a | 8.8a | 10.7a | 5.0a |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Stem Borer Damage (% Dead Hearts) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | LDN | | | | | | MSD | | NVS | | PSA | |
| | | | 50DT | 55DT | 60DT | 70DT | 75DT | 80DT | 30DT | 50 DT | 30DT | 50 DT | 30DT | 50 DT |
| 1 | Camphor oil | 1000 | 4.7a | 2.9bc | 3.2bc | 5.2ab | 3.2b | 3.7b | 8.4a | 26.1ab | 8.4ab | 9.9bc | 10.6ab | 8.1ab |
| 2 | Cedar wood oil | 1000 | 4.7a | 2.7bc | 3.0bc | 4.3bc | 3.0b | 3.2bc | 7.0a | 19.1bc | 5.2ab | 7.0bcd | 9.3b | 9.0ab |
| 3 | Eucalyptus oil | 1000 | 5.0a | 2.8bc | 3.0bc | 4.6bc | 3.0b | 3.56b | 8.2a | 17.7c | 6.9ab | 9.6bc | 7.9b | 8.7ab |
| 4 | Lemon grass oil | 1000 | 4.9a | 2.5bc | 2.4c | 3.7bc | 2.9b | 3.0bc | 4.7ab | 14.0c | 4.3b | 6.3bcd | 7.4b | 6.5bc |
| 5 | Neem azal | 1000 | 5.2a | 2.4bc | 2.4c | 4.0bc | 2.9b | 2.9bc | 5.4ab | 2.5d | 9.3ab | 11.6ab | 6.4b | 8.3ba |
| 6 | Dinotefuran | 200 | 4.7a | 3.6b | 3.9b | 4.5bc | 3.2b | 3.2bc | 4.8ab | 1.3d | 3.4b | 4.7cd | 5.4b | 5.8bc |
| 7 | Rynaxypyr | 150 | 5.0a | 1.9c | 2.2c | 2.9c | 1.3b | 1.8c | 3.6b | 0.6d | 2.6b | 2.9d | 1.7c | 2.2c |
| 8 | Untreated Control | Water | 4.9a | 5.8a | 6.8a | 7.1a | 7.6a | 8.3a | 6.5ab | 34.0a | 15.0a | 18.6a | 17.9a | 15.3a |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Stem Borer Damage (% Dead Hearts) | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | RCI | RPR | | | SKL | | | TTB | | |
| | | | 50 DT | 30DT | 50 DT | 30DT | 58DT | 88DT | 109DT | 30DT | 50 DT | |
| 1 | Camphor oil | 1000 | 13.5a | 13.7ab | 18.3a | 5.0ab | 7.7ab | 5.5a | 6.9abc | 3.3bcd | 2.7b | **7.6** |
| 2 | Cedar wood oil | 1000 | 13.8a | 10.2ab | 12.9a | 4.4ab | 7.4ab | 5.4a | 7.1abc | 3.3bcd | 3.5b | **7.2** |
| 3 | Eucalyptus oil | 1000 | 11.2ab | 13.9ab | 15.2a | 4.8ab | 6.5ab | 4.9a | 5.8bc | 1.7d | 2.5b | **6.9** |
| 4 | Lemon grass oil | 1000 | 16.8a | 13.3ab | 18.2a | 4.6ab | 7.1ab | 5.0a | 9.0ab | 3.4bc | 3.3b | **7.0** |
| 5 | Neem azal | 1000 | 7.1b | 9.9b | 16.3a | 3.2ab | 4.1ab | 6.2a | 8.8ab | 1.8d | 1.8b | **5.9** |
| 6 | Dinotefuran | 200 | 6.2b | 12.4ab | 16.1a | 2.7ab | 3.5ab | 5.4a | 4.7bc | 4.5b | 3.b | **5.8** |
| 7 | Rynaxypyr | 150 | 6.4b | 10.6ab | 14.4a | 2.2ab | 2.9b | 2.5a | 3.7c | 3.5b | 4.1b | **4.3** |
| 8 | Untreated Control | Water | 17.1a | 15.1a | 19.6a | 6.9a | 8.5a | 6.3a | 10.6a | 7.8a | 7.5a | **11.1** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Stem Borer Damage (%White Ears) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-harvest | | | | | | | | |
| | | | CBT | CHN | CHP | IRS | KRK | LDN | MSD | MTU | NVS |
| 1 | Camphor oil | 1000 | 3.6a | 8.4bc | 7.7b | 5.4c | 3.7a | 3.8b | 22.9b | 6.0a | 14.1b |
| 2 | Cedar wood oil | 1000 | 5.2a | 9.9b | 6.1bc | 11.4a | 3.4a | 3.1b | 17.1bc | 4.1a | 8.8cd |
| 3 | Eucalyptus oil | 1000 | 4.5a | 8.6bc | 8.6b | 8.9abc | 8.1a | 3.5b | 13.3bc | 10.0a | 12.1bc |
| 4 | Lemon grass oil | 1000 | 4.6a | 11.3b | 6.6bc | 9.3abc | 5.9a | 2.8b | 10.5c | 5.7a | 8.6cd |
| 5 | Neem azal | 1000 | 4.3a | 6.1cd | 9.2ab | 6.6bc | 2.8a | 2.8b | 2.0d | 5.4a | 15.3b |
| 6 | Dinotefuran | 200 | 4.2a | 4.8de | 4.0cd | 8.7abc | 0.6a | 3.7b | 2.0d | 7.2a | 7.2d |
| 7 | Rynaxypyr | 150 | 2.5a | 2.4e | 2.2d | 8.4abc | 4.2a | 2.6b | 1.3d | 5.8a | 6.4d |
| 8 | Untreated Control | Water | 8.7a | 16.4a | 13.2a | 10.4ab | 5.1a | 8.8a | 38.8a | 6.4a | 21.6a |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Stem Borer Damage (%White Ears) | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-harvest | | | | | | | |
| | | | PSA | PTB | RCI | RGL | RPR | SKL | TTB | |
| 1 | Camphor oil | 1000 | 10.9ab | 17.0a | 9.3ab | 2.8a | 17.3ab | 7.9a | 2.5bc | **9.0** |
| 2 | Cedar wood oil | 1000 | 8.6ab | 15.9a | 9.1ab | 5.8a | 14.0bc | 10.7a | 2.5bc | **8.5** |
| 3 | Eucalyptus oil | 1000 | 7.3ab | 22.8a | 8.6ab | 3.1a | 15.9abc | 10.1a | 1.6c | **9.2** |
| 4 | Lemon grass oil | 1000 | 6.9ab | 26.7a | 10.3ab | 2.9a | 18.1a | 9.4a | 2.4bc | **8.9** |
| 5 | Neem azal | 1000 | 5.5ac | 20.7a | 3.4b | 2.2a | 16.5ab | 8.7a | 1.5c | **7.1** |
| 6 | Dinotefuran | 200 | 4.6bc | 28.9a | 6.7ab | 4.7a | 17.3ab | 9.2a | 3.1b | **7.4** |
| 7 | Rynaxypyr | 150 | 1.3bc | 29.7a | 7.3ab | 2.1a | 12.3c | 8.4a | 2.3bc | **6.2** |
| 8 | Untreated Control | Water | 12.0a | 27.3a | 17.2a | 6.9a | 18.2a | 11.2a | 5.9a | **14.3** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Gall midge Damage (% Silver Shoots) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CHP | | JDP | | MTU | PTB | RCI | SKL | | | TTB | | |
| | | | 56DT | 70DT | 30DT | 50DT | 50DT | 50DT | 50DT | 30DT | 58DT | 88DT | 30DT | 50DT | Mean |
| 1 | Camphor oil | 1000 | 8.6a | 5.4bc | 7.8ab | 6.0ab | 22.1a | 37.2a | 11.2ab | 3.0a | 12.1abc | 6.2a | 2.0bc | 2.9bc | **10.4** |
| 2 | Cedar wood oil | 1000 | 7.4abc | 3.8cd | 11.8ab | 9.0ab | 28.2a | 29.4a | 11.6ab | 4.7a | 13.3abc | 7.1a | 3.0bc | 2.5bc | **11.0** |
| 3 | Eucalyptus oil | 1000 | 9.0ab | 5.1bc | 23.4ab | 7.9ab | 29.6a | 31.2a | 9.2bc | 3.5a | 11.3bc | 6.3a | 2.2bc | 2.7bc | **11.8** |
| 4 | Lemon grass oil | 1000 | 6.5bc | 2.7d | 14.5ab | 9.1ab | 21.3a | 29.1a | 16.2a | 5.0a | 17.6ab | 6.4a | 3.7b | 3.1bc | **11.3** |
| 5 | Neem azal | 1000 | 9.1ab | 6.3ab | 14.8ab | 7.4ab | 29.6a | 33.4a | 4.8c | 4.8a | 17.0ab | 5.3a | 1.6c | 1.8c | **11.4** |
| 6 | Dinotefuran | 200 | 6.0bc | 2.8d | 5.8b | 4.7b | 21.8a | 30.5a | 5.5c | 2.7a | 11.5bc | 5.1a | 3.4b | 3.1bc | **8.6** |
| 7 | Rynaxypyr | 150 | 5.5c | 2.0d | 5.0b | 4.3b | 19.9a | 22.2a | 6.3bc | 3.3a | 10.3c | 6.0a | 3.1bc | 3.9ab | **7.7** |
| 8 | Untreated Control | Water | 10.7a | 8.5a | 25.9a | 12.4a | 24.4a | 42.2a | 16.6a | 5.6a | 18.3a | 7.6a | 8.1a | 6.0a | **15.6** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Leaf Folder (%Damaged Leaves) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BPT | | CHN | | GNV | | JDP | | KBP | KRK | | KUL | | LDN | |
| | | | 70DT | 85DT | 30DT | 50DT | 60DT | 30DT | 50DT | 70DT | 30DT | 30DT | 50DT | 55DT | 66DT | 50DT | 55DT |
| 1 | Camphor oil | 1000 | 4.0a | 1.7a | 3.5bc | 3.4bc | 1.5b | 6.0ab | 6.9ab | 7.6a | 7.8a | 7.4a | 23.4a | 5.0a | 7.0a | 10.0a | 6.7b |
| 2 | Cedar wood oil | 1000 | 6.2a | 0.9a | 3.4bc | 3.2bc | 1.2b | 7.0ab | 2.8b | 4.7a | 6.1a | 9.9a | 43.6a | 5.1a | 7.1a | 10.1a | 6.4b |
| 3 | Eucalyptus oil | 1000 | 5.1a | 1.4a | 2.9bcd | 2.8bcd | 1.1b | 8.3ab | 8.3ab | 4.8a | 5.2a | 9.4a | 25.8a | 4.9a | 3.9a | 10.4a | 6.4b |
| 4 | Lemon grass oil | 1000 | 5.2a | 3.5a | 4.1b | 3.9b | 1.4b | 7.0ab | 6.9ab | 4.5a | 5.9a | 6.4a | 35.2a | 5.4a | 5.9a | 9.9a | 5.5b |
| 5 | Neem azal | 1000 | 6.4a | 0.3a | 2.6cd | 2.6cd | 1.0b | 3.3b | 5.8ab | 5.9a | 3.6a | 8.9a | 41.0a | 5.1a | 5.9a | 10.3a | 5.5b |
| 6 | Dinotefuran | 200 | 5.5a | 4.3a | 1.8cd | 2.0de | 1.4b | 6.6ab | 6.2ab | 3.2ab | 3.7a | 7.6a | 12.7a | 5.8a | 6.1a | 10.2a | 6.6b |
| 7 | Rynaxypyr | 150 | 4.9a | 2.8a | 1.2de | 1.6e | 0.4b | 6.6ab | 2.0b | 0.3b | 7.9a | 9.3a | 33.8a | 6.4a | 5.0a | 9.9a | 3.6c |
| 8 | Untreated Control | Water | 5.5a | 6.3a | 6.2a | 6.0a | 6.1a | 11.0a | 13.1a | 7.6a | 7.9a | 8.4a | 29.4a | 5.2a | 6.0a | 9.9a | 12.5a |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Leaf Folder (%Damaged Leaves) | | | | | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | LDN | | | | MLN | | MSD | | NLR | | NVS | | RCI | | TTB | |
| | | | 60DT | 70DT | 75DT | 80DT | 47DT | 72DT | 30DT | 50DT | 45DT | 52DT | 30DT | 50DT | 78DT | 88DT | 30DT | |
| 1 | Camphor oil | 1000 | 7.3b | 10.0b | 7.2b | 7.7b | 15.0b | 17.4b | 3.2a | 7.5ab | 22.6a | 19.8a | 16.4ab | 19.0bc | 71.3a | 39.0b | 2.1bc | **12.3** |
| 2 | Cedar wood oil | 1000 | 6.7bc | 9.8b | 6.8b | 7.5b | 13.1b | 20.3b | 4.3a | 6.3bc | 29.0a | 24.0a | 13.1bc | 16.2bcd | 69.6a | 44.0b | 1.8bc | **13.0** |
| 3 | Eucalyptus oil | 1000 | 7.0bc | 9.9b | 7.1b | 7.8b | 14.9b | 14.5b | 3.4a | 4.9cb | 35.6a | 29.0a | 15.7b | 15.4cd | 70.3a | 37.3b | 1.5c | **12.6** |
| 4 | Lemon grass oil | 1000 | 5.7bc | 7.5c | 6.2b | 6.8b | 6.5c | 7.5c | 4.6ab | 4.2c | 28.3a | 22.7a | 12.3bc | 20.5b | 68.3a | 45.0b | 2.0bc | **12.0** |
| 5 | Neem azal | 1000 | 6.0bc | 8.1c | 6.1b | 6.8b | 4.8c | 7.2c | 3.9ab | 3.4d | 35.2a | 25.1a | 17.0ab | 14.0d | 70.0a | 19.6c | 1.6c | **11.3** |
| 6 | Dinotefuran | 200 | 7.8b | 9.9b | 6.4b | 7.3b | 4.0c | 6.8c | 3.8ab | 2.8d | 33.0a | 16.5a | 10.4c | 12.1d | 71.0a | 10.3d | 2.3bc | **9.7** |
| 7 | Rynaxypyr | 150 | 4.7c | 6.7c | 3.7c | 4.8c | 13.1b | 16.5b | 1.7b | 1.1d | 37.6a | 16.8a | 9.7c | 28.2a | 71.0a | 14.0cd | 2.9b | **11.0** |
| 8 | Untreated Control | Water | 16.3a | 18.0a | 19.2a | 20.0a | 37.2a | 41.5a | 5.5ab | 9.3a | 23.6a | 21.7a | 22.9a | 26.4a | 72.6a | 78.6a | 5.2a | **18.7** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Brown Plant Hopper (No./10 Hills) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ADT | | BPT | | GNV | | | | LDN | | | | |
| | | | 50DT | 80DT | 67DT | 82DT | 40DT | 60DT | 90DT | 100DT | 50DT | 60DT | 70DT | 75DT | 80DT |
| 1 | Camphor oil | 1000 | 6.0ab | 11.3a | 53.3a | 36.6a | 47.7b | 61.0ab | 47.3b | 30.0b | 10.6a | 9.6b | 21.6a | 15.6b | 17.3a |
| 2 | Cedar wood oil | 1000 | 6.3ab | 3.3b | 44.6a | 38.3a | 51.6ab | 56.0bc | 49.3b | 28.7b | 10.6a | 9.7b | 23.3a | 14.3bc | 16.3a |
| 3 | Eucalyptus oil | 1000 | 4.3ab | 8.0ab | 61.6a | 36.0a | 54.7ab | 54.6bc | 42.3b | 28.7b | 11.0a | 10.0b | 22.6a | 15.0bc | 16.6a |
| 4 | Lemon grass oil | 1000 | 4.3ab | 9.0a | 48.3a | 34.3ab | 50.0b | 55.3bc | 43.3b | 26.7bc | 10.7a | 8.6bc | 22.3a | 10.3cd | 13.0a |
| 5 | Neem azal | 1000 | 5.0ab | 8.0ab | 45.0a | 31.6ab | 32.6bc | 47.3c | 41.3b | 25.3bc | 11.7a | 8.3bc | 23.0a | 10.3cd | 12.3a |
| 6 | Dinotefuran | 200 | 3.0b | 7.0ab | 45.6a | 36.3a | 17.6c | 21.7d | 12.7c | 12.3c | 10.6a | 6.6c | 21.0a | 7.3d | 8.3a |
| 7 | Rynaxypyr | 150 | 4.0ab | 8.0ab | 48.0a | 21.0b | 55.3ab | 67.7bc | 65.3ab | 66.6a | 11.6a | 8.6bc | 21.6a | 11.3bcd | 13.3a |
| 8 | Untreated Control | Water | 7.6a | 11.0a | 58.0a | 42.3a | 88.3a | 87.6a | 92.3a | 96.0a | 12.6a | 21.6a | 25.0a | 30.0a | 34.0a |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Brown Plant Hopper (No./10 Hills) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MTU | | | | NDL | | | | NVS | | RGL | | |
| | | | 40DT | 50DT | 60DT | 70DT | 70DT | 80DT | 85DT | 90DT | 60DT | 63DT | 47DT | 54DT | 80DT |
| 1 | Camphor oil | 1000 | 23.6a | 77.0a | 108.6a | 377.3a | 62.8a | 200.9a | 35.2a | 321.4a | 12.0a | 7.6bc | 68.6a | 70.6a | 136.6a |
| 2 | Cedar wood oil | 1000 | 43.3a | 91.3a | 320.3a | 1343.6a | 84.7a | 242.8a | 37.6a | 332.3a | 11.3a | 2.0f | 60.6a | 74.0a | 138.3a |
| 3 | Eucalyptus oil | 1000 | 39.3a | 126.0a | 531.6a | 431.0a | 59.0a | 169.8a | 49.0a | 394.2a | 13.3a | 6.6c | 58.6a | 80.0a | 124.0a |
| 4 | Lemon grass oil | 1000 | 31.3a | 120.0a | 466.6a | 860.0a | 82.8a | 144.6a | 65.2a | 520.0a | 12.0a | 8.6b | 55.3a | 77.3a | 104.3a |
| 5 | Neem azal | 1000 | 40.0a | 130.3a | 451.3a | 1044.0a | 90.0a | 108.0a | 31.9a | 279.5a | 11.6a | 6.0cd | 59.3a | 84.0a | 128.3a |
| 6 | Dinotefuran | 200 | 17.6a | 10.0a | 56.6a | 107.3a | 63.3a | 167.6a | 12.8a | 137.1a | 11.0a | 4.6de | 69.3a | 42.0b | 103.3a |
| 7 | Rynaxypyr | 150 | 26.3a | 130.0a | 92.3a | 707.6a | 73.3a | 201.9a | 28.5a | 509.5a | 11.6a | 3.3e | 48.6a | 82.6a | 117.6a |
| 8 | Untreated Control | Water | 66.6a | 392.3a | 905.6a | 3168.3a | 71.9a | 152.3a | 44.2a | 316.1a | 11.3a | 13.3a | 62.6a | 78.0a | 158.6a |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Brown Plant Hopper (No./10 Hills) | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | RPR | | | SKL | | | | |
| | | | 30DT | 50DT | 70DT | 72DT | 76DT | 93DT | 97DT | |
| 1 | Camphor oil | 1000 | 7.3ab | 74.0ab | 112.6ab | 22.6a | 5.3b | 15.3a | 34.6ab | **64.9** |
| 2 | Cedar wood oil | 1000 | 7.3ab | 65.3ab | 88.6b | 22.0a | 4.0b | 15.6a | 32.3ab | **102.1** |
| 3 | Eucalyptus oil | 1000 | 8.6ab | 67.3ab | 98.0b | 18.3a | 5.3b | 20.6a | 33.0ab | **81.8** |
| 4 | Lemon grass oil | 1000 | 4.0b | 68.0ab | 104.0b | 16.6a | 4.6b | 14.6a | 30.3ab | **97.5** |
| 5 | Neem azal | 1000 | 9.3ab | 75.3ab | 97.3b | 17.0a | 4.6b | 15.3a | 33.0ab | **94.1** |
| 6 | Dinotefuran | 200 | 7.3ab | 52.6b | 84.0b | 14.3a | 2.3b | 17.0a | 25.0b | **36.8** |
| 7 | Rynaxypyr | 150 | 7.3ab | 70.6ab | 98.0b | 15.3a | 3.3b | 19.0a | 27.3b | **81.1** |
| 8 | Untreated Control | Water | 11.3a | 90.6a | 146.6a | 16.3a | 10.6a | 18.0a | 40.6a | **193.4** |

**Means in a column followed by different letters are significantly different at P=0**

**Table 2.15 (Contd…) Insect pest incidence in different treatments, BIET *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Whitebacked Planthopper(No/10 Hills) | | | | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BPT | | GVT | KUL | | MTU | | NVS | | SKL | | | | | |
| | | | 67DT | 82DT | 40DT | 61DT | 69DT | 50DT | 70DT | 60DT | 63DT | 46DT | 72DT | 76DT | 93DT | 97DT | |
| 1 | Camphor Oil | 1000 | 13.6a | 11.3a | 165.0ab | 20.6a | 47.6bc | 3.0a | 54.6a | 13.0a | 8.6bc | 18.3ab | 20.6a | 6.0bc | 12.3a | 13.3ab | **29.2** |
| 2 | Cedar wood oil | 1000 | 13.3a | 4.6a | 175.3ab | 22.0a | 63.3bc | 4.3a | 109.6a | 12.3a | 2.3g | 18.6ab | 18.3a | 7.0ab | 13.0a | 13.3ab | **34.1** |
| 3 | Eucalyptus oil | 1000 | 12.0a | 9.6a | 156.0ab | 26.3a | 67.0ab | 10.6a | 95.0a | 11.6a | 7.0dc | 16.3abc | 21.6a | 5.6bc | 12.6a | 12.3ab | **33.1** |
| 4 | Lemon grass oil | 1000 | 12.6a | 6.6a | 169.0ab | 27.7a | 51.0ab | 15.0a | 121.6a | 13.3a | 10.0b | 16.3abc | 17.3a | 7.0ab | 16.0a | 11.0bc | **35.3** |
| 5 | Neem azal | 1000 | 10.3a | 6.6a | 107.6ab | 33.0a | 60.0a | 9.3a | 129.3a | 13.0a | 5.6de | 14.3bc | 21.3a | 7.0abc | 11.3a | 13.0ab | **31.7** |
| 6 | Dinotefuran | 200 | 9.6a | 4.3a | 73.3a | 16.0a | 25.0c | 3.6a | 28.3a | 12.6a | 4.3ef | 7.3d | 19.6a | 3.3c | 11.0a | 8.0c | **16.8** |
| 7 | Rynaxypyr | 150 | 12.3a | 7.3a | 155.6ab | 25.3a | 50.0ab | 9.6a | 107.3a | 11.3a | 3.0fg | 10.6cd | 20.6a | 4.6bc | 12.0a | 10.0bc | **31.8** |
| 8 | Untreated Control | Water | 14.3a | 11.6a | 216.0b | 28.6a | 84.0ab | 23.0a | 243.3a | 11.6a | 14.0a | 22.0a | 24.3a | 10.6a | 10.6a | 15.6a | **51.7** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form /ha | Green Leaf Hopper (No./10 Hills) | | | | | | | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CBT | | JDP | | NVS | | RCI | | RPR | | SKL | | | | | | TTB | |
| | | | 28DT | 50DT | 60DT | 75DT | 60DT | 63DT | 79DT | 82DT | 50DT | 70DT | 42DT | 46DT | 72DT | 76DT | 93DT | 97DT | 30DT | 50DT |
| 1 | Camphor oil | 1000 | 4.0a | 2.3a | 38.0a | 19.7a | 12.6a | 9.0bc | 70.0a | 56.0b | 14.0a | 6.7a | 5.0a | 7.3b | 20.0a | 3.0b | 13.0a | 12.0a | 6.6ab | 5.6ab | **16.9** |
| 2 | Cedar wood oil | 1000 | 4.3a | 4.6a | 23.6a | 15.6a | 13.3a | 3.3g | 71.0a | 57.0b | 12.6a | 6.6a | 5.0a | 8.0ab | 21.0a | 4.0b | 13.0a | 10.3a | 5.0bc | 4.3ab | **15.7** |
| 3 | Eucalyptus oil | 1000 | 3.0a | 2.6a | 28.3a | 16.6a | 15.0a | 7.7cd | 69.0a | 46.6bc | 12.0a | 7.3a | 4.3a | 7.0b | 22.0a | 3.0b | 13.0a | 10.0a | 5.0bc | 3.6b | **15.4** |
| 4 | Lemon grass oil | 1000 | 3.0a | 3.6a | 37.0a | 26.0a | 14.3a | 10.3b | 71.3a | 50.6bc | 12.0a | 7.3a | 4.6a | 6.7b | 27.6a | 3.0b | 17.6a | 9.6a | 5.0bc | 4.6ab | **17.5** |
| 5 | Neem azal | 1000 | 3.0a | 2.6a | 29.3a | 28.7a | 13.3a | 6.6de | 74.0a | 29.0d | 10.6a | 8.6a | 4.3a | 7.0b | 24.0a | 3.6b | 14.3a | 10.0a | 3.3c | 3.0b | **15.3** |
| 6 | Dinotefuran | 200 | 2.3a | 1.3a | 11.3a | 12.7a | 14.7a | 5.3ef | 77.0a | 38.6cd | 10.6a | 8.6a | 5.0a | 2.0c | 20.0a | 1.3b | 11.7a | 3.6a | 6.3ab | 4.0b | **13.1** |
| 7 | Rynaxypyr | 150 | 3.3a | 1.0a | 12.0a | 11.0a | 14.3a | 4.0dgf | 75.6a | 41.6bcd | 14.6a | 8.6a | 3.3a | 3.0bc | 20.3a | 2.0b | 14.3a | 6.0a | 5.3bc | 4.0b | **14.2** |
| 8 | Untreated Control | Water | 5.3a | 4.6a | 40.6a | 26.3a | 14.6a | 17.0a | 70.3a | 76.3a | 15.3a | 13.3a | 7.3a | 14.3a | 19.3a | 7.6a | 15.0a | 15.6a | 9.0a | 7.3a | **21.1** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Hispa (% Damage Leaves) | | | Mean |
|---|---|---|---|---|---|---|
| | | | KRK | RCI | | |
| | | | 30DT | 33DT | 40DT | |
| 1 | Camphor oil | 1000 | 10.3a | 61.6a | 25.6bc | **32.6** |
| 2 | Cedar wood oil | 1000 | 8.2a | 63.3a | 27.3bc | **33.0** |
| 3 | Eucalyptus oil | 1000 | 6.0a | 65.6a | 19.0dc | **30.3** |
| 4 | Lemon grass oil | 1000 | 8.6a | 65.0a | 40.6ab | **38.1** |
| 5 | Neem azal | 1000 | 7.7a | 60.3a | 21.6c | **29.9** |
| 6 | Dinotefuran | 200 | 10.5a | 61.3a | 10.3d | **27.4** |
| 7 | Rynaxypyr | 150 | 9.5a | 62.0a | 16.6cd | **29.4** |
| 8 | Untreated Control | Water | 7.7a | 64.6a | 49.6a | **40.7** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Cut Worm (% Damage) | | | Mean |
|---|---|---|---|---|---|---|
| | | | IRS | | PTB | |
| | | | 30DT | 45DT | 45DT | |
| 1 | Camphor oil | 1000 | 11.0a | 11.7ab | 11.6a | **11.4** |
| 2 | Cedar wood oil | 1000 | 8.0a | 12.3ab | 13.9a | **11.4** |
| 3 | Eucalyptus oil | 1000 | 9.3a | 10.3ab | 10.3a | **10.0** |
| 4 | Lemon grass oil | 1000 | 10.0a | 12.7ab | 10.6a | **11.1** |
| 5 | Neem azal | 1000 | 10.0a | 6.3b | 10.7a | **9.0** |
| 6 | Dinotefuran | 200 | 9.7a | 14.0a | 12.2a | **12.0** |
| 7 | Rynaxypyr | 150 | 9.0a | 9.7ab | 10.4a | **9.7** |
| 8 | Untreated Control | Water | 8.7a | 16.0a | 10.5a | **11.7** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Gundhi Bug (% Damage) | | | | | Mean |
|---|---|---|---|---|---|---|---|---|
| | | | NVS | | REW | | | |
| | | | 70DT | 73DT | 34DT | 38DT | 45DT | |
| 1 | Camphor oil | 1000 | 12.7a | 7.7b | 17.7a | 8.3b | 10.3b | **11.3** |
| 2 | Cedar wood oil | 1000 | 11.0a | 2.3c | 15.0a | 8.3b | 9.0b | **9.1** |
| 3 | Eucalyptus oil | 1000 | 11.7a | 7.0b | 16.7a | 6.7b | 10.3b | **10.5** |
| 4 | Lemon grass oil | 1000 | 12.3a | 7.7b | 15.7a | 7.3b | 11.0b | **10.8** |
| 5 | Neem azal | 1000 | 11.7a | 5.7c | 19.0a | 10.0b | 11.7b | **11.6** |
| 6 | Dinotefuran | 200 | 12.0a | 3.3c | 18.7a | 8.0b | 1.7c | **8.7** |
| 7 | Rynaxypyr | 150 | 11.7a | 2.7c | 18.7a | 7.0b | 2.3c | **8.5** |
| 8 | Untreated Control | Water | 12.7a | 14.0a | 19.0a | 21.7a | 23.7a | **18.2** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Blue Beetle (No of beetles/10 Hills) | | | | | Mean |
|---|---|---|---|---|---|---|---|---|
| | | | SKL | | | | RPR | |
| | | | 25DT | 53DT | 83DT | 103DT | 70DT | |
| 1 | Camphor oil | 1000 | 1.0b | 2.3a | 4.7ab | 2.7a | 6.0a | **3.3** |
| 2 | Cedar wood oil | 1000 | 1.7ab | 1.7a | 5.3ab | 2.0a | 4.0a | **2.9** |
| 3 | Eucalyptus oil | 1000 | 1.0ab | 0.7a | 5.0ab | 2.7a | 7.3a | **3.3** |
| 4 | Lemon grass oil | 1000 | 1.0b | 1.3a | 6.0a | 2.7a | 6.0a | **3.4** |
| 5 | Neem azal | 1000 | 1.0ab | 1.0a | 4.7ab | 3.3a | 7.3a | **3.5** |
| 6 | Dinotefuran | 200 | 0.3b | 0.7a | 2.0b | 1.0a | 6.0a | **2.0** |
| 7 | Rynaxypyr | 150 | 0.3b | 0.3a | 3.0ab | 1.7a | 6.0a | **2.3** |
| 8 | Untreated Control | Water | 4.0a | 2.0a | 7.0a | 4.0a | 6.7a | **4.2** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Insect pests incidence in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Whorl Maggot (% Damaged Leaves) | | | | | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CHN | | IRS | | JDP | | KRK | MLN | NDL | | | PTB | | TTB | | |
| | | | 30DT | 50DT | 30DT | 45DT | 50DT | 55DT | 30DT | 47DT | 40DT | 50DT | 60DT | 25DT | 45DT | 30DT | 50DT | |
| 1 | Camphor oil | 1000 | 3.2bc | 2.1c | 8.3a | 14.7a | 9.9a | 6.3abc | 6.4a | 28.7b | 6.86a | 3.71a | 4.90a | 1.09b | 12.5a | 3.2b | 3.2ab | **7.7** |
| 2 | Cedar wood oil | 1000 | 3.2bc | 2.3bc | 11.3a | 12.7a | 6.9ab | 5.8abc | 5.4a | 22.4bc | 6.70a | 3.67a | 3.13a | 1.18b | 12.8a | 2.5bc | 2.9abc | **7.2** |
| 3 | Eucalyptus oil | 1000 | 2.9c | 2.1c | 9.3a | 12.7a | 9.2a | 7.1ab | 5.3a | 28.8b | 7.95a | 3.68a | 3.04a | 0.78b | 13.4a | 2.6bc | 2.2bc | **7.4** |
| 4 | Lemon grass oil | 1000 | 4.2ab | 3.1b | 10.7a | 12.3a | 8.7a | 7.0ab | 7.0a | 13.5c | 5.89a | 5.28a | 4.46a | 0.93b | 17.7a | 2.2bc | 2.3bc | **7.0** |
| 5 | Neem azal | 1000 | 2.6cd | 1.6c | 9.7a | 7.3b | 8.5a | 6.8ab | 6.4a | 14.9c | 4.75a | 3.88a | 4.44a | 0.90b | 15.2a | 1.4c | 1.6c | **6.0** |
| 6 | Dinotefuran | 200 | 1.7de | 0.9d | 8.7a | 14.3a | 3.8b | 2.8c | 8.1a | 13.9c | 6.91a | 4.42a | 4.07a | 1.52b | 8.0a | 2.8bc | 2.8abc | **5.9** |
| 7 | Rynaxypyr | 150 | 1.2e | 0.7d | 10.3a | 11.3ab | 5.3ab | 3.4c | 5.7a | 22.9bc | 4.37a | 2.90a | 3.50a | 0.88b | 8.4a | 3.2bc | 2.8bc | **5.8** |
| 8 | Untreated Control | Water | 5.5a | 4.5a | 9.0a | 14.3a | 10.5a | 8.7a | 4.6a | 46.9a | 4.76a | 3.40a | 3.07a | 8.68a | 18.8a | 5.6a | 4.7a | **10.2** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Incidence of Natural enemies in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Mirid Bugs (No./10 hills) | | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | KUL | | MTU | | SKL | | | | | | TTB | | |
| | | | 69DT | 81DT | 50DT | 70DT | 42DT | 46DT | 72DT | 76DT | 93DT | 97DT | 30DT | 50DT | |
| 1 | Camphor Oil | 1000 | 6.0b | 92.3ab | 3.3a | 43.3a | 5.0a | 7.3b | 20.0a | 3.0b | 13.0a | 12.0a | 6.6ab | 5.6ab | **18.1** |
| 2 | Cedar wood oil | 1000 | 11.6ab | 116.6ab | 3.6a | 81.6a | 5.0a | 8.0ab | 21.0a | 4.0b | 13.0a | 10.3ab | 5.0bc | 4.3ab | **23.7** |
| 3 | Eucalyptus oil | 1000 | 19.3a | 83.3b | 10.0a | 51.3a | 4.3a | 7.0b | 22.0a | 3.0b | 13.0a | 10.0ab | 5.0bc | 3.6b | **19.3** |
| 4 | Lemon grass oil | 1000 | 14.0ab | 84.3ab | 6.3a | 88.6a | 4.6a | 6.6b | 27.6a | 3.0b | 17.6a | 9.6ab | 5.0bc | 4.6ab | **22.7** |
| 5 | Neem azal | 1000 | 22.6a | 157.0a | 8.3a | 65.3a | 4.3a | 7.0b | 24.0a | 3.6b | 14.3a | 10.0ab | 3.3bc | 3.0b | **26.9** |
| 6 | Dinotefuran | 200 | 24.6a | 31.3c | 1.0a | 21.3a | 5.0a | 2.0c | 20.0a | 1.3b | 11.6a | 3.6c | 6.3ab | 4.0b | **11.0** |
| 7 | Rynaxypyr | 150 | 26.0a | 114.0ab | 10.0a | 82.6a | 3.3a | 3.0bc | 20.3a | 2.0b | 14.3a | 6.0bc | 5.3ab | 4.0b | **28.4** |
| 8 | Untreated Control | Water | 27.6a | 128.0ab | 14.0a | 120.0a | 7.3a | 14.3a | 19.3a | 7.6a | 15.0a | 15.6a | 9.0a | 7.3a | **36.3** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Incidence of Natural enemies in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Spiders (No/10 Hills) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CBT | | GNV | | KUL | | | | | LDN | | | | | |
| | | | 28DT | 50DT | 56DT | 70DT | 55DT | 61DT | 69DT | 81DT | 50DT | 50DT | 55DT | 60DT | 70DT | 75DT | 80DT |
| 1 | Camphor oil | 1000 | 2.3a | 2.0ab | 4.3b | 2.6bc | 4.6a | 5.3a | 6.3a | 9.0a | 7.0a | 16.6a | 12.6bcd | 14.0bc | 23.3a | 18.0b | 19.6b |
| 2 | Cedar wood oil | 1000 | 1.6a | 2.0ab | 4.0bc | 2.6bc | 6.3a | 4.3a | 8.0a | 9.0a | 5.6a | 16.6a | 13.0bc | 14.3b | 21.6a | 17.6b | 18.0bc |
| 3 | Eucalyptus oil | 1000 | 3.0a | 3.0ab | 5.0b | 2.3c | 3.3a | 4.0a | 3.6a | 6.3ab | 6.3a | 17.6a | 14.6b | 15.6bc | 22.3a | 16.3bc | 17.3bc |
| 4 | Lemon grass oil | 1000 | 2.6a | 1.3ab | 2.6bc | 2.0c | 3.3a | 5.6a | 5.0a | 7.3ab | 7.0a | 18.0a | 13.6bc | 14.6bc | 23.6a | 16.0bcd | 17.0bcd |
| 5 | Neem azal | 1000 | 3.0a | 2.6ab | 5.0b | 4.3b | 4.6a | 5.6a | 4.3a | 8.3ab | 6.6a | 17.3a | 13.6bc | 14.0bc | 24.0a | 14.3dc | 15.3cd |
| 6 | Dinotefuran | 200 | 1.3a | 1.0ab | 2.0c | 1.6c | 6.3a | 6.6a | 5.6a | 4.3b | 7.6a | 18.3a | 10.3d | 11.6d | 23.3a | 13.0d | 14.3d |
| 7 | Rynaxypyr | 150 | 1.6a | 0.6a | 4.6b | 4.3b | 4.6a | 5.0a | 5.6a | 7.0ab | 7.0a | 18.3a | 11.3dc | 12.6cd | 23.0a | 14.3cd | 15.3cd |
| 8 | Untreated Control | Water | 3.3a | 3.3b | 8.3a | 10.0a | 6.0a | 5.6a | 4.0a | 7.3ab | 7.0a | 18.6a | 22.6a | 24.3a | 23.3a | 26.3a | 28.3a |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.15 (Contd…) Incidence of Natural enemies in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Spiders (No./10Hills) | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MTU | | NDL | | | RPR | SKL | | | | |
| | | | 60DT | 70DT | 40DT | 50DT | 60DT | 70DT | 25DT | 53DT | 83DT | 104DT | |
| 1 | Camphor oil | 1000 | 7.3a | 10.6a | 7.0a | 7.3ab | 10.6a | 4.0a | 2.3abc | 3.3ab | 5.0ab | 2.6ab | **8.3** |
| 2 | Cedar wood oil | 1000 | 10.0a | 10.6a | 5.6a | 10.0b | 10.6a | 5.3a | 1.6bc | 3.3ab | 6.6a | 2.6ab | **8.5** |
| 3 | Eucalyptus oil | 1000 | 10.3a | 15.3a | 6.3a | 10.3b | 15.3a | 5.3a | 2.3abc | 3.3ab | 5.0ab | 3.0ab | **8.7** |
| 4 | Lemon grass oil | 1000 | 8.6a | 13.3a | 7.0a | 8.6ab | 13.3a | 5.3a | 2.6ab | 3.3ab | 5.0ab | 3.6ab | **8.4** |
| 5 | Neem azal | 1000 | 9.6a | 15.0a | 6.6a | 9.6ab | 15.0a | 6.6a | 2.3abc | 3.3ab | 5.0ab | 2.6ab | **8.8** |
| 6 | Dinotefuran | 200 | 7.3a | 14.0a | 7.6a | 7.3a | 14.0a | 5.3a | 1.0bc | 1.3b | 2.6b | 2.0ab | **7.6** |
| 7 | Rynaxypyr | 150 | 5.6a | 12.6a | 7.0a | 5.6ab | 12.6a | 6.0a | 0.6c | 1.0b | 2.3b | 1.6b | **7.6** |
| 8 | Untreated Control | Water | 11.3a | 13.3a | 7.0a | 11.3ab | 13.3a | 6.6a | 4.3a | 4.3a | 4.6ab | 5.0a | **11.2** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.16 Grain Yield in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Yield (kg)/ha | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BPT | CBT | CHN | CHP | GVT | IRS | JDP | KBP | KJT | KRK | KUL | LDN | MLN | MSD |
| 1 | Camphor oil | 1000 | 3586.6a | 4327.5a | 4333.3c | 4191.1cd | 6133.3ab | 3050.0a | 3708.3a | 4616.6ab | 2900.0c | 1611.6ab | 5083.3ab | 5741.6c | 1866.6bc | 1745.8ef |
| 2 | Cedar wood oil | 1000 | 3841.3a | 4059.3ab | 4450.0c | 4347.8cd | 6166.6ab | 2963.3a | 3568.3a | 3750.0b | 4066.6b | 1908.3ab | 4966.6abc | 6166.6bc | 1716.6bc | 1979.1de |
| 3 | Eucalyptus oil | 1000 | 3256.0a | 4014.8ab | 4916.6b | 4151.9d | 6333.3ab | 3305.0a | 3616.6a | 4366.6ab | 2583.3cd | 1488.3b | 5000.0abc | 6000.0bc | 1933.3bc | 2158.3d |
| 4 | Lemon grass oil | 1000 | 3489.3a | 4061.5ab | 4166.6c | 4504.5cd | 6466.6ab | 3133.3a | 3795.0a | 4466.6ab | 3166.6c | 1703.3ab | 4750.0c | 6641.6ab | 2583.3ab | 2543.3c |
| 5 | Neem azal | 1000 | 3792.0a | 4155.0ab | 4950.0b | 4112.8d | 6300.0ab | 3373.3a | 3726.6a | 4733.3a | 4650.0ab | 1720.0ab | 4900.0bc | 6666.6ab | 2950.0a | 3025.0b |
| 6 | Dinotefuran | 200 | 4196.0a | 4055.7b | 5300.0ab | 4641.5ab | 7433.3a | 2985.0a | 4075.0a | 4166.6ab | 5115.0a | 2250.0a | 5216.6a | 7100.0a | 2833.3a | 3143.3b |
| 7 | Rynaxypyr | 150 | 4141.3a | 4741.3ab | 5633.3a | 4857.0a | 6833.3ab | 2801.6a | 4030.0a | 4416.6ab | 5336.6a | 1846.6ab | 5166.6ab | 7183.3a | 1916.6bc | 3870.0a |
| 8 | Untreated Control | Water | 3544.0a | 3767.5ab | 3616.66d | 3035.6d | 4866.6b | 2766.6a | 3433.3a | 4650.0a | 2133.3d | 1585.0ab | 4950.0abc | 5366.6c | 1166.6c | 1458.3f |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table 2.16 (Contd…) Grain Yield in different treatments, BIET, *Kharif* 2017**

| Sl. No. | Common Name | Rate g or ml of form/ha | Yield (kg)/ha | | | | | | | | | | | | Mean | IOC(%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MTU | NDL | NLR | NVS | PSA | PTB | RCI | REW | RGL | RPR | SKL | TTB | | |
| 1 | Camphor oil | 1000 | 2579.0b | 4444.16a | 2221.6b | 3103.3d | 8283.3a | 1300.0a | 2733.3b | 1683.3ab | 6150.0a | 6166.6a | 1911.6ab | 4981.6c | **3786.7** | **13.3** |
| 2 | Cedar wood oil | 1000 | 2388.3b | 4629.3a | 2441.6b | 3383.3cd | 7983.3ab | 1266.6a | 2760.0b | 1700.0ab | 6493.3a | 6358.3a | 1665.0b | 5851.6b | **3879.7** | **16.1** |
| 3 | Eucalyptus oil | 1000 | 2314.3b | 4073.6a | 2343.3b | 3208.3bc | 7833.3ab | 1633.3a | 2716.6b | 1708.3ab | 6273.3a | 6241.6a | 1800.0b | 6188.3ab | **3825.3** | **14.5** |
| 4 | Lemon grass oil | 1000 | 2191.6b | 3703.3a | 2221.6b | 3446.6bc | 7350.0abc | 1500.0a | 2773.3b | 1558.3ab | 6030.0a | 5966.6ab | 2130.0ab | 4895.0c | **3816.9** | **14.2** |
| 5 | Neem azal | 1000 | 2399.6b | 4888.6a | 2471.6b | 2983.3ab | 7233.3abc | 1283.3a | 3360.0b | 1391.6b | 6676.6a | 6166.6a | 2303.3ab | 6463.3a | **4102.9** | **22.8** |
| 6 | Dinotefuran | 200 | 3322.6a | 3666.3a | 2300.0b | 3510.0e | 7216.6abc | 1216.6a | 3253.3b | 2166.6a | 6020.0a | 6158.3a | 2746.6a | 4771.6c | **4186.9** | **25.3** |
| 7 | Rynaxypyr | 150 | 2576.6b | 4073.6a | 3063.3a | 3590.0ab | 6933.3bc | 2516.6a | 3350.0a | 2116.6a | 6476.6a | 6116.6a | 2735.0a | 4866.6c | **4276.5** | **28.0** |
| 8 | Untreated Control | Water | 2784.6ab | 4370.0a | 2453.3b | 2800.0a | 6033.3c | 1333.3a | 2660.0b | 1233.3b | 5756.6a | 5191.6b | 1655.0b | 4253.3d | **3340.9** | |

**Means in a column followed by different letters are significantly different at P=0.05**

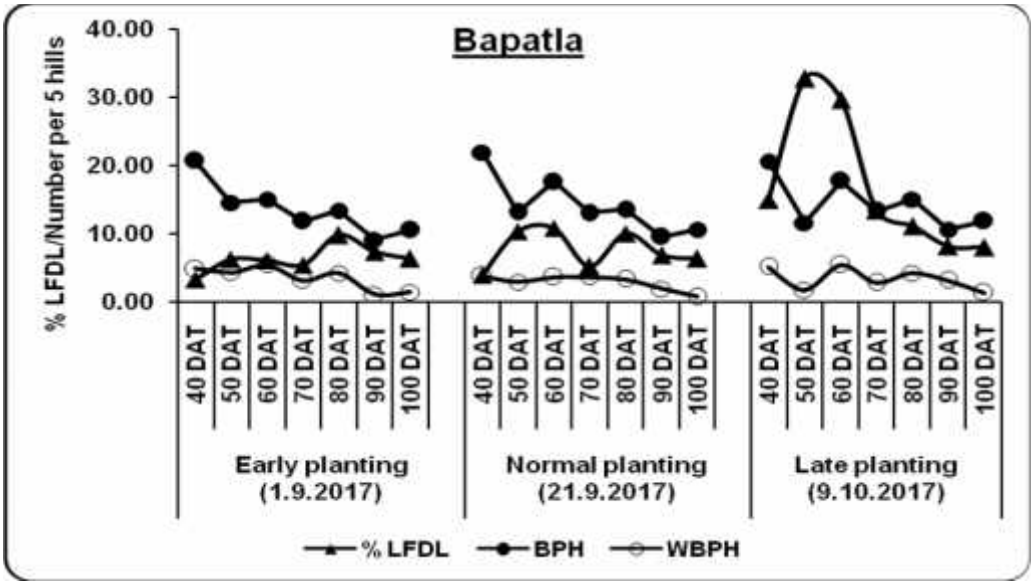
## ECOLOGICAL STUDIES

Climate change associated impact on onset of monsoon and its distribution pattern is forcing farmers to alter dates of sowing and planting of rice crop in various States in India. Alterations in sowing and planting dates can have profound effect on the insect pest incidence and their population dynamics resulting in varying damage levels. Hence, it is vital to have the knowledge of insect pests in relation to planting dates and crop phenology for their efficient management. Keeping this in view, the trial on effect of planting dates on insect pest incidence was continued and the results were presented below.

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

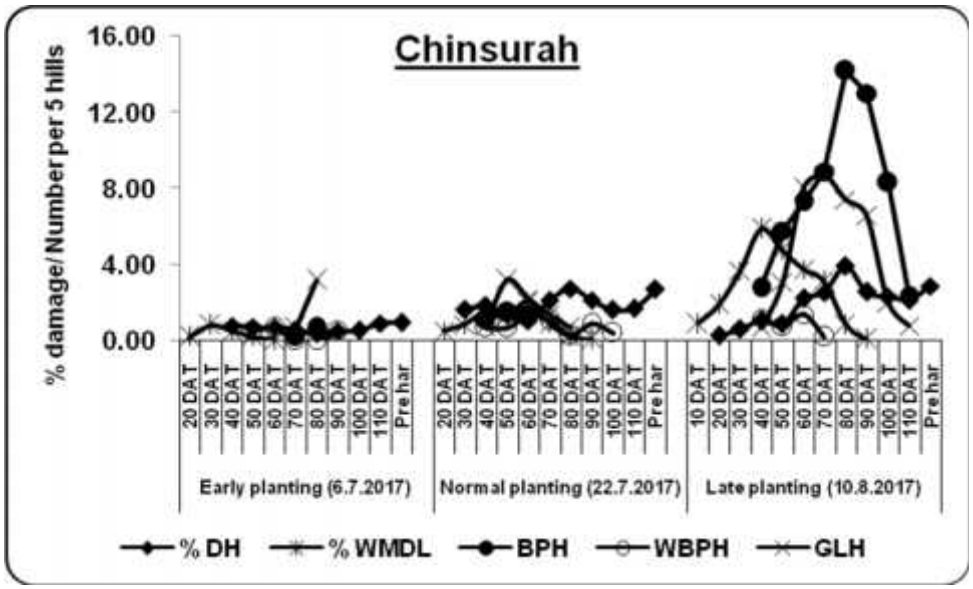
This trial was conducted at 20 locations during *Kharif* 2017. At each location, most popular variety of that region was planted at three dates *viz.*, normal planting as per the recommended package of practices of that region, 20 days earlier to normal planting, designated as 'early planting' and 20 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.

**Bapatla (15° 90' N & 80° 47' E):** Incidence of leaf folder, BPH and WBPH was observed in all the three plantings starting from 40 DAT onwards in BPT 5204. Leaf folder damage ranged between 3.30 and 32.76% in three plantings with highest damage in late planting (16.85%) as compared to early (6.34%) and normal plantings (7.65%). BPH numbers ranged between 13.57 – 14.37 hoppers/ 5 hills in all the three plantings. However, low incidence of WBPH was observed in all the plantings (2.83-3.47 hoppers/5 hills).

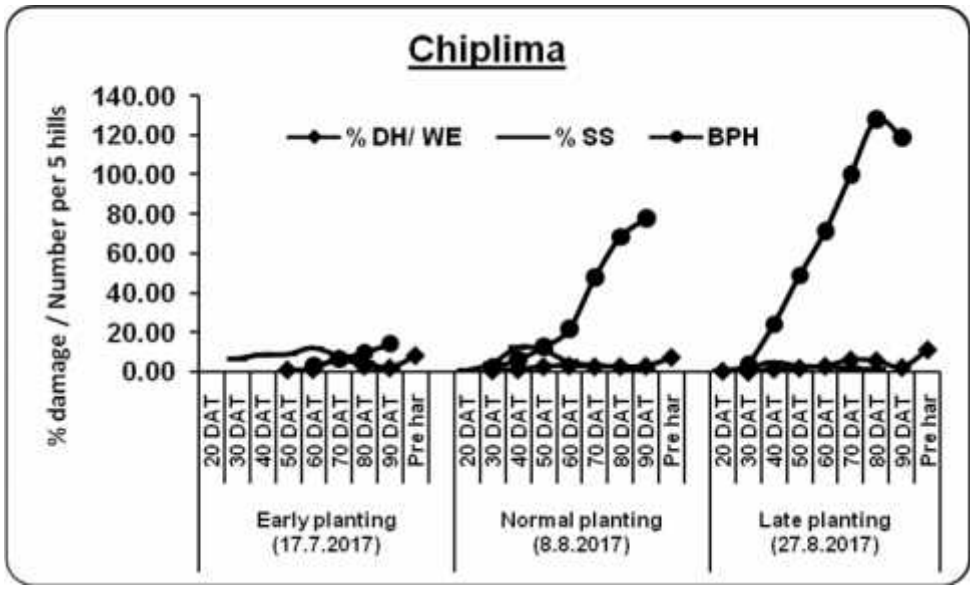



**Chinsurah (22° 88' N & 88° 39' E):** BPH incidence was low (0.2 to 14.2 hoppers/ 5 hills) in Swarna (MTU 7209) variety grown in all the plantings. Low incidence of stem borer (0.28 – 3.92 % DH), gall midge (0.18 – 1.47 %SS), leaf folder (<1 %DL), whorl maggot (0.6 – 5.9 %DL), hispa (0.9 – 4.2 %DL), WBPH (<2 hoppers/5 hills) and GLH (0.7 – 8.7 hoppers/5 hills) was observed in all the three plantings.

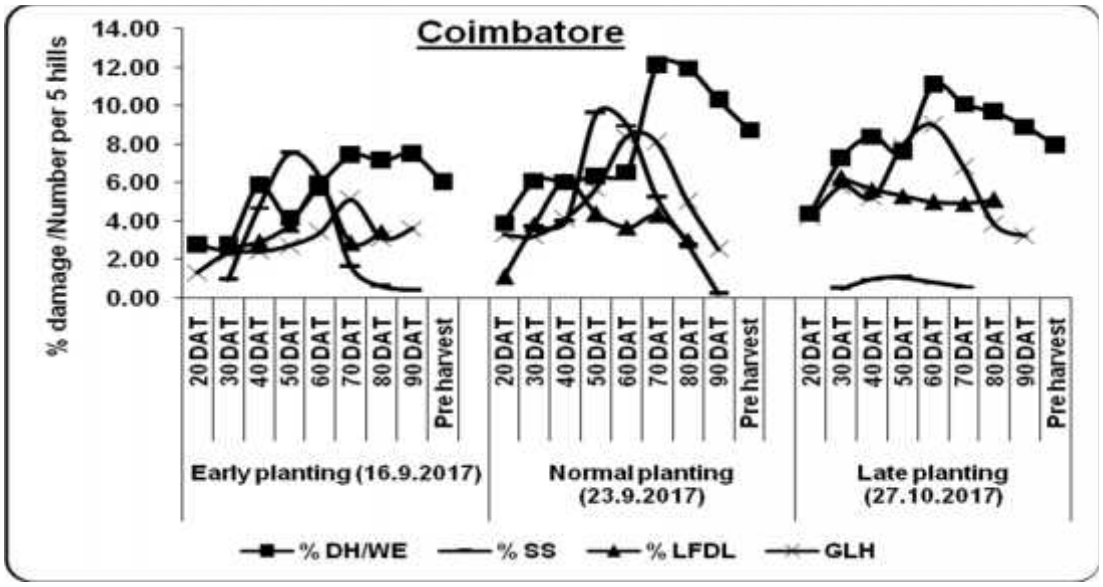
Highest grain yield of 50 q/ ha was recorded in early planting followed by normal planting with 43.60 q/ ha and late planting with 40.40 q/ ha.



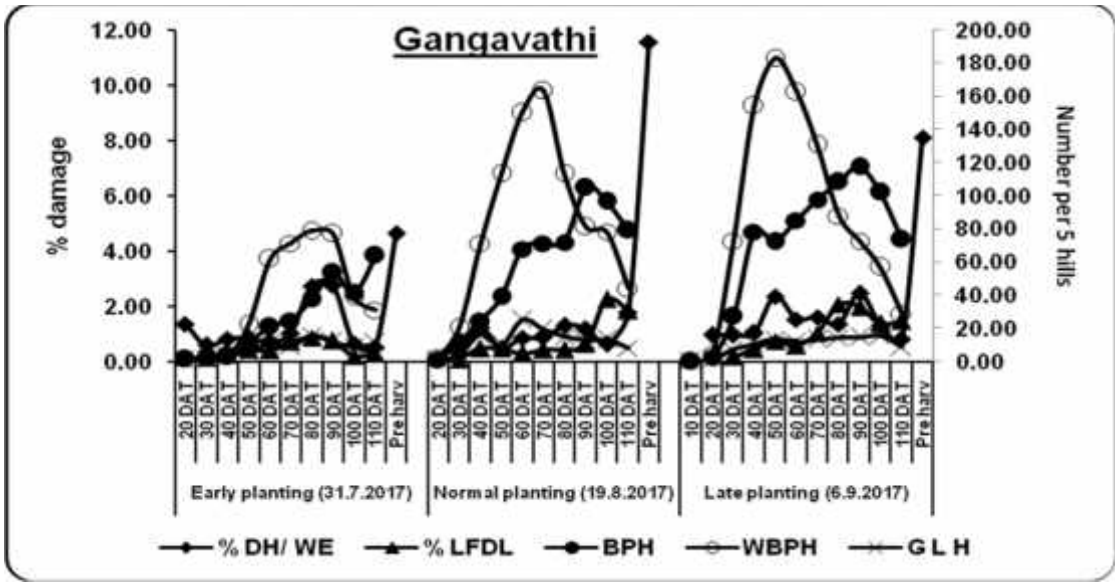

**Chiplima** (**21° 46'N & 83° 98'E):** Incidence of stem borer, gall midge and BPH was observed in Jaya variety grown in all the three plantings. Stem borer damage varied from 7.43 to 11.26% WE with maximum white ears in late planting at pre-harvest stage. Gall midge damage crossed ETL in early planting at 60 DAT (12.17% SS) and in normal planting at 40 DAT (12.52% SS) and 50 DAT (11.05% SS). BPH population varied from 1.7 to 128.1 hoppers/5 hills and crossed ETL in normal planting at 80 DAT onwards (68.30 – 77.50 hoppers/ 5 hills) and in late planting at 60 DAT onwards (71.10 – 128.10 hoppers/5 hills). Grain yield of 40.5, 37 and 27.5 q/ ha was recorded in early, normal and late plantings, respectively.




**Coimbatore (11° 02' N & 76° 95' E):** Stem borer, gall midge, leaf folder and GLH incidence was reported on CO 51 grown in all the plantings at this location. Stem borer damage crossed ETL in normal planting at 70 - 90 DAT (10.29-12.10% DH) and in late planting at 60 - 70 DAT (10.09-11.09% DH). Low damage of all other pests was observed in all the three plantings. Grain yield varied from 35.81 to 39.20 q/ ha in all the three plantings.

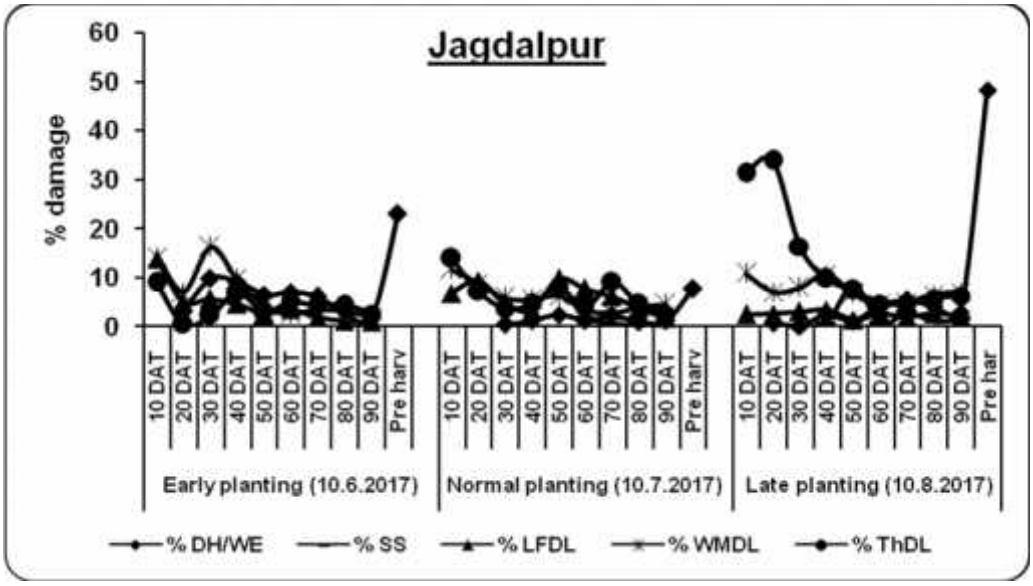



**Gangavati (15° 43' N & 76° 53' E):** WBPH population (1.8 – 163.3 hoppers/5 hills) was high as compared to BPH population (1.3-105.1 hoppers/5 hills) in all the three plantings on BPT 5204 grown in this trial. WBPH numbers crossed ETL at 60 – 90 DAT in early planting (61.80 – 78.80 hoppers/ 5 hills), at 40 – 100 DAT in normal planting (71.30-163.30 hoppers/5 hills) and at 30-90 DAT in late planting (72.80 – 182.90 hoppers/ 5 hills) . Similarly, BPH population crossed ETL between 90 – 110 DAT (53.60 - 64.10 hoppers/ 5 hills) in early planting, at 60-110 DAT in normal planting (68.00 – 105.10 hoppers/ 5 hills) and at 40-110 DAT in late planting (72.60 – 117.50 hoppers/ 5 hills) . Low damage by stem borer (< 2% DH & 4.65- 11.57% WE), leaf folder (<5% DL) and GLH (<5 hoppers/hill) was recorded. Low grain yield of 14.35, 20.92 and 21.62 q/ ha was recorded in early, normal and late plantings, respectively.

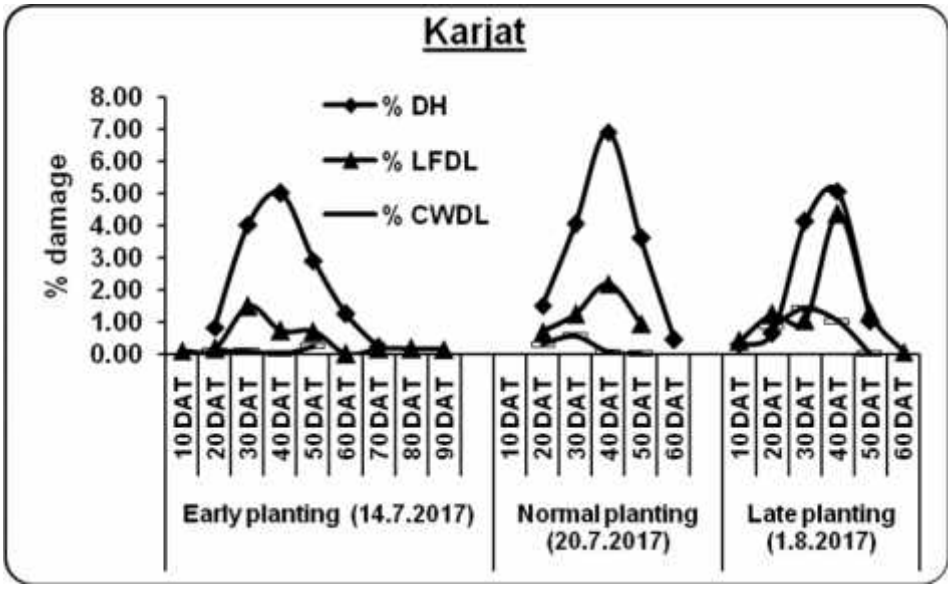



**Jagdalpur 19° 4' N & 82° 0' E):** Low incidence of stem borer (1.36-5.73% DH), gall midge (0.3-8.4% SS) leaf folder (1.0-13.8% DL), whorl maggot (1.9-16.2% DL), hispa (0.1-7.3%), BPH (0.6-2.1 hoppers/5 hills), WBPH (0-0.6 hoppers/5 hills) and GLH (0.2-11.7 hoppers/5 hills) was observed in Swarna variety in all the three plantings. However, incidence of white ears crossed ETL in early planting

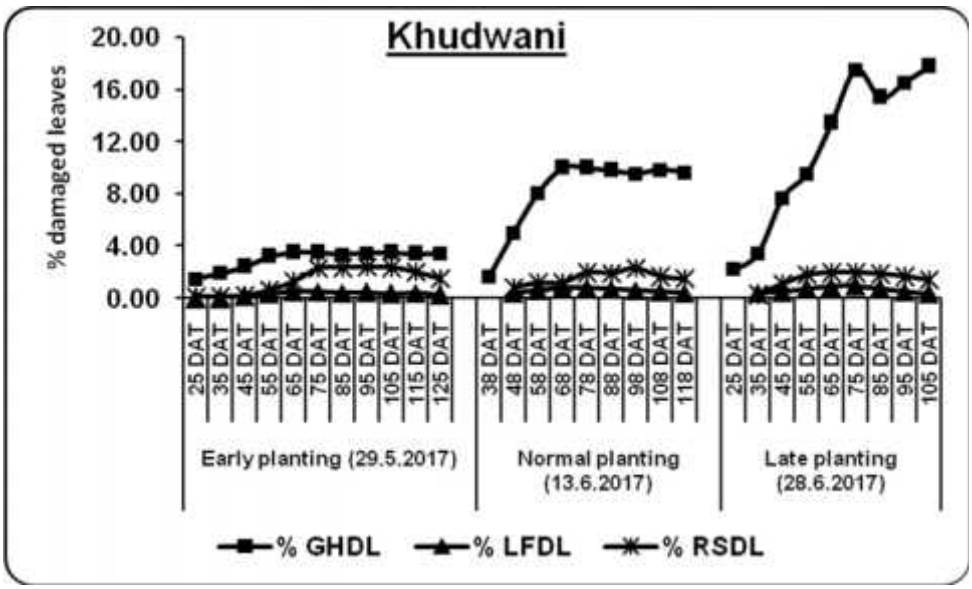
(23.02%) and late planting (48.24%). Similarly, thrips damage was very high in late planting at 10-30 DAT (16.34 – 33.92% DL). Grain yield varied from 20.4 – 36.8 q/ ha in all the three plantings.



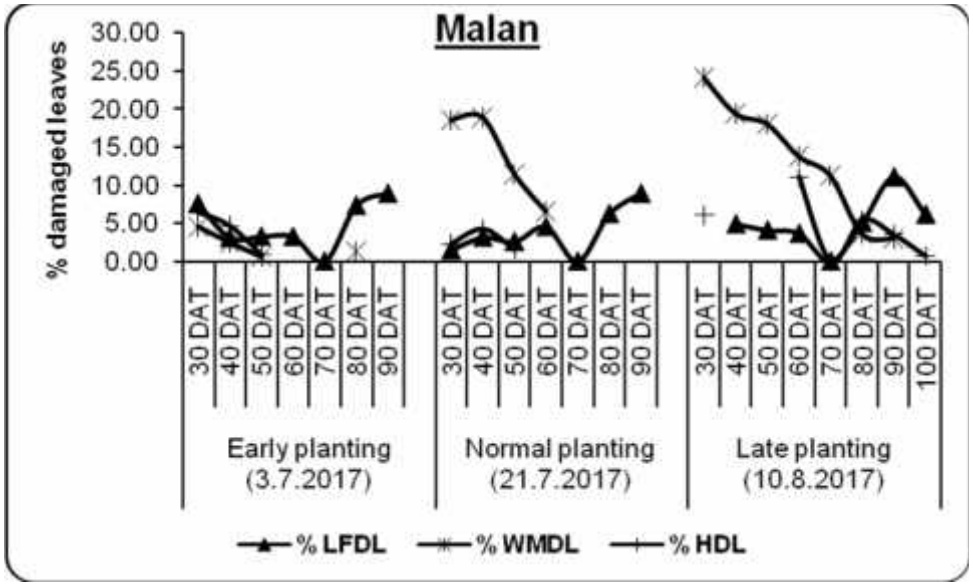

**Karjat (18° 92' N & 73° 33' E):** Low incidence of stem borer (<7% DH), leaf folder (<5% DL) and case worm (<5% DL) was reported from all the three plantings in Karjat 3 variety grown in this trial. Yield of 36.3-44.9 q/ ha was recorded in various plantings.



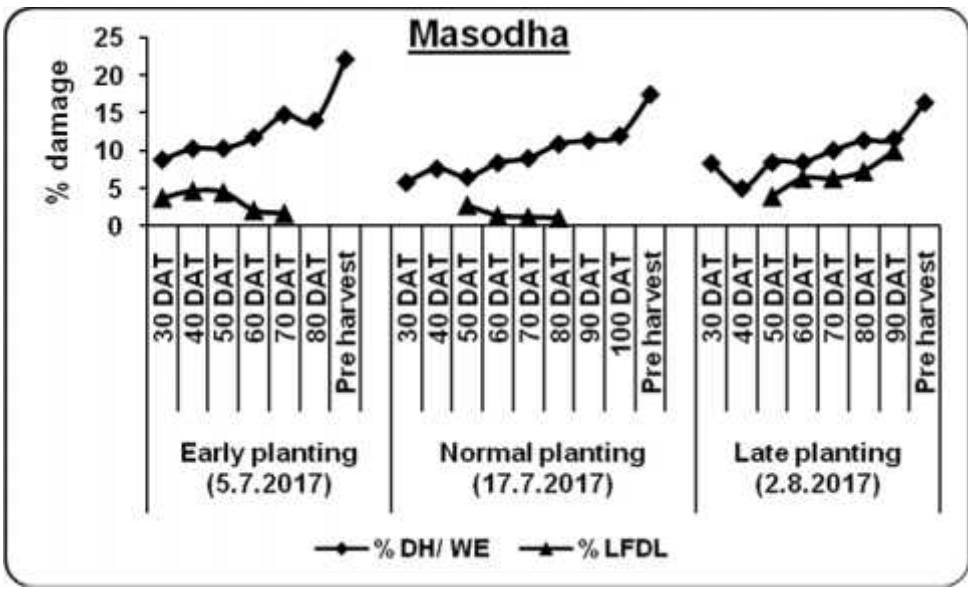

**Khudwani (33° 71' N & 75° 10' E):** Incidence of grasshopper was high in late planting from 65 to 105 DAT (13.43 – 17.77% DL) while it was low (≤10% DL) in early and normal plantings. However, very low incidence of leaf folder (<2% DL) and rice skipper (<3% DL) was reported from all the three plantings. High yield of 60.8 to 73.4 q/ ha was recorded in different plantings of Jhelum variety.



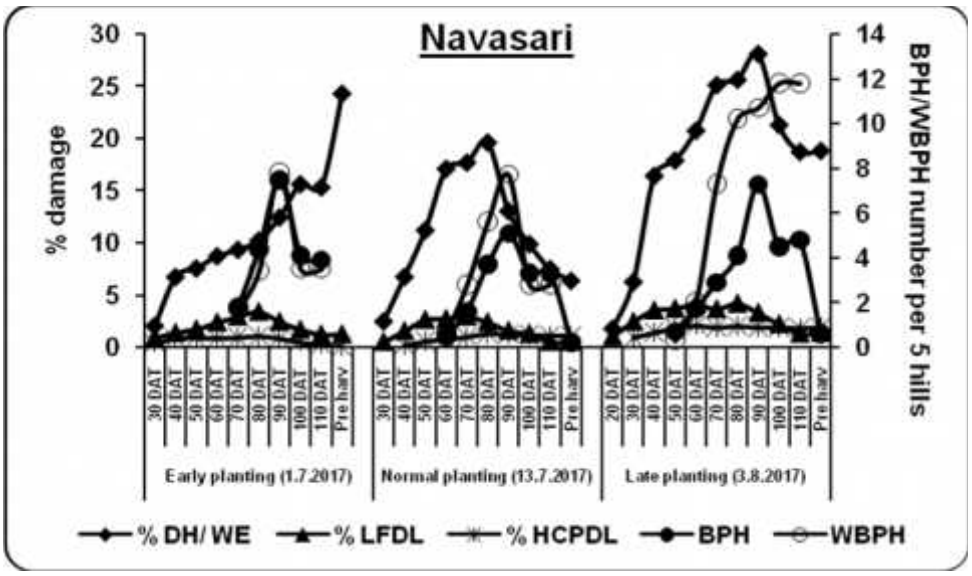

**Malan (32° 11' N & 76° 25' E):** Incidence of leaf feeding insects like leaf folder, whorl maggot and hispa was observed in all the three plantings in a scented variety, Kasturi. Damage by whorl maggot was high in late planting starting from 30 DAT to 70 DAT (11.2-24.1% DL) followed by normal planting from 30-50 DAT (11.5-18.9% DL). Leaf folder and hispa damage was low (<10% DL) in all the plantings. Low grain yield of 21.45, 19.64 and 3.41 q/ ha was recorded in early, normal and late plantings, respectively.




**Masodha (26°77' N & 82° 14'E):** Stem borer and leaf folder incidence was observed in Pusa Basmati variety grown in this trial. Stem borer damage crossed ETL from 40 DAT onwards up to pre harvest in early planting (10.25-14.77%), from 80 DAT to pre harvest in normal planting (10.86-17.46%) and from 70 DAT to pre harvest in late planting (10.01-16.37%). However, leaf folder damage was very low (1.0-9.9% DL). Yield ranged from 26 to 34 q/ ha in all the three plantings.

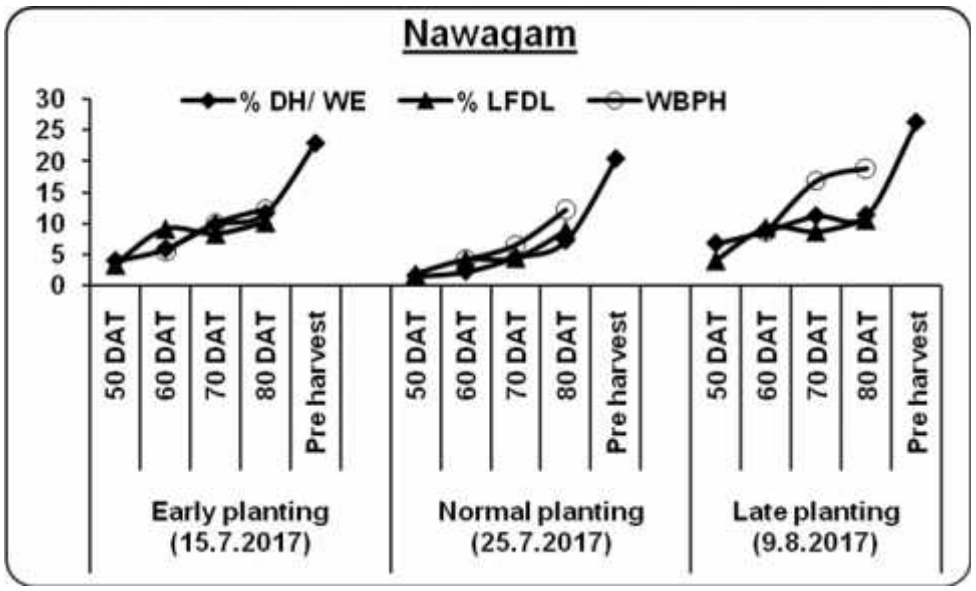



**Navasari (20° 94' N & 72° 95' E):** Stem borer incidence was high in all the three plantings in GR 11 variety. Stem borer damage crossed ETL at 80 DAT onwards up to pre harvest in early planting (10.22-15.31% DH & 24.27% WE), at 50-90 DAT in normal planting (11.22-19.61% DH) and at 40 DAT to pre harvest in late planting (16.4-28.07% DH & 18.8% WE) with highest damage in late planting.

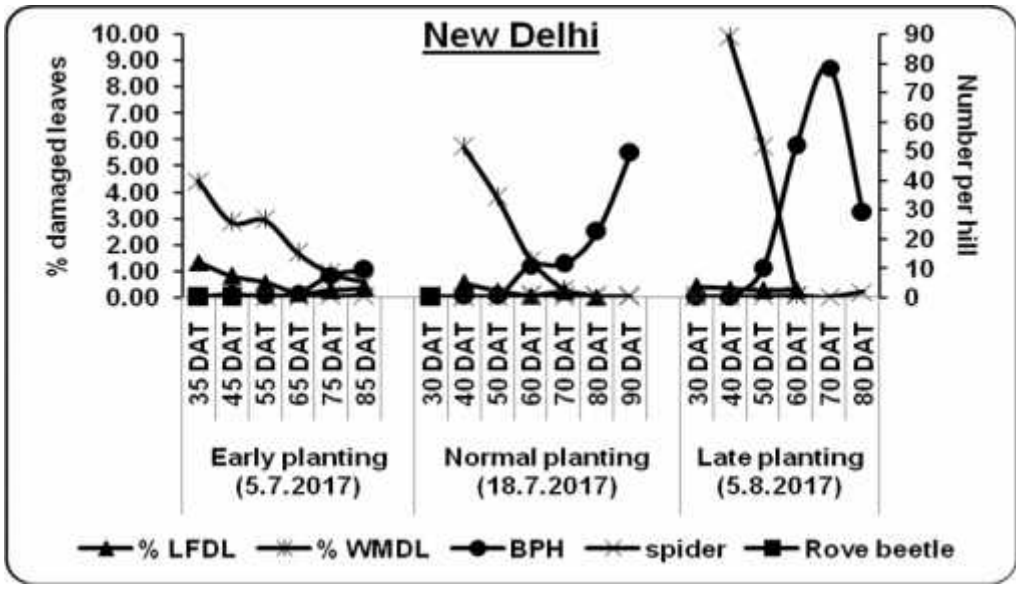



Low incidence of leaf folder (<5% DL), horned caterpillar (<3% DL), BPH, WBPH and GLH with less than 2 hoppers/hill were recorded. Grain yield of 32.44 to 41.47 q/ ha was recorded in all the three plantings.

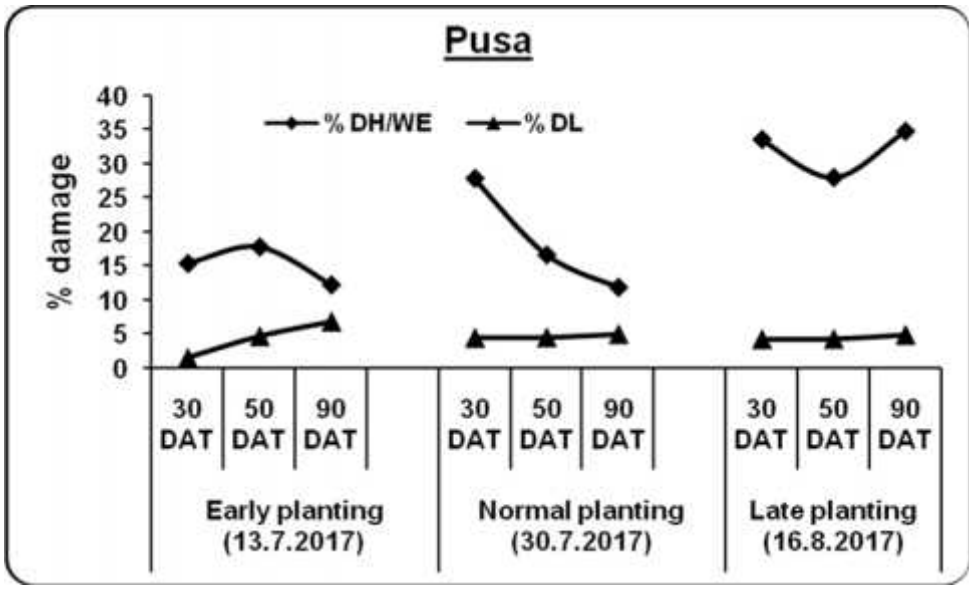
**Nawagam (23° 26' N & 71°95' E):** Incidence of dead hearts (3.8-9.46% DH) caused by stem borer, leaf folder damaged leaves (1.7-10.45% DL) and WBPH (4 - 18.8 hoppers/5 hills) was low in all the three plantings in GR 11 variety. However, the incidence of white ears caused by stem borer was high in early (22.85%), normal (20.35%) and late plantings (26.25%). Yield varied between 31.08 and 37.92 q/ ha in different plantings.



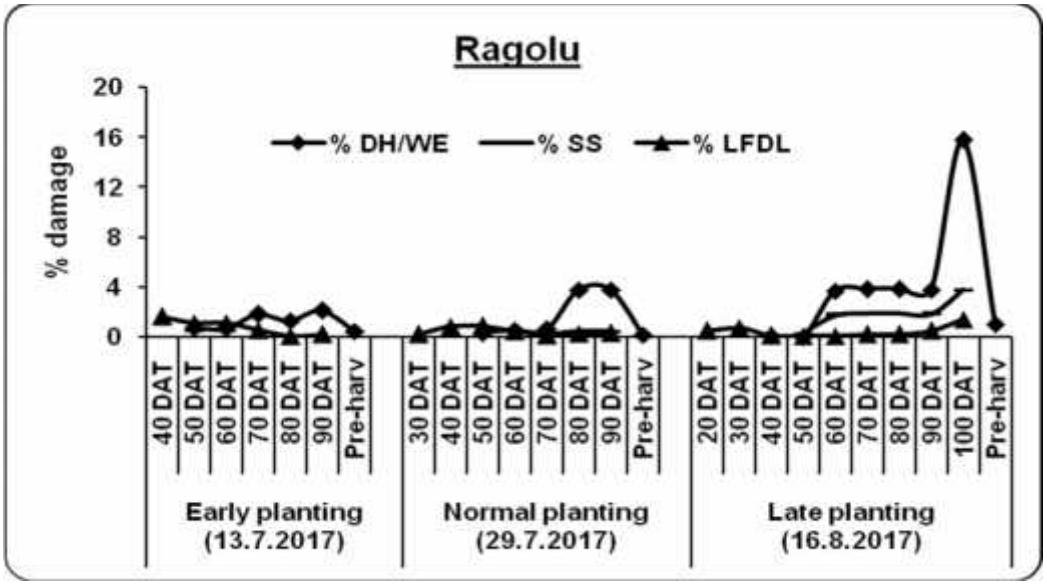

**New Delhi (28° 61' N & 77° 20' E):** High population of BPH was observed in late planting at 70 DAT (78 hoppers/hill) and 60 DAT (52 hoppers/hill) followed by normal planting at 90 DAT (49 hoppers/hill), 80 DAT (22 hoppers/hill) and 70 DAT (11 hoppers/hill). Whorl maggot damage was also high in late planting at 30 DAT (14.73% DL). Very low incidence of leaf folder (<2% DL) and WBPH (<3 hoppers/hill) were recorded in different plantings. Spiders (<2/hill) and rove beetles (<1/hill) were also recorded in all the three plantings in Pusa 1121 variety grown in this trial.



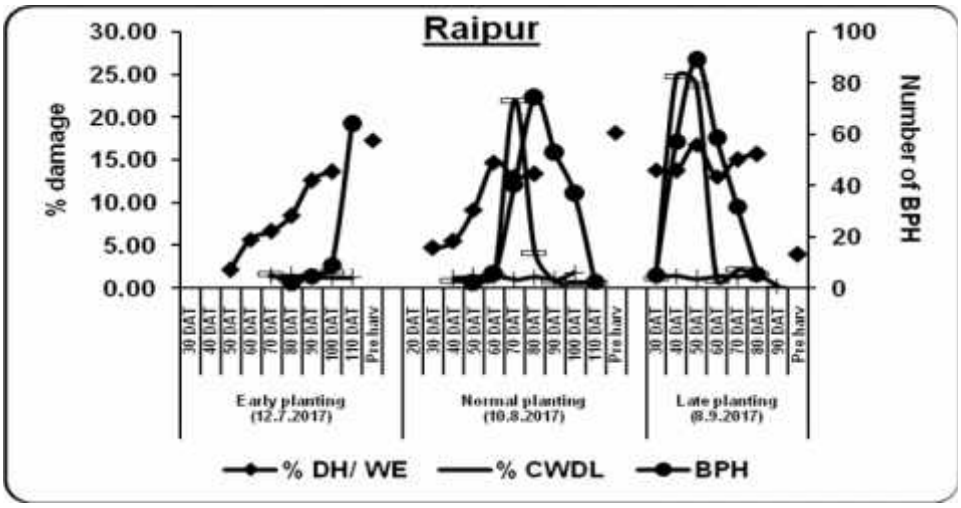

**Pusa (25°98'N & 85°64' E):** Rajendra mansuri variety was grown in this trial in all the three plantings. High incidence of stem borer was observed in late planting (28.02 – 33.59% DH & 34.78% WE) compared to normal planting (16.71-27.88% DH & 11.95% WE) and early planting (15.43-17.86% DH & 12.31% WE). Low incidence of leaf folder was reported in all the three plantings (1.5-6.8% DL).




**Ragolu (18°35'N & 83°89' E):** Low incidence of stem borer was observed in all the plantings (<5% DH) except at 100 DAT in late planting (15.75% WE) in Swarna variety grown in this trial. Incidence of gall midge and leaf folder was also low (<5%) in three plantings. Natural enemies like spiders (0-3.1/hill), coccinellids (0-2.2/hill) and damsel flies (0.1-1.2) were also recorded in different plantings. Grain yield varied between 45 and 52 q/ ha in three plantings.

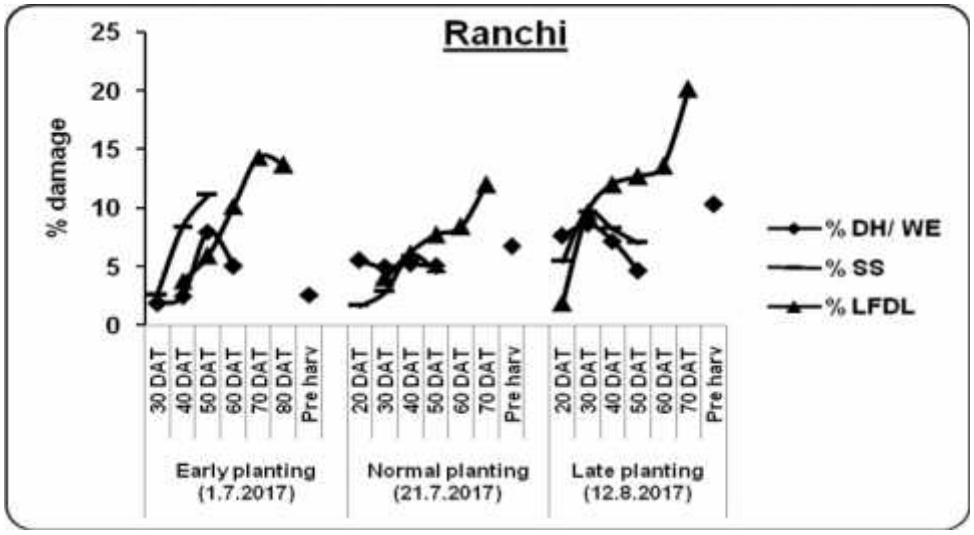



**Raipur (21° 25'N & 81°63'E):** Incidence of stem borer, leaf folder, whorl maggot, hispa, case worm, BPH and GLH was observed in Swarna variety in all the three plantings. Dead heart damage caused by stem borer was high in late planting (13.07-16.80% DH) and crossed ETL during 30 - 80 DAT. This was followed by damage in normal planting at 60 – 80 DAT (12.99-14.71% DH) and early planting at 90- 100 DAT (12.59-13.62% DH). However, white ear damage caused by stem borer was high in normal planting (18.19% WE) followed by early planting (17.30% WE) while it was very low in late planting (3.97% WE). Caseworm damage was high in late planting at 40 DAT (24.71% DL) and 50 DAT (23.79% DL) followed by normal planting at 70 DAT (21.98% DL).

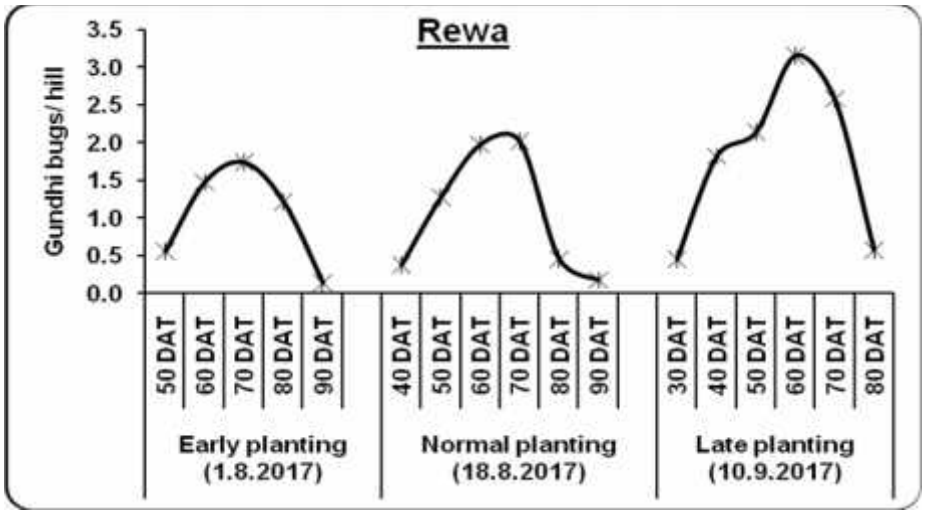



BPH population was high in late planting from 40 - 60 DAT (57.20 - 88.80 hoppers/5 hills), 80 - 90 DAT (52.70-74.20 hoppers/ 5 hills) in normal planting and 110 DAT (64.00 hoppers/ 5 hills) in late planting. Grain yield of 53.9, 50.3 and 25.9 q/ ha was recorded in early, normal and late plantings, respectively.

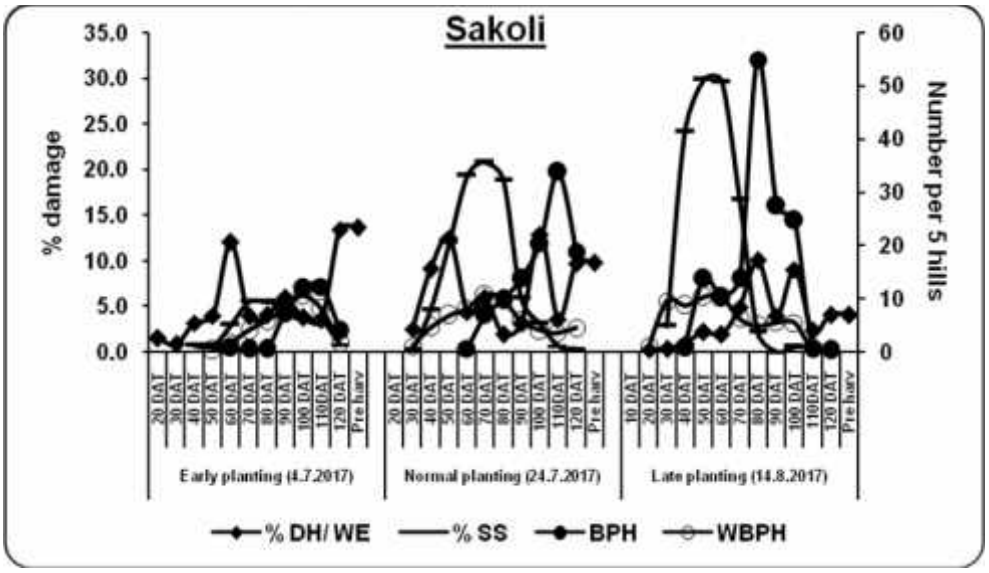
**Ranchi (23° 34'N & 85°31'E):** Sahbhagi variety was grown in all the three plantings in this trial. Leaf folder incidence was high in late planting from 40 - 70 DAT (12.03-20.17% DL) followed by early planting from 60 to 80 DAT (10.15 – 14.32% DL) and normal planting at 70 DAT alone (12.02% DL). Gall midge incidence was high in early planting at 50 DAT (11.11% SS). Low incidence of stem borer (1.85-8.65% DH), hispa (1.86-9.69% DL) and GLH (<8 hoppers/5 hills) was recorded in all the three plantings. Highest yield of 49.7 q/ ha was recorded in early planting followed by 44.9 q/ ha in normal planting and 39.8 q/ ha in late planting.



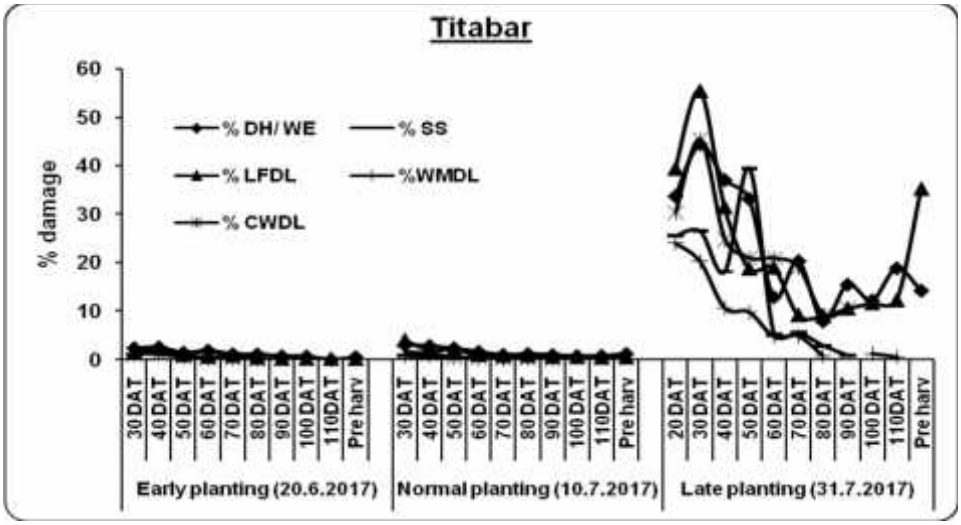

**Rewa (24° 53'N & 81° 30'E):** Low to moderate incidence of gundhi bug was observed in all the three plantings in PS III variety with highest incidence of 3 bugs/ hill in late planting at 60 DAT.



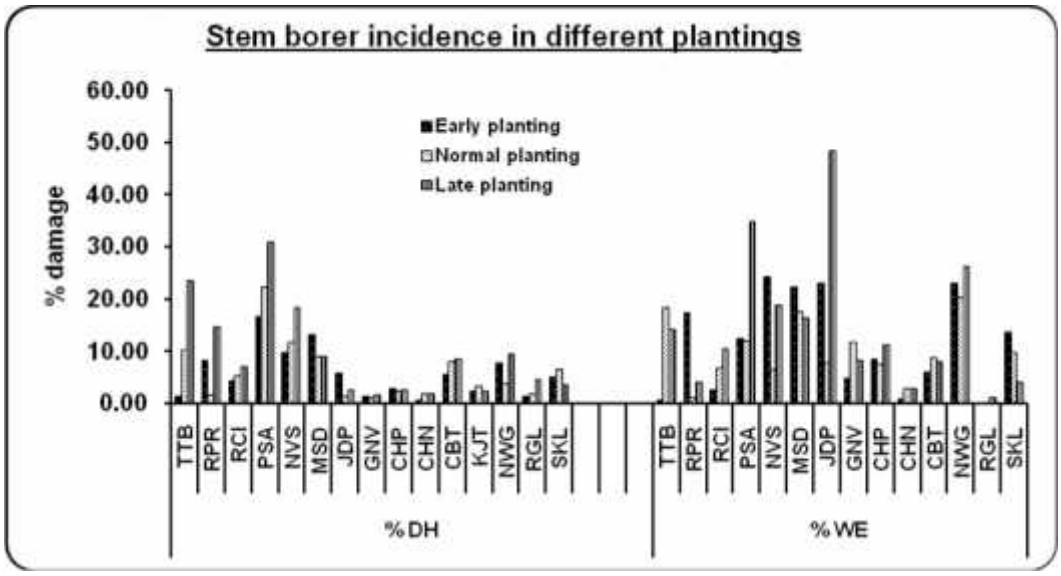

**Sakoli (21° 08'N & 79° 99'E**): Gall midge incidence was high in late planting and crossed ETL during 40 to 70 DAT (16.69-29.86% SS) followed by damage in normal planting at 50 to 80 DAT (12.0-20.8% SS). Similarly, highest BPH population was observed at 80 DAT in late planting (54.90 hoppers/5 hills). Low incidence of leaf folder (<5% DL), WBPH and GLH (<3 hoppers/5 hills) was reported in all the three plantings. Grain yields of 37.16, 27.20 and 18.04 q/ ha was recorded in early, normal and late plantings, respectively.

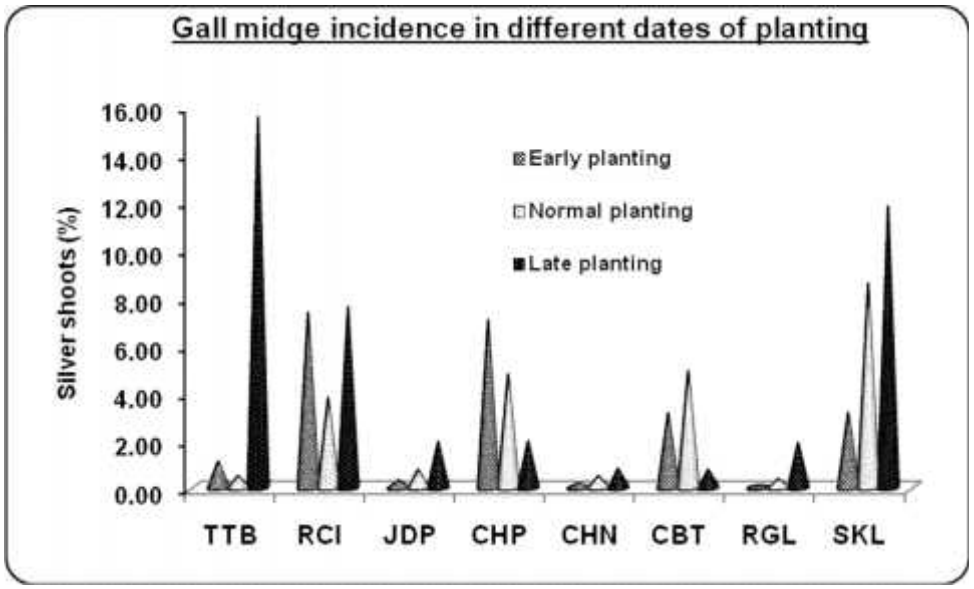


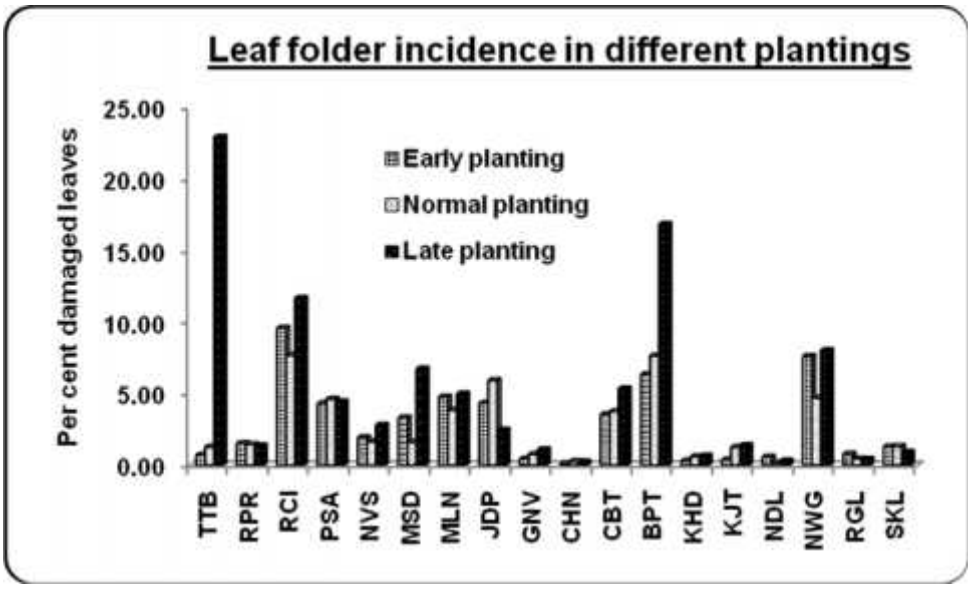

**Titabar (26° 58'N & 94° 19'E):** Incidence of stem borer, gall midge, leaf folder, whorl maggot, caseworm and GLH was observed high in late planting in Ranjit variety. Dead heart damage by stem borer varied from 7.92 to 44.34% with 14.21% white ears and exceeded ETL from 20 DAT onwards up to pre harvest stage. Similarly, gall midge damage also exceeded ETL from 20-50 DAT (18.2-39.4% SS). Highest leaf folder damage of 55.5% DL was observed at 30 DAT in late planting and it exceeded ETL from 20 DAT to harvest stage (10.56-55.5% DL) excluding 70 and 80 DAT (9.05-9.2% DL). Late planting also resulted in high whorl maggot damage during 20 to 40 DAT (10.68-23.95% DL) and caseworm damage from 20 DAT onwards (10.65-45.35% DL). Incidence of all these pests was very low in early and normal plantings.

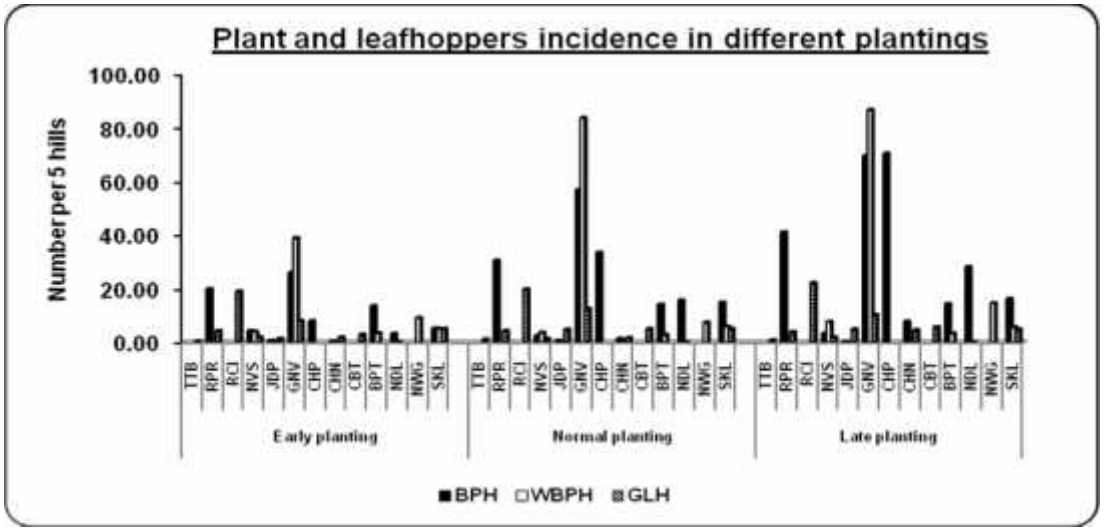



Across locations, insect pest incidence data revealed that incidence of stem borer was reported from 15 locations, of which highest dead heart damage was observed in late planting at Pusa (30.81% DH) followed by Titabar (23.57% DH). Highest white ear damage was also observed in late planting at Jagdalpur (48.24% WE) followed by Pusa (34.78% WE) and Nawagam (26.25% WE). Gall midge damage was reported from 8 locations with highest damage in late planting at Titabar (15.56% SS) and Sakoli (11.81% SS). Among the foliage feeders, leaf folder incidence was reported from 18 locations, of which highest damage of 22.93% DL was observed in late planting at Titabar followed by Bapatla (16.85% DL). Whorl maggot incidence was reported from 6 locations with highest damage at Malan in normal planting (13.28% DL). Caseworm damage was recorded in 3 locations with highest damage in late planting at Titabar (22.67% DL). Sap sucking insects like BPH was reported from 9 locations with highest mean population in late planting at Chiplima (70 hoppers/5 hills) and Gangavathi (69.6 hoppers/5 hills). WBPH population was observed in 8 locations with higher numbers at Gangavathi in late planting (87 hoppers/5 hills) followed by normal planting (84 hoppers/ 5 hills) at the same location. Low population of GLH was observed at 9 locations.




Gall midge incidence in different dates of planting
Silver shoots (%)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Early planting
Normal planting
Late planting
TTB
RCI
JDP
CHP
CHN
CBT
RGL
SKL


Leaf folder incidence in different plantings
Per cent damaged leaves
25.00
20.00
15.00
10.00
5.00
0.00
Early planting
Normal planting
Late planting
TTB
RPR
RCI
PSA
NVS
MSD
MLN
JDP
GNV
CHN
CBT
BPT
KHD
KJT
NDL
NWG
RGL
SKL


Plant and leafhoppers incidence in different plantings
Number per 5 hills
100.00
80.00
60.00
40.00
20.00
0.00
Early planting
Normal planting
Late planting
BPH
WBPH
GLH

Overall, the pest incidence was low to moderate in different dates of planting across locations during *Kharif* 2017. Incidence of stem borer, gall midge, leaf folder, whorl maggot, caseworm, thrips, grasshopper, BPH, WBPH, GLH and Gundhi bug was high in late planting compared to early and normal planting **(Fig 2.1)**. Hispa and rice skipper damage was high in normal planting followed by late planting.

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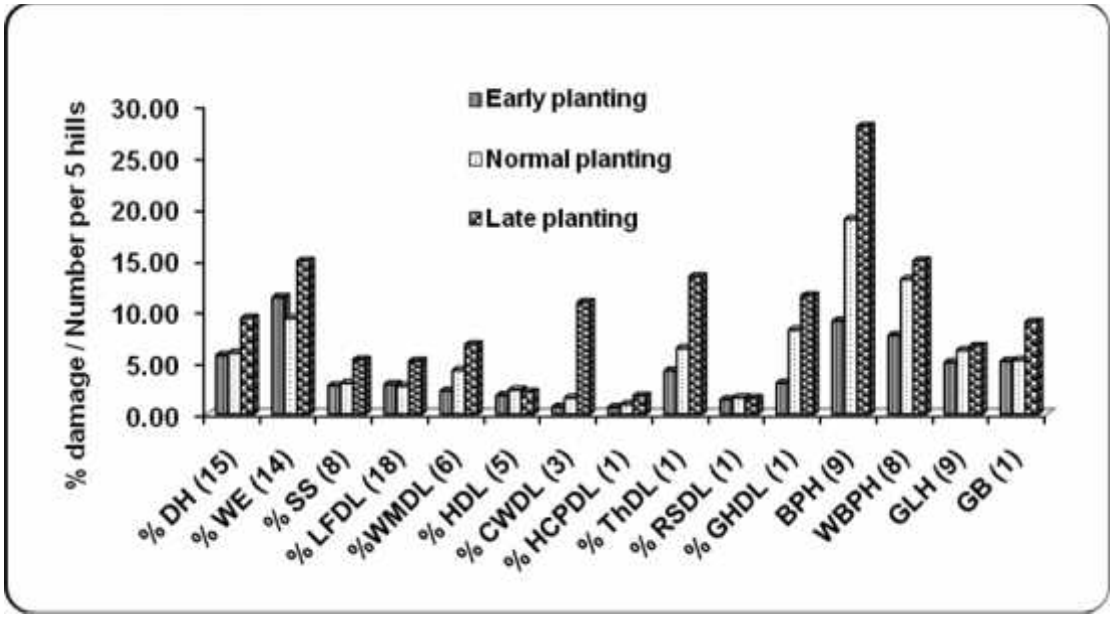



**Fig 2.1** Insect pest incidence in different dates of planting during *Kharif* 2017

*Effect of planting dates on insect pest incidence (EPDP) trial was conducted at 20 locations during Kharif 2017. In general, the pest incidence was low to moderate in different dates of planting across locations. Stem borer damage was reported from 15 locations, of which highest dead heart damage was observed in late planting at Pusa (30.81% DH) followed by Titabar (23.57% DH). Highest white ear damage was also observed in late planting at Jagdalpur (48.24% WE) followed by Pusa (34.78% WE) and Nawagam (26.25% WE). Gall midge damage was reported from 8 locations with highest damage in late planting at Titabar (15.56% SS) and Sakoli (11.81% SS). Among the foliage feeders, leaf folder incidence was reported from 18 locations, of which highest damage of 22.93% DL was observed in late planting at Titabar followed by Bapatla (16.85% DL). Whorl maggot incidence was reported from 6 locations with highest damage at Malan in normal planting (13.28% DL). Caseworm damage was recorded in 3 locations with highest damage at Titabar in late planting (22.67% DL). Among the plant and leaf hoppers, BPH was reported from 9 locations with highest population at Chiplima in late planting (70 hoppers/5 hills) and Gangavathi (69.6 hoppers/5 hills). WBPH population was observed in 8 locations with higher numbers at Gangavathi in late planting (87/5 hills) followed by normal planting (84/ 5 hills). Low population of GLH was observed at 9 locations. Minor pests such as horned caterpillar at Navasari, rice skipper and grasshopper incidence at Khudwani and thrips at Jagdalpur were observed in all the three plantings.*

## 2.5 BIOCONTROL AND BIODIVERSITY STUDIES

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

### i) Ecological Engineering for Planthopper Management (EEPM)

This trial has the objective of habitat management through cultural and non-pesticidal methods along with floral diversity to increase natural biological control and augment egg predators of hoppers for managing planthoppers by enhancing natural enemy fitness. Data were recorded on hoppers and their natural enemies and analyses were done using the independent 't' test. The trial was conducted at six locations during kharif 2017 *viz.*, Gangavathi, Moncompu, Mandya, Maruteru, Rajendranagar and Warangal.

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

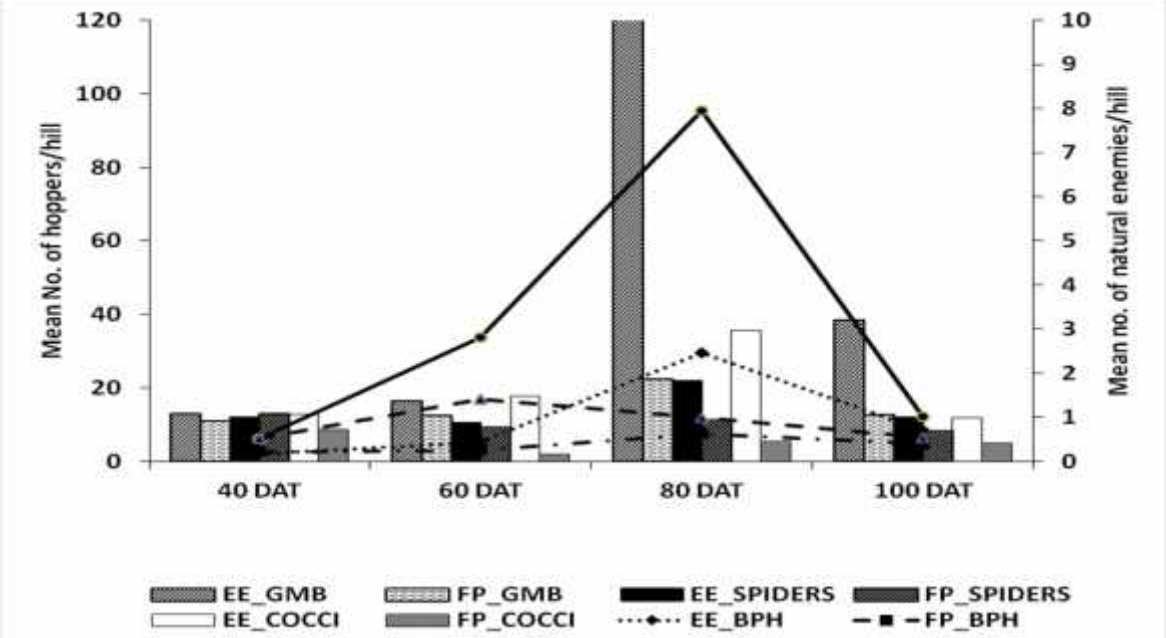



**Fig.2.2** Abundance of hoppers and its natural enemies at Gangavathi, EEPM, *kharif* 2017

Four observations were recorded on planthoppers and their natural enemies throughout the crop period. A mixed population of BPH and WBPH were observed with WBPH being dominant. In the ecological engineering plots the hopper population was higher ranging from 1.94/hill at 40 DAT to a maximum of 29.6/hill at 80 DAT, thereafter decreasing to 8.48 at 100 DAT **(Fig.2.2)**. Similarly, the population of WBPH ranged from 6.18/hill at 40 DAT to a maximum of 95.38/hill at 80 DAT, thereafter decreasing to 8.48 at 100 DAT. On the other hand, the population in Farmers Practice plots with chemical interventions the population was highest at 60 DAT (3.12 and 16.78 BPH and WBPH /hill respectively).

The mean hopper numbers over the crop period were significantly higher in EE plots (BPH 11.31 and WBPH 36.87/hill) in comparison to farmers' practices (FP) (BPH 4.42 and WBPH 10.21/hill, Table 1.xx). 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 (5.47/hill) was 5 times higher than that of the farmers practice (1.22/hill). Mean parasitisation by three species of parasitoids in the EE plots was significantly higher (31.15%; t= 7.01; P= <0.01) compared to 12.53 % under farmers practice. The highest parasitisation of 49.04 per cent was observed at 60 DAT in the ecological engineering plots while the lowest parasitisation of 5.08 % was observed at 75 DAT in Farmer' practice plots. Parasitisation up to 61.96 per cent by *Anagrus* sp followed by *Oligosita* (23.94%) and by *Gonatocerus* (14.10%) was recorded in EE plots, however similar trend was also observed in FP plots showing 62.16 per cent by *Anagrus* sp followed by *Oligosita* (27.03%) and least by *Gonatocerus* (10.81%). **(Table 2.17)**

**Table 2.17** Effect of ecological engineering on populations of hoppers and their natural enemies at Gangavathi, EEPM, *kharif* 2017

**A. Hoppers and its predators**

| Parameters | BPH (No./ hills) | | WBPH (No./hills) | | Green mirids (No./hills) | | Spiders (No./hills) | | Coccinellids (No./hills) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EE | FP | EE | FP | EE | FP | EE | FP | EE | FP |
| Mean | 11.31 | 4.42 | 36.87 | 10.35 | 5.47 | 1.22 | 1.18 | 0.87 | 1.62 | 0.43 |
| t value | 5.02 ** | | 7.85** | | 7.55** | | 2.67** | | 8.99** | |
| df | 398 | | 398 | | 398 | | 398 | | 398 | |
| P - value | <0.01 | | <0.01 | | <0.01 | | <0.01 | | <0.01 | |

**B. Parasitoids**

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

At **Moncompu**, bund planting of marigold was taken up in EE plots.. The pooled analysis revealed that number of hoppers was very low and did not differ significantly in EE and FP plots **(Table 2.18)**. However, green mirids (3.95/10 hills) and spiders (3.95/10 hills) were significantly higher in ecological engineering plots. Drynid parasitisation of hoppers did not differ significantly between the two treatments.

**Table 2.18** Effect of ecological engineering on hoppers and their natural enemies at Moncompu, MPNE, *kharif* 2017

| Parameters | Hoppers (No./10 hills) | | Green mirids (No./10 hills) | | Spiders (No./10 hills) | | Drynids (No./10 hills) | |
|---|---|---|---|---|---|---|---|---|
| | EE | FP | EE | FP | EE | FP | EE | FP |
| Mean | 0.84 | 0.84 | 3.95 | 2.35 | 3.95 | 2.70 | 1.65 | 1.25 |
| t value | NS | | 2.54** | | 1.90* | | 0.97 NS | |
| df | 398 | | 398 | | 398 | | 398 | |
| P - value | - | | 0.01 | | 0.05 | | NS | |

At **Mandya**, floral diversity was increased in EE plots by growing cowpea and *sun hemp* on the bunds, alleyways and application of vermicompost. A mixed population of planthoppers and leafhoppers were observed through the crop period. There were no significant differences in the mean population of BPH in EE plots (30.8/10 hills) compared to that of FP plots (24.70/10 hills) **(Table 2.19)**. The population of planthoppers ranged from 28-134/ 10 hills in the ecologically engineered plots while it ranged from 16-103/10 hills in the farmers practice. The population of natural enemies was higher in the ecological engineering plots and in case of coccinellids it was signficanyly higher (6.5/10 hills) than that of farmers' practice plots (1.60/ 10 hills).

**Table 2.19** Effect of ecological engineering on hoppers and their natural enemies at **Mandya, MPNE**, *kharif* 2017

**A. Hoppers**

| Parameters | BPH (No./ hill) | | WBPH (No./ hill) | | GLH (No./ hill) | |
|---|---|---|---|---|---|---|
| | **EE** | **FP** | **EE** | **FP** | **EE** | **FP** |
| Mean | 61.60 | 49.4 | 75.80 | 67.20 | 8.00 | 8.40 |
| t value | 0.48 NS | | 0.14 NS | | 0.15 NS | |
| df | 8 | | 8 | | 8 | |
| P - value | 0.64 | | 0.89 | | 0.89 | |

**B. Natural enemies of hoppers**

| Parameters | Mirids (No./ hill) | | Coccinellids (No./ hill) | | Spiders (No./ hill) | |
|---|---|---|---|---|---|---|
| | **EE** | **FP** | **EE** | **FP** | **EE** | **FP** |
| Mean | 28.20 | 18.80 | 13.0 | 3.20 | 4.00 | 3.40 |
| t value | 0.86 NS | | 2.63* | | 0.44 NS | |
| df | 8 | | 8 | | 8 | |
| P - value | 0.42 | | 0.03 | | 0.67 | |

The EE interventions tested at **Maruteru** were alleyways, organic manuring and bund flora. The observations on hoppers and their natural enemies were taken five times over the crop period. The hopper population was observed from 50 DAT and reached a peak at 60 DAT, 112.8 and 106.1/hill in ecological engineered and farmers' practice plots respectively **(Fig. 2.3).**

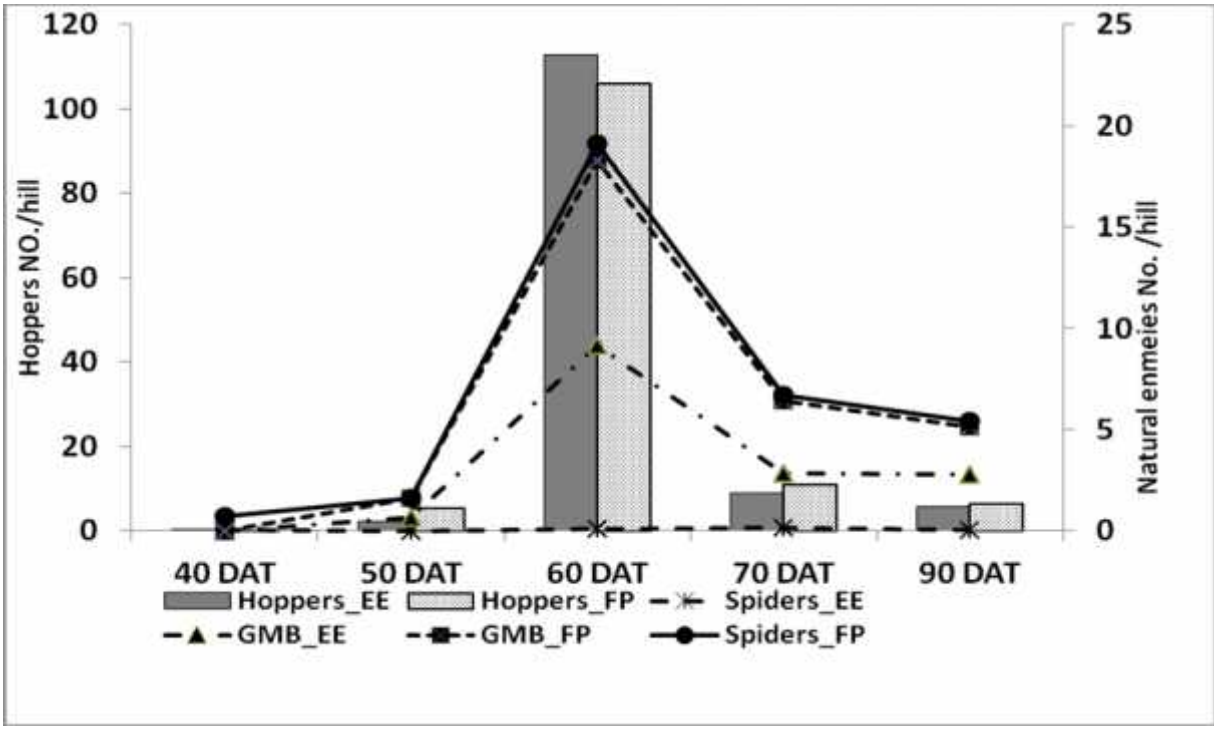



**Fig. 2.3** Abundance of hoppers and its natural enemies at Maruteru, EEPM, *kharif* 2017

The pooled data analysis showed that the population of hoppers in plots with farmers' practices and EE plots were on par **(Table 2.20)**. The population of natural enemies also showed a similar trend.

**Table 2.20** Effect of ecological engineering on hoppers and its natural enemies at Maruteru, MPNE, *kharif* 2017

| Para-meters | Hoppers (No./ hill) | | Mirids (No./ hill) | | Spiders (No./ hill) | | Coccinellids (No./ hill) | |
|---|---|---|---|---|---|---|---|---|
| | EE | FP | EE | FP | EE | FP | EE | FP |
| Mean | 25.96 | 25.88 | 4.91 | 5.04 | 1.19 | 1.26 | 0.42 | 0.31 |
| t value | 0.02 $^{NS}$ | | 0.23$^{NS}$ | | 0.59$^{NS}$ | | 1.29$^{NS}$ | |
| df | 498 | | 298 | | 498 | | 298 | |
| P - value | 0.98 | | 0.81 | | 0.56 | | 0.20 | |

At **Warangal,** there were 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). 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. Three observations were recorded on hoppers and their natural enemies through the crop period. A mixed population of BPH and WBPH was observed. At 54 DAT, the hopper and its natural enemies were on par in all three treatments, though the numbers of hoppers was higher in FP plots, the population was not significantly different from the EE plots **(Table 2.21)**. The population of hoppers reached a peak at 78 DAT and ranged from 3.16 to 154.37/hill in different treatments. The highest BPH number was observed in Farmers' practice plots (154.37/hill) and the lowest in the ecological engineering plots with alternate

wetting and drying (7.45/hill). 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 green mirids, spiders and coccinellids were significantly different at 78 DAT in the three treatments. The number of spiders were higher in farmers' practice plots (30.1/10 hills).The number of coccinellids at 54 DAT was significantly higher in EEP II plots followed by EEP I. Mirid bugs were significantly higher at 54 (15.80/ 10 hills) and 78 DAT (7.67/ 10 hills) in EEP II followed by EEP I plots.

**Table 2.21** Effect of ecological engineering on populations of hoppers and their natural enemies at Warangal, EEPM, *kharif* 2017

**A. Hoppers**

| | BPH (No./ hill) | | | WBPH (No. /hill) | | |
|---|---|---|---|---|---|---|
| | **54 DAT** | **78 DAT** | **95 DAT** | **54 DAT** | **78 DAT** | **95 DAT** |
| EEP-I | 5.14 | 7.45 | 3.91 | 2.79 | 3.16 | 1.79 |
| EEP-II | 5.84 | 11.03 | 5.73 | 2.93 | 4.19 | 2.66 |
| FP | 6.20 | 154.37 | 6.16 | 2.95 | 6.01 | 2.87 |
| SED | NS | 28.05 | 0.56 | NS | 0.16 | 0.28 |
| CD(0.05) | | 64.68 | 1.30 | | 0.36 | 0.64 |
| CD(0.01) | | 94.11 | 1.89 | | 0.54 | 0.93 |

**B. Natural enemies of hoppers**

| **Treatments** | **Spiders No. /10 hills** | | | **Coccinellids No. /10 hills** | | | **Mirids No. /10 hills** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **54 DAT** | **78 DAT** | **95 DAT** | **54 DAT** | **78 DAT** | **95 DAT** | **54 DAT** | **78 DAT** | **95 DAT** |
| EEP-I | 2.09 | 26.07 | 19.60 | 8.33 | 10.20 | 8.33 | 12.27 | 3.60 | 10.27 |
| EEP-II | 2.03 | 21.00 | 20.07 | 9.87 | 8.80 | 7.73 | 15.80 | 7.67 | 11.93 |
| FP | 2.08 | 30.13 | 19.07 | 5.87 | 11.33 | 9.67 | 11.73 | 2.13 | 9.67 |
| SED | 0.12 | 2.31 | 0.78 | 1.22 | 0.92 | 0.81 | 1.03 | 0.83 | 1.23 |
| CD(0.05) | NS | 5.32 | NS | 2.81 | NS | NS | 2.37 | 1.92 | NS |
| CD(0.01) | | | | | | | 3.45 | 2.79 | |

Egg baiting was taken up at this centre for parsitisation but no parasitoids emerged. . The EE plots yielded higher **(Table 2.22)** with the highest being in EEP-I (3413 kg /ha) while the FP plots yielded an average of 1694 kg/ha only. The B: C ratio was also higher in the ecological engineering plots with the highest of 1.38 being observed in EEP-I plots with alternate wetting and drying along with ecological engineering. The lowest B:C ratio was observed in FP plots (0.60).

**Table 2.22** Grain Yield and Benefit cost ratio of Ecological engineering at Warangal, EEPM, *kharif* 2017

| Treatment | Grain yield (Kg/ha) | B:C ratio |
|---|---|---|
| EEP-I | 3412.47 | 1.38 |
| EEP-II | 2654.44 | 1.07 |
| FP | 1694.86 | 0.60 |
| SED | 271.95 | 0.10 |
| CD(0.05) | 627.12 | 0.23 |
| CD(0.01) | 912.50 | 0.34 |

**Table 2.23** Natural enemy population on marigold planted on bunds in EEP plots*

| Treatments | Mirids | | | Coccinellids | | | Spiders | | |
|---|---|---|---|---|---|---|---|---|---|
| | 54 DAT | 78 DAT | 95 DAT | 54 DAT | 78 DAT | 95 DAT | 54 DAT | 78 DAT | 95 DAT |
| EEP-I | 0.02 | 0.32 | 0.50 | 0.00 | 0.02 | 0.34 | 0.12 | 1.04 | 1.24 |
| EEP-II | 0.06 | 0.40 | 0.46 | 0.02 | 0.12 | 0.30 | 0.16 | 1.34 | 1.28 |

*Mean of 50 marigold plants

A low population of mirids, coccinellids and spiders were also observed on the marigold plants grown on the bounds indicating a sharing of natural enemies **(Table 2.23)**.

This trial was taken up for the first time in Rajendranagar. The EE interventions followed at **Rajendranagar** included alleyways, water management, bund flora of marigold yellow flower hybrid Thai 999. The populations of hoppers were very low. Hence, no valid conclusions could be drawn.

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

## iii) Bio-intensive pest management trial (BIPM)

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

The trial involved mainly two treatment blocks *viz.*, i) Bio-intensive pest management and ii) Input intensive pest management or Farmers Practice block

spread over an area of a minimum of half acre for each block planted with a local popular variety of the region. The results of the trials at various locations are given below

### *1. Chinsurah*

Observations were recorded on the damage by whorl maggot, stem borer, and natural enemies like spiders, coccinellids and staphylinids. Whorl maggot incidence observed in the early crop growth ranged from 0.00 to 32.00 per cent of leaves damaged in the two treatments (Table 7.xxx). The incidence was on par in BIPM and FP plots. The dead heart damage by stem borer was significantly higher in FP plots (12.39%) compared to that of BIPM plots (4.17%). A similar trend was observed with white ear damage in the reproductive phase with 6.19 % damage recorded in BIPM plots as compared to 15.97% in FP plots **(Table 2.24)**. The populations of other pests were low.

**Table 2.24** Pest incidence under Bio-intensive pest management trial at Chinsurah, *kharif* 2017

| **Parameters** | **WM** | | **DH** | | **WE** | |
|---|---|---|---|---|---|---|
| | **(% damage)** | | **(% damage)** | | **(% damage)** | |
| | **BIPM** | **FP** | **BIPM** | **FP** | **BIPM** | **FP** |
| Mean | 4.05 | 5. 30 | 4.17 | 12.39 | 6.19 | 15.97 |
| t value | 0.86$^{NS}$ | | 6.22** | | 5.89** | |
| df | 118 | | 238 | | 238 | |
| P - value | 0.40 | | <0.01 | | <0.01 | |

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

The natural enemy population was significantly higher in the BIPM plots **(Table 2.25)**. The number of spiders (2.83/ 10 hills) was higher than that of FRP plots (1.50/10 hills) but statistically on par. Poulations of coccinellids (6.00/ 10 hills) and staphylinids (3.67/10 hills) were significantly higher than that of Farmers' practice plots. Due to the lower stem borer damage in the vegetative and reproductive phase the yield was also significantly higher in BIPM plots (4270 kg/ha) than that of FP plots (3275 kg/ha).

**Table 2.25** Population of natural enemies and yield under Bio-intensive pest management trial at Chinsurah, *kharif* 2017

| **Parameters** | **Spiders** | | **Coccinellids** | | **Staphylinid** | | **Yield*** | |
|---|---|---|---|---|---|---|---|---|
| | **(No./10 hills)** | | **(No./10 hills)** | | **(No./10 hills)** | | **(kg/ha)** | |
| | **BIPM** | **FP** | **BIPM** | **FP** | **BIPM** | **FP** | | |
| Mean | 2.83 | 1.50 | 6.00 | 1.80 | 3.67 | 1.50 | 4270 | 3275 |
| t value | 1.50$^{NS}$ | | 3.60** | | 2.22* | | 5.43** | |
| df | 118 | | 118 | | 118 | | 38 | |
| P - value | 0.13 | | <0.01 | | 0.03 | | <0.01 | |

*projected yield

The observations on stem borer composition at Chinsurah during kharif 2017revealed that YSB was the only species observed. The egg mass parasitisation ranged from 40.00-75.00% while the egg parasitisation varied from 33.91 to 76.00 %. The mean egg mass parasitisation was 58.11 while mean egg parasitisation was 55.30 per cent. Three parasitoids were observed emerging from egg masses, *Trichogramma japonicum,Telenomus spp.,* and *Tetrastichus schoenobii* of which *Tetrastichus* was the dominant parasitoid accounting for 89-94 per cent of the parasitoid population on stemborer egg masses followed by *Telenomus* sp. (6.38 %) and *Trichogramma* (< 1 per cent).

***2. Jagdalpur***

Incidence of whorl maggot, thrips, leaffolder, caseworm, stem borer, BPH, GLH and predators like spiders, coccinellids and others was observed. The per cent leaves damaged by whorl maggot were significantly higher in BIPM plots (10.65%) compared to farmer's practice plots (6.74%). Similarly damage by leaffolder was also higher in BIPM plots (6.31%) as compared to farmers practice (2.82%). On the other hand damage and incidence of caseworm, thrips, hispa and GLH was on par in both the treatments **(Table 2.26)**. The DH caused by stemborer was less than ten per cent but was significantly higher in the BIPM plots. The beneficials such as spiders and coccinellids recorded in BIPM plots were significantly higher in numbers in BIPM plots. The coccinellid population (1.14/10 hills) was higher in the BIPM plots compared to that of Farmers' practice plots. **(Table 2.27)**. The yield BIPM plots also yielded higher (4459 kg/ha) than that of FP plots (3547 kg/ha).

**Table 2.26** Pest incidence under Bio-intensive pest management trial at Jagdalpur, *kharif* 2017

**A.**

| Para-meters | Per cent leaves damaged by | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | WM | | Thrips | | Caseworm | | LF | | Hispa | |
| | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 10.65 | 6.74 | 12.27 | 10.39 | 1.12 | 0.18 | 6.31 | 2.82 | 1.11 | 0.24 |
| t value | 6.89** | | 1.46$^{NS}$ | | 35.22$^{NS}$ | | 9.01 | | 4.38$^{NS}$ | |
| df | 838 | | 598 | | 598 | | 838 | | 478 | |
| P - value | <0.01 | | 0.14 | | 0.08 | | <0.01 | | 0.06 | |

*WM- whorl maggot; LF- leaffolder

**B.**

| Parameters | DH (No./hill) | | BPH (No./10 hills) | | GLH (No./10 hills) | |
|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 4.54 | 2.38 | 9.40 | 0.74 | 26.50 | 14.20 |
| t value | 3.40** | | 12.12** | | 7.93$^{NS}$ | |
| df | 478 | | 458 | | 458 | |
| P - value | <0.01 | | <0.01 | | 0.28 | |

*DH – Dead heart; BPH –brown planthopper; GLH – Green leafhopper

**Table 2.27** Population of natural enemies and yield under Bio-intensive pest management trial at Jagdalpur, *kharif* 2017

| Parameters | Spiders (No./10 hills) | | Coccinellids (No./10 hills) | | Yield (kg/plot) | | Yield* (kg/ha) | |
|---|---|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 4.38 | 2.31 | 1.14 | 0.45 | 33.11 | 34.00 | 4459 | 3647 |
| t value | 4.95** | | 3.66 | | 4.35** | | 4.35** | |
| df | 838 | | 838 | | 9 | | 8 | |
| P - value | <0.01 | | <0.01 | | <0.01 | | <0.01 | |

*projected yield

### *3. Kurumbapet (Puduchery)*

Incidence of gall midge, leaffolder and stem borer was observed in BIPM and Farmers' practice plots. The per cent leaves damaged were significantly lower in BIPM plots (12.43%) compared to farmer's practice plots (18.41%). On the other hand though pest level was low the stem borer and gall midge damage was more in BIPM plots. **(Table 2.28)**. The yield was on par in both treatments **(Table 2.29)** while straw yield was significantly higher in Farmers practice. However, the 1000 grain weight was on par in both treatments.

**Table 2.28** Pest incidence under Bio-intensive pest management trial at Kurumbapet, *kharif* 2017

| Parameters | SS (% damage) | | DL (% damage) | | DH (% damage) | |
|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 3.26 | 2.29 | 12.43 | 18.41 | 5.24 | 2.12 |
| t value | 1.94* | | 4.50** | | 4.56** | |
| df | 358 | | 358 | | 358 | |
| P - value | 0.05 | | <0.01 | | <0.01 | |

*SS- Silver shoots; DL- Damaged leaves; DH-Dead Heart

**Table 2.29** Yield parameters under Bio-intensive pest management trial at Kurumbapet, *kharif* 2017

| Parameters | Grain Yield (kg/ha) | | Straw Yield (kg/ha) | | 1000 grain weight (g) | |
|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 4640.67 | 5272.17 | 9978.67 | 12165.33 | 18.47 | 18.19 |
| t value | $1.40^{NS}$ | | 2.38* | | $0.40^{NS}$ | |
| df | 10 | | 10 | | 10 | |
| P - value | 0.19 | | 0.03 | | 0.70 | |

### *4. Karjat*

Incidence of stem borer and leaffolder was observed. The incidence was very low for both pests. However, the dead hearts observed was consistently and significantly higher in the farmers practice plots with a maximum 6.08 % when compared to BIPM plots with a maximum of damage of 4.43 per cent at 36 DAT. **(Table 2.30)**. The yield was significantly higher in BIPM plots (3134 kg/ha) compared to 2173 kg/ha in FP plots.

**Table 2.30** Pest incidence under Bio-intensive pest management trial at Karjat, *kharif* 2017

| Parameters | DH (% damage) | | Yield kg/ha) | |
|---|---|---|---|---|
| | **BIPM** | **FP** | **BIPM** | **FP** |
| Mean | 4.43 | 6.08 | 3134 | 2173 |
| t value | 7.14** | | 8.55** | |
| df | 10 | | 10 | |
| P - value | <0.01 | | <0.01 | |

* DH-Dead Heart

### *5. Ludhiana*

The treatments were planted with variety PR 121, in six replications. The practices followed in BIPM plots were application of vermicompost @ 500 g/ $m^2$ and rice husk ash @ 100 g/ $m^2$ 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 son 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; spraying chlorpyriphos @ 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. White ears at reproductive phase (3.26%) were significantly lower than that of FP plots (5.46%). Leaffolder and dead hearts damage were on par in both the treatments **(Table 2.31)**. Similarly, the population of BPH and WBPH per hill did not differ significantly in BIPM plots and FP plots.

The populations of beneficials though higher in BIPM plots were statistically on par in both treatments. The Ichneumonid number(10.23/10hills) was significantly higher in the BIPM plots compared to that of Farmers' practice plots (8.83/10 hills) **(Table 2.32)**. The yield was on par in both FP plots (7856kg/ha) and BIPM plots (7774 kg/ha).

**Table 2.31** Pest incidence under Bio-intensive pest management trial at Ludhiana, *kharif* 2017

| Para-meters | WM % damage | | DH % damage | | LF % damage | | WE % damage | | BPH (No./hill) | | WBPH (No./hill) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 1.07 | 1.48 | 2.33 | 2.81 | 6.03 | 5.77 | 3.26 | 5.46 | 18.17 | 20.71 | 31.83 | 31.40 |
| t value | 1.30 NS | | 1.23 NS | | 0.53NS | | 4.01 ** | | 0.57NS | | 0.11NS | |
| df | 82 | | 82 | | 82 | | 10 | | 82 | | 82 | |
| P - value | 0.19 | | 0.22 | | 0.60 | | 0.00 | | 0.57 | | 0.91 | |

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

**Table 2.32** Population of natural enemies and yield under Bio-intensive pest management trial at Ludhiana, *kharif* 2017

| Parameters | Spiders (No./hill) | | Coccinellids (No./hill) | | Ichneumonid (No./hill) | | Braconid (g/m2) | | Yield* (kg/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 9.41 | 8.88 | 2.45 | 2.14 | 10.23 | 8.83 | 9.52 | 9.07 | 7773.63 | 7855.46 |
| t value | 0.69NS | | 1.03 NS | | 1.91* | | 0.61 NS | | 0.66** | |
| df | 82 | | 82 | | 82 | | 82 | | 10 | |
| P - value | 0.49 | | 0.39 | | 0.05 | | 0.54 | | 0.52 | |

*projected yield

### *6. 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, silver shoots, leaffolder, caseworm, stem borer and predators like spiders, coccinellids and mirids was observed over four dates of observation and the mean analysed data is being presented below. The per cent leaves damaged by whorl maggot and caseworm were significantly lower in BIPM plots (3.80 and 5.80% respectively) compared to farmer's practice plots (5.90 and 8.82%). However, damage by gall midge which was the major pest during the kharif season was significantly higher in BIPM plots (54.56%) as compared to farmers practice. On the other hand, damage and incidence of stemborer and leaffolder were on par in both treatments **(Table 2.33)**.

The beneficials such as spiders and coccinellids recorded in BIPM plots were higher in numbers in BIPM plots. The spider population (10.00/10 hills) was significantly higher in the BIPM plots compared to that of Farmers' practice plots. **(Table 2.34)**. The yield however was higher in FP plots (2551 kg/ha) than that of BIPM plots (1378 kg/ha).

**Table 2.33** Pest incidence under Bio-intensive pest management trial at Pattambi, *kharif* 2017

| Para-meters | Per cent damage by | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | WM | | SS | | Caseworm | | LF | | DH/WE | |
| | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 3.80 | 5.90 | 54.56 | 42.27 | 5.80 | 8.82 | 2.77 | 3.09 | 1.24 | 0.17 |
| t value | 2.46** | | 2.70** | | 1.84* | | 0.58 NS | | 2.4 NS | |
| df | 478 | | 358 | | 358 | | 358 | | 238 | |
| P - value | 0.01 | | 0.01 | | 0.05 | | 0.56 | | 0.06 | |

*WM- whorl maggot; LF- leaffolder

**Table 2.34** Population of natural enemies and yield under Bio-intensive pest management trial at Pattambi, *kharif* 2017

| Parameters | Spiders (No./10 hills) | | Coccinellids (No./10 hills) | | Mirid (No./10 hills) | | Yield* (kg/ha) | |
|---|---|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 10.00 | 5.50 | 4.50 | 3.33 | 4.17 | 3.67 | 1377.78 | 2551.17 |
| t value | 5.49** | | 1.10NS | | 0.48 NS | | 5.76** | |
| df | 358 | | 118 | | 118 | | 10 | |
| P - value | <0.01 | | 0.23 | | 0.63 | | <0.01 | |

*projected yield

### *7. Raipur*

Incidence of stem borer, leaffolder, hispa, caseworm BPH, and predators like spiders, coccinellids were recorded on eight dates of observation throughout the crop growth period. The per cent leaves damaged by hispa, leaffolder and caseworms was lower in BIPM plots but statistically not significant. The per cent dead hearts were also on par in BIPM and FP plots **(Table 2.35)**. The white ear damage on the other hand was significantly higher in the FP plots (13.42%) compared to that of BIPM plots (7.51%). The total number of white ears recorded in BIPM plots was 384 compared to 483 recorded in FP plots. Similarly, the population of BPH was significantly higher in FP plots (47.3/10hills) compared to BIPM plots (13.3/10 hills).

The beneficial insects in BIPM plots were statistically on par in both treatments. FP plots yielded higher (6740kg/ha) than that of BIPM plots (5029 kg/ha) **(Table 2.36)**.

### *8. Ranchi*

Incidence of hispa, stem borer, leaffolder and gall midge were recorded on seven dates of observation throughout the crop growth period. The per cent damage hispa, leaffolder stemborer and gall midge by was on par in BIPM and FP plots **(Table 2.37)**. FP plots yielded significantly higher (3914kg/ha) than that of BIPM plots (3239 kg/ha).

### *9. Titabar*

The treatments were planted with Keteki Joha variety, in six replications of plot size 100 $m^2$. The practices followed in BIPM plots were wet seed treatment with *Pseudomonas florescens* 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 joponicum* 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 incidences was observed. The flowering plant marigold was grown in the border of the plot. The practices followed in the FP treatment were no seed treatment; no fertilizer in nursery, application of N- 60kg, $P_2O_5$ -20kg and K2O -40 kg/ha and no application of insecticides. The pest incidence was significantly lower in BIPM plots **(Table 2.38)**. The silver shoot damage (0.25% SS) and dead hearts caused by stem borer (0.52%) were significantly lower in BIPM plots as compared to FP plots (6.45% silver shoots and 13.88 % DH, respectively). The per cent leaves damaged by whorl maggot and leaffolder were also significantly lower in BIPM plots than that of FP plots. BIPM plots also yielded significantly higher (5013kg/ha) than that of FP plots (3506 kg/ha)**(Table 2.39)**.

**Table 2.35** Pest incidence under Bio-intensive pest management trial at Raipur, *kharif* 2017

| Para-meters | Hispa | | LF | | DH | | BPH | | CW | | WE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % damage | | % damage | | % damage | | (No./10 hills) | | % damage | | % damage | |
| | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 2.15 | 2.42 | 1.54 | 1.36 | 7.51 | 8.45 | 13.3 | 47.3 | 1.95 | 2.95 | 7.51 | 13.42 |
| 1 | 0.82$^{NS}$ | | 1.07 $^{NS}$ | | 1.19 $^{NS}$ | | 8.76* | | 2.576$^{NS}$ | | 6.02** | |
| df | 478 | | 838 | | 478 | | 478 | | 478 | | 358 | |
| P - value | 0.41 | | 0.28 | | 0.23 | | 0.05 | | 0.06 | | <0.01 | |

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

**Table 2.36** Population of natural enemies and yield under Bio-intensive pest management trial at Raipur, *kharif* 2017

| Parameters | Spiders | | Coccinellids | | Total yield | |
|---|---|---|---|---|---|---|
| | (No./10 hills) | | (No./10hills) | | Kg/ha | |
| | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 3.33 | 3.33 | 3.50 | 3.23 | 5029 | 6740 |
| t value | 0.18$^{NS}$ | | 0.59 $^{NS}$ | | 5.85** | |
| df | 838 | | 598 | | 46 | |
| P - value | 0.86 | | 0.55 | | <0.01 | |

*projected yield

**Table 2.37** Pest incidence under Bio-intensive pest management trial at Ranchi, kharif 2017

| Para-meters | Hispa % damage | | LF % damage | | DH % damage | | SS (No./10 hills) | | WE % damage | | Yield Kg/ha | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 3.80 | 3.12 | 6.23 | 5.42 | 5.72 | 4.41 | 5.83 | 4.91 | 7.82 | 7.10 | 3239 | 3914 |
| t value | 1.76$^{NS}$ | | 2.64 $^{NS}$ | | 1.35 $^{NS}$ | | 1.63 $^{NS}$ | | 0.93$^{NS}$ | | 2.41* | |
| df | 358 | | 598 | | 358 | | 314 | | 238 | | 10 | |
| P - value | 0.08 | | 0.06 | | 0.18 | | 0.10 | | 0.35 | | 0.04 | |

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

**Table 2.38** Pest incidence under Bio-intensive pest management trial at Titabar, *kharif* 2017

| Para-meters | GM (% damage) | | DH/WE (% damage) | | LF (% damage) | | WM (% damage) | | GLH (No./hill) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 0.25 | 6.45 | 0.52 | 13.88 | 0.27 | 5.77 | 0.11 | 3.85 | 0.35 | 2.22 |
| t value | 8.73** | | 12.11** | | 13.05** | | 9.57** | | 6.41NS | |
| df | 106 | | 106 | | 106 | | 106 | | 106 | |
| P - value | <0.01 | | <0.01 | | <0.01 | | <0.01 | | 0.06 | |

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

**Table 2.39** Yield under Bio-intensive pest management trial at Titabar, *kharif* 2017

| Parameters | Grain Yield (kg/plot) | | Grain Yield* (kg/ha) | | Straw Yield* (tonnes/ha) | |
|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 16.17 | 11.55 | 5013 | 3506 | 8056 | 5920 |
| t value | 32.55** | | 5.13 | | 4.37** | |
| df | 10 | | 10 | | 10 | |
| P - value | <0.01 | | <0.01 | | <0.01 | |

*projected yield

The per cent leaves damaged by whorl maggot and leaffolder were also significantly lower in BIPM plots than that of FP plots. BIPM plots also yielded significantly higher (5013kg/ha) than that of FP plots (3506 kg/ha)**(Table 2.39)**.

### *10. IIRR, Hyderabad*

At IIRR, Hyderabad, all practices recommended for BIPM were followed except the spraying of neem formulation. The plot size was 45.36 $m^2$ and 38.85$m^2$ with nine replications and the variety TN 1 for BIPM and FP plots respectively. Under the Farmers' practice all recommended agronomic practices were followed. Only stem borer damage was observed and the dead hearts at vegetative phase was on par in the BIPM plots and FP plots. Similar trend was observed in the reproductive phase, with white ear damage in BIPM plots (9.51% WE) being on par with that of FP plots (10.56%). The yield was significantly higher in BIPM plots (4250 kg/ha) compared to that 3156 kg/ha in FP plots **(Table 2.40)**. The crop in organic manuring BIPM plots has been showing a steady increase in yields in the past three years.

**Table 2.40** Pest incidence and yield under Bio-intensive pest management trial at IIRR, Hyderabad, *kharif* 2017

| Parameters | DH (% damage) | | WE (% damage) | | Yield (kg/ha) | |
|---|---|---|---|---|---|---|
| | BIPM | FP | BIPM | FP | BIPM | FP |
| Mean | 5.75 | 5.25 | 9.51 | 10.56 | 4250 | 3156 |
| t value | 0.93NS | | 1.02NS | | 3.65** | |
| df | 478 | | 23 | | 10 | |
| P - value | 0.36 | | 0.31 | | 0.01 | |

DH – Dead heart; WE- white ears

*Bio intensive pest management trial was initiated to explore the feasibility of biointensive approaches for managing pests for organic rice cultivation. The trial was conducted in 10 locations this year. The pest incidence was either reduced in BIPM plots as in Chinsurah and Titabar, Raipur and Jagdalpur or on par as in Ludhiana and IIRR compared to Farmers' practice. The natural enemies were higher in BIPM plots in all locations. In Hyderabad after three years of this trial, higher yields were obtained in BIPM plots indicating a period of three years for stabilization of yields in organic practices. The results also indicated an increase in natural enemy population in the organic BIPM plots.*

## 2.6. INTEGRATED PEST MANAGEMENT STUDIES

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

### i) Yield Loss Estimation Trial (YLET)

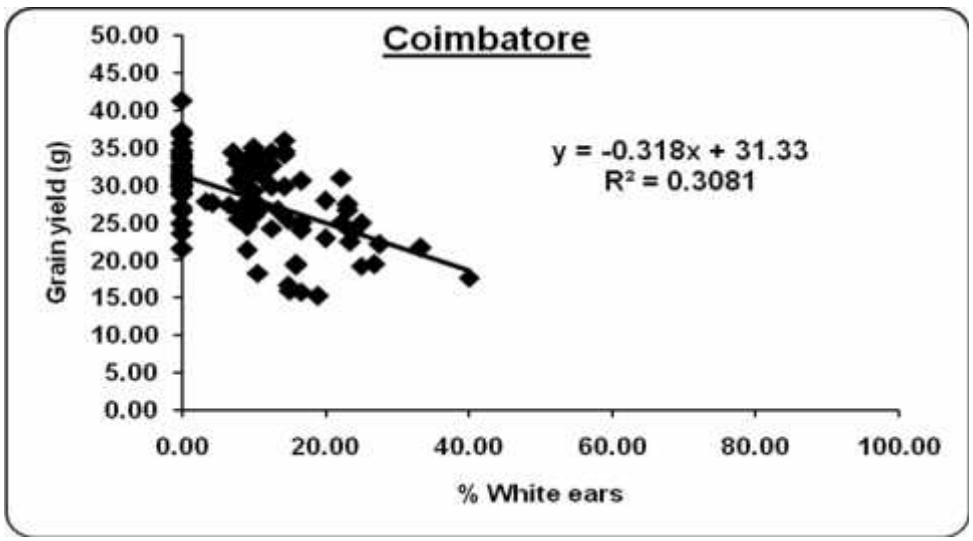
Quantification of actual yield losses caused by insect pests at different stages of crop growth period was the main objective of this trial. Target pests included stem borer and leaf folder. Varying levels of specific pest damage were created by augmenting through the release of egg masses or larvae at different crop growth stages to know the impact on grain yield.

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

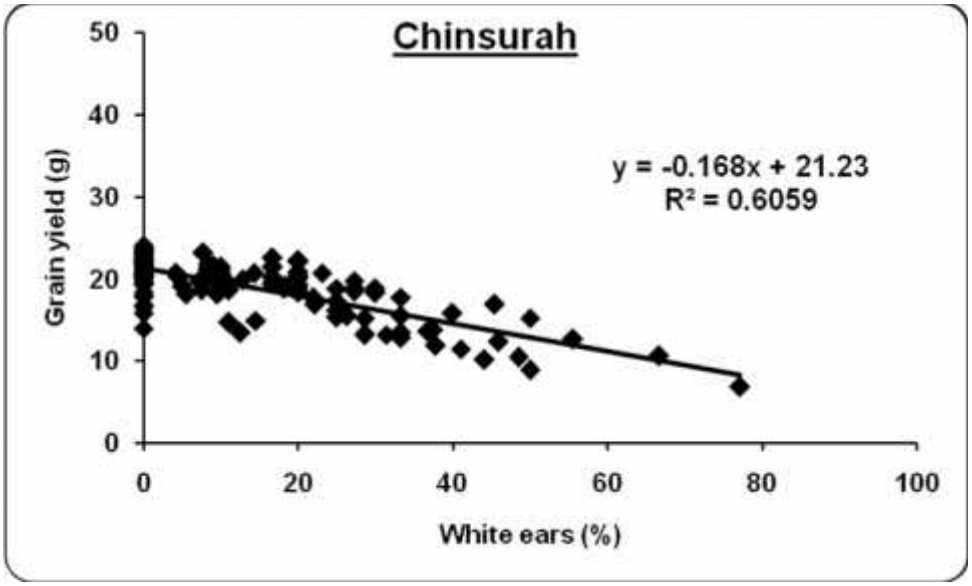
During *Kharif* 2017, the trial was conducted at 8 locations. Yield data at different damage levels was obtained from 6 locations for YSB and from 3 locations for leaf folder. Pest wise and location wise results are given below:

**TARGET PEST: STEM BORER**

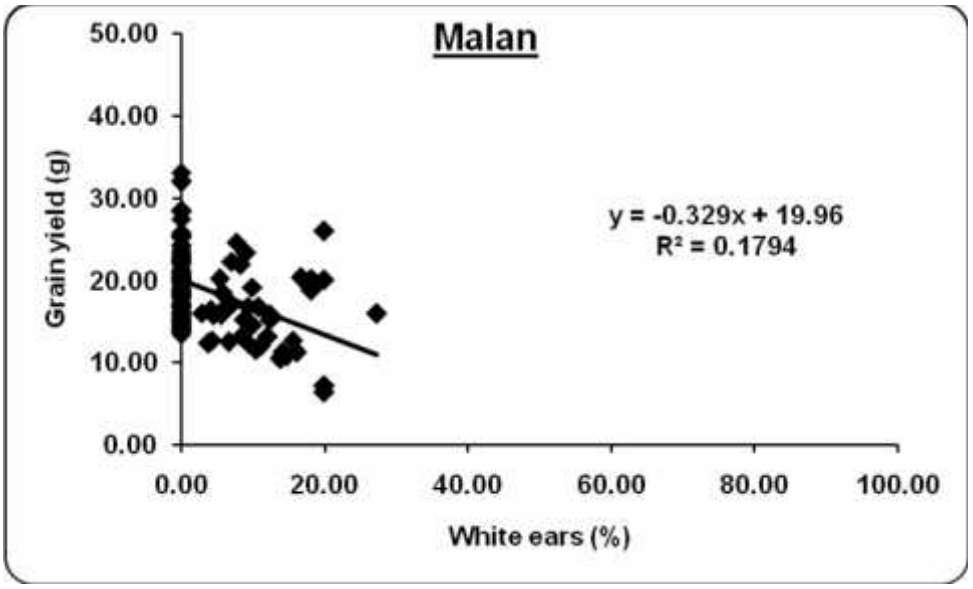
At **Coimbatore**, white ear damage varied from 0 to 40% with grain yield of 15.25 to 41.30 g per hill in CO 51 variety. Regression analysis revealed a significant negative relationship between white ear damage and grain yield ($R^2$ = 0.3081). Yield reduction of 3.18 was reported for every 10% increase in white ears.



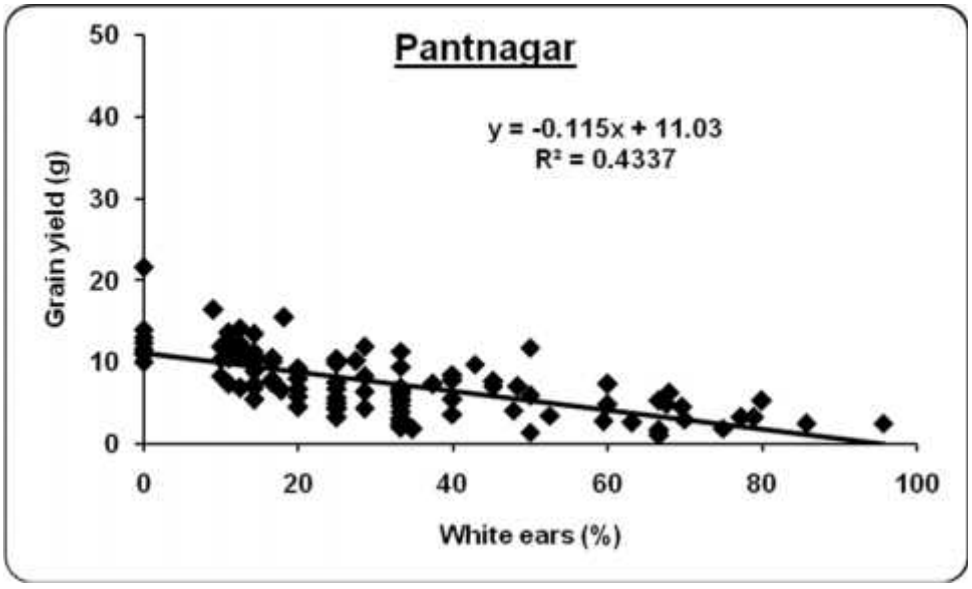
At **Chinsurah**, white ear damage varied between 0 and 77.14% with grain yield of 6.79 to 23.90 g per hill in MTU 7029 (Swarna) variety. A significant negative relation was observed between white ear damage and grain yield with 1.68 g reduction in grain yield for every 10% increase in white ears.



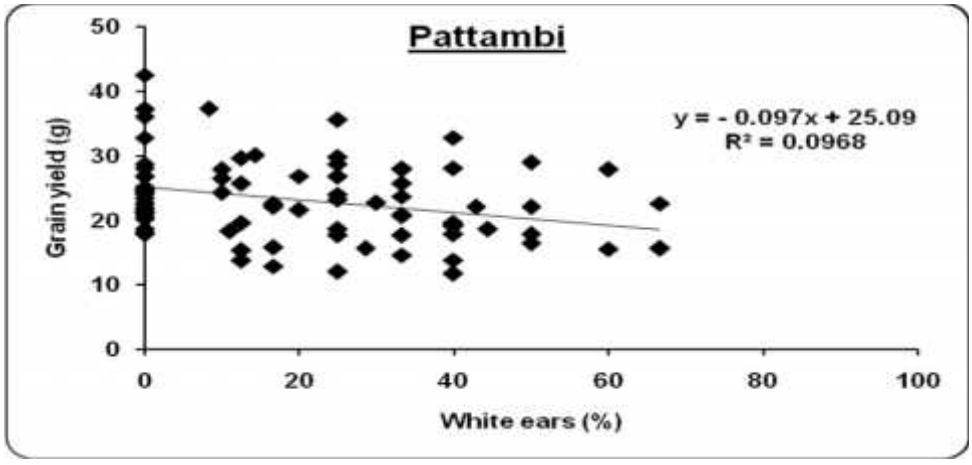

At **Malan**, white ear damage ranged from 0 to 27.27% with grain yield of 6.35 to 33.12 g per hill in Kasturi variety. There was a negative relationship between white ears and grain yield but not significant ($R^2$=0.1794).



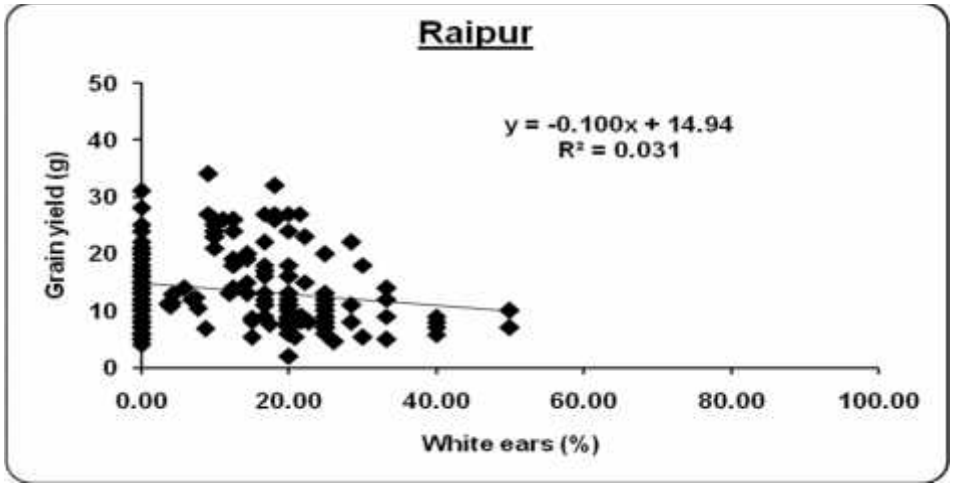

At **Pantnagar**, white ear damage varied from 0 to 95.65% with grain yield of 1.06 to 21.56 g per hill in HKR 47 variety. Regression analysis revealed a significant negative relationship between white ears and grain yield ($R^2$ = 0.4337). A reduction of 1.15 g in yield was observed for every 10% increase in white ears.




At **Pattambi,** white ear damage up to 66.7% was observed with grain yield of 11.7 to 42.5 g per hill in Jyothi variety. Grain yield was too low in augmented plot to draw valid conclusions.




At **Raipur**, white ear damage ranged from 0 to 50% with grain yield of 2 to 34 g per hill in Swarna variety. The relationship between white ears and grain yield was negative but not significant.



Pooled analysis of the yield data from 367 hills of Coimbatore, Chinsurah and Pantnagar was considered and grain yields were transformed into natural logarithm values ln(GY) prior to analysis. Regression model yielded the equation as ln(GY) = 3.211- 0.027x, where x = % white ears. The coefficient of determination ($R^2$) for this model was 0.5335 ($p< 0.00001$). Based on this model, per cent reduction in grain yield was predicted as 23.66% at 10% white ears, 41.73% at 20% white ears and so on **(Fig. 2.4)**.

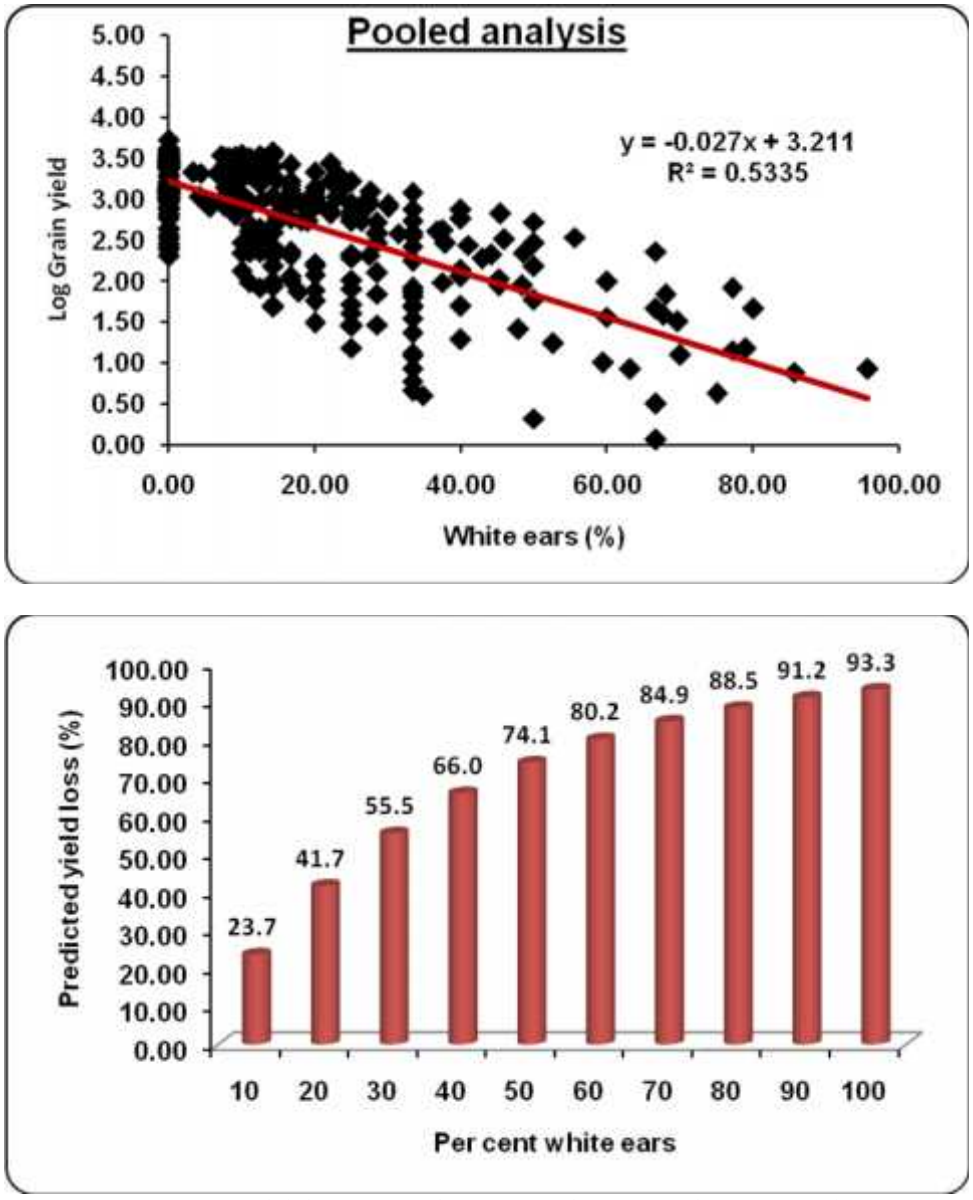
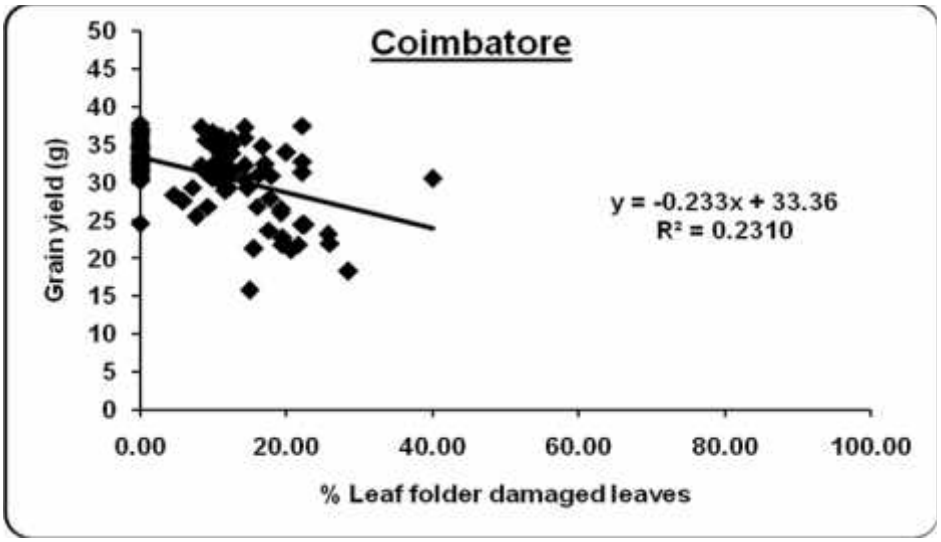



**Fig 2.4** Yield loss predictions due to white ear damage

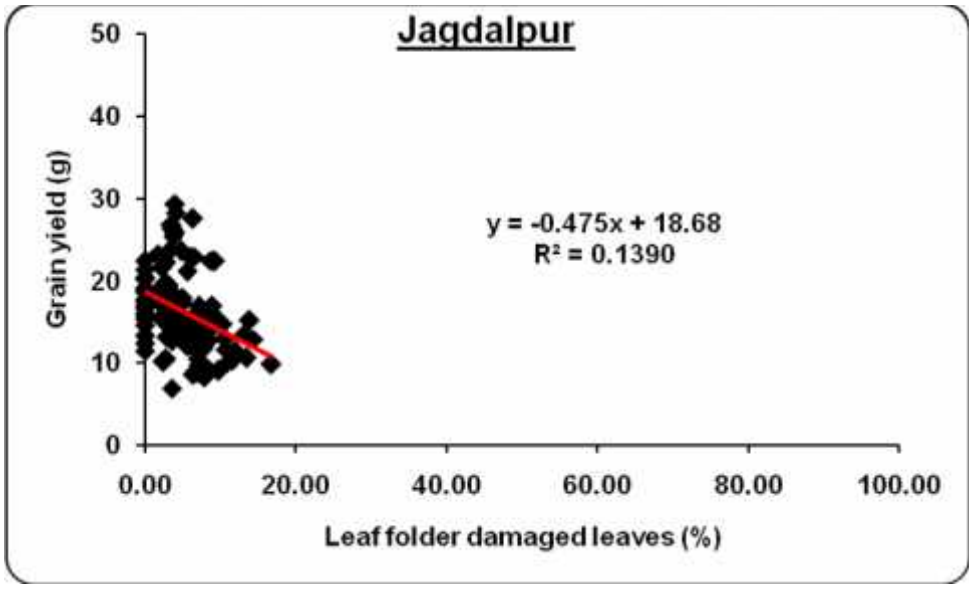
## TARGET PEST: LEAF FOLDER

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

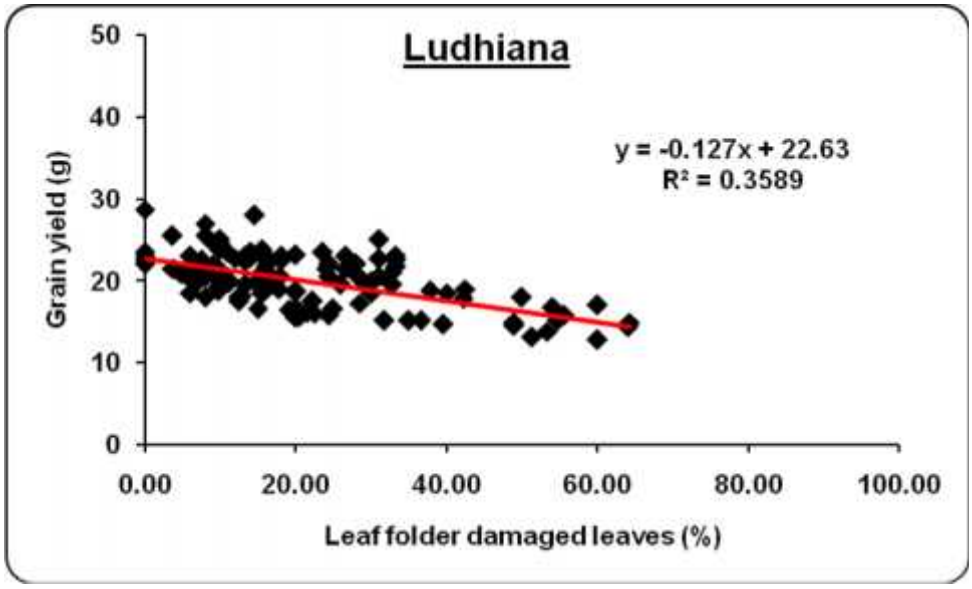
At **Coimbatore**, leaf folder damaged leaves ranged from 0 to 40% with grain yield of 15.75 to 37.80 g per hill. Regression analysis revealed negative relationship between leaf folder damaged leaves and yield ($R^2$=0.2310) but it was not significant.




At **Jagdalpur**, very low leaf folder damage was observed (0-16.81%) resulting in low grain yield of 6.53 to 30.43 g per hill. Regression analysis revealed a non-significant negative relationship between leaf folder damaged leaves and grain yield ($R^2$ = 0.1390)




At **Ludhiana,** leaf folder damaged leaves ranged from 0 to 64.29% with grain yield of 12.75 to 28.70 g per hill. Regression analysis revealed a significant negative relationship between leaf folder damaged leaves and grain yield ($R^2$ = 0.3589). An increase in leaf folder damaged leaves by 10% resulted in a reduction of 1.27 g grain yield per hill.




*Yield loss estimation trial was conducted at 6 locations for stem borer and 3 locations for leaf folder during Kharif 2017. Regression analysis revealed a significant negative relationship between per cent white ears and grain yield at Coimbatore, Chinsurah and Pantnagar. Pooled analysis of white ears vs natural logarithm of grain yield revealed a significant regression ($R^2$ = 0.5335). Based on this model, per cent reduction in grain yield was predicted to be 23.7% for 10% white ears, 41.7% reduction for 20% white ears, 74.1% reduction for 50% white ears and more than 88.5% for more than 80% white ears. A significant negative relationship was observed between leaf folder damaged leaves and grain yield at Ludhiana ($R^2$=0.3589; P<0.00001; n=133) with a reduction of 1.27 g for every 10% increase in the leaf folder damaged leaves.*

## ii) Integrated pest management special trial (IPMs)

In recent years, intensive cultivation of rice has resulted in the frequent occurrence of biotic stresses as major constraints in rice production. Though the concept of IPM is old and accepted by all the stakeholders, implementation at farmers' level is limited**.** IPM implementation involves certain skills and knowledge that help in identification of pest and also their susceptible stages for effective management. As IPM involves a number of components, farmers must have capability of taking decisions and selecting IPM options accordingly for economical and long term management. Keeping this in view, IPMs trial was continued in collaboration with agronomists and plant pathologists with an objective to validate IPM practices from a basket of options available and demonstrate to farmers the management of pests (including insects, diseases and weeds) in a holistic way.

During *Kharif* 2017, IPMs trial was conducted at 17 locations. At 7 locations *viz.*, Coimbatore, Karjat, Mandya, Pantnagar, Rajendranagar, Raipur and Sakoli, the trial was carried out in three farmers' fields. At 2 locations, Jagdalpur and Warangal, the trial was conducted in two farmers' fields while in the rest of 8 locations, i.e., Chinsurah, Chiplima, Gangavathi, Ludhiana, Malan, Masodha, Nellore and Titabar, the trial was carried out in one farmer field. Details of farmers, villages, pest incidence and management practices followed are discussed below location wise:

**Coimbatore:** IPMs trial was conducted in Sri L Kathiresan, Sri K Rajamani and Sri L Moorthi's fields at Pattiyarkovilpathi, Narasipuram village, Thondamuthur block, Coimbatore district, Tamilnadu. BPT 5204 was grown in both IPM and farmer practices plots of one acre each. Practices followed in IPM and FP plots are given in a table below. Incidence of stem borer, leaf folder, BPH, WBPH, GLH and leaf blast was observed in both IPM and farmer practice plots. Dead heart damage caused by stem borer and leaf folder damage started at 15 DAT in farmer practices plot whereas they appeared at 23 DAT in IPM plots. Stem borer damage did not cross ETL in IPM plots while it crossed ETL at 45 DAT (13.62%) and continued till harvest in FP plot. Similarly, high leaffolder damage of 17.38% was observed at 52 DAT in FP plot **(Table 2.41)**. Area under disease progress curve (AUDPC) of leaf blast was high (214.9) in the field where farmer practices were adopted. Implementation of IPM practices invariably reduced the disease intensity at all the three locations (L1- 107.1; L2- 68.6 and L3-124.6). Data on weed population was recorded at weekly intervals from 15 DAT to 73 DAT. The weed population was comparatively low in IPM adopted fields. The mean grain yield increase of 19.1% was reported in IPM adopted field **(Table 2.41)**. Grain yield was highest in IPM plots varying from 57.36 to 58.88 Q/ ha as compared to farmers practices (48.80 q/ ha). BC ratio was highest in IPM plots and ranged between 3.36 and 3.57 as against farmers' practices (2.78) because of high grain yield and low cost of cultivation **(Table 2.42)**.

**Practices followed in IPMs trial at Coimbatore, *Kharif* 2017**

| **LOCATION: COIMBATORE** | | |
|---|---|---|
| **Village**: Narsipuram; **Mandal/district**: Thondamuthur block, Coimbatore district, Tamilnadu State<br>Farmer 1: Sri L Kathirasan; Farmer 2: Sri K Rajamani; Farmer 3: Sri L Moorthy | | |
| | **Practices followed in IPM** | **Farmers practices** |
| Area | 1.15 acre | 1.0 acre |
| Variety | BPT 5204 | BPT 5204 |
| Fertilizers applied | 80:64.5:60:34.5 kg NPKS/ha<br>Urea, Complex fertilizer and MOP | 100:64.5:0:34.5kg NPKS/ha<br>Urea, Complex fertilizers |
| Nursery | Seed treatment with Pseudomonas 10g/kg seed | No seed treatment |
| Main field | • Basal application of Pseudomonas 1kg/acre<br>• Pre-emergence herbicide application Butachlor 500 ml/acre<br>• Post emergence herbicide application Nominee gold @ 80 ml/acre<br>• Installation of YSB pheromone trap @ 3 /acre<br>• Inundative release of *Trichogramma chilonis* 2 cc/acre two times @ 45 & 60th DAT<br>• Application of Neem formulation Azardirachtin 10000 ppm (Neemazal @ 200ml/acre)<br>• Application of Cartap hydrochloride @ 400g/acre<br>• Application of fungicide tricyclazole @ 250g/acre | • Pre-emergence herbicide application Butachlor 500 ml/acre<br>• Application of Lambda cyhaothrin @ 400ml/acre<br>• Application of Monocrotophos @ 500ml/acre<br>• Application of Profenophos @ 300,l/acre<br>• Application of carbendazim @ 200g/acre |

**Table 2.41 Pest incidence and grain yield in IPMs trial at Coimbatore, *kharif* 2017**

| **Treatments** | | **% DH** | | | **% LFDL** | | **Leaf blast** | **Yield** |
|---|---|---|---|---|---|---|---|---|
| | | **45 DAT** | **66 DAT** | **80 DAT** | **37 DAT** | **52 DAT** | **AUDPC** | **kg/ ha** |
| IPM | | 4.1 (2.0)b | 4.2(2.0)b | 3.0(1.7)b | 5.6(2.2)b | 5.7(2.3)b | 100.1 | 5805a |
| FP | | 13.6(3.7)a | 12.8(3.6)a | 11.8(3.4)a | 12.7(3.4)a | 17.4(4.1)a | 214.9 | 4880b |
| **LSD (0.05)** | | **0.29** | **0.22** | **0.51** | **0.49** | **0.46** | | **102** |
| F1- Sri L. Kathiseran | | 8.5(2.7)a | 8.7(2.9)a | 6.8(2.4)a | 10.0(3.0)a | 12.0(3.3)a | 161.0 | 5384a |
| F2 - Sri K. Rajamani | | 9.1(2.9)a | 8.6(2.9)a | 7.7(2.6)a | 8.2(2.5)a | 11.9(3.2)a | 141.7 | 5336a |
| F3-Sri L Moorthi | | 8.9(2.9)a | 8.2(2.7)a | 7.8(2.7)a | 9.2(2.9)a | 10.8(3.0)a | 169.8 | 5308a |
| **LSD (0.05)** | | **0.29** | **0.28** | **0.26** | **0.42** | **0.27** | | **136** |
| F1- Sri L. Kathiseran | IPM | 3.5(1.7)b | 4.6(2.1)b | 1.7(1.4)b | 7.4(2.6)ab | 6.5(2.5)b | 107.1 | 5888a |
| | FP | 13.6(3.7)a | 12.8(3.6)a | 11.8(3.4)a | 12.7(3.4)a | 17.4(4.1)a | 214.9 | 4880b |
| F2 - Sri K. Rajamani | IPM | 4.6(2.1)b | 4.4(2.2)b | 3.4(1.8)b | 3.6(1.7)b | 6.3(2.4)b | 68.6 | 5736a |
| | FP | 13.6(3.7)a | 12.8(3.6)a | 11.8(3.4)a | 12.7(3.4)a | 17.4(4.1)a | 214.9 | 4880b |
| F3-Sri L Moorthi | IPM | 4.2(2.0)b | 3.6(1.9)b | 3.8(1.9)ab | 5.7(2.3)ab | 4.3(1.9)b | 124.6 | 5792a |
| | FP | 13.6(3.7)a | 12.8(3.6)a | 11.8(3.4)a | 12.7(3.4)a | 17.4(4.1)a | 214.9 | 4880b |
| **LSD (0.05)** | | **0.41** | **0.4** | **0.38** | **0.59** | **0.38** | | **193** |

| **Treatments** | **Weed Population No/m²** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **15 DAT** | **23 DAT** | **30 DAT** | **37 DAT** | **45 DAT** | **52 DAT** | **59DAT** | **66 DAT** | **73 DAT** |
| IPM | 1.93(1.54) | 1.87(1.51) | 2.33(1.63) | 2.67(1.75) | 3.00(1.84) | 2.33(1.65) | 2.67(1.74) | 1.93(1.53) | 1.13(1.20) |
| FP | 0.93(1.06) | 1.07(1.10) | 1.13(1.12) | 2.00(1.31) | 2.40(1.38) | 1.53(1.18) | 1.73(1.25) | 1.60(1.23) | 1.20(1.13) |
| **LSD (0.05)** | **0.19** | **0.19** | **0.28** | **0.29** | **0.32** | **0.27** | **0.3** | **0.18** | **NS** |

**Table 2.42 Returns and BC ratio in IPMs trial at Coimbatore, *kharif* 2017**

| Name of the Farmer | Treatments | Yield (q/ha) | Gross Returns (Rs.) | Cost of Cultivation (Rs.) | Net Returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|
| Sri L Kathiseran | IPM | 58.88 | 88320 | 26300 | 62020 | 3.36 |
| Sri L Kathiseran | FP | 48.80 | 73200 | 26375 | 46825 | 2.78 |
| Sri K Rajamani | IPM | 57.36 | 86040 | 24125 | 61915 | 3.57 |
| Sri L Moorthi | IPM | 57.92 | 86880 | 24625 | 62255 | 3.53 |

Price of paddy = Rs1500/ q

**Chinsurah:** IPM trial was conducted in Sri Manabendra Ghosh's field at Damra village, Mogra in West Bengal. Incidence of stem borer, leaf folder, whorl maggot, hispa, BPH, WBPH, GLH, brown spot, neck blast and sheath blight was observed in IPM and farmer practices plots whereas leaf blast was recorded only in farmers practices in swarna sub 1 variety. Stem borer damage crossed ETL from 36 DAT onwards in FP plot (11.92%) and continued till harvest with highest white ear damage of 25.76% in FP plots as against 2.78% in IPM plot **(Table 2.43a)**. Low incidence of foliage feeders was observed from 15 DAT onwards till harvest in both IPM and FP plots. Sucking pest complex of BPH, WBPH and GLH was observed from 43 DAT onwards and population increased with crop growth crossing ETL at 85 DAT (59.60 hoppers/5 hills) and 92 DAT (86.40 hoppers/5 hills) in FP plot. Adoption of IPM practices reduced the severity of leaf blast (IPM-0; FP-54.6), brown spot (IPM- 115.5; FP-317.1), sheath blight (IPM- 174.3; FP-361.2) and bacterial leaf blight (IPM- 14.7; FP-462). The data on weed population and weed biomass were recorded at 30 and 60 DAT **(Table 2.43b)**. Significant decrease in weed population and biomass in IPM implemented has resulted in higher growth, yield attributes and grain yield increase by 13.2% of the variety Swarna sub 1. High BC ratio of 1.78 was obtained in IPM as compared to FP plot (1.58) mainly due to higher grain yield (58.28q/ ha) with increased returns **(Table 2.44)**.

| **Practices followed in IPMs trial at Chinsurah, *Kharif* 2017** | | |
|---|---|---|
| **LOCATION: CHINSURAH** | | |
| | **IPM practices followed** | **Farmers practices followed** |
| Area | 0.5 acre | 0.5 acre |
| Variety | Swarna Sub 1 | Swarna Sub 1 |
| Nursery | Application of 1.5 kg mustard cake | Application of 5 kg mustard cake |
| Main field | • Field preparation with power tiller, cutting of bunds and leveling the field<br>• Application of 31 kg 10-26-26; Urea 28 KG<br>• Installation of pheromone traps @ 8/acre for stem borer mass trapping | • Field preparation with power tiller, cutting of bunds and leveling the field<br>• Application of 30 kg SSP; 23 kg MOP; Urea 30 kg |

**Table 2.43a Pest incidence and grain yield in IPMs trial at Chinsurah, *kharif* 2017**

| Treatments | %DH | | %WE | %HDL | %WMDL | %LFDL | BPH | | WBPH | GLH |
|---|---|---|---|---|---|---|---|---|---|---|
| | 50 DAT | 57 DAT | Pre harv | 29 DAT | 36 DAT | 43 DAT | 85 DAT | 92 DAT | 85 DAT | 64 DAT |
| IPM | 1.87 ± 0.97 | 1.88 ± 0.79 | 2.78 ± 0.88 | 0.50 ± 0.32 | 1.42 ± 0.30 | 0.78 ± 0.14 | 4.60 ± 0.9 | 4.80 ± 1.1 | 4.40 ± 1.4 | 3.60 ± 0.7 |
| FP | 13.69 ± 1.45 | 14.14 ± 1.97 | 25.76 ± 3.16 | 4.14 ± 0.57 | 9.07 ± 1.58 | 4.49 ± 0.48 | 59.60 ± 4.01 | 86.40 ± 5.07 | 39.40 ± 3.20 | 41.20 ± 4.34 |

**Table 2.43b Diseases, Weed population and weed biomass at Chinsurah, *kharif* 2017**

| Treatments | SHBL | BLB | BS | Weed population (No/m2) | | Weed biomass (g/ m2) | |
|---|---|---|---|---|---|---|---|
| | AUDPC | | | 30 DAT | 60 DAT | 30 DAT | 60 DAT |
| IPM | 174.3 | 14.7 | 115.5 | 36 ± 9 | 65 ± 10 | 3.4 ± 0.97 | 6.23 ± 1.76 |
| FP | 361.2 | 462 | 317.1 | 63 ± 12 | 93 ± 20 | 6.66 ± 1.16 | 9.34 ± 2.41 |

**Table 2.44 Returns and BC ratio in IPMs trial at Chinsurah, *kharif* 2017**

| Treatments | Yield (q/ha) | Gross Returns (Rs.) | Cost of Cultivation (Rs.) | Net Returns (Rs.) | BC ratio |
|---|---|---|---|---|---|
| IPM | 58.28 | 81592 | 45860 | 35732 | 1.78 |
| FP | 51.60 | 72240 | 45860 | 26380 | 1.58 |

Price of paddy = 1400 Rs/ q

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

| **Practices followed in IPMs trial at Chiplima, *Kharif* 2017** | | |
|---|---|---|
| **Details** | **IPM block** | **FP block** |
| Variety | Swarna | Swarna |
| Practices followed in main field | • Seed treatment with Carbandezim @ 2 g/ kg seed. Application of Carbofuran 3 G@ 30 kg / ha, 5 days after transplanting.<br>• Transplanted seedlings at a spacing of 20 x 15 cm. Left alleyways of 30 cm after every 2 m.<br>• Fertilizers (NPK) applied 100:50:50.<br>• One spray of Cartap hydrochloride 50 WP @ 600 g / ha at 25 DAT<br>• Application of tricyclazole 75 WP @ 300 g /ha at 40 DAT Spraying of acephate 75 SP @ 750 g /ha at 45 DAT Spraying of pymetrozin 50 WP @ 300 g /ha at 65 DAT | • Fertilizers (NPK) applied- 120:60:60 NPK<br>• Sprayed Cartap hydrochloride 50 WP @ 600 g /ha at 20 DAT<br>• Application of acephate 75 SP @ 600 g /ha at 45 DAT<br>• Sprayed of tricyclazole 75 WP@ 300 g /ha at 40 DAT<br>• Sprayed acephate 50 WP @ 600 g /ha at 60 DAT<br>• Application of Thiamethoxam 25 WDG @ 200 g /ha at 70 DAT<br>• Applied imidacloprid 17.8 SL @ 200 ml /ha at 85 DAT |

**Table 2.45 Pest incidence, grain yield & BC ratio in IPMs trial at Chiplima, *kharif* 2017**

| Treatments | %DH | %DH | %WE | %SS | BPH/ 5 hills | Yield |
|---|---|---|---|---|---|---|
| | 45 DAT | 90 DAT | Pre har | 45 DAT | 90 DAT | Q/ha |
| IPM | 0.26 ± 0.20 | 1.52 ± 0.49 | 1.94 ± 0.27 | 0.75 ± 0.31 | 16.4 ± 1.2 | 51.00 |
| FP | 1.36 ± 0.42 | 2.60 ± 0.39 | 3.56 ± 0.72 | 5.20 ± 0.51 | 32.8 ± 1.3 | 44.00 |

**Gangavati:** IPMs trial was conducted in Sri Rudrappa's field at Kesaratti village, Gangavati district of Karnataka state. BPT 5204 was grown in both IPM and FP plots. Low incidence of stem borer and leaf folder (<2%) was observed in both the treatments **(Table 2.46).** Incidence of planthoppers *i.e.,* BPH and WBPH started at 15 DAT in both IPM and FP plots. WBPH population was higher than BPH population **(Fig 2.5).** Highest population of WBPH was found in IPM plot at 43 and 50 DAT (>100 WBPH/hill) and at 78 DAT in FP plot (69/hill). Similarly, BPH numbers were high at 43-50 DAT in IPM plot (>50/hill) and at 78 DAT in FP plot. Grain yield of 74.98 q/ ha was recorded in IPM plot compared to FP plot (71.50 q/ ha) resulting in higher gross returns **(Table 2.47)**. BC ratio was high in IPM

(1.44) due to low cost of cultivation and higher net returns as compared to FP plot.

| **Practices followed in IPMs trial at Gangavathi, *Kharif* 2017** | |
|---|---|
| **IPM practices** | **Farmers Practices** |
| Variety – BPT 5204 | Variety – BPT 5204 |
| Seed treatment with Pseudomonas @ 10gm/l for 30 mins<br>Seedling dip with pseudomonas@ 4 gm/l for 20 mins<br>Application of Rynaxypyr @ 4kg/ac<br>Transplanting @ 20X15 Cm<br>Leaving alleyways<br>Fertilizer application @200:100:100 NPK/ha<br>Application of weedicide, Butachlor @ 400 ml/l<br>For BLB- COC@ 0.05 gm/l + Stpetocycline @ 0.05gm/l<br>Application of Dinotefuran @0.4 gm/l<br>Application of Hexaconazole 2 ml/l<br>Application of Pymetrozine @ 0.6 g/l + Tricyaclazole @ 0.6 gm/l<br>Application of Profenofos 50 EC @ 2ml/l | No seed treatment<br>Application of weedicides Butachlor @ 400 ml/ac<br>Transplanting @15X10 cm<br>Leaving alleyways<br>Fertilizer application @ 300:125:125 kg/ha<br>Application phorate 10 G @ 12 kg/ha<br>Application of hexaconzole @2 ml/l+ Streptocycline @ 0.06g/l + chlorpyriphos & cypermethrin (Hamla 505) + Acephate<br>Application of carbendiaim@ 1gm/l + Dinotefuran<br>Application of Pymetrozine @ 0.6 g/l + Hexaconzole @ 2 ml/l + Acephate @ 2 gm /l<br>Application of Acephate 95 SG @ 1.5 g/l trifloxystrobin & tebuconazole (Nativo) @ 0.4 gm/l<br>Spray of tricyaclazole @ 0.6 gm/l<br>Application of propiconazole @ 1 ml/l + Buprofezine 25SC @ 1 ml/l |

**Table 2.46 Pest incidence and grain yield in IPMs trial at Gangavathi, *kharif* 2017**

| Treatments | %DH | %WE | %LFDL | BPH | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 43 DAT | Pre harv | 92 DAT | 43 DAT | 50 DAT | 57 DAT | 64 DAT | 71 DAT | 78 DAT |
| IPM | 0.53 ± 0.16 | 0.14 ± 0.09 | 0.82 ± 0.16 | 267.8 ±14.6 | 263.2 ± 16.8 | 45.0 ± 6.4 | 61.0 ± 8.0 | 114.6 ± 6.1 | 149.0 ± 13.9 |
| FP | 0.61 ± 0.30 | 0.46 ± 0.24 | 1.48 ± 0.30 | 82.2 ± 9.5 | 94.4 ± 8.9 | 221.0 ± 12.9 | 128.2 ± 14.1 | 205.6 ± 16.5 | 249.8 ± 23.9 |

| Treatments | WBPH | | | | | | | Yield |
|---|---|---|---|---|---|---|---|---|
| | 36 DAT | 43 DAT | 50 DAT | 57 DAT | 64 DAT | 71 DAT | 78 DAT | Kg/ ha |
| IPM | 232.2 ± 21.0 | 509.2 ± 30.5 | 513.2 ± 26.4 | 63.2 ± 8.1 | 98.4 ± 6.1 | 231.2 ± 10.6 | 273.8 ± 17.7 | 7498.4 ± 395.8 |
| FP | 36.8 ± 4.2 | 102.2 ± 8.7 | 105.4 ± 8.4 | 254.0 ± 19.7 | 164.0 ± 16.2 | 323.2 ± 13.0 | 347.6 ± 18.6 | 7149.6 ± 440.8 |

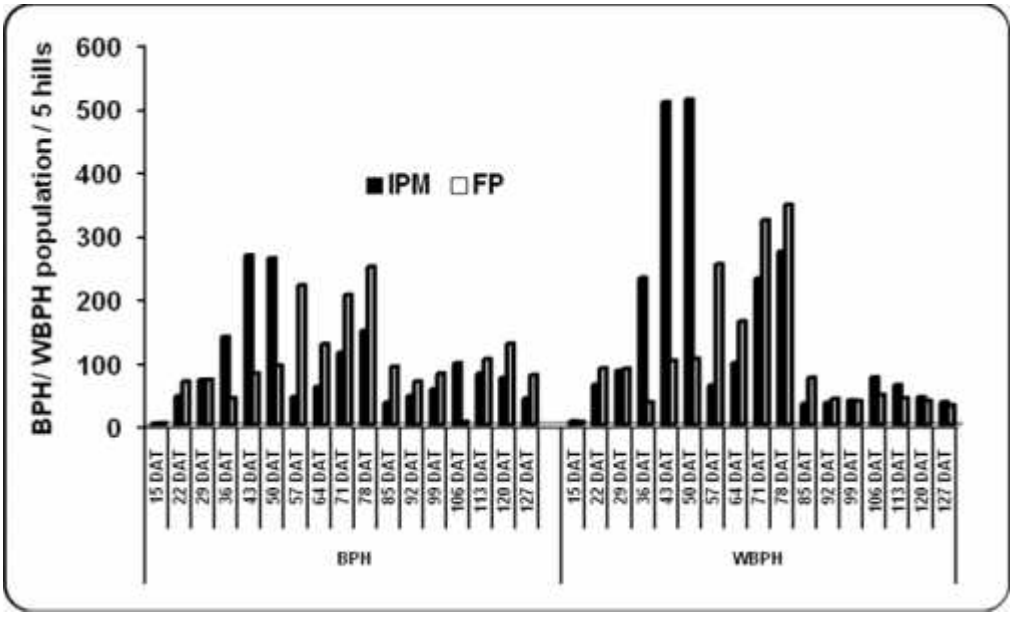



**Fig 2.5** Planthopper population in IPM and FP plots in IPMs trial at Gangavati, *Kharif* 2017

**Table 2.47 Returns and BC ratio in IPMs trial at Gangavati, *kharif* 2017**

| Treatments | Yield (q/ha) | Gross Returns (Rs.) | Cost of Cultivation (Rs.) | Net Returns (Rs.) | BC ratio |
|---|---|---|---|---|---|
| IPM | 74.98 | 149960 | 104275 | 45685 | 1.44 |
| FP | 71.50 | 143000 | 118650 | 24350 | 1.21 |

Price of paddy = 2000 Rs/ q

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

| **Practices followed in IPMs trial at Jagdalpur, *Kharif* 2017** | | |
|---|---|---|
| | **IPM Practices followed** | **Farmers Practices followed** |
| Area | 1 acre | 1 acre |
| Variety | Safri | Safri-17 |
| Nursery | Application of 3.2 kg N, 2 kg P, 1.2 kg K / 400m$^2$nursery | Application of 2 kg N, 1 kg P, 1 kg K / 400m$^2$ nursery |
| Main field | • Application of 80:50:30 kg NPK per hectare<br>• Seedlings transplanted at spacing of 20/15 cm; Left alleyways of 30 cm after 10 rows.<br>• Applied Butachlor 1.5 kg ai/ha at 4 DAT+ 1 hand weeding<br>• Applied chlorpyriphos @ 1 lit/acre at 20 DAT<br>• Applied weedicide metsulfurom methyl @ 20 DAT + One hand weeding at 40 DAT<br>• Nitrogen top dressing at 45 DAT<br>• Sprayed Tricyclazole 300 g/ha against blast<br>• Sprayed cartaphydrochloride 50WP @ 600g/ha at 60 DAT | • Application of 40 kg N, 50 kg P & 10 Kg K/ acre<br>• Applied phorate 10 G @ 5kg/ha<br>• Hand weeding twice<br>• Sprayed Carbendazim @ 200 g/ha against blast |

White ear damage was found low in IPM plots as compared to FP plots in both the farmers' fields **(Table 2.48)**. White ear damage was high in Sri Babulal's FP plot (30.1%) as compared to Sri Kirtu Ram Nag's FP plot (21.2%). Similarly, gall midge damage was also observed high in FP plots at 45 and 60 DAT compared to IPM plots. Damage by leaf folder (30%) and whorl maggot (33.3%) at 15 DAT was significantly higher in FP plot of Sri Babulal as against other FP plot and IPM plots. However, thrips damage was at par in both the FP plots (20 – 29.7%) but significantly different from IPM plots (5.4-9.4%) of both the farmers. At two locations where the trail was conducted against leaf blast, the disease severity was low (L1- 15.3; L2- 9.6) in IPM adopted field when compared to Farmer's practices (L1- 38.5; L2- 44.2). Grain yield was significantly high in IPM plots (37.28 – 38.40 q/ha) as compared to FP plots (28.50 – 29.92q/ha). Though the grain yield was low in FP plot, BC ratio was high in FP plot of Sri Babulal (2.33) compared to IPM plots and Sri Kirtu Ram Nag's FP plot (2.10-2.18) due to low cost of cultivation resulting in high net returns **(Table 2.49)**.

**Table 2.48 Pest incidence and grain yield in IPMs trial at Jagdalpur, *kharif* 2017**

| Treatments | | %WE | %SS | | %LFDL | | | %WMDL | | %ThDL | | Leaf blast | Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre harv | 45 DAT | 60 DAT | 15 DAT | 30 DAT | 60 DAT | 15 DAT | 30 DAT | 15 DAT | 30 DAT | AUDPC | kg/ ha |
| IPM | | 6.5(2.4)b | 9.3(2.9)b | 3.4(1.7)b | 5.4(2.2)b | 6.4(2.6)b | 5.7(2.4)b | 3.5(1.8)b | 9.1(3.1)b | 7.9(2.5)b | 7.4(2.7)b | 12.45 | 3784a |
| FP | | 25.6(5.0)a | 22.0(4.6)a | 12.6(3.4)a | 23.4(4.6)a | 24.1(4.9)a | 12.6(3.6)a | 25.1(4.9)a | 28.9(5.4)a | 24.9(5.0)a | 23.5(4.9)a | 41.35 | 2921b |
| **LSD** | | **2.27** | **0.94** | **1.65** | **1.73** | **0.74** | **0.86** | **0.27** | **0.38** | **1.43** | **0.43** | | **181** |
| Sri Kirtu Ram Nag | | 13.4(3.5)a | 21.4(4.4)a | 10.7(2.9)a | 8.2(2.8)b | 12.7(3.5)a | 10.7(3.2)a | 10.4(3.0)a | 18.2(4.1)a | 18.7(4.0)a | 17.7(4.1)a | 26.9 | 3289b |
| Sri Babulal | | 18.7(3.9)a | 10.0(3.0)b | 5.3(2.2)a | 20.5(4.0)a | 17.8(3.9)a | 7.6(2.8)a | 18.2(3.8)a | 19.8(4.4)a | 14.0(3.5)a | 13.3(3.5)a | 26.9 | 3416a |
| **LSD** | | **0.99** | **1.21** | **0.96** | **0.49** | **0.54** | **0.57** | **1.01** | **0.57** | **1.04** | **0.72** | | **96** |
| Sri Kirtu Ram Nag | IPM | 5.6(2.3)b | 14.1(3.5)bc | 3.9(1.7)b | 6.2(2.4)b | 7.2(2.8)c | 6.8(2.6)bc | 4.0(1.9)c | 7.3(2.8)b | 7.8(2.5)b | 9.4(3.1)b | 15.3 | 3728a |
| | FP | 21.2(4.6)ab | 28.5(5.3)a | 17.4(4.0)a | 10.3(3.2)b | 18.2(4.3)b | 14.5(3.9)a | 16.9(4.2)b | 29.0(5.4)a | 29.7(5.4)a | 25.9(5.1)a | 38.5 | 2850c |
| Sri Babulal | IPM | 7.3(2.4)b | 4.5(2.2)c | 2.8(1.6)b | 4.4(2.0)b | 5.5(2.4)c | 4.6(2.2)c | 3.1(1.7)c | 10.9(3.4)b | 8.1(2.5)b | 5.4(2.4)b | 9.6 | 3840a |
| | FP | 30.1(5.4)b | 15.5(3.9)1b | 7.8(2.8)ab | 36.5(6.1)a | 30.0(5.5)a | 10.7(3.3)ab | 33.3(5.8)a | 28.8(5.4)a | 20.0(4.5)a | 21.1(4.6)a | 44.2 | 2992b |
| **LSD** | | **1.4** | **1.7** | **1.36** | **0.7** | **0.76** | **0.81** | **1.43** | **0.8** | **1.48** | **1.01** | | **136** |

| Treatments | Weed Population No/m² | Weed Dry Biomass g/m² |
|---|---|---|
| | 47 DAT | 47 DAT |
| **IPM** | 12.90(3.64) | 9.74 |
| **FP** | 33.40(5.79) | 26.39 |
| **LSD(0.05)** | 0.52 | 3.72 |

**Table 2.49 Returns and BC ratio in IPMs trial at Jagdalpur, kharif 2017**

| Farmer name | Treatments | Yield (q/ha) | Gross Returns (Rs.) | Cost of Cultivation (Rs.) | Net Returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|
| Sri Kirtu Ram Nag | IPM | 37.28 | 63376 | 29935 | 33441 | 2.12 |
| | FP | 28.50 | 48450 | 23125 | 25325 | 2.10 |
| Sri Babulal | IPM | 38.40 | 65280 | 29935 | 35345 | 2.18 |
| | FP | 29.92 | 50864 | 21825 | 29039 | 2.33 |
| Price of paddy =1700 Rs/ q | | | | | | |

**Karjat:** IPMs trial was conducted in three farmers' fields' *viz.*, Sri Madhukar Balu Chandan of Vadap (Gaurkamat) village, Sri Saduram Patil of Khandpe village and Sri Mohan Dhule of Markewadi 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* 2017** | | |
|---|---|---|
| Practices adopted | IPM block | Farmers practices |
| Varieties | 1)Sri Madhukar Balu Chandan, Vadap (Gaurkamat) village - Karjat-7<br>2) Sri Saduram Patil, khandpe village- Awani<br>3) Sri Mohan Dhule, Markewadi village Karjat 9 | Local Ratna<br>Awani<br>Karjat 9 |
| Nursery | • Seed treatment with carbendazim @ 10 g/ 10 kg seed<br>• Raised bed 3x1m treated with rice husk (hull) ash @3kg/bed | • Land burned with waste materials<br>• Application of Phorate1 kg |
| Main field | • Deep ploughing<br>• Application of FYM 4 T, Suphala 215 Kg, Urea 87 Kg<br>• 2-3 seedlings transplanted at a spacing 20 x15 cm.<br>• Alleyways of 40cm left after every 10 rows<br>• Bispyribasodium 250ml/ha (Nomini gold).<br>• Pheromens trap @ 8 / acre<br>• Use of bird perches in the field<br>• Use Vaibhav sickle for harvesting Spraying of Acephate 75 sp @ 1000 g/500lit Water, Phorate 10 kg/ha | • Deep ploughing<br>• Application of FYM 2 T,Urea 145 kg, Suphala 75 kg<br>• 4-5 seedlings transplanted randomly<br>• Hand Weeding once<br>• Phorate 10 kg/ha (two applications) |

**Table 2.50. Weed population in IPMs trial at Karjat, *Kharif* 2017**

| | **Weed Population (No/m²)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Treatments** | **15 DAT** | **22 DAT** | **29 DAT** | **36 DAT** | **43 DAT** | **50 DAT** | **57 DAT** | **64 DAT** | **71 DAT** | **78 DAT** | **92 DAT** |
| **IPM** | 1.67 (1.41) | 1.87 (1.52) | 3.67 (2.01) | 5.27 (2.37) | 5.53 (2.43) | 6.47 (2.63) | 3.73 (2.05) | 7.07 (2.74) | 6.93 (2.72) | 5.60 (2.45) | 4.87 (2.30) |
| **FP** | 2.73 (1.72) | 5.87 (2.51) | 10.53 (3.27) | 13.80 (3.76) | 10.87 (3.33) | 12.33 (3.55) | 15.73 (3.97) | 14.67 (3.85) | 13.93 (3.76) | 12.80 (3.63) | 11.80 (3.49) |
| **LSD (0.05)** | 0.16 | 0.19 | 0.35 | 0.17 | 0.13 | 0.23 | 0.09 | 0.22 | 0.16 | 0.22 | 0.08 |

**Table 2.51 Pest incidence in IPMs trial at Karjat, *kharif* 2017**

| **Treatments** | | **%DH 29 DAT** | **%WE Pre harv** | **%LFDL 57 DAT** |
|---|---|---|---|---|
| F1- Sri Madhukar Balu Chandan | IPM | 2.4(1.7)e | 0.0(0.7)c | 0.5(0.9)d |
| | FP | 5.6(2.5)c | 1.7(1.5)a | 1.7(1.5)a |
| F2 - Sri Saduram Patil | IPM | 3.1(1.9)de | 0.0(0.7)c | 0.8(1.1)c |
| | FP | 8.4(3.0)b | 0.6(1.0)b | 1.2(1.3)b |
| F3-Sri Mohan Dhule | IPM | 3.6(2.0)d | 0.0(0.7)c | 0.5(1.0)d |
| | FP | 11.1(3.4)a | 0.9(1.2)b | 1.1(1.3)b |
| **LSD (0.05)** | | **0.3** | **0.16** | **0.08** |

The weed population was recorded at weekly intervals from 15 DAT to 92 DAT. The weed intensity was higher in farmers practice by 2 to 5 times. The relative grain yield advantage was 50.3% in IPM adopted fields **(Table 2.50)** .Very low incidence of stem borer and leaf folder (<5%) was observed in both IPM and FP plots in all the three farmers fields except in Sri Mohan Dhule's FP plot which

recorded DH damage of 11.1% at 29 DAT **(Table 2.51)**. Grain yield of 44.15 q/ ha was obtained from IPM plot with a BC ration of 1.84 as compared to FP plot (1.68) due to low net returns **(Table 2.52)**.

**Table 2.52 Returns and BC ratio in IPMs trial at Karjat, *kharif* 2017**

| Treatments | Grain Yield (q/ha) | Straw yield (q/ ha) | Gross Returns (Rs.) | Cost of Cultivation (Rs.) | Net Returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|
| IPM | 44.15 | 52.09 | 87680 | 47605 | 40075 | 1.84 |
| FP | 36.09 | 42.58 | 71673 | 42621 | 29052 | 1.68 |

Price of paddy = 1750 Rs/ q; Price of straw = Rs 200/q

**Ludhiana:** IPMs trial was carried out in Sri Iqbal Singh's field of Tugal village, Ludhiana district, Punjab State. PR 121 variety was grown in both IPM and FP plots. Low incidence of stem borer, leaf folder, whorl maggot, BPH and WBPH was observed in both the treatments. Among the diseases, sheath blight and false smut were observed in both the treatments. In IPM field, the AUDPC value was low with reference to sheath blight (67.2) and false smut (9.6) while it was more in farmer's field (Shbl – 99.4; FS-25.2). Weed population was also low in both IPM and FP plots with 4.3% increase in grain yield compared to farmers' practices **(Table 2.53)**. Observations on natural enemies like spiders, coccinellids, ichneumonids and braconids were also taken in both IPM and FP plots. Grain yield was relatively high in IPM (78.20q/ ha) as compared to FP plot (75.04) resulting in higher BC ratio (3.22) due to high gross returns and low cost of cultivation **(Table 2.54)**.

**Practices followed in IPMs trial at Ludhiana, *Kharif* 2017**

| | **IPM Practices followed** | **Farmers Practices followed** |
|---|---|---|
| Variety | PR 121 | PR 121 |
| Nursery | • Seed treatment with 20 g Bavistin 50 WP and 1 g Streptocycline<br>• Application of urea @ 1.04 kg and Zinc sulphate @ 1 kg/ acre nursery | • Application of urea @ 1.04 kg/ acre nursery and Zinc sulphate @ 1 kg/ acre nursery |
| Main field | • Alley ways of 30 cm after every 2 m<br>• Application of Butachlor @ ½ l/ acre<br>• Sprayed Fame 480 SC @ 20 ml/acre<br>• Sprayed Confidor 17.8SL @ 40 ml/ acre & Tilt @ 200ml/ acre<br>• Recommended dose of urea-110 kg/ acre<br>• Installation of pheromone traps @ 8 / ha<br>• Release of tricho cards<br>• Water management for planthoppers | • Application of 150 kg Urea, 25 kg Zinc sulphate/ acre<br>• Application of Butachlor @ ½ l/ acre<br>• Application of Chlorpyriphos @ 1.0l/ acre<br>• Sprayed Confidor 17.8SL @ 40 ml/ acre<br>• Sprayed Tilt @ 200ml/ acre |

**Table 2.53 Pest incidence, grain yield & BC ratio in IPMs trial at Ludhiana, *kharif* 2017**

| Treatments | % DH | % WE | % LFDL | % WMDL | WBPH | False smut | Sheath blight | Weed popultaion (No/m2) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 65 DAT | Pre harv | 65 DAT | 30 DAT | 65 DAT | AUDPC | | 37 DAT | 44 DAT | 58 DAT |
| IPM | 5.35 ± 1.67 | 4.74 ± 0.61 | 10.29 ± 0.89 | 3.06 ± 0.77 | 21 ± 1.0 | 9.87 | 67.2 | 2.4 ± 0.55 | 1.6 ± 0.55 | 1.2 ± 0.45 |
| FP | 2.29 ± 0.72 | 4.82 ± 0.61 | 3.37 ± 0.23 | 3.56 ± 0.09 | 28 ± 3.0 | 25.2 | 99.4 | 2 ± 0.71 | 2 ± 0.71 | 1.6 ± 0.55 |

Price of paddy = Rs 1510/ Q

**Table 2.54 Returns and BC ratio in IPMs trial at Ludhiana, *kharif* 2017**

| Treatments | Yield (q/ ha) | Gross returns (Rs.) | Cost of cultivation (Rs.) | Net returns (Rs.) | BC ratio |
|---|---|---|---|---|---|
| IPM | 78.20 | 118082 | 36640 | 81442 | 3.22 |
| FP | 75.04 | 113310 | 39455 | 73855 | 2.87 |

Price of paddy = Rs 1510/ Q

**Malan:** The trial was conducted in Sri Amar singh's field of Hatwas Jhikla village, Kangra district, Himachal Pradesh. HPR 2880 was grown in IPM plot and HPR 1068 in FP plot. Incidence of foliage feeding insects like leaf folder, whorl maggot and hispa was observed from 29 DAT onwards. Incidence of whorl maggot was very high in FP plot starting at 29 DAT (47.14% WMDL) to 43 DAT (41.58% WMDL) as compared to IPM plot (1.14-7.00%). Hispa and leaf folder damage was also found high in FP plot as compared to IPM plot **(Table 2.55)**. The weed population was two to four times lower in IPM adopted field. The relative grain yield advantage was 15.9%. BC ratio was relatively high in IPM plot (2.11) due to higher grain yield (35 q/ ha) and low cost of cultivation compared to FP plot (2.07) (**Table 2.56**).

| **Practices followed in IPMs trial at Malan, *Kharif* 2017** | | |
|---|---|---|
| **Practices adopted** | **IPM block** | **Farmers practices** |
| **Area** | 1 hectare | 1 hectare |
| **Variety** | HPR 2880 | HPR 1068 |
| **Nursery** | Application of weedicide, Butachlor | Hand weeding |
| **Main field** | Application of IFFCO 12:32:16 @ 125 kg, urea – 184 kg and MOP 33 kg.<br>Application of Machete weedicide | Application of IFFCO @ 94 kg, urea 62 kg and MOP 25 kg.<br>Manual weeding |

**Table 2.55 Pest incidence in IPMs trial at Malan, *kharif* 2017**

| | % LFDL | % WMDL | | | % HDL | Weed Population No/m² | | Weed Dry Biomass g/m² | |
|---|---|---|---|---|---|---|---|---|---|
| Treatments | 78 DAT | 29 DAT | 36 DAT | 43 DAT | 36 DAT | 30 DAT | 60 DAT | 30 DAT | 60 DAT |
| IPM | 3.30 ± 0.26 | 7.00 ± 2.56 | 1.85 ± 0.79 | 1.14 ± 1.03 | 5.49 ± 1.24 | 16.8 ± 4.0 | 18.0 ± 1.2 | 5.42 ± 1.44 | 15.16 ± 2.90 |
| FP | 13.04 ± 1.70 | 47.14 ± 5.40 | 45.43 ± 3.39 | 41.56 ± 0.89 | 10.72 ± 3.35 | 38.0 ± 6.3 | 78.2 ± 19.4 | 15.83 ± 2.01 | 49.28 ± 10.87 |

**Table 2.56 Returns and BC ratio in IPMs trial at Malan, *kharif* 2017**

| Treatments | Yield (q/ ha) | Gross returns (Rs.) | Cost of cultivation (Rs.) | Net returns (Rs.) | BC ratio |
|---|---|---|---|---|---|
| IPM | 35.00 | 59500 | 28242 | 31258 | 2.11 |
| FP | 30.16 | 51272 | 24746 | 26526 | 2.07 |

Price of paddy = Rs 1700/ Q

**Mandya:** IPMs trial was conducted in three farmers' fields in three different villages, i.e., in Sri Prakash's field at Mallanayakanakatte village, Sri Chikkanna's field at Holalu village and Sri Basavaraju's field at Gandhalu village of Mandya district in Karnataka State. Incidence of stem borer, leaf

folder, caseworm and BPH was observed in Sri Prakash's field at Mallanayakanakatte village whereas armyworm incidence was noticed in Sri Chikkanna's and Basavaraju's fields. In general, pest damage was low across the farmers' fields except in case of FP plot of Sri Prakash which registered 13.4% DH damage at 85 DAT **(Table 2.57**). Similarly, armyworm larvae were high in FP plot in Sri Chikkanna's field (>7/hill). At three locations, diseases *viz.*, leaf blast, neck blast and sheath blight were recorded. In all the locations leaf blast severity was low (L1- 21.3; L2- 29.4; L3- 21.7) when IPM practices were adopted compared to farmers field (L1- 112.7; L2- 72.38; L3- 46.6). Neck blast severity was reduced (L1- 29.4; L2- 21.5; L3- 26.3) due to application of IPM practices compared to farmers practices adopted fields (L1- 78.5; L2- 72.8; L3- 104.9). Similar trend was observed with respect to sheath blight disease progress (IPM = LI - 63.7; L2- 31.0; L3 – 120.2; FP = LI – 127.4; L2- 145.5; L3 – 158.4). The data recorded on weed population at 36 and 64 DAT showed non-significant numbers between IPM and FP plots and grain yield was significantly high under IPM practice with 9.18% higher. There was no significant difference in grain yields between IPM and FP plots and among the farmers' fields due to low pest damage. Yields ranged between 42.80 and 44.80q/ ha in IPM plots and 40 – 40.4q/ ha in FP plots. However BC ratio was low in FP plots (1.64-1.75) as compared to IPM plots (1.99-2.09) mainly due to high cost of cultivation resulting in low net returns in FP plots **(Table 2.58)**.

**Practices followed in IPMs trial at Mandya, Kharif 2017**

| Practices adopted | IPM practices | Farmers practices<br>Sri Prakash | Sri Chikkanna | Sri Basavaraju |
|---|---|---|---|---|
| Area | 1 ac | 1 ac | 1ac | 1ac |
| Variety | Gangavathi Sona | Gangavathi Sona | KMP 149 | Gangavathi Sona |
| Fertilizers applied | 100:50:50 NPK/ha in 3 split doses; Zinc sulphate @ 8kg/ac as basal application | 100Kg - 10:26:26 complex fertilizer; 100Kg Urea | 70 kg - 10:26:26 complex fertilizer; 100Kg Urea | 100Kg - 10:26:26 complex fertilizer; 120Kg Urea |
| Nursery | • Seed treatment with Carbendezim @ 4g/kg of seeds<br>• Monocrotophos 36SL @1.5ml/lit of water @15 days after sowing | | | |
| Main field | • Alley ways of 30cm after every 2m<br>• Londex power @ 4kg/ac - herbicide at 3 days after transpalnting<br>• Chlorantraniliprole spray @60ml/acre against YSB, LF and CW<br>• Installation of pheromone traps for monitoring stem borer @ 8 traps / ha<br>• Mid season drainage for BPH management<br>• Tricyclazole 75WP @0.6g/lit against neck blast<br>• Dusting Malathion 5D around bunds in the evening hours and bund cleaning and installation of bird perches against Army worm | Randomly transplanted<br>Butachlor 1Lit/ac + one hand weeding<br>2 sprays of Chlorophyriphos 20EC @ 2ml/lit against Caseworm, LF<br>Carbendazim 50WP @ 1g/lit against sheath blight and blast<br>Monocrotophos 36SL @2ml/lit of water aginst army worm | Randomly transplanted<br>Hand weeding two times<br>one spray of Chlorophyriphos 20EC @ 2ml/lit and one spray of Lamda cyhalothrin<br>Carbendazim 50WP @ 1g/lit against sheath blight and blast<br>Choloropyriphos 20EC @2ml/lit of water + Dicholorovos 76WSC @1.7ml/lit | Randomly transplanted<br>Butachlor 1Lit/ac + one hand weeding<br>2 sprays of Chlorophyriphos 20EC @ 2ml/lit against Caseworm, LF<br>Carbendazim 50WP @ 1g/lit against sheath blight and blast<br>Profenophos 50EC@2ml/lit water + DDVP @1.7ml/it of water against armyworm |

**Table2.57 Pest incidence and grain yield in IPMs trial at Mandya, *kharif* 2017**

| Treatments | | %DH | %LFDL | %CWDL | BPH | Armyworm (larva/hill) | | Leaf blast | Neck blast | Weed population (No/m2) | | Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 85 DAT | 50 DAT | 22 DAT | 85 DAT | 99 DAT | 106 DAT | AUDPC | | 36 DAT | 64 DAT | kg/ ha |
| IPM | | 0.9 (1.0)b | 1.1 (1.3)b | 2.3 (1.6)b | 3.8 (1.4)a | 0.6 (0.9)b | 0.6 (0.9)b | 24.1 | 25.7 | 3.6 | 4.6 | 4400 |
| FP | | 4.9 (1.9)a | 2.2(1.6)a | 1.8(2.2)a | 7.7 (2.1)a | 3.3 (1.7)a | 4.0 (1.8)a | 77.2 | 85.4 | 4.8 | 4.1 | 4026 |
| **LSD** | | **0.21** | **0.1** | **0.2** | **0.3** | **0.15** | **0.18** | | | | | **155.8** |
| Sri Prakash | | 8.0 (2.7)a | 1.9 (1.5)a | 3.6 (1.9)ab | 17.3 (3.9)a | 0.0(0.7)b | 0.0(0.7)b | 67.0 | 54.0 | 4.2 | 3.4 | 4240 |
| Sri Chikkanna | | 0.7(0.9)b | 1.6 (1.4)a | 5.2 (2.3)a | 0.0(0.7)b | 4.0 (1.8)a | 4.4 (2.0)a | 50.9 | 47.2 | 4.1 | 5.6 | 4140 |
| Sri Basavaraj | | 0.0(0.7)b | 1.5 (1.3)a | 1.9 (1.5)b | 0.0(0.7)b | 1.9 (1.4)a | 2.6 (1.6)a | 34.2 | 65.6 | 4.3 | 4.1 | 4260 |
| **LSD** | | **0.21** | **0.14** | **0.27** | **0.38** | **0.21** | **0.22** | | | | | **132.4** |
| Sri Prakash | IPM | 2.7 (1.6)b | 1.5 (1.4)ab | 2.6 (1.8)bc | 11.4 (2.9)b | 0.0(0.7)c | 0.0 (0.7)c | 21.3 | 29.4 | 3.8 | 4.2 | 4440 |
| | FP | 13.4 (3.7)a | 2.3 (1.7)a | 4.5 (2.1)ab | 23.2 (4.8)a | 0.0(0.7)c | 0.0 (0.7)c | 112.7 | 78.5 | 4.6 | 2.6 | 4040 |
| Sri Chikkanna | IPM | 0.0(0.7)c | 1.3 (1.3)ab | 3.5 (1.9)abc | 0.0(0.7)c | 0.8 (0.9)c | 1.2 (1.2)c | 29.4 | 21.5 | 4.0 | 5.0 | 4280 |
| | FP | 1.4 (1.2)bc | 1.7 (1.5)ab | 6.9 (2.7)a | 0.0(0.7)c | 7.2 (2.7)a | 7.6 (2.8)a | 72.4 | 72.8 | 4.2 | 6.2 | 4000 |
| Sri Basavaraj | IPM | 0.0(0.7)c | 0.6 (1.0)b | 0.8 (1.1)c | 0.0(0.7)c | 1.0 (1.2)bc | 0.8 (1.0)c | 21.7 | 26.3 | 3.0 | 4.6 | 4480 |
| | FP | 0.0(0.7)c | 2.5 (1.6)a | 3.0 (1.9)abc | 0.0(0.7)c | 2.8(1.7)b | 4.4 (2.1)b | 46.6 | 104.9 | 5.6 | 3.6 | 4040 |
| **LSD** | | **0.3** | **0.2** | **0.38** | **5.4** | **0.29** | **0.3** | | | | | **187.3** |

**Table 2.58 Returns and BC ratio in IPMs trial at Mandya, kharif 2017**

| Farmers | Treatments | Yield (q/ ha) | Gross returns (Rs.) | Cost of cultivation (Rs.) | Net returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|
| Sri Prakash | IPM | 44.40 | 79920 | 38380 | 41540 | 2.08 |
| Sri Prakash | FP | 40.40 | 72720 | 41750 | 30970 | 1.74 |
| Sri Chikkanna | IPM | 42.80 | 77040 | 38645 | 38395 | 1.99 |
| Sri Chikkanna | FP | 40.00 | 72000 | 41250 | 30750 | 1.75 |
| Sri Basavaraj | IPM | 44.80 | 80640 | 38645 | 41995 | 2.09 |
| Sri Basavaraj | FP | 40.40 | 72720 | 44250 | 28470 | 1.64 |

Price of paddy = Rs 1800/ Q

**Masodha:** IPMs trial was conducted in Sri Rakesh Kumar Dubey's field at Pirkhauli village, Faizabad district in Uttar Pradesh. Kalanamak variety was grown in both IPM and FP plots. Incidence of stem borer was relatively high and crossed ETL in FP plot at 57 DAT (10.31%) onwards with 16.45% WE damage as compared to IPM plot that had ≤ 2.0% damage **(Table 2.59**). BC ratio was high in IPM plot (2.51) due to high grain yield and low cost of cultivation as against FP plot (1.64).

| Practices followed in IPMs trial at Masodha, *Kharif* 2017 | | |
|---|---|---|
| **Practices adopted** | **IPM block** | **Farmers practices** |
| Area | 1 acre | 1 acre |
| Variety | Kalanamak | Kalanamak |
| Fertilizers applied | 80:40:40:15 NPK kg/ha | Composite Fertlizer (12:32:16) NPK @ 75 kg/acre+ 92 kg Urea |
| Nursery | Seed treatment with carbendazim @ 2g/kg seed | No Seed treatment |
| Main field | • Transplating at 20 x 15 cm spacing<br>• Applied Butachlor @ 1.5 kg a.i. /ha 2-3 days of transplanting<br>• Installation of pheromone traps with 5 mg lure @ 8 traps/ha after 20 DAT<br>• N top dressing based on Leaf Color Chart<br>• One spray of Cartap hydrochloride 50 WP @ 600 g /ha at 60 DAT | • Random planting of seedlings<br>• Applied Butachlor @ 1.5 kg/ha 2-3 days of transplanting<br>• Sprayed Chlorpyriphos 1.5 litre/ha |

**Table 2.59 Insect pest incidence, grain yield & BC ratio in IPMs trial at Masodha, *kharif* 2017**

| | %DH | | %WE | %LFDL | Yield | Gross returns (Rs.) | Cost of cultivation (Rs.) | Net returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|---|---|---|
| Treatments | 57 DAT | 99 DAT | pre har | 78 DAT | kg/ ha | | | | |
| IPM | 1.68 ± 0.82 | 1.86 ± 0.47 | 2.01 ± 0.03 | 0.40 ± 0.22 | 2818 ± 54.31 | 45088 | 17950 | 27138 | 2.51 |
| FP | 10.31 ± 0.94 | 13.81 ± 2.09 | 16.45 ± 1.22 | 1.58 ± 0.20 | 2010 ± 59.63 | 32160 | 19563 | 12597 | 1.64 |
| Price of paddy = Rs. 1600/ q | | | | | | | | | |

**Nellore:** The trial was conducted at Paturu village, Nellore district of Andhra Pradesh in Sri Vijaya Sena Reddy's field. Incidence of stem borer, gall midge and leaf folder was observed in both the treatments **(Table 2.60)**. Leaf folder incidence was very high in both FP (63.79%) and IPM plots (44.71%) at 20 DAT. Gall midge incidence was observed from 37 DAT but crossed ETL at 69 DAT with high damage in FP plot (17.20% SS) compared to IPM plot (15.26% SS).

| Practices followed in IPMs trial at Nellore, *Kharif* 2017 | | |
|---|---|---|
| | **IPM Practices** | **Farmers Practices** |
| Variety | NLR 33892 | NLR 33892 |
| Nursery | Seed treatment with Carbendazim @ 2 g/ kg seed<br>Application of Carbofuran @ 1.1 kg/ha 7 days before pulling of seedlings | Seed treatment with Carbendazim @ 2 g/ kg seed<br>Application of Carbofuran granules 7 days before pulling of seedlings |
| Main field | • Application of 2 bags urea, 3 bags DAP and half bag MOP per acre<br>• Application of pre emergence herbicide, Butachlor, one week after transplantation<br>• Application of cartap hydrochloride at 60 DAT<br>• Spraying of Propiconazole at 70 DAT | • Application of 4 bags DAP, half bag MOP and 3 bags Urea<br>• Application of pre emergence herbicide, Butachlor, one week after transplantation<br>• Application of Pymetrozine at 50 DAT and Dinotefuran at 80 DAT<br>• Application of cartap hydrochloride at 60 DAT<br>• Spraying of Propiconazole at 70 DAT<br>• Application of Nativo at 85 DAT |

**Table2.60 Pest incidence, grain yield & BC ratio in IPMs trial at Nellore, *kharif* 2017**

| Treatments | %LFDL | %SS | %WE | Yield q/ ha | Gross returns (Rs.) | Cost of cultivation (Rs.) | Net returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|---|---|
| | 20 DAT | 69 DAT | 86 DAT | | | | | |
| IPM | 44.71 | 15.36 | 1.84 | 82.03 | 112381 | 33325 | 79056 | 3.37 |
| FP | 63.79 | 17.20 | 3.72 | 76.90 | 105353 | 39925 | 65428 | 2.64 |

Price of paddy = Rs. 1370/q

Stem borer incidence was low throughout the crop growth in both IPM and FP plots. High BC ratio of 3.37 was obtained in IPM plot due to high returns and low cost of cultivation **(Table 2.60)**.

**Pantnagar:** IPM trial was conducted in three farmers' fields, Sri Golak Mandal of Jay nagar – Dinesh Pur village, Sri PS Papola of Jawaharnagar village and Sri Vishesh Mandal of Jai nagar No.2 village of Udhamsingh nagar, Uttarakhand State. Varieties grown and practices followed in IPM and FP plots are given below in a Table.

Incidence of stem borer, leaf folder, whorl maggot, hispa and BPH was observed in both IPM and FP plots in all the three farmers' fields. Dead heart damage crossed ETL at 15 DAT in both IPM (11.1%) and FP plots (18.4%) in Sri PS Papola's field while there was no incidence in Sri Golak Mandal and Sri Vishesh Mandal's fields in both IPM and FP plots. However, at 64 DAT, dead heart damage was high in IPM and FP plots (10%) in Sri Golak Mandal's and at 71 DAT; damage was high in FP plot alone (11.3%) in Sri PS Papola's field. Leaf folder, whorl maggot and hispa damage was low (<10%) in both treatments in all the three farmers fields. BPH population crossed ETL and was at par in both IPM (50.2) and FP plots at 71 DAT in Sri Golak Mandal's field and at 85 DAT in Sri PS Papola's field in both IPM (52.27) and FP (51.8) plots **(Table 2.61)**. Grain yield was at par in IPM and FP plots and ranged between 47.31 and 55.67q/ ha.

| Practices followed in IPMs trial at Pantnagar, *kharif* 2017 | | | | |
|---|---|---|---|---|
| **Details** | **IPM practices** | **Farmers practices** | | |
| | | **Sri Golak mandal, Village- Jay Nagar, Dinesh Pur** | **Sri PS Papola, Jawaharnagar village** | **Sri Vishesh Mandal, Jai nagar No.2 village** |
| **Variety** | HKR 47 | HKR 47 | PR 121 | HKR 47 |
| **Main Field** | Application of DAP @ 37.5 kg/ha, Celzyme 5 kg/ acre (Nutrion 500g/ ha by Farmer2 instead of celzyme), Zinc Liberal @ 375 g/ha<br>Applied Butachlor @3 liter/ha<br>Sprayed Cartap Hydrocloride @ 600g/ha<br>Applied streptocycline@15 g/ha + copper oxycloride@ 500 g/ha<br>Installed pheromone traps for YSB @ 8/ ha | Application of DAP @ 37.5 kg/ha, Celzyme 5 kg/ acre, Zink Liberal @ 375 g/ha<br>Applied Pretilachlor @ 1500 ml/ ha (Refit)<br>Application of Fertera @ 10kg/ha,Fipronil 5SC @ 1000ml/ha, Buprofezine @ 1000 ml/ha<br>Applied Streptocycline@15g/ha + copper oxicloride @ 500g/ha | Application of DAP @ 37.5 kg/ha, Nutrion 500g/ ha, Zink Liberal @ 375 g/ha<br>Applied Pretilachlor 50 EC @ 1500 ml/ ha (Refit)<br>Application of Fertera @ 10kg/ha,Coragen @ 150 ml/ha, Buprofezine @ 750 ml/ha<br>Applied streptocycline @15 g/ha + copper oxicloride @ 500g/ha | Application of NPK @ 50 kg/acre, Zink Liberal @ 375 g/ha<br>Applied Pretilachlor 50 EC @ 1500 ml/ ha (Refit)<br>Applicationof cartap 4G @ 25kg/ ha, Fipronil 5 SC @ 1000ml/ ha, Monocrotophos 36 SL@ 1500 ml/ha<br>Applied Streptocycline@15g/ha + copper oxicloride @ 500g/ha |

**Table 2.61 Pest incidence and grain yield in IPMs trial at Pantnagar, *kharif* 2017**

| Treatments | | %DH | | | %LFDL | %WMDL | %HDL | BPH | | | Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 15 DAT | 64 DAT | 71 DAT | 71 DAT | 29 DAT | 29 DAT | 71 DAT | 78 DAT | 85 DAT | kg/ ha |
| IPM | | 3.7(1.6)a | 6.2(2.5)a | 3.8(1.9)b | 3.6(1.8)b | 5.7(2.3)a | 5.2(2.1)a | 24.3(4.6)a | 13.1(3.6)a | 19.2(3.5)a | 5076a |
| FP | | 6.1(1.9)a | 6.0(2.4)a | 5.8(2.3)a | 6.4(2.2)a | 4.9(2.2)a | 4.1(2.0)a | 27.7(4.9)a | 14.7(3.7)a | 19.1(3.4)a | 5125a |
| **LSD** | | **0.42** | **0.74** | **0.34** | **0.41** | **1.04** | **1.32** | **0.68** | **0.56** | **0.71** | **254** |
| Sri Golak Mandal | | 0.0(0.7)b | 10.1(3.3)a | 1.5(1.3)c | 13.1(3.6)a | 6.6(2.6)a | 5.5(2.4)a | 54.6(7.4)a | 17.5(4.2)a | 0.0(0.7)c | 5451a |
| Sri PS Papola | | 14.8(3.8)a | 5.0(2.3)b | 8.7(3.0)a | 0.6(1.0)b | 5.6(2.5)a | 3.9(2.0)a | 12.6(3.6)b | 18.3(4.3)a | 52.0(7.2)a | 5117b |
| Sri Vishesh Mandal | | 0.0(0.7)b | 3.3(1.7)c | 4.0(2.1)b | 1.2(1.2)b | 3.7(1.6)b | 4.6(2.1)a | 10.8(3.3)b | 5.8(2.5)b | 5.4(2.4)b | 4734c |
| **LSD** | | **0.34** | **0.52** | **0.57** | **0.42** | **0.83** | **0.97** | **0.73** | **0.5** | **0.37** | **137** |
| Sri Golak Mandal | IPM | 0.0(0.7)c | 10.3(3.3)a | 1.3(1.2)d | 9.4(3.1)b | 5.3(2.4)a | 4.5(2.2)a | 50.2(7.1)a | 14.8(3.9)a | 0.0(0.7)c | 5334ab |
| | FP | 0.0(0.7)c | 10.0(3.2)a | 1.8(1.5)cd | 16.9(4.1)a | 7.9(2.8)a | 6.5(2.6)a | 59.0(7.7)a | 20.2(4.5)a | 0.0(0.7)c | 5567a |
| Sri PS Papola | IPM | 11.1(3.3)b | 4.2(2.1)bc | 6.2()2.5)b | 0.6(1.1)c | 5.7(2.5)a | 3.4(1.9)a | 11.6(3.5)b | 18.0(4.2)a | 52.2(7.2)a | 5163b |
| | FP | 18.4(4.3)a | 5.8(2.5)ab | 11.3(3.4)a | 0.5(1.0)c | 5.6(2.5)a | 4.4(2.2)a | 13.6(3.7)b | 18.6(4.3)a | 51.8(7.2)a | 5070b |
| Sri Vishesh Mandal | IPM | 0.0(0.7)c | 4.1(2.0)bc | 3.8(2.0)bc | 0.7(1.1)c | 6.2(1.9)a | 7.8(2.0)a | 11.2(3.4)b | 6.4(2.6)b | 5.4(2.4)b | 4731c |
| | FP | 0.0(0.7)c | 2.5(1.5)c | 4.3(2.1)bc | 1.7(1.4)c | 1.1(1.2)a | 1.3(1.3)a | 10.4(3.2)b | 5.2(2.4)b | 5.4(2.4)b | 4736c |
| **LSD** | | **0.49** | **0.73** | **0.81** | **0.6** | **1.17** | **1.37** | **1.03** | **0.71** | **0.53** | **194** |

**Rajendranagar:** IPMs trial was conducted in three farmers' fields' viz., Sri K Srinivas, Sri S Karunakar Reddy and G Laxminarayana of Amdapur village in Shamshabad mandal of Telangana State. RNR 15048 (Telangana Sona) was grown in all the farmers fields except in FP plot of Sri Karunakar reddy who cultivated MTU 1010.

| **Practices followed in IPMs trial at Rajendranagar, *Kharif* 2016** | | |
|---|---|---|
| **Practices adopted** | **IPM block (**Sri Katkuri Srinivas) | **Farmers practices** (Sri Katkuri Ramdas) |
| **Variety** | RNR 15048 (Telangana Sona) | RNR 15048 (Telangana Sona) |
| **Nursery** | • Application of 4 kg urea, 6 kg SSP, 2 kg MOP<br>• Applied Carbofuran 3G in nursery | Application of 4 kg urea, 6 kg SSP, 2 kg MOP |
| **Main field** | • Application of 100:90:30 kg DAP, urea and MOP<br>• Applied oxadiargyl @ 35 g/ acre + one hand weeding<br>• Applied Cartap Hydrochloride 50 SP @ 400g/ acre at panicle initiation stage<br>• Adopted alley ways<br>• Installed Pheromone traps @ 8/acre | • Application of 120:120:20 kg DAP, urea and MOP<br>• Two hand weedings were done<br>• Applied carbofuran 3G @ 10 kg/ acre<br>• Sprayed Chloropyrphos 50 EC @ 500 ml/ acre in main field at tillering stage<br>• Sprayed Acephate 75 SP @ 300g/ acre |
| **Practices adopted** | **IPM block (**Sri S Karunakar Reddy) | **Farmers practices** (Sri S Karunakar Reddy) |
| **Variety** | RNR 15048 (Telangana Sona) | MTU 1010 |
| **Nursery** | • Application of 4: 6:2 kg urea,,SSP, MOP<br>• Applied Carbofuran 3G in nursery | • Application of 4 kg urea, 6 kg SSP & 2 kg MOP<br>• Applied Phorate 10 G @ 250 g/ 5 cents nursery |
| **Main field** | • Application of 90:90:30 kg urea, SSP and MOP<br>• Adopted alley ways<br>• Applied oxadiargyl @ 35 g/ acre + one hand weeding<br>• Installed Pheromone traps @ 8/acre<br>• Released Trichogramma @ 20,000/ acre twice<br>• Sprayed Coragen @ 60 ml/ acre at PI stage | • Application of 120:120:20 kg urea, SSP and MOP<br>• Application of Butachlor 1.25 l/acre + Application of nominee gold @ 100ml/ acre + One hand weeding<br>• Applied Chlorantraniliprole 0.4%G @ 4kg/acre at tillering<br>• Sprayed Profenophos 50EC @ 400ml/acre in main field at tillering |
| **Practices adopted** | **IPM block (**Sri G Lakshminarayana) | **Farmers practices (**Sri G Lakshminarayana) |
| **Variety** | RNR 15048 (Telangana Sona) | RNR 15048 (Telangana Sona) |
| **Nursery** | Application of 4: 6:2 kg urea,,SSP, MOP | Application of 4: 6:2 kg urea,,SSP, MOP<br>Applied Phorate 10 G @ 250 g/ 5 cents nursery |
| **Main field** | • Application of 100:90:30 kg urea, SSP & MOP<br>• Adopted alley ways<br>• Applied oxadiargyl @ 35 g/ acre + two hand weedings<br>• Applied Cartap Hydrochloride 50 SP @ 400g/ acre at panicle initiation stage | • Application of 100:120:20 kg urea, SSP & MOP<br>• Sprayed Coragen @ 60 ml/ acre at PI stage<br>• Applcation of oxadiargyl @ 35 g/ acre + nominee gold @ 100ml/ acre + two hand weedings |

Incidence of stem borer and leaf folder was observed in both IPM and FP fields **(Table2.62)**. White ear damage caused by stem borer was significantly low in IPM plot (10.3%) as compared to FP plot (12.4%). White ear damage was high in Sri K

Srinivas (12.5%) and Sri S karunakar Reddy's fields (13.4%) compared to Sri G Laxminarayana's field (8.2%). The weed population in IPM plots was four times lower than farmers practice. The mean grain yield advantage was 20.1% in IPM adopted plots. Grain yield was significantly high in IPM plot (48.21q/ha) resulting in higher returns and higher BC ratios in IPM plots (1.50-1.70) than in FP plots (1.06-1.29)**(Table 2.63)**

**Table 2.62 Pest incidence and grain yield in IPMs trial at Rajendranagar, *kharif* 2017**

| Treatments | | % DH | % WE | % LFDL | Weed population (No./ m2) | Yield |
|---|---|---|---|---|---|---|
| | | 62 DAT | 114 DAT | 62 DAT | 62 DAT | kg/ ha |
| IPM | | 5.0(2.3)a | 10.3(3.2)b | 0.3(0.9)b | 8.33 | 4821.7a |
| FP | | 4.5(2.2)a | 12.4(3.5)a | 0.5(1.0)a | 33.4 | 4002.3b |
| **LSD** | | **0.14** | **0.3** | **0.05** | **0.69** | **300.31** |
| Sri K Srinivas | | 4.6(2.2)ab | 12.5(3.6)a | 0.7(1.1)a | 19.6 | 4733.4a |
| Sri S Karunakar Reddy | | 3.6(2.0)b | 13.4(3.7)a | 0.4(0.9)b | 40.8 | 4114.9c |
| Sri G Lakshminarayana | | 6.2(2.5)a | 8.2(2.9)b | 1.0(0.8)c | 2.2 | 4387.7b |
| **LSD** | | **0.5** | **0.49** | **0.12** | **0.1** | **234.83** |
| Sri K Srinivas | IPM | 5.8(2.5)ab | 13.6(3.7)a | 0.4(0.9)b | 15 | 4961.2a |
| Sri K Ramdas | FP | 3.3(2.0)bc | 11.4(3.4)a | 1.1(1.3)a | 24.2 | 4505.6b |
| Sri S Karunakar Reddy | IPM | 4.2(2.1)bc | 12.5(3.6)a | 0.4(0.9)b | 8 | 4488.0b |
| | FP | 2.9(1.8)c | 14.4(3.8)a | 0.4(0.9)b | 73.6 | 3741.8c |
| Sri G Lakshminarayana | IPM | 4.9(2.3)abc | 4.9(2.3)b | 0.1(0.7)c | 2 | 5016.0a |
| | FP | 7.4(2.8)a | 11.5(3.4)a | 0.1(0.8)bc | 2.4 | 3759.4c |
| **LSD** | | **0.68** | **0.7** | **0.16** | **0.22** | **332.1** |

**Table 2.63.Returns and BC ratio in IPMs trial at Rajendranagar, *kharif* 2017**

| Name of the Farmer | Treatments | Yield (q/ha) | Gross Returns (Rs.) | Cost of Cultivation (Rs.) | Net Returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|
| Sri K Srinivas | IPM | 49.61 | 78880 | 49640 | 29240 | 1.59 |
| | FP | 45.06 | 71645 | 55415 | 16230 | 1.29 |
| Sri S Karunakar Reddy | IPM | 44.88 | 71359 | 47500 | 23859 | 1.50 |
| | FP | 37.42 | 59498 | 56195 | 3303 | 1.06 |
| Sri G Lakshminarayana | IPM | 50.16 | 79754 | 46850 | 32904 | 1.70 |
| | FP | 37.59 | 59768 | 52775 | 6993 | 1.13 |

Price of paddy = Rs1590/ q

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

| Practices followed in IPMs trial at Raipur, *Kharif* 2017 | | |
|---|---|---|
| | **IPM Practices followed** | **Farmers Practices followed** |
| Variety | Swarna | Swarna |
| Nursery | Seed treatment with Carbendazim @ 2 g/ kg seed | |
| Main field | Application of 50 kg DAP, 10 kg MOP & 75 kg Urea<br>Planting at 25 x 25 cm spacing<br>Alley ways of 30 cm after every 2 m<br>Application of Butachlor<br>Regular monitoring<br>Installation of pheromone traps<br>Application of cartap hydrochloride | Application of 50 kg DAP, 10 kg MOP & 50 kg Urea<br>Random planting<br>Application of weedicides, Saathi @ 60 g/ acre and Nomeni gold @ 80 ml/ acre<br>Application of Triazophos+Deltamethrin @ 200ml/ acre<br>Application of Netivo @ 150g/ acre<br>Spraying of thiamethoxyzim @ 150 g/ acre–two times |

Incidence of stem borer, BPH and WBPH was observed in both IPM and FP plots in four farmers' fields. Stem borer damage was found significantly high in FP plot (22.6% DH & 20.1% WE) as compared to IPM plots (1.6–2.6% DH & 2.2-2.9% WE). BPH population was significantly high in FP plot (72.0/5 hills) at 64 DAT with nil population in IPM plots **(Table 2.64)**. Thereafter population decreased at 85 DAT and again increased at 92 DAT with maximum numbers of BPH in FP plot (84.2/5 hills). Weed population and weed biomass at 30 and 60 DAT was almost double than IPM practiced fields indicating the severity of weed problem in farmers fields, which has reflected in grain yields (19% yield increase) and emphasizing the necessity of adopting IPM practices **(Table 2.65).** Grain yield was low in FP plot (38.04q/ ha) compared to IPM plots (44.52q/ ha) resulting in lower returns and relatively low BC ratio (2.17) compared to IPM plots.

**Table2.64 Pest incidence in IPMs trial at Raipur, *kharif* 2017**

| Farmer name | Treatments | % DH | % WE | BPH | | |
|---|---|---|---|---|---|---|
| | | 64 DAT | 99 DAT | 64 DAT | 85 DAT | 92 DAT |
| F1 - Bhagwat yadaw | IPM | 1.7(1.3)b | 2.9(1.6)b | 0.0(0.7)b | 41.0(6.4)a | 3.4(1.9)c |
| F2 - Yogendra yadaw | IPM | 2.6(1.6)b | 2.2(1.5)b | 0.0(0.7)b | 31.4(5.6)a | 33.6(5.8)b |
| F3 - Govardhan Sahu | IPM | 1.6(1.3)b | 2.6(1.5)b | 0.0(0.7)b | 5.0(2.3)c | 36.2(6.1)b |
| F4 - Vedprakash Yadaw | FP | 22.6(4.8)a | 20.1(4.5)a | 72.0(8.4)a | 20.4(4.5)b | 84.2(9.2)a |
| **LSD** | | **0.81** | **1.42** | **1.28** | **0.91** | **0.91** |

**Table 2.65 Weed parameters, Returns and BC ratio in IPMs trial at Raipur, *kharif* 2017**

| Treatments | Weed population (No/ m2) | | Weed Dry Biomass( g/m2) | | Yield (q/ha) | Gross Returns (Rs.) | Cost of Cultivation (Rs.) | Net Returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|---|---|---|
| | 30 DAT | 60 DAT | 30 DAT | 60 DAT | | | | | |
| IPM | 87 ± 9 | 62 ± 14 | 7.89 ± 1.15 | 8.55 ± 0.92 | 44.52 | 69006 | 24035 | 44971 | 2.87 |
| FP | 154 ± 16 | 177 ± 22 | 15.55 ± 1.07 | 25.50 ± 1.62 | 38.04 | 58962 | 27150 | 31812 | 2.17 |

Price of paddy = Rs1550/ q

**Sakoli:** The trial was carried out in three farmers' field's *viz.*, Sri Tekram Modku Kharkate, Sri Umesh Gangaram Waghmare and Sri Dinesh Giridhar Wadhai of Dharmapuri village, Sakoli tehsil in Bhandara district of Maharashtra State. Details of farmers and practices followed are given below.

| **Practices followed in IPMs trial at Sakoli, *Kharif* 2017** | | |
|---|---|---|
| **Name of the farmer: Sri Tekram Modku Kharkate; Village: Dharmapuri, Tahsil: Sakoli; Bhandara district** | | |
| | **IPM Practices followed** | **Farmers Practices followed** |
| Variety | Pawanputra | Pawanputra |
| Nursery | Seed treatment with Carbandezim @ 2 g/ kg seed<br>Application of 20:20:0:13 – 8 kg<br>Application of Carbofuran @ 1.1 kg ai/ ha, 4 days before pulling seedlings | Application of 20:20:0:13 – 8 kg<br>Applied Phorate 10 G @ 1.66 kg, 4 days before pulling seedlings |
| Main field | • Application of 20:20:0:13 - 125 kg + urea 42 kg/ ha<br>• Seedlings planted at spacing of 20 x 15 cm<br>• Left alleyways of 30 cm after every 2 m or 10 rows.<br>• Application of Butachlor @ 1.5 kg a.i./ ha on 3rd day after transplanting + 2 manual weedings<br>• Top dressing of urea @ 42 kg/ha<br>• Application of Cartap hydrochloride 50 WP @ 600 g / ha at 70 DAT.<br>• Installation of pheromone traps with 5 mg lure @ 8 traps/ ha for stem borer monitoring<br>• Application of Propiconazole 0.1%.<br>• Mid season drainage for BPH management | • Application of 20:20:0:13 - 125 kg + urea 42 kg/ ha top dressing<br>• Seedlings were planted randomly<br>• Applied Saathi (Pyrazosulfuron Ethyl 10% WP) @ 200 g/ ha at 5th day after transplanting + 2 manual weedings done<br>• Sprayed monocrotophos @ 500 ml/ ha<br>• Application of Acephate @ 500 g/ ha |
| **Name of the farmer: Sri. Umesh Gangaram Waghmare; Village: Dharmapuri; Tahsil: Sakoli; Bhandara district** | | |
| | **IPM Practices followed** | **Farmers Practices followed** |
| Variety | Balwan | Balwan |
| Nursery | Seed treatment with Carbandezim @ 2 g/ kg seed<br>Application of Carbofuran @ 1.1kg ai/ ha, 6 days before pulling seedlings | Seed treatment with 3% salt solution<br>Applied Phorate 10 G @ 1.25 kg, 6 days before pulling seedlings |
| Main field | • Application of 20:20:0:13 - 125 + urea 31.5 kg<br>• Seedlings transplanted at spacing of 20 x 15 cm<br>• Alleyways of 30 cm after every 2 m or 10 rows.<br>• Application of Butachlor @ 1.5 kg a.i./ ha on 6th day after transplanting + 1 manual weeding<br>• Top dressing of urea @ 31.5 kg/ha<br>• Installation of pheromone traps with 5 mg lure @ 8 traps/ ha for stem borer monitoring<br>• Spraying of Monocrotophos @ 700 ml/ ha<br>• Application of Cartap hydrochloride 50 WP @ 600 g / ha at 69 DAT.<br>• Application of Propiconazole 0.1%.<br>• Mid season drainage for BPH management | • Application of 20:20:0:13 - 125 + urea 31.5 kg<br>• Seedlings were transplanted randomly<br>• Manual weeding was done<br>• Top dressing of urea @ 31.5 kg/ha<br>• Sprayed Cannon @ 750 ml/ ha for the management of planthoppers.<br>• Application of Acephate @ 500 g/ ha |

| **Name of the farmer: Sri. Dinesh Giridhar Wadhai; Village: Dharmapuri; Tahsil: Sakoli, Bhandara district** | | |
|---|---|---|
| | **IPM Practices followed** | **Farmers Practices followed** |
| Variety | Jai ram | Jai ram |
| Nursery | Seed treatment with Carbandezim @ 2 g/ kg seed<br>Applied 20:20:00:13 complex fertilizer @ 10 kg<br>Application of Carbofuran @ 1.1kg ai/ ha 7 days before pulling seedlings | Seed treatment with 3% salt solution<br>Applied 20:20:00:13 @ 10 kg |
| Main field | • Application of 20:20:00:13 @ 125 kg/ha + urea – 62.5 kg<br>• Seedlings transplanted at spacing of 20 x 15 cm<br>• Alleyways of 30 cm after every 2 m or 10 rows.<br>• Application of Butachlor @ 1.5 kg a.i./ ha on 5th day after transplanting + 1 manual weeding<br>• Installation of pheromone traps @ 8 traps/ ha for stem borer monitoring<br>• Top dressing of urea @ 50 kg/ha<br>• Application of Cartap hydrochloride 50 WP @ 600 g / ha at 64 DAT.<br>• Application of Propiconazole 0.1%<br>• Mid season drainage for BPH management | • Application of 20:20:00:18 @ 125 kg/ha + Urea 125 kg<br>• Seedlings were transplanted randomly<br>• Application of Erase @ 1 liter/ ha on 5th day after transplantation<br>• Manual weeding was done<br>• Top dressing of urea @ 50 kg/ha |

Incidence of stem borer, gall midge, leaf folder, BPH and WBPH was recorded in IPM and farmers practices. Dead heart damage was significantly low in IPM plots in all the farmers' fields whereas it crossed ETL in FP plots of Sri Kharkate at 29 DAT (10.2%) and Sri Waghmare at 50 DAT (11.7%). Damage by gall midge, leaf folder and BPH populations were low in both IPM and FP plots across the farmers **(Table 2.66)**. Among the diseases, leaf blast, neck blast, bacterial leaf blight, brown spot, sheath blight, sheath rot and stem rot were recorded at all the locations. At Sri Kharkate's field, disease progress (AUDPC value) of leaf blast, brown spot, and sheath rot was low in the IPM field (LB- 48.86; BS-396.9; SHR -131.6) and high in Farmers field (LB- 68.04; BS-492.8; SHR -174.3). However diseases *viz.*, neck blast, bacterial leaf blight, sheath blight and stem rot severity was high in IPM fields (NB- 219.1; BB-1535.8; SHB-760.9; STR – 636.3) and low in farmers' field. In Sri Waghmare's field, adoption of IPM practices reduced the disease severity of neck blast (IPM –153.3; FP-228.2), whereas other diseases *viz.*, leaf blast, bacterial leaf blight, brown spot, sheath rot and stem rot severity was high even IPM practices adopted. At Sri Wadhia's field, the diseases viz., bacterial blight, sheath rot and stem rot severity was low when IPM practices were adopted. In IPM fields, disease progress of leaf blast, neck blast and sheath blight was high in terms of AUDPC value and low in farmer's field **(Table 2.67)**.

The data on weed population and weed biomass was recorded at 30 and 60 DAT. All the farmers have noticed significant reduction in weed population in IPM adopted fields. Significant improvement in grain yield was noticed with 37.3% higher in IPM adopted. The weed population was 1 ½ times less in IPM fields compared to farmers practice **(Table 2.68)**.

Grain yield was significantly high in IPM plots (56.66 q/ ha) as compared to FP plots (41.33q/ha). Highest yield was obtained from Sri Waghmare's IPM plot (64.39q/ha) and was significantly superior to yield from IPM plots of other farmers

and FP plots **(Table 2.68)**. BC ratio was significantly high in IPM plots (2.78-4.13) in all the three farmers' fields due to higher returns and low cost of cultivation compared to FP plots (2.31-2.89).

**Table 2.66 Insect pest incidence and grain yield in IPMs trial at Sakoli, *kharif* 2017**

| Treatments | | %DH | | %SS | | %LFDL | BPH | | Yield |
|---|---|---|---|---|---|---|---|---|---|
| | | 29 DAT | 50 DAT | 71 DAT | 92 DAT | 99 DAT | 92 DAT | 99 DAT | kg/ ha |
| IPM | | 2.3(1.6)b | 2.9(1.8)b | 3.7(1.9)a | 2.1(1.6)b | 1.8(1.5)b | 15.2(3.9)a | 15.6(4.1)a | 5666.9a |
| FP | | 7.2(2.7)a | 7.4(2.7)a | 5.2(2.4)a | 5.5(2.4)a | 2.9(1.8)a | 13.5(3.6)a | 12.4(3.4)b | 4133.6b |
| **LSD** | | **0.87** | **0.37** | **0.64** | **0.25** | **0.2** | **0.85** | **0.51** | **333.4** |
| Sri Kharkate | | 6.7(2.5)a | 3.9(2.1)b | 3.5(2.0)b | 4.2(2.1)a | 2.4(1.7)ab | 8.9(3.1)b | 11.1(3.3)b | 4940.4b |
| Sri Waghmare | | 4.5(2.1)ab | 7.6(2.7)a | 5.9(2.5)a | 4.2(2.1)a | 2.8(1.8)a | 18.2(4.2)a | 17.8(4.1)a | 5459.6a |
| Sri Wadhia | | 3.1(1.8)b | 4.0(2.0)b | 4.0(2.0)b | 3.0(1.8)a | 1.8(1.5)b | 15.9(3.9)a | 13.1(3.8)ab | 4300.8c |
| **LSD** | | **0.44** | **0.32** | **0.4** | **0.47** | **0.18** | **0.59** | **0.53** | **317.3** |
| Sri Kharkate | IPM | 3.1(1.9)bc | 3.0(1.9)cd | 3.0(1.9)b | 1.7(1.5)c | 2.5(1.7)b | 9.6(3.2)bc | 13.4(3.8)ab | 5640.0b |
| | FP | 10.2(3.2)a | 4.8(2.3)bc | 3.9(2.1)b | 6.7(2.6)a | 2.2(1.6)bc | 8.2(3.0)c | 8.8(2.8)c | 4240.8d |
| Sri Waghmare | IPM | 2.4(1.6)c | 3.6(2.0)bcd | 4.6(2.2)ab | 2.2(1.6)c | 1.4(1.4)d | 19.6(4.4)a | 20.0(4.4)a | 6439.2a |
| | FP | 6.7(2.7)ab | 11.7(3.5)a | 7.3(2.7)a | 6.3(2.5)ab | 4.2(2.2)a | 16.8(4.0)ab | 15.6(3.8)ab | 4480.0cd |
| Sri Wadhia | IPM | 1.5(1.4)c | 2.3(1.6)d | 3.4(1.8)b | 2.5(1.7)c | 1.5(1.4)cd | 16.4(4.0)abc | 13.4(4.0)ab | 4921.6c |
| | FP | 4.7(2.2)bc | 5.7(2.5)b | 4.6(2.2)ab | 3.4(2.0)bc | 2.2(1.6)bc | 15.4(3.0)abc | 12.8(3.6)b | 3680.0e |
| **LSD** | | **0.63** | **0.46** | **0.56** | **0.67** | **0.25** | **0.83** | **0.74** | **448.7** |

**Table2.67 Disease incidence in IPMs trial at Sakoli, *kharif* 2017**

| Farmers fields | Treatments | Leaf blast | Neck blast | BLB | Brown spot | Sheath blight | Sheath rot | Stem rot |
|---|---|---|---|---|---|---|---|---|
| Sri Kharkate | IPM | 48.86 | 219.1 | 1535.8 | 396.9 | 760.9 | 131.6 | 636.3 |
| | FP | 68.04 | 210 | 1414 | 492.8 | 737.8 | 174.3 | 561.4 |
| Sri Waghmare | IPM | 169.93 | 153.3 | 2104.9 | 504.2 | 1033.4 | 203.7 | 858.8 |
| | FP | 80.78 | 228.2 | 1757.8 | 396.6 | 1042.9 | 189 | 844.9 |
| Sri Wadhia | IPM | 70.28 | 394.1 | 2041.2 | 269.5 | 736.4 | 102.2 | 668.5 |
| | FP | 64.89 | 373.8 | 2217.6 | 270.9 | 716.8 | 128.8 | 712.6 |

**Table 2.68 Returns and BC ratio in IPMs trial at Sakoli, *kharif* 2017**

| Farmer's name | Treatments | Weed population (No./m2) | | Weed dry weight (g/m2) | | Yield (Q/ ha) | Gross Returns (Rs.) | Cost of cultivation (Rs.) | Net Returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 30 DAT | 60 DAT | 30 DAT | 60 DAT | | | | | |
| F1 - Sri Kharkate | IPM | 12 | 12 | 16.48 | 7.60 | 56.4 | 124080 | 36465 | 87615 | 3.40 |
| | FP | 15 | 14 | 34.12 | 11.52 | 42.4 | 93280 | 34131 | 59149 | 2.73 |
| F2 - Sri Waghmare | IPM | 9 | 8 | 27.72 | 9.88 | 64.39 | 141658 | 34293 | 107365 | 4.13 |
| | FP | 12 | 11 | 50.96 | 17.70 | 44.8 | 98560 | 34071 | 64489 | 2.89 |
| F3 - Sri Wadhia | IPM | 7 | 7 | 11.92 | 2.64 | 49.21 | 108262 | 39009 | 69253 | 2.78 |
| | FP | 12 | 10 | 24.52 | 5.18 | 36.8 | 80960 | 35050 | 45910 | 2.31 |

Price of Paddy =2200 Rs/ Q

**Titabar:** The trial was conducted at Sri Dilip Das's field at Mazgoan village, Titabar mandal, Jorhat district of Assam. Ranjit variety was grown in both IPM and FP blocks. Practices followed were given in the table below. Dead heart damage exceeded ETL in FP plot at 36 DAT onwards and maximum damage of 13.79% was

observed at 50 DAT. Incidence of gall midge (<9% SS), leaf folder and whorl maggot (<5%) was very low in both IPM and FP treatments **(Table 2.69**). At this location, adoption of IPM practices reduced the disease severity of sheath blight (9.9%) and bacterial leaf blight (10.9) whereas cultivation of rice crop without IPM practices recorded high disease severity (ShBL – 25.9%; BLB – 30.1%)**(Table 2.70**). Grain yield was high in IPM plot (51.38 q/ha) resulting in higher BC ratio of 1.95 due to higher returns and low cost of cultivation.

| **Practices followed in IPMs trial at Titabar, *Kharif* 2017** | | |
|---|---|---|
| | **IPM Practices followed** | **Farmers Practices** |
| Variety | Ranjit | Ranjit |
| Nursery | Seed treatment with Carbendazim @ 2.5 g/ kg seed | |
| Main field | • Fertilizer application @ 20:10:10 NPK/ha<br>• Application of pretilachlor within a week of transplanting<br>• Installation of pheromone traps @ 8/ ha for stem borer monitoring<br>• At 45 DAT, applied chlorpyriphos 20EC @ 2ml/L for stem borer management<br>• Placement of tricho cards for stem borer and leaffolder management<br>• Sprayed fresh cowdung solution @200g/L at mid tillering stage against BLB | • Fertilizer application @60:20:40 NPK/ha<br>• Twice manual weeding<br>• Application of chlorpyriphos |

**Table 2.69 Pest incidence in IPMs trial at Titabar, *kharif* 2017**

| Treatments | % DH | | % SS | % LFDL | % WMDL | Disease Severity (%) | | Weed dry wt (g/m2) |
|---|---|---|---|---|---|---|---|---|
| | 43 DAT | 50 DAT | 50 DAT | 36 DAT | 64 DAT | SHBL | BLB | |
| IPM | 1.85 ± 0.5 | 1.23 ± 0.8 | 1.14 ± 0.5 | 0.88 ± 0.4 | 0.40 ± 0.2 | 9.9 | 10.9 | 32.18 ± 2.04 |
| FP | 12.30 ± 1.9 | 13.79 ± 1.3 | 8.18 ± 0.5 | 4.02 ± 0.7 | 3.15 ± 0.3 | 25.9 | 30.1 | 61.96 ± 2.72 |

**Table2.70 Returns and BC ratio in IPMs trial at Titabar, *kharif* 2017**

| Treatments | Yield (Q/ha) | Gross Returns (Rs.) | Cost of cultivation (Rs.) | Net Returns (Rs.) | BC ratio |
|---|---|---|---|---|---|
| IPM | 51.38 | 77070 | 39465 | 37605 | 1.95 |
| FP | 37.13 | 55695 | 33224 | 22471 | 1.68 |

Price of paddy = Rs. 1500/q

**Warangal:** IPMs trial was conducted at two locations i.e., Singaram village and Ontimamidipally village of Wardhannapet mandal in Warangal district of Telangana State. At Singaram village, IPM trial was carried out in Sri Dasari Narasimha Reddy's field while observations from farmers' practices were taken from Sri Billa Komal Reddy's field. Similarly, at Ontimamidipally village, Sri Guda Ravi was involved in IPM trial and farmer's practices were observed in Sri Guda Ramanaiah's field. Practices followed in both IPM and FP plots are given below:

| Practices followed in IPMs trial at Warangal, *Kharif* 2017 | | |
|---|---|---|
| | **IPM Practices followed** | **Farmers Practices followed** |
| Name of the Farmer & Varieties | Dasari Narasimha Reddy S/o D. Gaura Reddy - **Siddhi (WGL 44)**<br>Guda Ravi S/o Guda Adi Reddy – **RNR 15048** | Billa Komal Reddy S/o B.Ramachandra Reddy - **Siddhi (WGL 44)**<br>Guda Ramanaiah S/o Guda Agaiah - **RNR 15048** |
| Area | 1 acre | 1 acre |
| Fertilizers | • Basal application of DAP 50 kg + urea 25 kg<br>• Top dressing of ammonium sulphate 50 kg at 20 DAT, urea 50 kg + MOP 25 kg at 40-45 DAT | • Basal application of DAP 50 kg + urea 25 kg<br>• Top dressing of ammonium sulphate 50 kg at 20 DAT, urea 50 kg + MOP 25 kg at 40-45 DAT |
| Nursery | • Application of Carbofuran 3G @ 160 g/ cent nursery | • Application of Carbofuran 3G @ 160 g/ cent nursery |
| Main field | • Formation of Alley ways<br>• Mid season drainage<br>• Installation of pheromone traps<br>• Application of weedicide –Topstar @ 35g/ acre + two hand weedings<br>• Application of carbofuran 3G @ 10 kg/ acre<br>• Spraying of Acephate @ 300 g + DDVP @ 200 ml/ acre | • Application of weedicide –Topstar @ 35g/ acre + two hand weedings<br>• Application of Chlorantraniliprole @ 4kg/acre<br>• Spraying Chlorpyriphos 20 EC @ 2.5 ml/lt + bioproduct<br>• Spraying of Dinotefuran @ 80 g/ acre (Buprefezin @ 320 ml/acre by Sri G Ramanaiah farmer).<br>• Sprayed Contaf @ 500 ml/acre |

At Singaram village, BPH population was very high in FP plot (169 hoppers/5 hills) at 47 DAT which increased tremendously by 64 DAT reaching a population of 905 hoppers/5 hills as against 76 hoppers/5 hills in IPM plot **(Table 2.71)**. However, population reduced to 70 hoppers/5 hills in FP plot at 95 DAT, due to the application of insecticide. Similar trend was observed in Ontimamidipally village also wherein, high population of 101 hoppers/5 hills was reported at 47 DAT which increased to 609/ 5 hills by 64 DAT and numbers were reduced to 84 hoppers/5 hills due to the application of insecticide. Nevertheless, population of BPH was low throughout the crop growth period in IPM plots mainly due to the IPM measures taken in these plots. Gall midge incidence was also low in IPM plots (7.5-10.9 %SS) as compared to FP plots (19.4-27.3 %SS) at 47 DAT and the trend continued at 64 DAT. Low incidence of stem borer, leaf folder, WBPH and GLH was observed in both IPM and FP plots at both the locations. Incidence of predators like spiders, coccinellids and mirids was observed in both IPM and FP plots with higher numbers in FP plots. Grain yield was significantly low in FP plot at Singaram village and both IPM and FP plots at Ontimamidipally village (1448-2580 kg/ha) as compared to IPM plot at Singaram village (3808 kg/ha). This resulted in very low BC ratio in the above plots (0.63-1.09) due to low gross returns and high cost of cultivation **(Table2.72)**.

**Table 2.71 Pest incidence and grain yield in IPMs trial at Warangal, *kharif* 2017**

| Location | Treat-ments | %SS | | BPH (No./ 5 hills) | | | WBPH | Yield |
|---|---|---|---|---|---|---|---|---|
| | | 47 DAT | 64 DAT | 47 DAT | 64 DAT | 95 DAT | 64 DAT | Kg/ha |
| Singaram village | IPM | 7.5(2.8)c | 10.1(3.2)c | 32.1(5.7)b | 51.0(7.2)c | 5.8(2.4)b | 10.6(3.3)c | 3808a |
| | FP | 19.4(4.4)b | 16.1(4.0)ab | 101.4(10.1)a | 608.8(24.4)b | 84.0(9.2)a | 27.0(5.2)b | 2432b |
| Ontimamidipally village | IPM | 10.9(3.4)c | 11.2(3.4)bc | 17.0(4.2)b | 75.8(7.2)c | 5.8(2.5)b | 13.0(3.7)c | 2580ab |
| | FP | 27.3(5.3)a | 17.9(4.3)a | 168.8(12.6)a | 905.0(30.0)a | 70.0(8.4)a | 37.0(6.1)a | 1448b |
| **LSD** | | **0.65** | **0.67** | **2.73** | **2.76** | **0.84** | **0.49** | **1360** |

**Table 2.72 Returns and BC ratio in IPMs trial at Warangal, *kharif* 2017**

| Location | Treatments | Yield Kg/ ha | Gross returns (Rs.) | Cost of Cultivation (Rs.) | Net returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|
| Singaram village | IPM | 3808 | 66640 | 41428 | 25212 | 1.61 |
| | FP | 2580 | 45150 | 41428 | 3722 | 1.09 |
| Ontimamidipally village | IPM | 2432 | 46208 | 44650 | 1558 | 1.03 |
| | FP | 1448 | 27512 | 43375 | -15863 | 0.63 |
| Market price realised by farmers = Rs. 17.5/kg at Singaram; Rs. 19/kg at Ontimamidipally | | | | | | |

Across the locations, adoption of IPM practices resulted in low incidence of weeds, insect pests and disease in IPM plots compared to FP plots. Weed population and weed biomass recorded at all the locations were considerably reduced by two to five times in IPM implemented plots compared to farmers practice and resulted in significantly higher grain yields. Among the insect pests, stem borer damage exceeded ETL in farmer practices plots at 10 locations, gall midge at two locations, leaf folder at four locations, brown planthopper at three locations and white backed planthopper at two locations. At all these locations, implementation of IPM resulted in reduced pest incidence in IPM plots compared to farmer practices. Similarly, in plots where IPM practices were followed had significantly less units of Area under disease progress curve (AUDPC) when compared with the farmers practices **(Fig 2.6a)**. The above studies thus indicated that the IPM practices which integrates all the necessary components for the reduction of disease inoculum, providing necessary nutrients for the development of a healthy host and also creating an atmosphere that is not favourable for the pathogen to survive, helps in the overall condition of less disease development and spread resulting in the reduced AUDPC. Low incidence of weeds, insects and diseases in IPM implemented plots resulted in high grain yields compared to farmer practices plots at all the locations leading to higher net returns due to low cost of cultivation and high BC ratio**(Fig 2.6b)**.

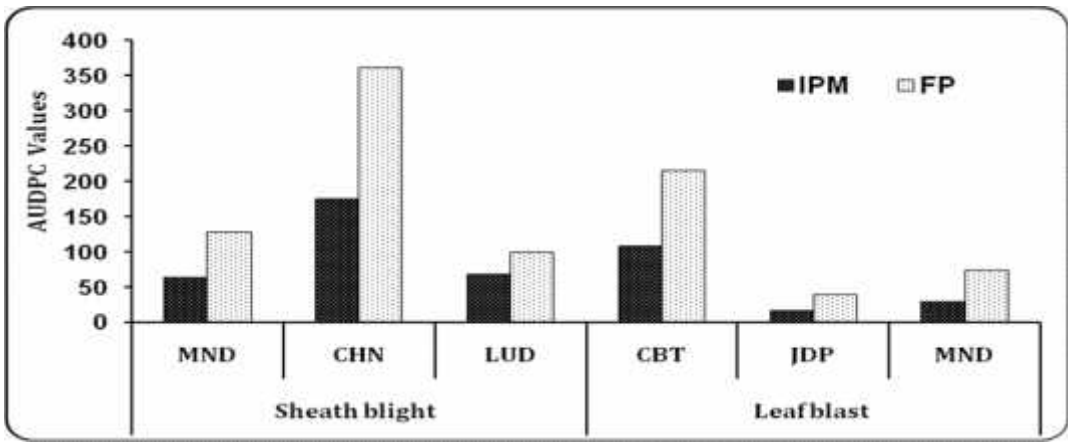



**Fig 2.6a** Disease incidence in different locations in IPMs trial, *Kharif* 2017

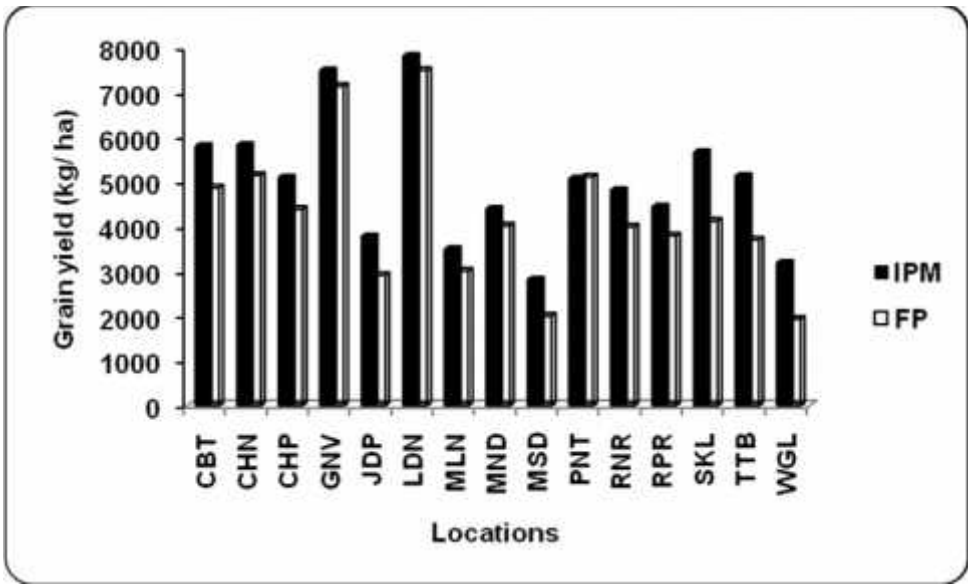



***Fig 2.6*** Grain yield recorded at various locations in IPMs trial, *Kharif* 2017

*Integrated Pest Management special (IPMs) trial was carried out in a participatory mode in farmers' fields' at 17 locations during 2017 with the main aim of managing all the pests including insects, diseases and weeds in a holistic way by providing a basket of options to the farmers. Across the locations, adoption of IPM practices resulted in low incidence of weeds, insect pests and diseases in IPM plots compared to FP plots. Weed population and weed biomass recorded at all the locations were considerably reduced by two to five times in IPM implemented plots compared to farmers practice plots and resulted in significantly higher grain yields. Low incidence of BPH in IPM plots was observed at Chinsurah (5 hoppers/5 hills) and Warangal (33 hoppers/5 hills) as compared to FP plots (86 and 386 hoppers/5 hills, respectively). Stem borer damage was found low in IPM plots at Chinsurah (2.78% WE), Jagdalpur (6.5% DH), Raipur (2.9% WE) and Titabar (1.23%) compared to farmer practices plots. Damage by leaf feeding insects like leaf folder, whorl maggot, hispa, thrips, caseworm and armyworm was also lower in IPM plots than FP plots across the locations. Similarly, in plots where IPM practices were followed had significantly less units of Area under disease progress curve (AUDPC) when compared with the farmers practices. Grain yield was significantly high in IPM plots at majority of locations resulting in high BC ratio due to higher returns and low cost of cultivation.*

# 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 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 formulate 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 insect pest scenario.

During 2017, insect populations in rice ecosystems were recorded daily, throughout the year using light traps (Chinsurah/Robinson type) in 29 locations. Corresponding weather data on temperature, rainfall, relative humidity, sunshine hours, etc. were also collected. Weekly cumulative catches of insects and weekly averages of weather parameters were worked out and are presented on standard week (SW) basis. Highlights and trends of the data collected during the year 2017 are presented zone-wise hereunder:

## Zone I- Hills

**Himachal Pradesh-Malan (22-43 SW):** WSB, CW, LF, BPH, WBPH, GLH, WM, black beetle, flee beetle, and predatory insects were recorded, but the numbers were low. Only whorl maggot adults reached double digit number with peak catches (126) in 34 SW.

**Jammu & Kashmir-Khudwani (13-44 SW):** GH, skipper, LF, SB, scarabaeids, and cutworms were recorded at this centre. The counts were not significant**.**

## Zone II- Northern

**Uttarakhand-Pantnagar (22-48 SW):** As reflected by trap catches rice entomofauna was active during 30-44 SWs. YSB catches consisted of mostly females and the maximum count (1183) was recorded in 37 SW. LF, GLH, BPH, WBPH, and RGB also were recorded. Activity of GLH, BPH, and WBPH was highest during 40 SW (1421, 70357 and 3150 respectively). LF appeared first in 30 SW, gradually increased to reach a maximum of 322 in 41 SW followed by a decline in population. RGB was found active during 36-45 SW with a peak catch of 490 in 39 SW.

**Uttar Pradesh-Masodha (6-26 SW):** YSB, LF, and GLH were found in light trap catches during the post-rainy season. YSB was found throughout the season with

highest weekly cumulative catch of 710 in 22 SW. LF and GLH occurred from 9 SW onwards till harvest. Both the insects were found most abundant during 22 SW with 710 and 789 individuals, respectively.

**Punjab-Ludhiana (1-51 SW):** Three species of SBs namely, YSB, PSB, and WSB were recorded at this location. However, YSB and PSB catches were low (56 and 70, respectively). PSB showed two distinct periods of activity during the crop growth seasons and highest catches (364) were found in 44 SW. LF catches were recorded continuously during 24-47 SW and the peak numbers (336) were observed in 40 SW. Sucking pests and mirid bugs were found only during the *Kharif* season. BPH and WBPH were caught in considerable numbers (6699 and 5215) during 44 SW. Population of mirid bugs reached its peak (518) in 45 SW.

**Haryana-Kaul (1-52 SW):** YSB, PSB, WSB, LF, GLH, BPH, WBPH and RGB were recorded at this centre. Insects were active only during a short period; YSB, PSB, GLH were recorded during 37-43 SW, 41-50 SW, and 35-45 SW respectively. Among the SBs; PSB was predominant and catches were highest (33) in 44 SW. LF was found active during 35-45 SW and maximum population of 28 was recorded in 44 SW.

**Jammu & Kashmir-Chatha (1-52 SW):** White grub, GSB, GH, SB, LF, GLH, and *Coffana* sp. were recorded. White grub appeared continuously during 15-20 SWs. There were two peaks in its population at 25 SW (3066) and 36 SW (1701), respectively. GSB occurred throughout the year except in the month of March and a few weeks in August and November. In 25 SW, GSB catches were the largest. Similarly, GH numbers were also highest (133) in 25 SW and it was active during most part of the year. SB appeared during 16-23 SW and highest catches (63) were noticed in 18 SW. LF activity was recorded during 1-8 SW and 37-45 SW and was most active in the first SW (119). GLH was observed throughout the year except in 27- 29 SWs. Largest catches were found during 26 SW (1988). *Coffana* sp. was recorded to a maximum of 980 in 41 SW during its active period (38-47 SWs).

## Zone III-Eastern

**Odisha-Chiplima (1-27 SW):** SB, GM, LF, GLH, BPH, WBPH and CW were reported from this centre. YSB first appeared in 4 SW and its catches increased gradually reaching a maximum (31+20) in 17 SW followed by a decline. There were no catches beyond 24 SW. GM was active between 7 and 20 SWs and catches were highest (28) in 14 SW. Both the species of GLH - *Nephotettix virescens* and *N. nigropictus* were recorded and the former was predominant. The combined catch was largest (3090) in 17 SW. BPH and WBPH populations were almost in equal proportions and peak catches (3745 and 3110 respectively) were observed in 18 and 19 SWs. BPH was found active till 25 SW. CW was found between 10 and 24 SWs with a maximum catch of 15 in 17 SW.

**West Bengal-Chinsurah (1-52 SW):** All the recorded insects namely; SBs, LF, GLH, BPH, WBPH, WLH and EHB were found active throughout the year. However,

temporal distribution of the insect populations revealed two distinct peaks in *Kharif* and *Rabi* seasons. Insect catches in *Kharif* were larger as compared to *Rabi*. YSB and GM were more abundant in (270+64 and 54 respectively) in 46 SW. GLH (*N. virescens)* catch was largest (107) in 41 SW, Whereas, *N. nigropictus*, BPH, and WBPH were most active (54, 3087, and 408 respectively) during 47 SW. WLH were found in considerable numbers (up to 155) throughout the year. EHB was most abundant during 41 SW with 27 bugs per trap.

## Zone V- Central

**Madhya Pradesh-Rewa (26-48 SW):** RGB was the only insect reported. Its activity started from 31 SW and temporal distribution was discontinuous. Catches ranged from 7 (29 SW) to 728 (34 SW).

**Chhattisgarh-Raipur (1-52 SW):** SBs, LF, GLH, BPH, ZZLH, CW, RGB and blue beetle were recorded at this location. Among the SBs, YSB and PSB were found almost throughout the year. YSB catches were highest (113+56) in 44 SW. LF and GLH catches were mostly confined to *Kharif* season for a limited period *i.e.* 42-48 SW and 34-48 SW, respectively with peak counts of 69 and 2412 respectively. BPH was found most active during 16-24 SW in *Rabi* and 34-49 SW in *Kharif* and their catches were highest (14749) in 47 SW. ZZLH was also observed all round the year with maximum catch (2507) in 43 SW. CW was found in moderate numbers during the cropping seasons. RGB and blue beetles were also trapped during the monsoon season but in smll numbers. Occasionally, *Spodoptera* moths also were attracted, in small numbers. Generalist predators like spiders, staphylinids, rove beetles, and earwigs were recorded round the year. Rove beetle catches were considerable and highest count of 334 was recorded in 10 SW.

**Chhattisgarh-Jagdalpur (1-52 SW):** Light trap catches at this location were characterised by the large size of GLH population. The pest was more active during the *Kharif* season and in 40 SW combined catch of *N. virescens* and *N. nigropictus* was 96494. YSB, CW, GM, LF, BPH, WBPH, ZZLH, RGB, and GH were also recorded at this location. BPH was active between 36 and 48 SW with the highest count of 436 in 39 SW. WBPH numbers were not considerable. ZZLH number was high during the *Kharif* season and 1106 hoppers were observed in 40 SW. YSB and CW peak populations (58+51 and 79 respectively) were recorded in 43 SW. GM, though was present catch size was small. LF catch was highest in 41 SW with 57 moths per trap. RGB activity picked up during 45-47 SWs and was highest during 46 SW (96). Grasshoppers were found to be more abundant in the month of October (40-44 SW) with a maximum weekly cumulative catch of 120 in 43 SW. Among the natural enemies, coccinellid and ground beetles were recorded round the year with a maximum of 1151 and 168 in 43 and 42 SW, respectively.

**Maharashtra-Sakoli (1-52 SW):** YSB, GM, LF, GLH, BPH, WBPH and rice moth were found at this location in light trap catches. YSB was found active throughout the year, while the remaining species showed distinct seasonal activity corresponding to

the major cropping seasons. In *Rabi,* YSB was most active (98+21) in 20 SW whereas, during *Kharif* the catches were highest in 42 SW (119+35). GM was active during 7-15 SWs and 27 and 46 SWs. In *Rabi,* largest GM catch was 30 in 12 SW, while it reached 240 during 42 SW. LF was present between 31-46 SWs with the largest weekly cumulative catch of 84 during 37 SW. GLH was active during most part of the cropping season. Catches were small (maximum 96 in 9 SW) in *Rabi* as compared to *Kharif* (maximum 270 in 42 SW). BPH was found active during 9-22 and 37-50 SWs. Catches in *Rabi* were lower (maximum 77 in 15 SW) than that in *Kharif* (6471 in 45 SW). Trend in WBPH catches was similar with the largest catch of 700 in 44 SW.

## Zone VI- Western

**Maharashtra-Karjat (1-52 SW):** YSB, GM, LF, GLH, BPH, CW, and RGB were recorded at this centre, but numbers were less. YSB was found throughout the year except in mid winter and summer months. YSB catch was the largest (89+89) in 33 SW.

**Gujarat-Nawagam (1-52 SW):** YSB, LF, WBPH, GLH and GH were recorded. Insect catches picked up with the progress of monsoon, but the numbers were moderate. Peak populations of YSB, LF, WBPH and GLH (66, 68, 84, and 38 respectively) were recorded in 41, 40, 40, and 35 SW respectively. GH catches were not considerable.

**Gujarat-Navsari (1-52 SW):** SBs, LF, GLH, BPH, WBPH, RGB, and paddy skipper were found in light trap catches. All the pests were reported only after 22 SW. YSB first appeared in 22 SW and its numbers increased gradually. YSB and other SBs catches were at peak (346+154 and 56 respectively) during 37 SW followed by a decline. Maximum numbers of LF (435) and skippers (247) were found during 36 SW. Sucking pests appeared late and hoppers were observed in 31 SW while RGB in 36 SW. GLH (*N. virescens* and *N.nigropictus*) catches were highest (96 and 92) in 40 SW. BPH and WBPH were found in highest numbers during 40 SW but the catches were moderate (119 and 124 respectively).

## Zone VII-Southern

**Andhra Pradesh-Maruteru (1-17 & 23-48 SW):** YSB, GM, LF, GLH, BPH, WBPH, ZZLH, Coccinellids and mirid bug were reported from this centre. Except LF and BPH remaining species showed continuous activity in both cropping seasons. During *Rabi* season the catch size increased with increasing temperatures. Large catches were recorded in 15 and 16 SWs. Highest numbers of YSB, GM, ZZLH and mirid bug (1790+3970, 682, 1036, and 4977 respectively) were in 16 SW, while GLH population was highest (1035) in 40 SW. BPH was found most active (28820) during 44 SW and WBPH numbers were observed to be maximum (29455) in 15 SW. Coccinellids count was highest (2112) in 14 SW. In *Kharif*, insect activity was highest during the October month. Highest counts of YSB, GM, LF, GLH, BPH, and WBPH were 1834+1624, 6594, 572, 1916, 33624 and 14301 respectively.

**Andhra Pradesh-Nellore (1-52 SW):** YSB, GM, LF, GLH, BPH, WBPH and mirid bugs were recorded at this location. During 19-24 SWs there were no insect catches. YSB catches were moderate (up to 75 in 7 SW). GM numbers were generally higher in *Kharif.* However, maximum catch was recorded in 12 SW (1062). LF numbers were moderate but higher in 46 and 47 SWs (152 and 99, respectively). GLH numbers were higher early in the year up to 8 SW and then declined, while BPH and WBPH numbers were moderate (4000 and 4450 respectively). At this location predatory mirid bugs population was significant with a peak of 1375 in 51 SW.

**Andhra Pradesh-Ragolu (1-52 SW):** SBs, GM, LF, GLH, BPH, WBPH and mirid bugs were recorded at this centre. There were no insect catches during 21-23 SWs, coinciding with the peak summer. YSB catches were not large and its maximum numbers were (56 +35) in 42 SW. GM was recorded continuously during the crop growth periods. Highest number of midges (270) was in 14 SW in *Rabi*, and in 43 SW (205) in *Kharif*. GLH appeared from 14 SW onwards and numbers increased gradually up to 352 in 40 SW followed by a decline. WBPH was found only in *Kharif* (maximum of 745 in 39 SW). BPH was noticed from 4 SW onwards except in summer months. The catches ranged from 35-862 in 51 SW and 39 SW respectively. Mirid bugs were found during the later part of the *Kharif* season in a range of 6 (51 SW)-66 (49 SW).

**Telangana-RajendraNagar (1-52 SW):** Insect seasonality coincided with the cropping seasons and in general numbers in *Rabi* were lower as compared to *Kharif*. YSB, PSB, LF, GLH, BPH, blue beetle, GLH, coccinellids and mirid bug were recorded at this centre. Overall, insect counts were small. Highest count of YSB (180+38) was recorded in 43 SW.

**Telangana-Warangal (1-52 SW):** YSB, GM, LF, BPH, WBPH, and GLH were recorded at this centre. YSB was found throughout the year though the numbers were small in summer months. The catches were largest (106+159) in 42 SW. GM was found more active during 39-47 SWs with a peak population of (371+572) in 40 SW. Trends in BPH and WBPH catches were identical with two distinct periods of activity corresponding to the crop growth seasons with maximum catches of 1492 and 1442 respectively, in 42 SW. GLH was more active during 33-47 SW with peak catch (1148) in 47 SW.

**Tamil Nadu-Aduthurai (1-52 SW)**: YSB, LF, GLH, BPH, EHB, GSB, black bug, blue beetle, coccinellids, ground beetles and rove beetles were recorded at this location. YSB though found throughout the year, it was more active during the early SWs. The largest catch size (829) was recorded in the first SW. GLH numbers were moderate except in 49 and 50 SW, and number was highest in 50 SW (1592). BPH numbers were low but in 52 SW a sharp spike was noticed (4505). Similarly, there was a sudden increase in catches of black bugs (15326) in 40 SW. Blue beetle also was found throughout the year and highest count (262) was in 9 SW. Numbers of ground and rove beetle were considerable with maximum counts of 166 and 988 respectively, during 11 and 49 SWs.

**TamilNadu-Coimbatore (1-52 SW):** YSB, CW, LF, GLH, BPH, WBPH, WLH, RGB, and mirid bugs were recorded. However, the catches were too small to draw any conclusions.

**Kerala-Moncompu (1-52 SW):** SBs, GM, LF, GLH, BPH, WBPH, ZZLH, blue beetle, black bug, coccinellids, mirid bug, and rove beetle were recorded. GLH was found more active up to 18 SW with highest count of 341 during the first SW. BPH also showed similar trend and was most abundant (912) in 12 SW. Black bug catches were highest (332) in 51 SW. Among the natural enemies, rove beetles were found in considerable numbers and maximum catches (591) were recorded in 50 SW, at the end of season.

**Kerala-Pattambi (1-52 SW):** YSB catches reached the peak (662) in 52 SW, whereas, WSB catches were observed to be maximum (154) in 42 SW. GM was absent during 10-29 SWs, but there was increase in catches from 29 SW onwards reaching a maximum of 211 in 39 SW. LF numbers were generally low. The two GLH species were present in considerable numbers. While *N. virescens* catches were maximum (4079) in 37 SW, *N. nigropictus* were (11837) in 35 SW. White leafhopper (WLH) catches also showed similar trend with maximum numbers (218) caught in 50 SW. BPH catches were higher in *Kharif* season, with a peak population of 43710 in 37 SW. CW catches were significant from 30 SW onwards reaching maximum (259) in 33 SW. Ground beetle and mirid bugs were found throughout the year. Maximum mirids (8251) were caught in 48 SW whereas; rice bug (430) in 36 SW.

**Karnataka-Mandya (1-52 SW):** YSB, LF, GLH, BPH and CW were recorded at this centre. Insect catches were generally low.

**Karnataka-Gangavathi (1-52 SW):** SBs, LF, GLH, BPH and WBPH were recorded at this centre. All these pests though were found throughout the year, catches were more during the crop growth periods. YSB catches showed an increasing trend from first SW onwards reaching peak numbers in 17 SW (311+246) followed by a decline. The catches again peaked up (210+133) by 47 SW. Numbers of other SBs were low. LF catches were highest (303) in 49 SW. GLH (*N. virescens* and *N. nigropictus*) catches were maximum (710 and 747 respectively) in 48 SW. Among the plant hoppers, WBPH catches reached peak level earlier (16752 in 44 SW) followed by highest BPH catches (15265 in 50 SW).

**Puducherry-Kurumbapet (1-52 SW):** YSB, LF, GLH, BPH, WBPH, and RGB were recorded round the year uniformly in small numbers. YSB catches were highest (75+28) in 51 SW.

**Puducherry-Karaikal (1-52 SW):** SBs, GLH, BPH, WBPH, EHB, and natural enemies were recorded at this centre. Except for staphylinids catches of other insects were considerably low. Largest catch of staphylinids (391) was observed in 12 SW.

## Pest-wise analysis of light trap catches:

During 2017, light trap catches across the locations, indicated that maximum number of insect species were recorded at Moncompu (15) followed by Raipur (14) and Jagdalpur (13). Eleven species were recorded at Coimbatore, Karaikal, and Maruteru **(Table 2.73)**.

In terms of occurrence and distribution, **Yellow stem borer** was widespread and recorded in 25 locations across the country, except in Northern Hills (Zone-I).

At 14 locations, weekly cumulative catches of this pest were more than 200. Highest catches were found at Maruteru (1790+3970), similar to last year followed by Pantnagar, Aduthurai, Pattambi and Masodha. YSB sex ratio was generally skewed towards females except at Maruteru and Warangal where, males were dominant. At Pantnagar, Masodha, and Aduthurai only females were recorded (**Fig. 2.7**).

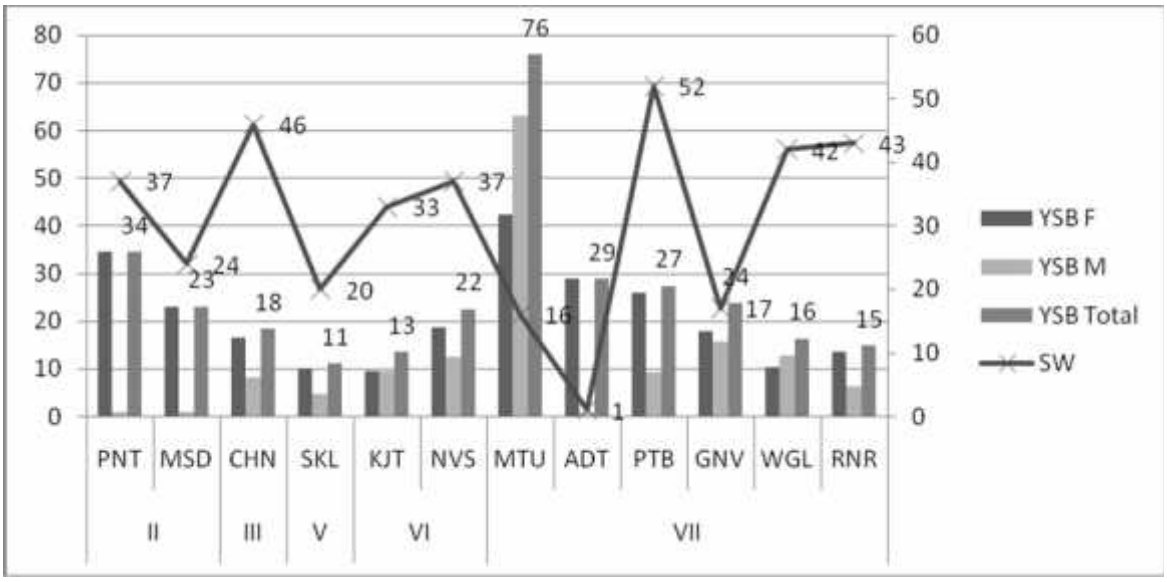



**Fig. 2.7** Weekly cumulative light trap catches of YSB (>200) (*square root transformed)

**Gall midge** was found in 12 locations distributed in four zones namely, Southern (7), Central (2), Eastern (2), and Western (1) Zones. In five locations catches were considerably higher (>200). It was most abundant in Nellore (1062) followed by Warangal (943), and Maruteru (682) (**Fig. 2.8**). In the previous year, this pest was reported from 10 centres with a maximum population of 1673 at Warangal.

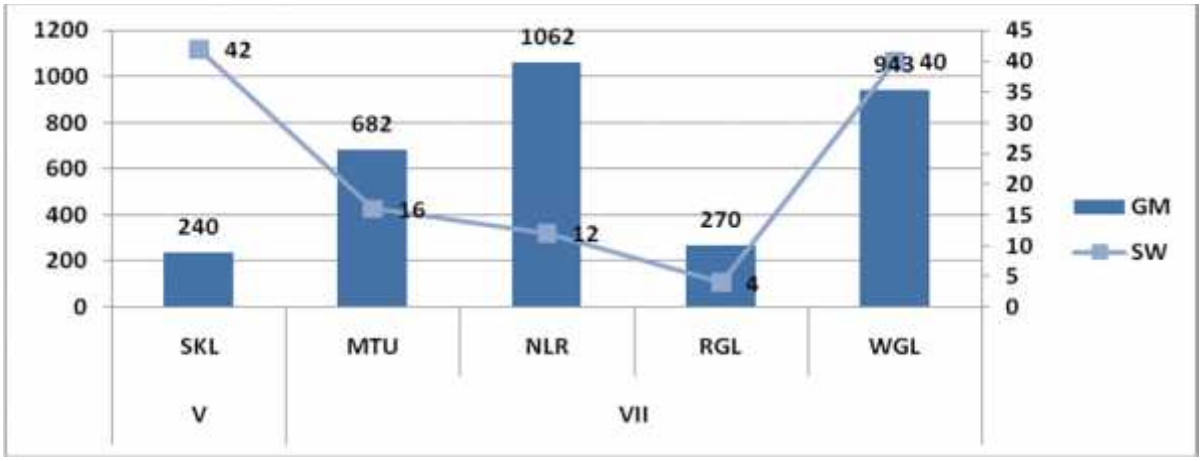



**Fig. 2.8** Weekly cumulative light trap catches of GM (>200)

**Leaf folder** was recorded in all the locations except Ragolu. In ten locations the weekly cumulative catches were more than 50 (**Fig. 2.9**). Highest population was recorded at Masodha (710) followed by Navsari (435), Ludhiana (336), and Gangavathi (303). During the year 2016, leaf folder was found all over the country in

24 centres and maximum catches were recorded at Gangavathi (916) followed by Chatha (441).

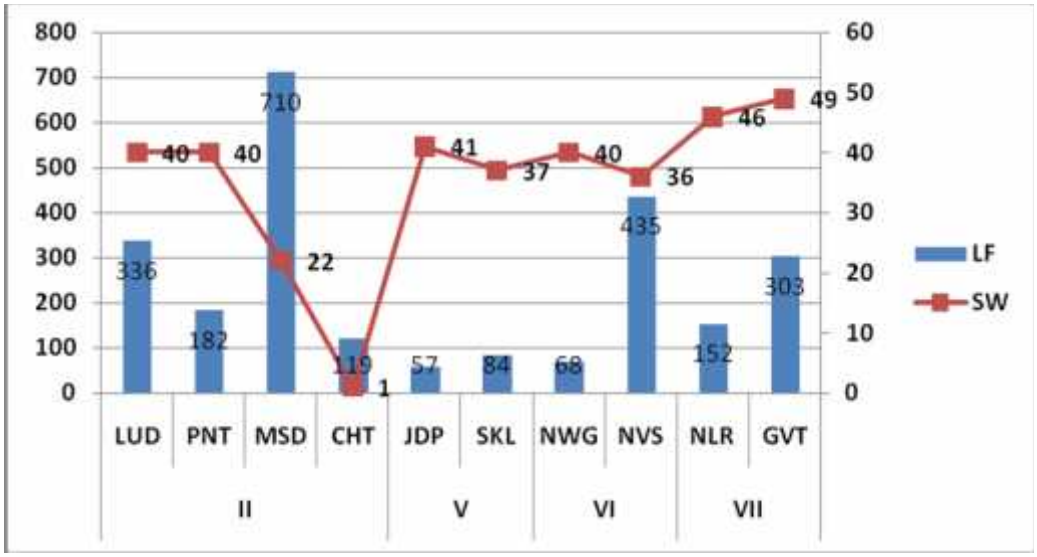



**Fig. 2.9** Weekly light trap cumulative catches of LF (>50)

**Green leafhopper** also was recorded in 23 locations spread over all the zones. At nine locations the catches were more than 1000, all in *Kharif* season (**Fig. 2.10**) except at Chiplima, where it was found in abundance during the *Rabi* season. At Jagdalpur the catches were the largest (96494) for the second consecutive year followed by Pattambi (15916) and Chiplima (3090).

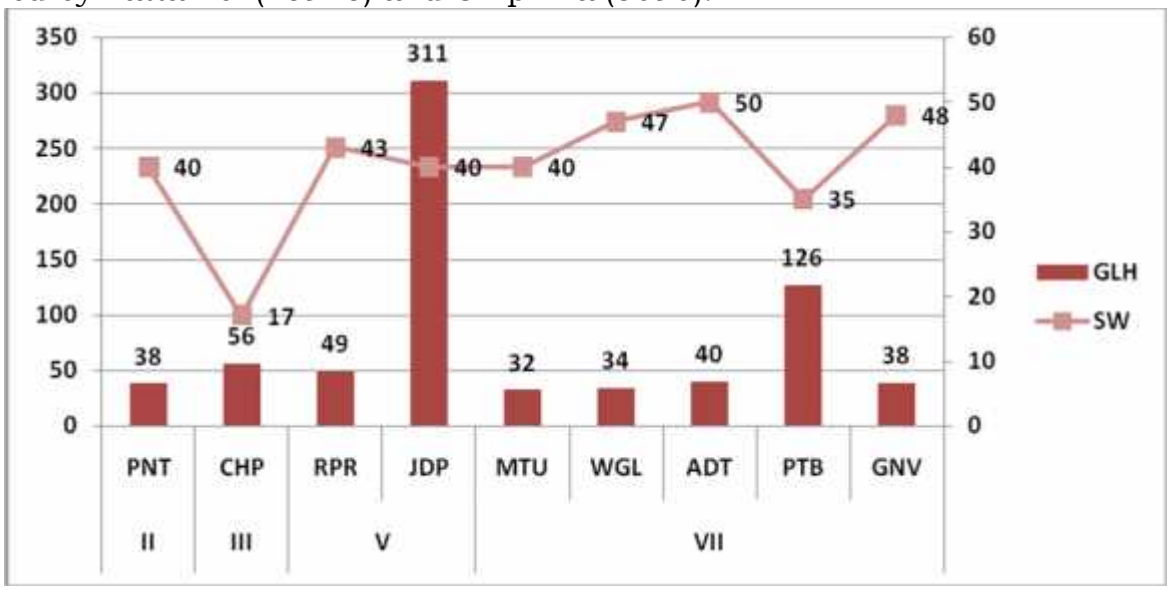



**Fig. 2.10** Weekly cumulative light trap catches of GLH (>1000) *square root transformed

**Brown planthopper** was recorded in 24 locations covering all the zones, except zone-I Hills. In 11 locations, the catches were in considerable numbers (>1000) (**Fig. 2.11**). In Pantnagar the population was maximum (70357) followed by Maruteru (51547), and Pattambi (43710). In the previous year, BPH was reported from 22

centres; with a maximum population of 33244 from Chiplima in 44 SW followed by Gangavathi (20601) and Moncompu (19880).

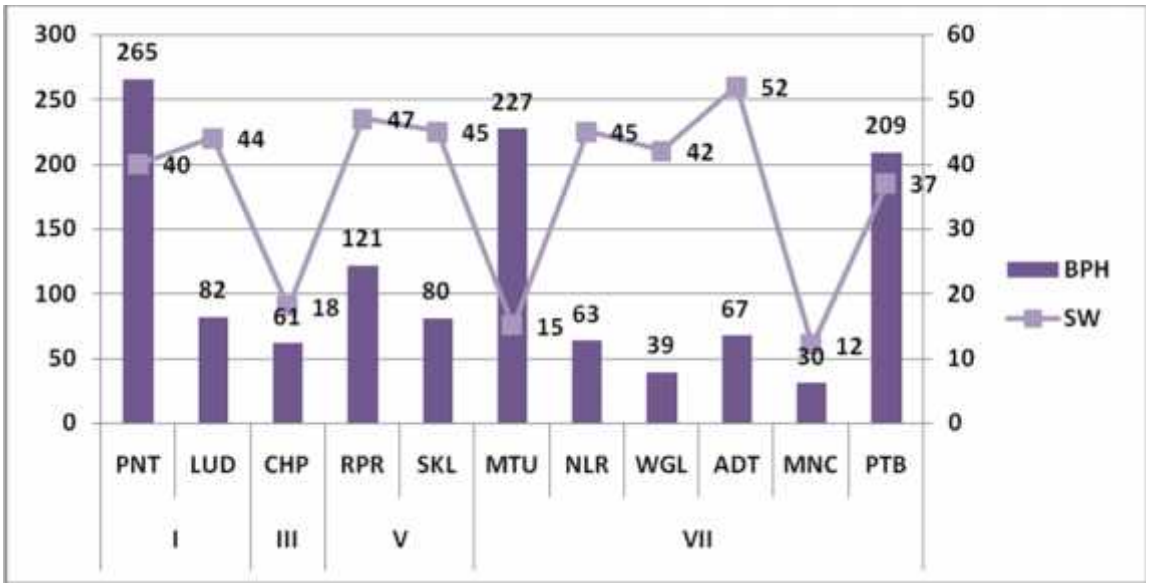



**Fig. 2.11** Weekly cumulative light trap catches of BPH (>1000) *square root transformed

**White backed planthopper** was recorded at 18 locations in all the zones except Hills. In seven locations, the catches were more than 1000 (**Fig. 2.12**). Catches were highest at Maruteru (29455), followed by Gangavathi (16752), and Ludhiana (5215). In year 2016, catches were highest at Gangavathi (23039), followed by Chiplima (17591), and Maruteru (12828).

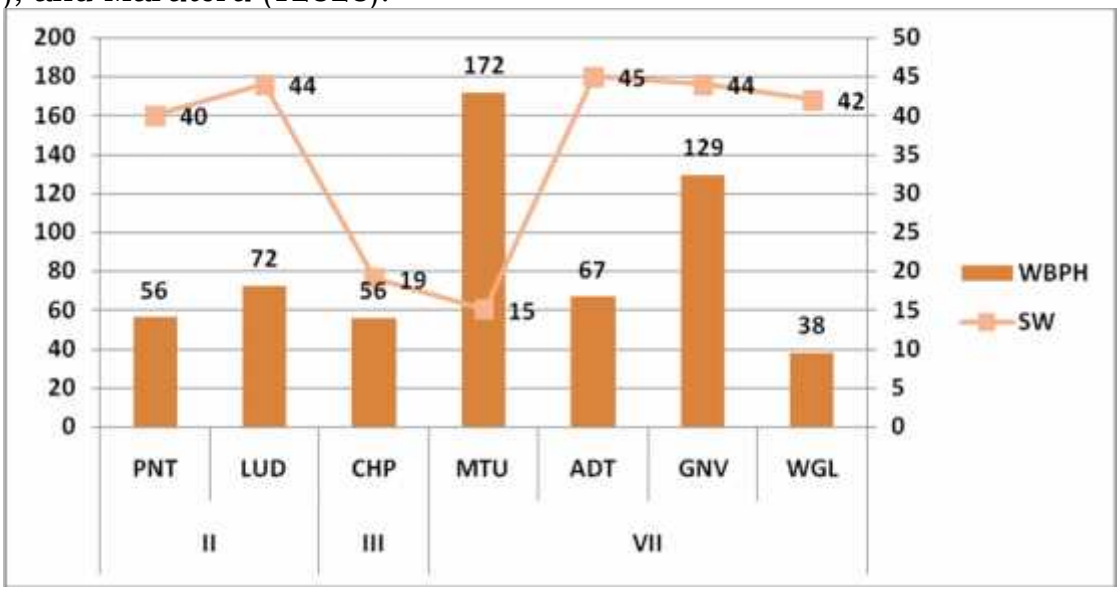



**Fig.2.12** Weekly cumulative light trap catches of WBPH (>1000) *square root transformed

Apart from the above insect pests of National significance, insect pests of regional importance were also recorded. **Rice gundhi bug** was found at 10 locations and maximum numbers (490) were observed at Pantnagar. At Ludhiana, all the three stem borers were found and the number of **pink stem borer** was considerable (364 in 44 SW). White grubs were reported from Khudwani, Moncompu and Chatha.

At Chatha they were found in large numbers (3066 in 25 SW). It is interesting and significant that *Coffana* sp. another plant hopper was reported from Chatha in considerable numbers (980 in 41 SW). **White leafhopper** was found in Chinsurah and Pattambi. **Zigzag leafhopper** was reported from 5 locations and the catch size was significant at Raipur and Jagdalpur (2507 and 1106 respectively). **Paddy skipper** was reported from Khudwani and Navsari but it was more abundant (247 in 36 SW) in the latter location. **Black bug** was reported only in southern zone from 4 locations. The maximum catch of 15326 in 40 SW was observed at Aduthurai.

*Overall, stem borers and planthoppers, mainly BPH continued to be the most widespread pests in terms of numbers as well as spread across the zones except Northern hills (Zone-I). There was a substantial increase in the populations of stem borers (upto a maximum of 5760/week in 16 SW), GLH (upto a maximum of 96494/week in 40 SW), BPH (70357/week in 40 SW), and WBPH (29455/week during 15 SW) as compared to the previous year. The leaf folder catches were slightly lower compared to that of last year; but it was recorded in maximum number of locations. In terms of spectrum, maximum number of insect species were recorded at Moncompu (15) followed by Raipur (14), and Jagdalpur (13). Eleven species were recorded at Coimbatore, Karaikal, and Maruteru.*

**Table 2.73. Geographic distribution of entomofauna in rice ecosystem based on light trap studies in year 2017**

| Zone/Location | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | Total No. of sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PESTS | | | | | | | | | | | | | | | | | | | | | | | | | NATURAL ENEMIES | | | | | | | | | | |
| | | | LF | YSB | BPH | GLH | WBPH | WSB | GM | CW | RGB | PSB | ZZLH | WLH | GH | Bl. Bu. | GSB | BB | EHB | Wh.gr. | Skip. | His. | C.Worm | WM | Fl. Btl. | L. Roll. | *Coffana* | coci. | Mi.bug | Ro.btl. | Gr.btl. | Staphy. | Gerr. | Rice bug | E.wig | Spider | |
| Zone-I Hills | 1 | KHD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| | 2 | MLN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9 |
| Zone-II Northern | 3 | PNT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 |
| | 4 | MSD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| | 5 | LDN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 |
| | 6 | KUL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9 |
| | 7 | CHT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| Zone-III Eastern | 8 | CHP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 |
| | 9 | CHN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 10 |
| Zone-V Central | 10 | JDP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 13 |
| | 11 | RPR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 14 |
| | 12 | SKL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| Zone-VI Western | 13 | KJT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9 |
| | 14 | NWG | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 |
| | 15 | NVS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 |
| Zone-VII: Sothern | 16 | CBT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 11 |
| | 17 | GNV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 |
| | 18 | KBP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| | 19 | KRK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 11 |
| | 20 | MTU | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 11 |
| | 21 | NLR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 |
| | 22 | MND | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 |
| | 23 | MNC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 15 |
| | 24 | PTB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 10 |
| | 25 | RGL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| | 26 | RNR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9 |
| | 27 | WGL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| | 28 | ADT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 11 |
| Total No. of locations | | | 27 | 25 | 24 | 23 | 18 | 14 | 12 | 10 | 10 | 5 | 5 | 5 | 5 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 8 | 6 | 5 | 3 | 2 | 1 | 1 | 1 | 1 | |

**Entomology *Rabi* 2017**

## SUMMARY

### 2.1 Host Plant Resistance Studies

**Leaf Folder Screening Trial (LFST)**
Field evaluation of 20 entries replicated thrice in **LFST** trial during *Rabi* 2016-17 at Aduthurai alone revealed 9 entries as promising *viz.*, MP 146, CN 1231-11-7, MP 209, MP 123, MP 249, Mahisagar, MP 22, MP 11 and MP 307 recording less than 10% leaf folder damaged leaves.

**Stem borer screening trial (SBST)**
Evaluation of 55 entries in 10 field tests identified 8 entries *viz.*, RP 5893-181-28-6-5-8-B-B-2-2, RP 5893-382-54-8-2-1-B-B-5, RP 5588-B-B-B-B-305, IIRR-BIO-SB-9, JGL 23655, JGL 23800, JGL 23848, JGL 23746, as promising in 3 of the 10 tests. Most of these entries had higher grain yield (>15g/plant) despite stem borer damage.

### 2.2 Chemical Control Studies

**Insecticide Evaluation Trial (IET)** was carried out at 8 locations to evaluate the efficacy of the newer insecticide combination product *viz.*, Spinetoram plus methoxyfenozide compared to other newer and recommended insecticides, against major insect pests of rice and consequent impact on grain yield during *Rabi* 2016-17. Based on the performance of the insecticide treatments for their efficacy in reducing pest infestation and their impact on grain yield across locations, spinetoram plus methoxyfenozide was on par with recommended rynaxypyr treatment against stem borer. Against gall midge all the treatments were at par. Triflumezopyrim and dinotefuran treatments were more effective and superior to the newer combination product against planthoppers. Among the insecticide treatments spinetoram + methoxyfenozide, triflumezopyrim and rynaxypyr treatments yielded at par and significantly higher than remaining treatments including control.

**Botanical Insecticides Evaluation Trial (BIET)** was carried out at 5 locations to evaluate the efficacy of four commercial formulatios and neemoil along with recommended insecticides, dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield during *Rabi*, 2016-17. Based on the performance of the treatments in reducing the pest incidence at various locations, the insecticide –rynaxypyr and the botanicals-Neemazal and Multineem were found effective against stem borer damage. Multineem was found effective against planthoppers also. Regarding the efficacy of treatments against leaf folder and whorl maggot, all botanical formulations were found effective and their efficacy was superior to control. Highest grain yield of 4487.2kg/ha was recorded in rynaxypyr and among botanicals Neemazal gave highest yield (3892.8 kg/ha).

**Monitoring of Pests species and Natural Enemies (MPNE)** trial was carried out at 7 locations. The stem borer species observed were YSB, PSB, DHB and WSB. Three egg parasitoids of stem borer were observed with *Trichogramma japonicum* being dominant at Chinsurah, Moncompu and Rajendranagar while *Tetrastichus schoenobii* was dominant at Aduthurai and *Telenomus* species dominant at Coimbatore and Pattambi.

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

**Bio Intensive Pest Management Trial (BIPM)** was taken up at Chinsurah during *Rabi* 2016-17. The pest incidence was reduced and natural enemy population was higher in BIPM plots. Subsequently the lower pest incidence also reflected in higher yields in BIPM plots.

**Effect of Planting Dates on Insect Pest incidence (EPDP)** trial was conducted at two locations, *i.e.,* at Aduthurai during samba season and at Chinsurah during boro season of 2016-17. At Aduthurai, incidence of stem borer (11.44 -16.27%) and gall midge (10.11%) was high in late planting while the incidence of leaf folder was high in early (17.81-25.59%) and late plantings (16.08-29.1%). At Chinsurah, very low incidence of stem borer, leaf folder, whorl maggot and hispa (<5%), BPH, WBPH and GLH (<5/hill) was observed in all the three plantings.

**Yield Loss Estimation Trial (YLET)** Yield loss estimation trial was conducted at three locations *viz*, Aduthurai, Chinsurah and Pattambi during *Rabi* 2016-17. Regression analysis revealed a significant negative relationship between white ears and grain yield at Chinsurah ($R^2$ = 0.5978) resulting in 2.2 g reduction in grain yield for every 10% increase in leaf folder damaged leaves. At Aduthurai and Pattambi, relationship between white ears and grain yield was negative but not significant.

**Integrated Pest Management Special (IPMS*)*** trial was conducted at two locations, Aduthurai and Maruteru during Rabi 2016-17. Incidence of stem borer (1.7-5.6% DH) and leaf folder (0.9-19.3% LFDL) was low in IPM plots compared to FP plots( 2.8-12.9% DH & 1.8-35.0% LFDL) at Aduthurai in all the six farmers fields in six villages. Gall midge damage was low in IPM plots (1.8-7.7% SS) compared to FP plots (0-12.3% SS) at Aduthurai while the damage was high in IPM plot (12.52-16.02% SS) than FP plot (11.26-12.01% SS) at Maruteru. 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 (3.17 – 3.77) than farmer practice plots (2.47-3.01).

**Rabi 2016-17**

## 2.1. Host Plant Resistance Studies

### Leaf folder Screening Trail (LFST)

Leaf folder screening trial was conducted at Aduthurai during *Rabi* 2016-17. The trial consisted of 20 entries replicated thrice, comprising of 5 nominations from Main Rice Research Station, Anand Agricultural University, Nawagam, one from Rice Research Station, Chinsurah and ten from IIRR, Rajendranagar along with resistant check (W 1263) and susceptible check (TN1). The average damage varied from 2.92 to 29.79% in various entries. Augmented screening data revealed 9 entries as promising *viz.*, MP 146, CN 1231-11-7, MP 209, MP 123, MP 249, Mahisagar, MP 22, MP 11 and MP 307 recording less than 10% leaf folder damaged leaves **(Fig 2.13)**.

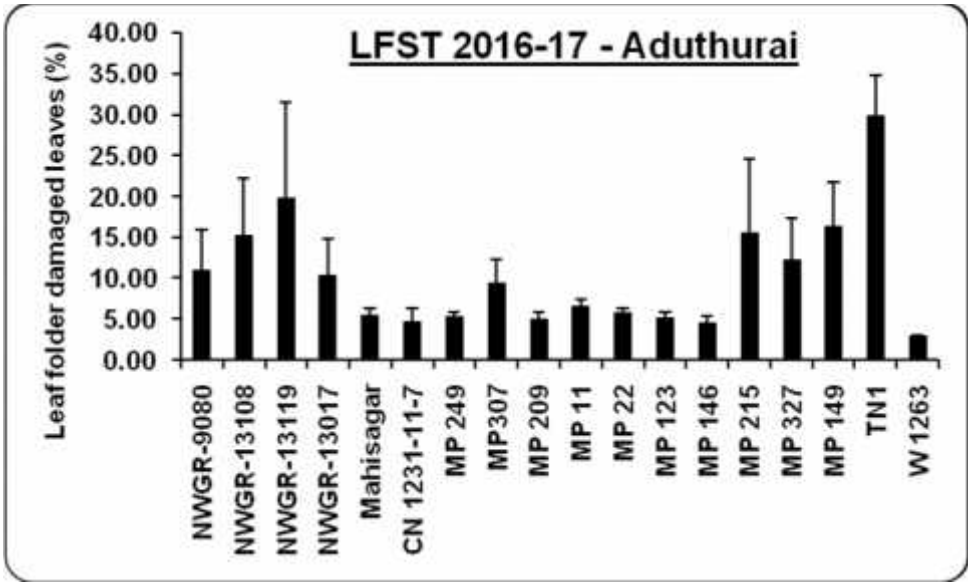



**Fig.2.13 Leaf folder damage at Aduthurai in LFST, *Rabi* 2016-17**

*Field evaluation of 20 entries replicated thrice in **LFST** trial during rabi 2016-17 at Aduthurai alone revealed 9 entries as promising viz., MP 146, CN 1231-11-7, MP 209, MP 123, MP 249, Mahisagar, MP 22, MP 11 and MP 307 recording less than 10% leaf folder damaged leaves.*

### Stem borer screening trial (SBST)

The trial constituted with 55 entries in *kharif* 2016 was retested at 4 locations in rabi 2016-17 at both vegetative and reproductive phases. Reaction of the entries to stem borer from the valid data obtained from two staggered sowings at these locations is discussed below.

*Dead heart damage*: The dead heart damage at vegetative phase in the trial varied from 0-37.9% with an average damage of 8.7% in 3 valid tests. JGL 23678, JGL 23655, RP 5588-B-B-B-B-51, RP 5588-B-B-B-B-153, RP 5588-B-B-B-B-159-2, BPT 5204, W1263 recorded ≤5% dead hearts in 1 of the 3 valid tests.

*White ear damage***:** The white ear damage at reproductive phase varied from 1.1%-26.5 % WE with an average of 10.5 % WE in 2 valid tests. Only RP 5893-382-54-8-2-1-B-B-5 had <3% damage in both the locations.

*Grain yield*: RP 5588-B-B-B-B-305, JGL 23800, JGL 23848, JGL 23746, IIRR-BIO-SB-9 had a grain yield of ≥15g/hill in 3 of the 5 valid tests despite stem borer damage.

**Overall reaction**: Evaluation of 55 entries in 10 field tests identified 8 entries as promising in 3 of the 10 tests **(Table 2.74)**. Most of these entries had higher grain yield despite stem borer damage.

**Table 2.74 Reaction of most promising cultures to stem borer in SBST trial, rabi 2016-17.**

| Entry No. | Designation | IIRR | ADT | CHN2 | SBDH NPT | ADT | CHN1 | SBWE NPT | ADT | RNR1 | RNR2 | CHN1 | CHN2 | GY NPT | OVERALL NPT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 75DT | 50DT | 51DT | | | | | Grain Yield(g/hill) | | | | | | |
| | | % Deadhearts | | | **3** | % White ears | | **2** | | | | | | **5** | **10** |
| 51 | RP 5893-181-28-6-5-8-B-B-2-2 | 37.9 | 5.2 | 6.5 | **0** | 7.4 | NT | **1** | 20.4 | 15.3 | 7.7 | NT | NT | **2** | **3** |
| 52 | RP 5893-382-54-8-2-1-B-B-5 | 11.7 | 2.1 | 6.97 | **0** | 1.1 | 2.7 | **2** | 19.9 | 13.7 | 7.4 | 13.5 | 12.0 | **1** | **3** |
| 24 | RP 5588-B-B-B-B-305 | 21.7 | 4.2 | 5.6 | **0** | 16.6 | 22.9 | **0** | 13.7 | 6.7 | 16.4 | 16.6 | 15.4 | **3** | **3** |
| 5 | JGL 23655 | 2.5 | 5.8 | 7.5 | **1** | 8.2 | 19.88 | **0** | 13.1 | 7.5 | 6.3 | 19.8 | 17.4 | **2** | **3** |
| 37 | JGL 23800 | 17.8 | 4.8 | 15.1 | **0** | 14.5 | 4.96 | **0** | 18.7 | 10.95 | 5.3 | 15.4 | 15.4 | **3** | **3** |
| 39 | JGL 23848 | 15.2 | 2.5 | 8.6 | **0** | 7.97 | 4.4 | **0** | 20.1 | 10.7 | 16.2 | 16.3 | 14.1 | **3** | **3** |
| 43 | JGL 23746 | 24.2 | 1.7 | 3.0 | **0** | 11.3 | 4.5 | **0** | 15.99 | 7.2 | 16.1 | 15.5 | 15.5 | **3** | **3** |
| 44 | IIRR-BIO-SB-9 | 11.2 | 2.2 | 5.9 | **0** | 20.4 | 4.9 | **0** | 18.9 | 10.89 | 13.0 | 15.8 | 15.8 | **3** | **3** |
| | | | | | | | | | | | | | | | |
| Total tested | | 50 | 55 | 55 | | 55 | 49 | | 55 | 55 | 55 | 48 | 48 | | |
| Average damage in the trial | | 14.3 | 4.0 | 7.9 | | 10.8 | 10.2 | | 16.1 | 10.4 | 10.8 | 12.1 | 11.6 | | |
| Promising level | | 5 | 0 | 0 | | 3 | 3 | | 18 | 15 | 15 | 15 | 15 | | |
| No. promising | | 7 | 0 | 0 | | 4 | 3 | | 13 | 3 | 4 | 9 | 9 | | |

## 2.2 CHEMICAL CONTROL STUDIES

### I) Insecticide Evaluation Trial (IET)

During Rabi 2016-17, the trial of *kharif* 2016 was continued and included evaluation of , the newer combination insecticide – Spinetoram 6% plus methoxyfenozide 30% at two doses of 135 and 144 g a.i./ha supplied by Dow Agrosciences, in comparison with triflumezopyrim (DPX-RAB 55 106 SC)., @ 25 g a.i./ha, rynaxypyr (Coragen 20 SC) @ 30 g a.i./ha, supplied by Dupont India Ltd., flubendiamide (Fame 48% SC) @ 24 g a.i./ha supplied by Bayer India Ltd., acephate 95 SG @ 500 g a.i./ha, supplied by Rallies India Ltd., dinotefuran (Osheen 20 SG) 40 g a.i./ha, supplied by PI industries Ltd. and untreated control treatment with no insecticide application.

There were eight treatments replicated thrice each and laid out in Randomized Complete Block Design (RCBD). The trial was carried out at 8 locations and at all the locations, a blanket application of all the treatments was given at 15 DAT, except triflumezopyrim treatment and untreated control. Subsequently applications of individual treatments were done based on pest incidence exceeding the economic threshold level guidelines. The triflumezopyrim treatment was applied only once during 45-60 DAT. The insecticides were applied as high volume sprays @ 500 litres of spray fluid/ha**.**

Standard procedural protocols were followed to record insect pest incidence at regular intervals throughout the crop growth period. Observations were recorded on total tillers (TT), dead hearts (DH) and silver shoots (SS) at 30 and 50 DAT to assess stem borer and gall midge damage, while at heading stage the stem borer damage was expressed as per cent white ears based on counts of panicle bearing tillers (PBT) and white ear heads (WE). Population counts were recorded on ten randomly selected hills in each plot in case of sucking pests such as brown planthopper (BPH), whitebacked planthopper (WBPH), green leafhopper (GLH) and natural enemies. The damage due to foliage feeders such as leaf folder, whorl maggot, hispa, etc., was assessed based on counts of total number of leaves as well as damaged leaves per10 hills. At the time of harvest, the grain yield was recorded from net plot leaving 2 border rows on all sides and expressed as kg/ha.

| Sl. No. | Location | Date of sowing | Date of planting | Date of harvesting | No of applications | Times of application (DAT) |
|---|---|---|---|---|---|---|
| 1 | Aduthurai | 23-09-2016 | 15-10-2016 | 07-02-2017 | 2 | 30 &75 |
| 2 | Chinsurah | 16-01-2017 | 16-02-2017 | 01-06-2017 | 2 | 15 & 52 |
| 3 | Coimbatore | 23-02-2017 | 24-03-2017 | 21-06-2017 | 2 | 10,35 & 65 |
| 4 | Chiplima | 28-12-2016 | 04-02-2017 | 02-06-2017 | 3 | 20,45 & 65 |
| 5 | Karjat | 10-01-2017 | 14-02-2017 | 03-06-2017 | 1 | 45 |
| 6 | Maruteru | 09-12-2016 | 08-01-2017 | 12-04-2017 | 3 | 15,35 & 52 |
| 7 | Puducherry | 28-12-2016 | 02-02-2017 | 28-05-2017 | 2 | 30 & 50 |
| 8 | Pattambi | 07-11-2016 | 25-11-2016 | 09-03-2017 | 3 | 15,30 & 60 |
| 9 | Raipur | 12-01-2017 | 09-02-2017 | 03-06-2017 | 3 | 45,75 & 100 |
| 10 | Ragolu | 17-12-2017 | 11-01-2017 | 28-04-2017 | 3 | 25,45 & 65 |
| 11 | Rajendranagar | 23-12-2016 | 01-02-2017 | 10-05-2017 | 3 | 15,44 & 62 |
| 12 | Warangal | 26-11-2016 | 06-01-2017 | 04-05-2017 | 2 | 25 & 55 |

The data collected for each date of application at each location as well as for yield at harvest were subjected to analysis by ANOVA test for Random Complete Block Design (RCBD) 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 each of the pest damages across observations and over locations. Pooled yield data analysis was also carried out to assess the impact of each treatment on yield.

**Results**

**Pest Infestation (Table2.75)**

**Stem borer** infestation during vegetative stage was low and recorded upto a maximum of 11.1% across 6 locations with minimum damage exceeding 5% DH in untreated control, during 30 to 76 DAT. The mean infestation across these locations varied between 2.7 and 5.0% DH in insecticide treatments compared to 7.6% DH in untreated control. All the insecticide treatments except dinotefuran were significantly superior to control. At heading stage, more than 5% white ears (WE) were recorded at 7 centres and differences were significant at all locations. At Maruteru, relatively higher incidence was recorded upto 31.6%, compared to other locations. The mean infestation ranged from 3.2 to 15.9% WE in all treatments including untreated control. Rynaxypyr recorded the lowest infestation of 3.2% WE. The insecticide treatments of rynaxypyr and spinetoram plus methoxyfenozide at higher dose were superior in their performance in reducing stem borer incidence at both vegetative and reproductive phases. All the insecticides were superior to control.

**Gall midge** infestation was recorded at two locations viz., Kurumbapet and Ragolu, ranging from 13.9 to 17.6% SS across treatments including control, during 50 to 75 DAT. There were no significant differences among the treatments.

Among the foliage feeders, leaf folder, hispa and whorl maggot incidence was recorded**. Whorl maggot incidence** was reported from Aduthurai and Pattambhi ranging from 5.7 to 12.6% DL. All the treatments including control were at par. Incidence of other two pests was negligible.

**Brown planthopper** incidence was high at Maruteru (maximum up to 347.7 hoppers/ 10 hills) during 58-95 DAT while at Chiplima, maximum hopper population was recorded upto 83.0 hoppers / 10 hills during 45 to 95 DAT. Across the locations, triflumezopyrim was the best treatment (11.9 hoppers/10 hills) followed by dinotefuran treatment (17.0 hoppers/10 hills) which was at par. Other insecticide treatments showed a population ranging from 20.8 to 30.5 hoppers per 10 hills compared to 58.4 hoppers recorded in control plots. **Whitebacked planthopper** infestation was recorded only at Maruteru upto a maximum of 57.3 hoppers/10 hills. There was significant reduction of WBPH population in triflumezopyrim treatment (4.5 hoppers/10 hills) followed by dinotefuran treatment (12.2 hoppers/10 hills) and acephate (13.3 hoppers/10 hills). The infestation in remaining treatments including control was 14.5 to 42.5 hoppers/10 hills. All the insecticide treatments were superior to control.

**Green leafhopper** incidence was reported from Aduthurai and Coimbatore ranging from 3.3 to 13.0 hoppers/10 hills during 30 to 100 DAT. Across the locations, all the insecticide treatments (5.1 to 6.4 hoppers/10 hills) were significantly superior to control (10.3 hoppers/10 hills).

Against the sucking pest complex consisting mainly of planthoppers the performance of triflumezopyrim and dinotefuran was consistently superior to other treatments including control, across locations.

Data on populations of natural enemies included reports on **spider** populations from three locations viz., Coimbatore, Maruteru and Pattambi. The spider numbers remained within a narrow range of 5.4 to 9.3/10 hills across treatments and locations. All the treatments were at par indicating that insecticide treatments did not have adverse impact on spider population. However, there were significant differences among the treatments in case of **mirid bugs** reported from Maruteru during 58 to 95 DAT. The triflumezopyrim treatment showed significantly lower populations of 1.5 bugs per 10 hills compared to 41.5 bugs/10 hills in control. Among the insecticide treatments, spinetoram + methoxyfenozide and rynaxypyr treatments were relatively safer showing 24.2 to 26.3 bugs/10 hills.

**Grain Yield (Table 2.76)**

There were significant differences in grain yield among the treatments at four out of eight locations. Based on mean yield of these locations, spinetoram + methoxyfenozide, triflumezopyrim and rynaxypyr treatments were significantly superior (4814 to 4844 kg/ha with % IOCs ranging from 17.3 to 17.9%) to the remaining treatments (4397 to 4663 kg/ha and 9.5 to 14.&% IOC). The control plot yielded 3979 kg/ha.

*Insecticide evaluation trial was carried out at 8 locations to evaluate the efficacy of the newer insecticide combination product viz., Spinetoram plus methoxyfenozide compared to other newer and recommended insecticides, against major insect pests of rice and consequent impact on grain yield during rabi 2016-17. Based on the performance of the insecticide treatments for their efficacy in reducing pest infestation and their impact on grain yield across locations, it was evident that the performance of spinetoram plus methoxyfenozide was on par with recommended rynaxypyr treatment against stem borer. Against gall midge all the treatments were at par. Triflumezopyrim and dinotefuran treatments were more effective and superior to the newer combination product against planthoppers. Among the insecticide treatments spinetoram + methoxyfenozide, triflumezopyrim and rynaxypyr* treatments *yielded at par and significantly higher than remaining treatments including control.*

**Table. 2.75 Insect pest incidence in different treatments, IET, *Rabi* 2016-17**

| Sl.No | Trade Name | Common Name | % a.i. formulation | Dose of formulation or product/ha | Stem Borer Damage (%DH) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | | CBT | | |
| | | | | | 30DT | 50DT | 30DT | 40DT | 65DT |
| 1 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 375 | 3.4a | 3.4bc | 4.0a | 5.4a | 4.3a |
| 2 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 400 | 3.4a | 2.9b | 4.1a | 4.2a | 3.3a |
| 3 | DPX-RAB 55 | DPX-RAB 55 | 106 SC | 237.5 ml | 6.0b | 3.8c | 4.2a | 3.3a | 2.7a |
| 4 | Fame | Flubendiamide 480 SC (g/L) | 48% SC(w/v) | 50 ml | 3.2a | 2.2a | 4.7a | 4.4a | 3.7a |
| 5 | Coragen | Rynaxypyr | 20 SC | 150 ml | 2.8a | 2.4a | 5.1a | 5.2a | 3.5a |
| 6 | Sulfoxaflor | Sulfoxaflor | 24% SC | 90 ml | 3.5a | 3.3b | 4.9a | 6.1a | 4.9a |
| 7 | Osheen | Dinotefuran | 20 SG | 200 g | 3.6a | 2.2a | 5.3a | 7.6a | 5.0a |
| 8 | Untreated Control | Water | - | - | 6.6b | 8.5d | 5.0a | 11.1b | 8.7b |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.75 (Contd…) Insect pest incidence in different treatments, IET, *Rabi* 2016-17**

| Sl.No | Trade Name | Common Name | % a.i. formulation | Dose of formulation or product/ha | Stem Borer Damage (%DH) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CHP | | | PTB | RGL | |
| | | | | | 50DT | 56DT | 76DT | 30DT | 50DT | Mean |
| 1 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 375 | 2.3bc | 2.8b | 1.7ab | 2.5a | 4.5a | **3.4b** |
| 2 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 400 | 1.0a | 2.8b | 1.4ab | 0.8a | 3.3a | **2.7a** |
| 3 | DPX-RAB 55 | DPX-RAB 55 | 106 SC | 237.5 ml | 6.7c | 3.7c | 4.8c | 3.8a | 3.2a | **4.2c** |
| 4 | Fame | Flubendiamide 480 SC (g/L) | 48% SC(w/v) | 50 ml | 3.6bc | 3.0b | 2.5b | 2.0a | 3.5a | **3.3b** |
| 5 | Coragen | Rynaxypyr | 20 SC | 150 ml | 2.0ab | 1.6a | 1.0a | 1.0a | 3.8a | **2.8a** |
| 6 | Sulfoxaflor | Sulfoxaflor | 24% SC | 90 ml | 7.5c | 3.6b | 2.8b | 5.6a | 3.5a | **4.6c** |
| 7 | Osheen | Dinotefuran | 20 SG | 200 g | 6.3c | 4.8c | 4.4c | 4.1a | 6.6a | **5.0cd** |
| 8 | Untreated Control | Water | - | - | 9.8d | 6.0d | 8.0d | 7.0a | 5.6a | **7.6d** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.75 (Contd…) Insect pest incidence in different treatments, IET, *Rabi* 2016-17**

| Sl. No | Trade Name | Common Name | % a.i. formula-tion | Dose of formulation or product/ha | Stem Bore Damage (%WE) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | CBT | CHN | CHP | MTU | PTB | RGL | Mean |
| 1 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxy-fenozide 30% w/v (28.3% w/w) SC | 36 SC | 375 | 10.6b | 4.5ab | 2.9a | 2.7b | 18.7b | 2.0a | 6.5b | **6.8b** |
| 2 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxy-fenozide 30% w/v (28.3% w/w) SC | 36 SC | 400 | 8.5b | 3.5a | 1.5a | 2.4b | 17.5b | 1.3a | 4.3ab | **5.6b** |
| 3 | DPX-RAB 55 | DPX-RAB 55 | 106 SC | 237.5 ml | 9.1b | 4.3ab | 7.3b | 5.9c | 29.1b | 7.5b | 6.7b | **10.0cd** |
| 4 | Fame | Flubendiamide 480 SC (g/L) | 48% SC(w/v) | 50 ml | 8.1b | 5.2ab | 6.2b | 3.6b | 11.6a | 2.6a | 9.5b | **6.7bc** |
| 5 | Coragen | Rynaxypyr | 20 SC | 150 ml | 8.0b | 4.3ab | 2.6a | 1.3a | 3.4a | 0.8a | 1.6a | **3.2a** |
| 6 | Sulfoxaflor | Sulfoxaflor | 24% SC | 90 ml | 9.5b | 5.9ab | 13.9c | 4.3c | 19.5b | 8.0b | 3.6b | **9.2c** |
| 7 | Osheen | Dinotefuran | 20 SG | 200 g | 5.3a | 7.4ab | 15.6c | 5.0c | 24.7b | 7.6b | 8.1ab | **10.5cd** |
| 8 | Untreated Control | Water | - | - | 17.3c | 10.1b | 17.8c | 12.0d | 31.6b | 10.7b | 11.9b | **15.9d** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.75 (Contd…) Insect pest incidence in different treatments, IET, *Rabi* 2016-17**

| Sl.No | Trade Name | Common Name | % a.i. formu-lation | Dose of formu-lation or product/ha | Gall midge Damage (% Silver shoots) | | | Mean |
|---|---|---|---|---|---|---|---|---|
| | | | | | KBP | RGL | | |
| | | | | | 50DT | 50DT | 75DT | |
| 1 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 375 | 8.9a | 18.2a | 25.6a | **17.6a** |
| 2 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 400 | 9.7a | 11.3a | 23.5a | **14.8a** |
| 3 | DPX-RAB 55 | DPX-RAB 55 | 106 SC | 237.5 ml | 11.9a | 10.9a | 23.5a | **15.4a** |
| 4 | Fame | Flubendiamide 480 SC (g/L) | 48% SC(w/v) | 50 ml | 13.5a | 7.8a | 20.5a | **13.9a** |
| 5 | Coragen | Rynaxypyr | 20 SC | 150 ml | 11.7a | 13.8a | 23.2a | **16.2a** |
| 6 | Sulfoxaflor | Sulfoxaflor | 24% SC | 90 ml | 11.6a | 12.9a | 22.9a | **15.8a** |
| 7 | Osheen | Dinotefuran | 20 SG | 200 g | 10.9a | 9.6a | 23.7a | **14.7a** |
| 8 | Untreated Control | Water | - | - | 7.6a | 14.3a | 24.8a | **15.5** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.75 (Contd…) Insect pest incidence in different treatments, IET, *Rabi* 2016-17**

| Sl. No | Trade Name | Common Name | % a.i. formulation | Dose of formu-lation or product/ha | Brown Planthopper(No./10hills) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | | | | CHN | | | |
| | | | | | 30DT | 50DT | 80DT | 100DT | 14DT | 18DT | 51DT | 55DT |
| 1 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 375 | 4.3a | 5.3b | 5.3a | 4.3a | 7.3a | 10.0a | 21.3a | 17.0c |
| 2 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 400 | 5.3a | 5.0b | 6.0a | 3.7a | 7.7a | 8.a3 | 21.0a | 17.0c |
| 3 | DPX-RAB 55 | DPX-RAB 55 | 106 SC | 237.5 ml | 4.7a | 6.0b | 6.3a | 4.3a | 8.3a | 10.3a | 23.7a | 3.7a |
| 4 | Fame | Flubendiamide 480 SC (g/L) | 48% SC(w/v) | 50 ml | 5.7a | 5.3b | 4.7a | 2.7a | 8.7a | 6.0a | 20.0a | 14.7bc |
| 5 | Coragen | Rynaxypyr | 20 SC | 150 ml | 3.7a | 3.0a | 5.0a | 3.7a | 11.7a | 10.0a | 20.3a | 12.0bc |
| 6 | Sulfoxaflor | Sulfoxaflor | 24% SC | 90 ml | 4.0a | 3.7a | 4.0a | 3.3a | 11.3a | 9.0a | 24.0a | 16.0c |
| 7 | Osheen | Dinotefuran | 20 SG | 200 g | 5.3a | 4.3a | 4.7a | 3.3a | 12.3a | 7.3a | 11.7a | 8.7b |
| 8 | Untreated Control | Water | - | - | 6.7a | 9.3c | 8.0b | 7.7b | 10.3a | 11.7a | 27.3a | 30.0d |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.75 (Contd…) Insect pest incidence in different treatments, IET, *Rabi* 2016-17**

| Sl. No | Trade Name | Common Name | % a.i. formulation | Dose of formulation or product/ha | Brown Planthopper (No./10hills) | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CHP | | | | MTU | | |
| | | | | | 45DT | 50DT | 65DT | 70DT | 58DT | 95DT | |
| 1 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 375 | 34.7c | 26.0c | 42.0d | 37.3c | 86.7b | 90.0c | **28.0b** |
| 2 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 400 | 32.3c | 22.3bc | 38.0cd | 34.3c | 81.3b | 145.3d | **30.5bc** |
| 3 | DPX-RAB 55 | DPX-RAB 55 | 106 SC | 237.5 ml | 16.3a | 13.3a | 20.0a | 14.0a | 26.7a | 8.7a | **11.9a** |
| 4 | Fame | Flubendiamide 480 SC (g/L) | 48% SC(w/v) | 50 ml | 37.0c | 30.7c | 41.7d | 36.0c | 51.7b | 85.0c | **25.0b** |
| 5 | Coragen | Rynaxypyr | 20 SC | 150 ml | 34.3c | 26.7c | 41.0d | 34.0c | 90.0b | 159.0d | **32.5c** |
| 6 | Sulfoxaflor | Sulfoxaflor | 24% SC | 90 ml | 22.7b | 19.7b | 33.7c | 26.3b | 63.3b | 50.7b | **20.8b** |
| 7 | Osheen | Dinotefuran | 20 SG | 200 g | 20.7b | 18.7b | 26.7b | 21.7b | 47.0a | 45.0b | **17.0ab** |
| 8 | Untreated Control | Water | - | - | 55.0d | 60.3d | 74.7e | 83.0d | 85.3b | 347.7e | **58.4d** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.75 (Contd…) Insect pest incidence in different treatments, IET, *Rabi* 2016-17**

| Sl. No | Trade Name | Common Name | % a.i. formu-lation | Dose of formu-lation or product/ha | Whitebacked Panthopper | | Mean | Green Leafhopper (No./10hills) | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MTU | | | ADT | | | | CBT | |
| | | | | | 58DT | 95DT | | 30DT | 50DT | 80DT | 100DT | 40DT | |
| 1 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 375 | 22.0c | 17.0b | 19.5c | 6.3ab | 7.3c | 7.7a | 6.3a | 4.3a | **6.4a** |
| 2 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 400 | 20.3c | 20.3b | 20.3c | 6.3ab | 6.0b | 7.3a | 5.3a | 4.0a | **5.8a** |
| 3 | DPX-RAB 55 | DPX-RAB 55 | 106 SC | 237.5 ml | 8.0a | 1.0a | 4.5a | 8.3ab | 7.3c | 6.7a | 4.7a | 4.0a | **6.2a** |
| 4 | Fame | Flubendiamide 480 SC (g/L) | 48% SC(w/v) | 50 ml | 15.3b | 13.7ab | 14.5b | 4.7a | 6.3c | 7.0a | 5.0a | 4.3a | **5.5a** |
| 5 | Coragen | Rynaxypyr | 20 SC | 150 ml | 21.0c | 23.7b | 22.3a | 5.3a | 4.3a | 7.7a | 5.7a | 6.3a | **5.9a** |
| 6 | Sulfoxaflor | Sulfoxaflor | 24% SC | 90 ml | 19.3c | 7.3a | 13.3b | 6.3ab | 5.3a | 8.7a | 5.3a | 3.3a | **5.8a** |
| 7 | Osheen | Dinotefuran | 20 SG | 200 g | 14.7b | 9.7a | 12.2b | 5.3a | 6.3b | 6.0a | 4.3a | 3.7a | **5.1a** |
| 8 | Untreated Control | Water | - | - | 27.7d | 57.3c | 42.5d | 11.0b | 13.0d | 10.0a | 10.0b | 7.7a | **10.3b** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.75 (Contd…) Insect pest incidence in different treatments, IET, *Rabi* 2016-17**

| Sl.No | Trade Name | Common Name | % a.i. formu-lation | Dose of formu-lation or product/ha | Whorl Maggot (% Damaged Leaves) | | | Mean |
|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | | PTB | |
| | | | | | 30DT | 50DT | 25DT | |
| 1 | Spinetoram 6% w/v (5.66% w/w) + Methoxy-fenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 375 | 7.9a | 3.6a | 5.5a | **5.7** |
| 2 | Spinetoram 6% w/v (5.66% w/w) + Methoxy-fenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 400 | 8.7ab | 5.5c | 12.4a | **8.9** |
| 3 | DPX-RAB 55 | DPX-RAB 55 | 106 SC | 237.5 ml | 11.4b | 9.4d | 15.0a | **11.9** |
| 4 | Fame | Flubendiamide 480 SC (g/L) | 48% SC(w/v) | 50 ml | 8.9b | 3.2a | 15.0a | **9.0** |
| 5 | Coragen | Rynaxypyr | 20 SC | 150 ml | 6.3a | 3.2a | 13.9a | **7.8** |
| 6 | Sulfoxaflor | Sulfoxaflor | 24% SC | 90 ml | 8.0a | 4.2b | 17.6a | **9.9** |
| 7 | Osheen | Dinotefuran | 20 SG | 200 g | 6.5a | 5.2c | 13.4a | **8.4** |
| 8 | Untreated Control | Water | - | - | 10.7b | 12.8e | 14.2a | **12.6** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.75 (Contd…) Incidence of natural enemies in different treatments, IET, *Rabi* 2016-17**

| Sl. No | Trade Name | Common Name | % a.i. formulation | Dose of formu-lation or product/ha | Spiders | | | | | Mean | Mirid Bugs | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CBT | MTU | | PTB | | | MTU | | |
| | | | | | 40DT | 58DT | 95DT | 30DT | 75DT | | 58DT | 95DT | |
| 1 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 375 | 2.3a | 11.0ab | 12.0a | 5.7a | 6.0a | 7.4a | 12.7a | 38.0ab | **25.3b** |
| 2 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 400 | 2.7a | 13.0ab | 9.0ab | 5.3a | 6.3a | 7.3a | 16.0a | 36.7ab | **26.3b** |
| 3 | DPX-RAB 55 | DPX-RAB 55 | 106 SC | 237.5 ml | 3.7a | 6.3b | 4.0b | 5.7a | 8.3a | 5.6a | 0.7c | 2.3c | **1.5d** |
| 4 | Fame | Flubendiamide 480 SC (g/L) | 48% SC(w/v) | 50 ml | 3.3a | 10.7b | 9.3a | 5.0a | 8.0a | 7.3a | 9.0a | 24.3b | **16.7c** |
| 5 | Coragen | Rynaxypyr | 20 SC | 150 ml | 3.0a | 14.3a | 12.3a | 5.7a | 9.0a | 8.9a | 14.0a | 34.3b | **24.2b** |
| 6 | Sulfoxaflor | Sulfoxaflor | 24% SC | 90 ml | 3.7a | 12.3a | 9.0ab | 5.3a | 7.3a | 7.5a | 8.0b | 17.7b | **12.8c** |
| 7 | Osheen | Dinotefuran | 20 SG | 200 g | 2.7a | 7.0b | 6.7b | 5.3a | 5.3a | 5.4a | 4.3b | 20.0b | **12.2c** |
| 8 | Untreated Control | Water | - | - | 7.3a | 10.7b | 15.3a | 5.7a | 7.7a | 9.3a | 9.7b | 73.3a | **41.5a** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.76 (Contd…) Grain Yield in different treatments, IET, *Rabi* 2016-17**

| Sl. No | Trade Name | Common Name | % a.i. formulation | Dose of formu-lation or product/ha | Yield (Kg/ha) | | | | | | | | | %IOC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | CBT | CHN | CHP | KBP | MTU | PTB | RGL | Mean | |
| 1 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 375 | 5000c | 4207a | 5194b | 4563a | 4600a | 2250c | 4990a | 4375 | **4397b** | **9.5** |
| 2 | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | Spinetoram 6% w/v (5.66% w/w) + Methoxyfenozide 30% w/v (28.3% w/w) SC | 36 SC | 400 | 5000c | 4428a | 5667a | 4700a | 5800a | 3597b | 4782a | 4775a | **4844a** | **17.9** |
| 3 | DPX-RAB 55 | DPX-RAB 55 | 106 SC | 237.5 ml | 4881c | 4567a | 4681d | 4250b | 5483a | 5723a | 4799a | 4204a | **4823a** | **17.5** |
| 4 | Fame | Flubendiamide 480 SC (g/L) | 48%SC (w/v) | 50 ml | 5111b | 4182a | 4903c | 4328b | 5150a | 4139b | 4799a | 4692a | **4663ab** | **14.7** |
| 5 | Coragen | Rynaxypyr | 20 SC | 150 ml | 5583a | 4367a | 5250b | 4642a | 4800a | 3818b | 5301a | 4718a | **4810a** | **17.3** |
| 6 | Sulfoxaflor | Sulfoxaflor | 24% SC | 90 ml | 4458d | 4037a | 4514e | 4289b | 4783a | 3939b | 4868a | 4848a | **4467b** | **10.9** |
| 7 | Osheen | Dinotefuran | 20 SG | 200 g | 4986c | 4045a | 4361e | 3819c | 4492a | 4381b | 5076a | 4074a | **4404b** | **9.7** |
| 8 | Untreated Control | Water | - | - | 4264d | 3872a | 3861f | 2938d | 4275a | 3892b | 4816a | 3913a | **3979c** | |

**Means in a column followed by different letters are significantly different at P=0.05**

## ii) Botanical Insecticide Evaluation Trial (BIET)

| Sl. No. | Location | Date of sowing | Date of planting | Date of harvesting | No of applications | Times of application (DAT) |
|---|---|---|---|---|---|---|
| 1 | Aduthurai | 23-09-2016 | 15-10-2016 | 07-02-2017 | 3 | 30,50 & 70 |
| 2 | Chinsurah | 16-12-2016 | 10-02-2017 | 15-05-2017 | 3 | 15,30 & 50 |
| 3 | Coimbatore | 23-02-2017 | 24-03-2017 | 21-06-2017 | 3 | 17,33 & 65 |
| 4 | Chiplima | 28-12-2016 | 04-02-2017 | 02-06-2017 | 4 | 20,40,50 & 60 |
| 5 | Puducherry | 28-12-2016 | 02-02-2017 | 29-05-2017 | 2 | 20 &38 |

**Results**

**Pest Infestation (Table2.77)**

**Stem borer** incidence was observed in five locations, of which Chinsura reported high dead hearts damage (18.5-20.3%) followed by Coimbatore (7.3-12.9%). There was significant difference in damage among the treatments at four centres. Mean dead heart damage in neem formulations ranged between 5.5-6.7% as compared to10.3% in control. Rynaypyr was the most effective treatment against stem borer with 3.4% dead heart damage.

Highest white ear damage was reported from Chinsura (17.3%) followed by Aduthurai with15.5% in untreated control. All botanicals significantly reduced white ear damage (7.8-9.0%) when compared to 15.0% in control. Rynaypyr was the most effective treatment against stem borer with 4.8% mean white ear damage. Among botanicals, multineem and nimbecidine were found effective.

**Brown planthopper** occurrence was observed at only 3 locations. There was no significant difference in the efficacy against BPH among treatments. Dinotefuran was the most effective treatment with mean number of 3.7 /10 hills as compared to 6.5 in control. All botanical formulations showed similar efficacy against the BPH with mean numbers ranging from 5.0 to 6.1/10 hills.

**Green leafhopper** incidence was reported from 2 locations. There was no significant difference among treatments at Coimbatore centre. Among botanicals, multineem was found effective against the hoppers with mean number of 5.9/10 hills when compared to 8.3 in control.

**Leaf folder** damage was reported from 4 locations and highest leaf damage was noticed in Chinsura (8.5-9.0%) in untreated plots during 30-50 days after planting. There were significant differences in leaf damage among the treatments at 4 locations. Rynaxypyr was the most effective treatment showing mean leaf damage of 1.7%. Among the botanials, neemazal recorded lowest infestation (2.8 % damage) in comparison to 5.4% in control.

**Whorl maggot** damage was recorded in 2 locations i.e., Aduthurai and Chinsura. Lowest mean damage of 3.1% was noticed in Rynaxypyr treatment followed by dinotefuran when compared to control. Among the botanicals, neemazal was the most effective treatment with 5.1% damage.

**Grain Yield (Table 2.78)**

There were significant differences in grain yield among the treatments including control at 4 locations out of total 5 locations. Based on mean yield of these locations, rynaxypyr recorded the highest grain yield of 4487.2kg/ha with 44.8% increase over control (IOC) followed by dinotefuran with 4327.8kg/ha (39.6%IOC). Among the botanicals, neemazal treatment recorded highest yield of 3892.8 kg/ha (25.6% IOC). All the treatments gave significantly higher yield than Control (3099.4 kg/ha).

***Summary***

*Botanical insecticides trial was carried out at 5 locations to evaluate the efficacy of four commercial formulatios and neemoil along with recommended insecticides, dinotefuran and rynaxypyr against major insect pests of rice and consequent impact on natural enemies and grain yield during Rabi, 2016. Based on the performance of the treatments in reducing the pest incidence at various locations, the insecticide –rynaxypyr and the botanicals-Neemazal and Multineem were found effective against stem borer damage. Multineem was found effective against plant hoppers. Regarding the efficacy of treatments against leaf folder and whorl maggot all botanical formulations were found effective and their efficacy was superior to control. Highest grain yield of 4487.2kg/ha was recorded in rynaxypyr and among botanicals Neemazal gave highest yield (3892.8 kg/ha).*

**Table. 2.77 Insect pest incidence in different treatments, BIET, *Rabi* 2016-17**

| Sl. No. | Common Name | Trade Name | Formulation | Rate g or ml of form/ha | Stem Borer Damage (%Dead Hearts ) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | | CBT | | | CHN | |
| | | | | | 30DT | 50DT | 30DT | 40DT | 65DT | 30DT | 50DT |
| 1 | Azadirachtin | Neem Baan | 1.0% EC | 1000 | 3.8bc | 4.9b | 6.0a | 7.9a | 6.1a | 14.4b | 12.6b |
| 2 | Azadirachtin | Neemazal | 1.0% EC | 1000 | 5.0ab | 4.3bc | 7.3a | 4.1a | 3.3a | 9.4c | 7.9c |
| 3 | Azadirachtin | Nimbecidine | 0.03 % EC | 2500 | 3.7bc | 4.1d | 4.1a | 4.0a | 3.0a | 14.8b | 12.9b |
| 4 | Azadirachtin | Multineem | 0.03 % EC | 2500 | 3.6bc | 2.6cd | 5.8a | 6.9a | 5.1a | 17.0ab | 14.4ab |
| 5 | Azadirachtin | Neem oil | | 2500 | 3.3bc | 3.0cd | 6.6a | 7.8a | 4.4a | 18.1ab | 16.0ab |
| 6 | Dinotefuran | Osheen | 20SG | 200 | 2.5c | 3.2cd | 6.2a | 7.2a | 6.2a | 7.7cd | 7.6c |
| 8 | Rynaxypyr | Coragen | 20% SC | 150 | 3.2bc | 3.6bcd | 2.0a | 4.3a | 1.4a | 5.1d | 3.8d |
| 9 | Untreated Control | | | | 7.1a | 7.9a | 7.3a | 12.9a | 8.8a | 20.3a | 18.5a |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.77 (Contd…) Insect pest incidence in different treatments, BIET, *Rabi* 2016-17**

| Sl. No. | Common Name | Trade Name | Formulation | Rate g or ml of form/ha | Stem Borer Damage (%Dead Hearts ) | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | CHP | | KBP | | |
| | | | | | 30DT | 50DT | 30DT | 50DT | |
| 1 | Azadirachtin | Neem Baan | 1.0% EC | 1000 | 3.8bc | 4.9b | 3.8bc | 4.9b | **6.7** |
| 2 | Azadirachtin | Neemazal | 1.0% EC | 1000 | 5.0ab | 4.3bc | 5.0ab | 4.3bc | **5.5** |
| 3 | Azadirachtin | Nimbecidine | 0.03 % EC | 2500 | 3.7bc | 4.1bc | 3.7bc | 4.1d | **5.7** |
| 4 | Azadirachtin | Multineem | 0.03 % EC | 2500 | 3.6bc | 2.6d | 3.6bc | 2.6dc | **6.2** |
| 5 | Azadirachtin | Neem oil | | 2500 | 3.3bc | 3.0cd | 3.3bc | 3.0cd | **6.5** |
| 6 | Dinotefuran | Osheen | 20SG | 200 | 2.5c | 3.2cd | 2.5c | 3.2cd | **4.7** |
| 8 | Rynaxypyr | Coragen | 20% SC | 150 | 3.2bc | 3.6bcd | 3.2bc | 3.6bcd | **3.4** |
| 9 | Untreated Control | | | | 7.1a | 7.9a | 7.1a | 7.9a | **10.3** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.77 (Contd…) Insect pest incidence in different treatments, BIET, *Rabi* 2016-17**

| Sl. No. | Common Name | Trade Name | Formulation | Rate g or ml of form/ha | Stem Borer Damage (%White Ears) | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Pre-harvest | | | | | |
| | | | | | ADT | CBT | CHN | CHP | KBP | |
| 1 | Azadirachtin | Neem Baan | 1.0% EC | 1000 | 9.7abc | 6.1a | 9.8bc | 9.7abc | 9.7abc | **9.0** |
| 2 | Azadirachtin | Neemazal | 1.0% EC | 1000 | 10.7ab | 5.2a | 7.0cd | 10.7ab | 10.7ab | **8.9** |
| 3 | Azadirachtin | Nimbecidine | 0.03 % EC | 2500 | 8.0bc | 5.5a | 10.2bc | 8.0bc | 8.0bc | **7.9** |
| 4 | Azadirachtin | Multineem | 0.03 % EC | 2500 | 6.8bc | 7.9a | 10.6bc | 6.8bc | 6.8bc | **7.8** |
| 5 | Azadirachtin | Neem oil | | 2500 | 7.9bc | 7.8a | 11.8b | 7.9bc | 7.9bc | **8.7** |
| 6 | Dinotefuran | Osheen | 20SG | 200 | 5.93bc | 7.5a | 6.2d | 5.93bc | 5.9bc | **6.3** |
| 7 | Rynaxypyr | Coragen | 20% SC | 150 | 5.37c | 3.8a | 4.4d | 5.3c | 5.3c | **4.8** |
| 8 | Untreated Control | | | | 15.57a | 11.1a | 17.3a | 15.5a | 15.5a | **15.0** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.77 (Contd…) Insect pest incidence in different treatments, BIET, *Rabi* 2016-17**

| Sl. No. | Common Name | Trade Name | Formulation | Rate g or ml of form/ha | Leaf Folder (% Damage Leaves) | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | CHN | | CHP | KBP | |
| | | | | | 80DT | 30DT | 50DT | 80DT | 80DT | |
| 1 | Azadirachtin | Neem Baan | 1.0% EC | 1000 | 2.8ab | 6.4b | 4.7b | 2.8ab | 2.8ab | **3.9** |
| 2 | Azadirachtin | Neemazal | 1.0% EC | 1000 | 2.3ab | 4.1c | 3.0c | 2.3ab | 2.3ab | **2.8** |
| 3 | Azadirachtin | Nimbecidine | 0.03 % EC | 2500 | 2.3ab | 7.3ab | 4.9b | 2.3ab | 2.3ab | **3.8** |
| 4 | Azadirachtin | Multineem | 0.03 % EC | 2500 | 2.0b | 6.6b | 5.5b | 2.0b | 2.0b | **3.6** |
| 5 | Azadirachtin | Neem oil | | 2500 | 1.9b | 7.6c | 6.2b | 1.9b | 1.9b | **3.9** |
| 6 | Dinotefuran | Osheen | 20SG | 200 | 1.9b | 3.1ba | 2.2cd | 1.9b | 1.9b | **2.2** |
| 8 | Rynaxypyr | Coragen | 20% SC | 150 | 1.7b | 1.9d | 1.4d | 1.7b | 1.7b | **1.7** |
| 9 | Untreated Control | | | | 3.2a | 9.0a | 8.5a | 3.2a | 3.2a | **5.4** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.77 (Contd…) Insect pest incidence in different treatments, BIET, *Rabi* 2016-17**

| Sl. No. | Common Name | Trade Name | Formu-lation | Rate g or ml of form /ha | Brown Plant Hopper(No./10hills) | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | | | CHP | | KBP | | |
| | | | | | 30DT | 50DT | 80DT | 30DT | 50DT | 30DT | 50DT | |
| 1 | Azadirachtin | Neem Baan | 1.0% EC | 1000 | 4.6a | 6.0ab | 11.3a | 4.5a | 6.0ab | 4.6a | 6.0ab | **6.1** |
| 2 | Azadirachtin | Neemazal | 1.0% EC | 1000 | 5.0a | 6.3ab | 3.3b | 5.0a | 6.3ab | 5.0a | 6.3ab | **5.3** |
| 3 | Azadirachtin | Nimbecidine | 0.03 % EC | 2500 | 4.6a | 4.3ab | 8.0ab | 4.6a | 4.3ab | 4.6a | 4.3ab | **5.0** |
| 4 | Azadirachtin | Multineem | 0.03 % EC | 2500 | 4.6a | 4.3ab | 9.0a | 4.6a | 4.3ab | 4.6a | 4.3ab | **5.1** |
| 5 | Azadirachtin | Neem oil | | 2500 | 5.3a | 5.0ab | 8.0ab | 5.3a | 5.0ab | 5.3a | 5.0ab | **5.6** |
| 6 | Dinotefuran | Osheen | 20SG | 200 | 3.3a | 3b | 7.0ab | 3.3a | 3.0a | 3.3a | 3.0b | **3.7** |
| 8 | Rynaxypyr | Coragen | 20% SC | 150 | 5.3a | 4ab | 8.0a | 5.3a | 4.0ab | 5.3a | 4.0ab | **5.1** |
| 9 | Untreated Control | | | | 4.0a | 7.6a | 11.0a | 4.0a | 7.6a | 4.0a | 7.6a | **6.5** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.77 (Contd…) Insect pest incidence in different treatments, BIET, *Rabi* 2016-17**

| Sl. No. | Common Name | Trade Name | Formulation | Rate g or ml of form/ha | Green Leaf Hopper (No/10 Hills) | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | | | CBT | | |
| | | | | | 30DT | 50DT | 80DT | 30DT | 40DT | |
| 1 | Azadirachtin | Neem Baan | 1.0% EC | 1000 | 8.6a | 7.6b | 11.3a | 4.0a | 3.6a | **7.1** |
| 2 | Azadirachtin | Neemazal | 1.0% EC | 1000 | 8.3a | 7.0b | 9.3ab | 2.0a | 4.3a | **6.2** |
| 3 | Azadirachtin | Nimbecidine | 0.03 % EC | 2500 | 8.0a | 6.3b | 8.0b | 4.6a | 4.6a | **6.3** |
| 4 | Azadirachtin | Multineem | 0.03 % EC | 2500 | 7.0a | 5.6b | 9.0ab | 4.3a | 3.3a | **5.9** |
| 5 | Azadirachtin | Neem oil | | 2500 | 8.6a | 6.0b | 8.0b | 3.3a | 4.0a | **6.0** |
| 6 | Dinotefuran | Osheen | 20SG | 200 | 6.0a | 6.0b | 7.0b | 3.0a | 2.3a | **4.9** |
| 7 | Rynaxypyr | Coragen | 20% SC | 150 | 7.6a | 6.3b | 8.0b | 4.3a | 3.0a | **5.9** |
| 8 | Untreated Control | | | | 9.0a | 10.3a | 11.0a | 4.6a | 6.6a | **8.3** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.77 (Contd…) Insect pest incidence in different treatments, BIET, *Rabi* 2016-17**

| Sl. No. | Common Name | Trade Name | Formulation | Rate g or ml of form/ha | Whorl Maggot (% Damage Leaves) | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | | CHN | | |
| | | | | | 30DT | 50DT | 30DT | 50DT | |
| 1 | Azadirachtin | Neem Baan | 1.0% EC | 1000 | 7.2ab | 5.9bc | 5.8b | 3.6b | **5.6** |
| 2 | Azadirachtin | Neemazal | 1.0% EC | 1000 | 7.3ab | 6.8b | 4.0c | 2.3c | **5.1** |
| 3 | Azadirachtin | Nimbecidine | 0.03 % EC | 2500 | 7.7ab | 6.3bc | 6.9b | 3.7b | **6.2** |
| 4 | Azadirachtin | Multineem | 0.03 % EC | 2500 | 6.3ab | 6.3bc | 7.5b | 4.1b | **6.1** |
| 5 | Azadirachtin | Neem oil | | 2500 | 8.1ab | 6.8b | 7.3b | 4.2b | **6.6** |
| 6 | Dinotefuran | Osheen | 20SG | 200 | 5.9ab | 4.9bc | 2.8cd | 1.9cd | **3.9** |
| 8 | Rynaxypyr | Coragen | 20% SC | 150 | 4.9b | 4.2c | 1.8d | 1.3d | **3.1** |
| 9 | Untreated Control | | | | 9.8a | 12.9a | 10.1a | 7.3a | **10.0** |

**Means in a column followed by different letters are significantly different at P=0.05**

**Table. 2.78 Grain Yield in different treatments, BIET, *Rabi* 2016-17**

| Sl. No. | Common Name | Trade Name | Formulation | Rate g or ml of form/ha | Yield/ha | | | | | | IOC (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ADT | CBT | CHN | CHP | KBP | Mean | |
| 1 | Azadirachtin | Neem Baan | 1.0% EC | 1000 | 4166.6bc | 3544.4a | 3555.5c | 2972.2bc | 3777.7bc | **3603.3** | **16.3** |
| 2 | Azadirachtin | Neemazal | 1.0% EC | 1000 | 4625.0bc | 3630.5a | 4430.5b | 3083.3bc | 3694.4bc | **3892.8** | **25.6** |
| 3 | Azadirachtin | Nimbecidine | 0.03 % EC | 2500 | 4486.1bc | 3416.6a | 3722.2c | 2944.4bc | 4319.4bc | **3777.8** | **21.9** |
| 4 | Azadirachtin | Multineem | 0.03 % EC | 2500 | 5083.3abc | 3251.3a | 3500.0cd | 3194.4abc | 4305.5abc | **3866.9** | **24.8** |
| 5 | Azadirachtin | Neem oil | | 2500 | 4986.1abc | 3531.9a | 3361.1cd | 2916.6abc | 3736.1abc | **3706.4** | **19.6** |
| 6 | Dinotefuran | Osheen | 20% SG | 200 | 5513.8ab | 3486.1a | 4944.4a | 3291.6ab | 4402.7ab | **4327.8** | **39.6** |
| 7 | Rynaxypyr | Coragen | 20% SC | 150 | 6263.8a | 3658.3a | 5277.7a | 3444.4a | 3791.6a | **4487.2** | **44.8** |
| 8 | Untreated Control | | | | 3680.5c | 3136.1a | 3027.7d | 2152.7c | 3500.0c | **3099.4** | |

**Means in a column followed by different letters are significantly different at P=0.05**

## 2.3 BIOCONTROL AND BIODIVERSITY STUDIES

### i) Monitoring of Pests and Natural Enemies (MPNE)

The data were received from seven locations *viz.*, Aduthurai, Chinsurah, Coimbatore, Maruteru, Moncompu Pattambi and Rajendranagar.

**1. Stem borer:**

The stem borer species composition and the egg parasitoids observed were reported from 6 centres. Four species of stem borer were observed *viz.*, yellow stemborer (YSB), *Scirpophaga incertulas*, pink stemborer (PSB), *Sesamia inferens,* White stem borer (*WSB) Scirpophaga fusciflua* and the dark headed borer (DHB) *Chilo polychrysus*.

**Species composition**

YSB was the dominant species in five locations *except Pattambi,* accounting for 54.24 -100 per cent of the stem borer population **(Fig.2.13)**. Of these centres, only YSB was reported from two centres - Chinsurah and Rajendranagar. Three stem borer species were observed over in all other locations. PSB was observed as a second species in four locations accounting for 5.00 – 26.00 per cent in Aduthurai, Coimbatore, Moncompu and Pattambi. WSB was the dominant species at Pattambi (40.51%) while in Moncompu, it was reported to the extent of 4.39%.

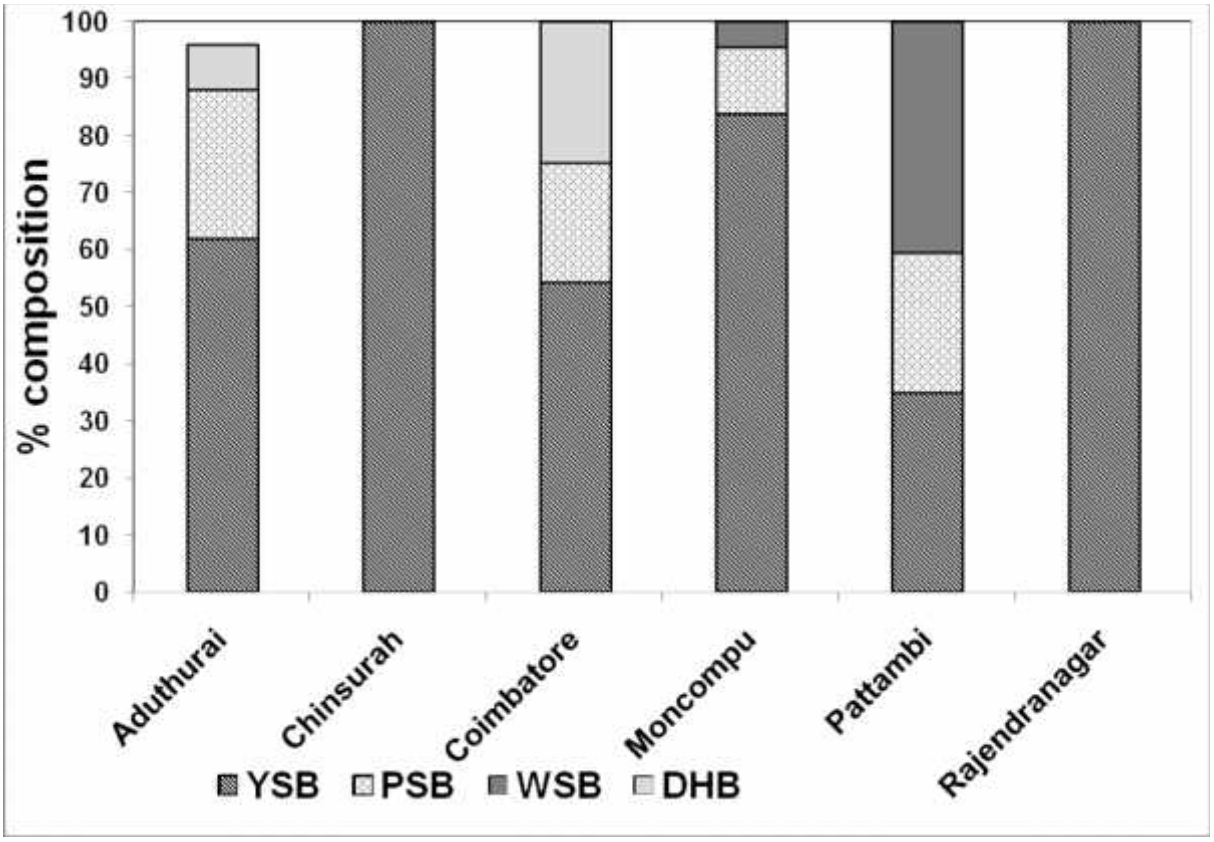



**Fig. 2.13** Stem borer species composition at various centres, MPNE, *rabi* 2017

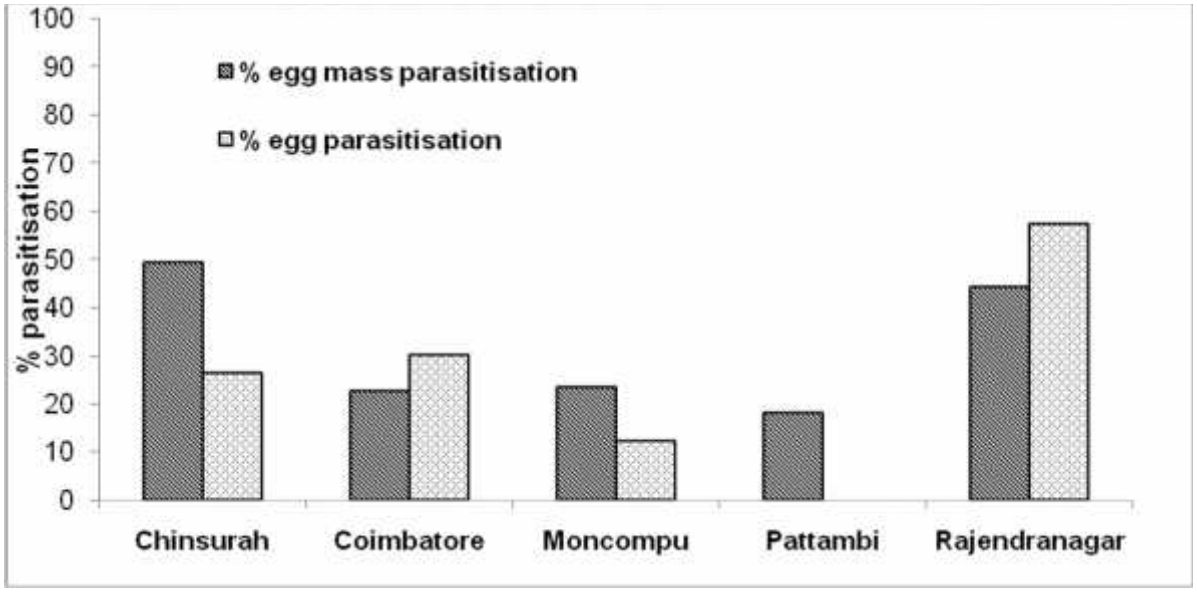



**Fig.2.14** Parasitisation of stem borer eggs at various centres, MPNE, *Rabi* 2017

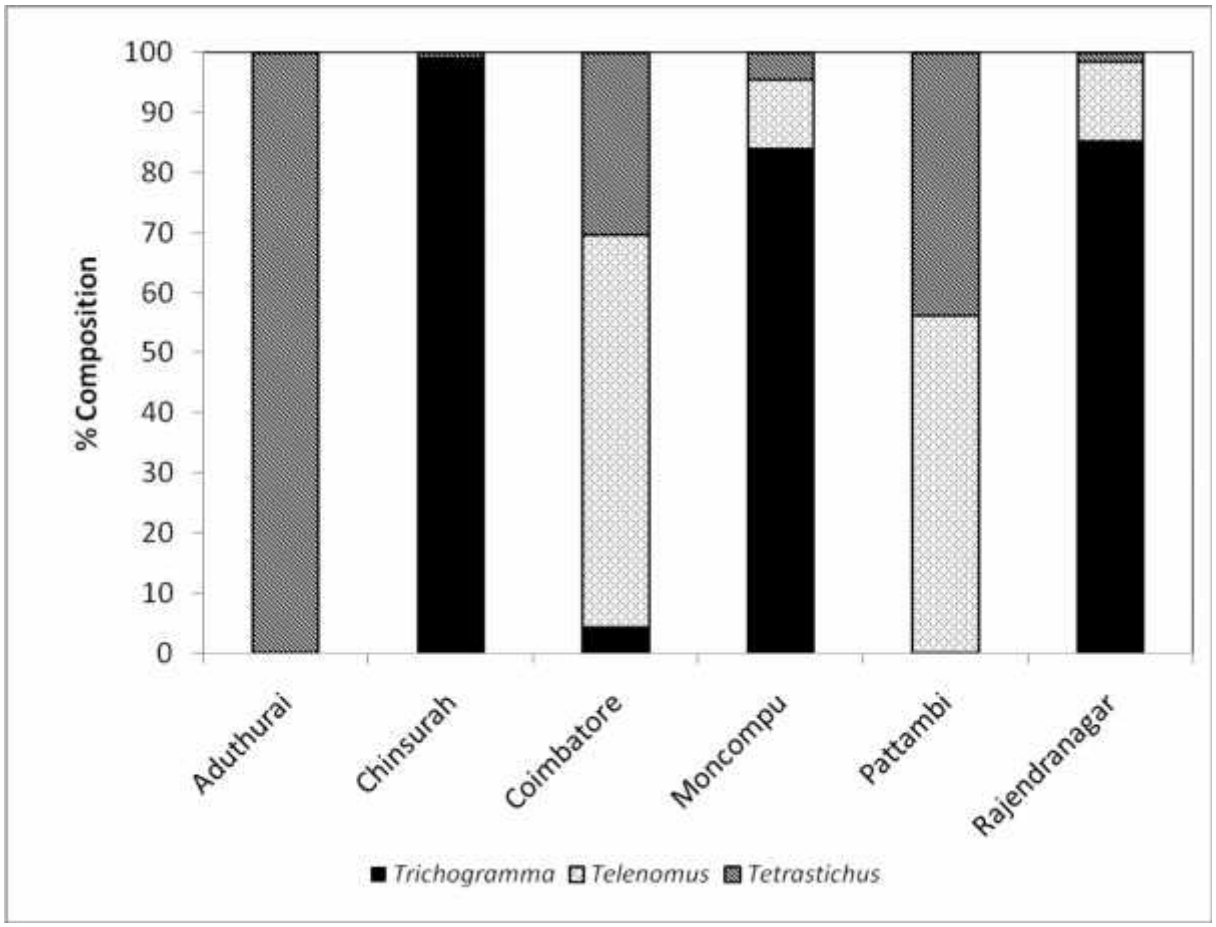



**Fig.2.15** Relative composition of stem borer parasitoids at different locations, MPNE, *Rabi* 2017

*Egg parasitoids of stem borer:* The egg mass parasitisation ranged from 15.00-49.44% while the egg parasitisation varied from 12.23 to 100.00 % at various locations **(Fig.2.14)**. The mean egg mass parasitisation was 28.89 while mean egg parasitisation was 45.29 across all locations. The egg mass parasitisation

was the lowest at Aduthurai (15.00 %) and highest at Chinsurah (49.44%). The mean egg parasitisation was highest at Aduthurai (100.00%) where *Tetrastichus* was the only egg parasitoid observed. The lowest egg parsitisation was observed at Moncompu (12.23%) where *Trichogramma* was the dominant parasitoid. Three species of parasitoids were recorded across three locations (Fig ). *Trichogramma* species was dominant at Chinsurah, Moncompu and Rajendranagar **(Fig.2.15)**, while only *Tetrastichus* sp. was observed at Aduthurai. *Telenomus* sp. was the dominant parasitoid at Coimbatore and Pattambi, accounting for 56.25 to 65.42 % of parasitoids observed. The average composition of the three parasitoids across locations was *Tetrastichus* (30.13 %), *Telenomus* (23.43%) and *Trichogramma* (45.45 %).

**2. Hoppers**

Information on the hoppers species composition was received from Aduthurai, Coimbatore and Maruteru. Only BPH was recorded at Aduthurai at low level of 9.3/10 hills. Spiders and coccinellids were also observed at the same level of 9.1-9.4 per ten hills. At Coimbatore, BPH and GLH were observed in low levels at an average of 2.5 and 6.6 per 10 hills. The predators observed were green mirids (3.45/10hills), spiders (6.53/10hills) and coccinellids (10.9/10 hills). At Maruteru, BPH and WBPH were observed with a mean of 21.71 and 1.51 per 10 hills, respectively over seven dates of observation. The predators observed were green mirids (3.45/10hills), coccinellids (1.57/10 hills) and spiders (5.43/10hills).

**3. Gall midge**

Data on gall midge during *rabi* were received only from Moncompu. 123 galls were observed from hundred hills of which 15.40 % were parasitized. The only parasitoid observed was *Platygaster oryzae*.

*Monitoring of pest species and natural enemies (MPNE) trial was carried out at 7 locations. The stem borer species observed were YSB, PSB, DHB and WSB. Three egg parasitoids of stem borer were observed with Trichogramma japonicum being dominant at Chinsurah, Moncompu and Rajendranagar while Tetrastichus schoenobii was dominant at Aduthurai and Telenomus species dominant at Coimbatore and Pattambi.*

**ii) Ecological Engineering for Planthopper Management (EEPM)**

This trial was carried out at Maruteru and Moncompu during Rabi 2017. The EE interventions tested at Maruteru were alleyways, organic manuring and planting of bund flora. The observations on hoppers and their natural enemies were taken 7 times starting from 20 DAT at10 days interval. The overall analysis of pooled data showed BPH population on par in EE treatment and farmers practices **(Table 2.79)**. However, the population of green mirids was significantly higher in EE plots (29.1/ 10 hills). The per plot yield recorded was higher in EE plots though statistically it was not significant.. The projected yield in EE plots (6105 kg/ha) was significantly more than that of FP plots (5748 kg/ha).

**Table.2.79** Effect of ecological engineering on hoppers and its natural enemies at Maruteru, EEPM, *rabi 2017*

| Parameters | BPH (No./ hill) | | Green mirids (No./ hill) | | Spiders (No./ hill) | | Yield (Kg/ha) | |
|---|---|---|---|---|---|---|---|---|
| | EE | FP | EE | FP | EE | FP | EE | FP |
| Mean | 5.31 | 6.99 | 2.91 | 1.91 | 0.64 | 0.67 | 6105 | 5748 |
| t value | 1.47 NS | | 2.03* | | 0.44NS | | | |
| df | 398 | | 398 | | 398 | | | |
| P - value | 0.14 | | 0.04 | | 0.66 | | | |

**projected yield*

**Table 2.80** Effect of ecological engineering on hoppers and its natural enemies at Moncompu, EEPM, *rabi 2017*

| Parameters | BPH (No./10 hills) | | Green mirids (No./ 10 hills) | | Spiders (No./ 10 hills) | | Coccinellids (No./ 10 hills) | | Drynid (No./ 10 hills) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EE | FP | EE | FP | EE | FP | EE | FP | EE | FP |
| Mean | 14.50 | 17.20 | 8.00 | 5.07 | 8.53 | 5.47 | 3.80 | 2.67 | 3.13 | 1.87 |
| t value | 1.57 NS | | 2.93** | | 2.70** | | 1.40NS | | 2.19* | |
| df | 398 | | 398 | | 398 | | 398 | | 398 | |
| P - value | 0.11 | | 0.01 | | 0.01 | | 0.16 | | 0.03 | |

At Moncompu, Marigold was tested as bund flora. The observations on hoppers and their natural enemies were taken 4 times starting from 15 DAT. The overall analysis of pooled data showed BPH population on par in EE treatment and farmers practices **(Table2.80)**. However, the populations of predators and parasitoids were significantly higher in EE plots.

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

**iii) Bio-intensive pest management trial (BIPM)**

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

***Chinsurah***

Observations were recorded on the damage by whorl maggot, stem borer and natural enemies like spiders, coccinellids and staphylinids. The per cent leaves damaged by whorl maggot was on par in BIPM and FP plots

**(Table2.81)**. The dead heart damage by stem borer was significantly higher in FP plots (13.06%) compared to that of BIPM plots (9.09%). A similar trend was observed with white ear damage in the reproductive phase with 6.47 % damage recorded in BIPM plots as compared to 10.86% in FP plots.

**Table 2.81** Pest and natural enemy incidence under Bio-intensive pest management trial at Chinsurah, *rabi* 2017

**A. Pest incidence**

| **Parameters** | **WM (% damage)** | | **DH (% damage)** | | **WE (% damage)** | | **Yield** | |
|---|---|---|---|---|---|---|---|---|
| | **BIPM** | **FP** | **BIPM** | **FP** | **BIPM** | **FP** | **BIPM** | **FP** |
| Mean | 1.78 | 1.73 | 9.09 | 13.06 | 6.47 | 10.86 | 5550 | **4485** |
| t value | 0.11NS | | 2.81** | | 1.77* | | 13.80* | |
| df | 118 | | 358 | | 118 | | 10 | |
| P - value | 0.91 | | <0.01 | | 0.05 | | 0.05 | |

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

**B. Predators**

| **Parameters** | **Coccinellid (No./10 hills)** | | **Spiders (No./10 hills)** | | **Staphylinid (No./10 hills)** | |
|---|---|---|---|---|---|---|
| | **BIPM** | **FP** | **BIPM** | **FP** | **BIPM** | **FP** |
| Mean | 2.50 | 1.53 | 2.67 | 0.85 | 1.50 | 0.50 |
| t value | 1.07NS | | 2.18* | | 1.81* | |
| df | 118 | | 118 | | 118 | |
| P - value | 0.29 | | 0.03 | | 0.05 | |

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

*Bio intensive pest management trial was taken up at Chinsurah during Rabi 2017. The pest incidence was reduced and natural enemy population higher in BIPM plots. Subsequently the lower pest incidence also reflected in higher yields in BIPM plots.*

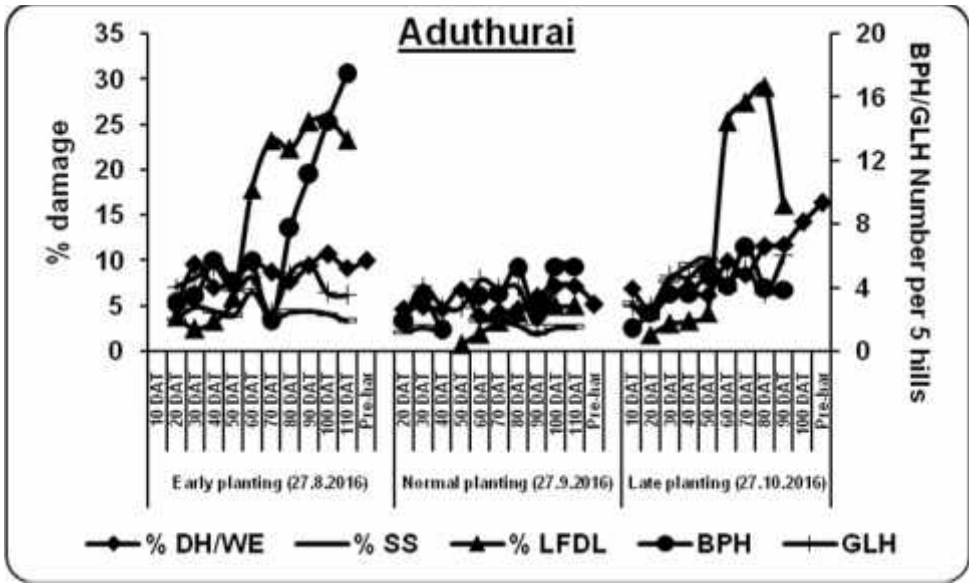
## ECOLOGICAL STUDIES

Under ecological studies, the trial on Effect of planting dates on insect pest incidence was carried out during *Rabi* 2016-17, results of which are presented below:

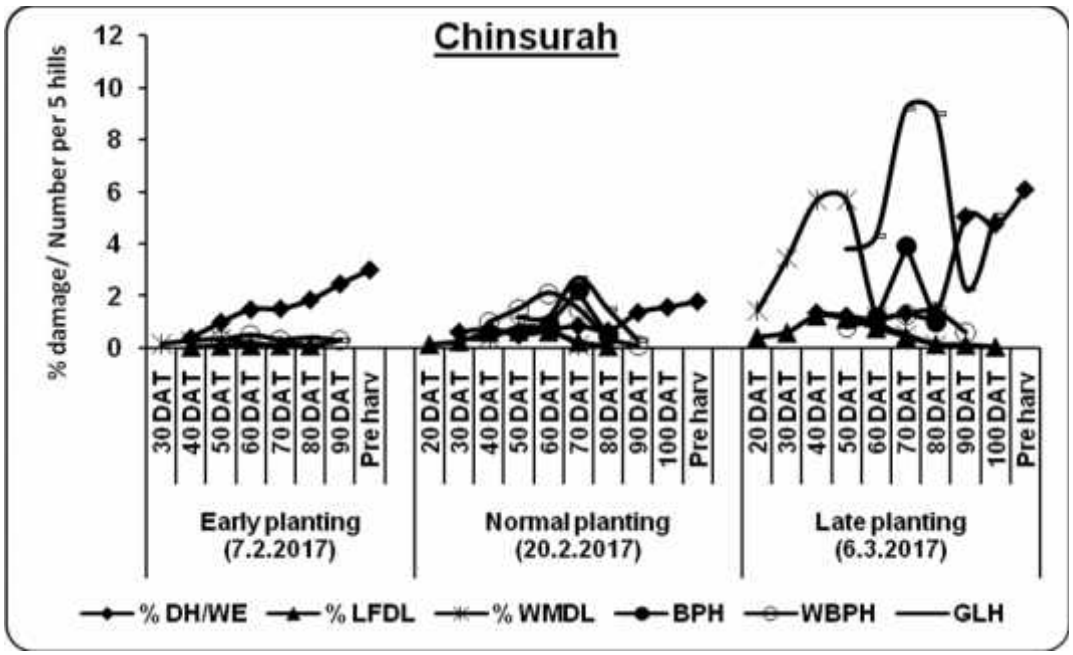
### Effect of Planting Dates on Insect Pest Incidence (EPDP)

The trial was conducted at two locations, *i.e.,* Aduthurai during samba season and Chinsurah during boro season.

At **Aduthurai**, incidence of stem borer, gall midge, leaf folder, whorl maggot, hispa, BPH and GLH was observed in CR 1009 variety grown in all the three plantings. Stem borer damage crossed ETL only in late planting from 80 DAT onwards (11.44 – 16.27%) and maximum white ears of 16.27% were observed. Gall midge incidence varied from 1.83 to 10.11% with maximum damage in late planting at 50 DAT. Leaf folder damage was high in early and late plantings and crossed ETL from 60 DAT onwards till harvest in early planting (17.81-25.59%) and late planting (16.08-29.1%). Low incidence of whorl maggot (<5%), hispa (<10%), BPH and GLH (<5/hill) was reported in all the three plantings. Grain yield ranged between 44.4 and 75.2 q/ ha.




At **Chinsurah**, very low incidence of stem borer (<6%), leaf folder and whorl maggot (<5%), BPH, WBPH and GLH (<5/hill) was observed in all the three plantings. Grain yield ranged between 41.80 and 51.40 q/ ha.




*Effect of planting dates on insect pest incidence (EPDP) trial was conducted at two locations, i.e., at Aduthurai during samba season and at Chinsurah during boro season of 2016-17. At Aduthurai, incidence of stem borer (11.44 -16.27%) and gall midge (10.11%) was high in late planting while the incidence of leaf folder was high in early (17.81-25.59%) and late plantings (16.08-29.1%). At Chinsurah, very low incidence of stem borer, leaf folder, whorl maggot and hispa (<5%), BPH, WBPH and GLH (<5/hill) was observed in all the three plantings.*

## *ii)* INTEGRATED PEST MANAGEMENT STUDIES

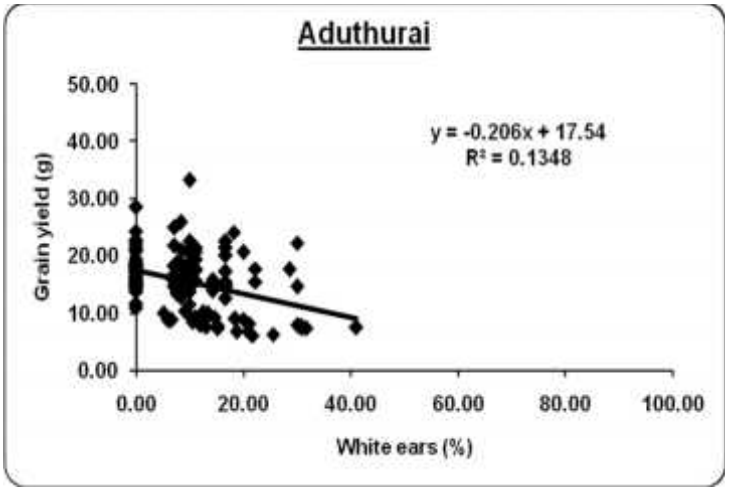
This section consists of two trials *viz.*, i) Yield Loss Estimation Trial (YLET) and ii) Integrated Pest Management special trial (IPMs). Details of these trials are given below:

### Yield Loss Estimation Trial (YLET)

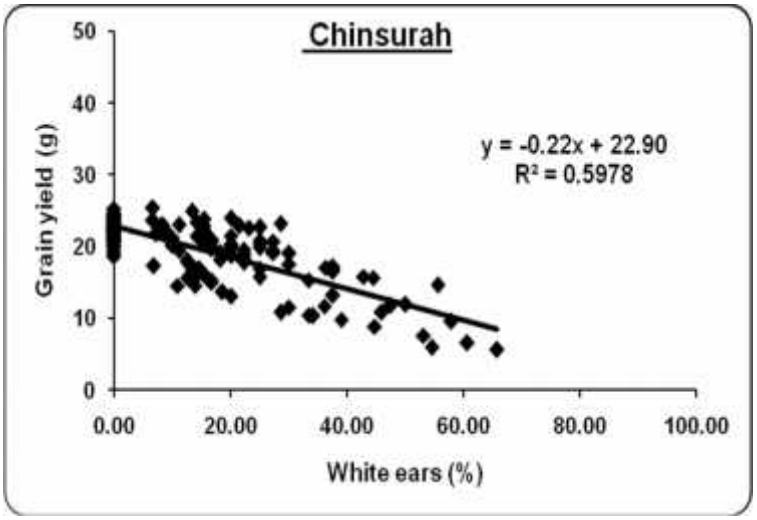
During *Rabi* 2016-17, yield loss estimation trial was conducted at three locations, i.e., Aduthurai, Chinsurah and Pattambi for stem borer and at one location, Aduthurai for leaf folder.

**Target pest: Stem borer**

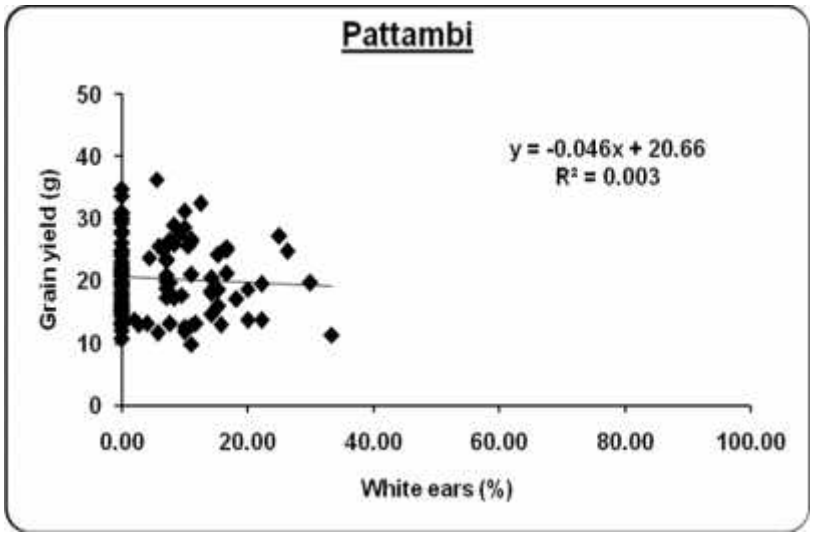
At **Aduthurai**, white ear damage varied from 0 to 41.03% with a grain yield of 6.11 to 33.20 g per hill in ADT 49 variety. Linear regression analysis revealed a negative relationship between per cent white ears and grain yield per hill, but it was not significant ($R^2$ = 0.1348).




At **Chinsurah**, white ear damage of 0 to 65.71% resulted in grain yield of 5.63 to 25.40 g per hill in Khitish (IET 4094) variety. Linear regression analysis revealed a significant negative relationship between white ears and grain yield ($R^2$ = 0.5978) resulting in a decrease of 2.2 g yield per hill for every 10% increase in white ears.

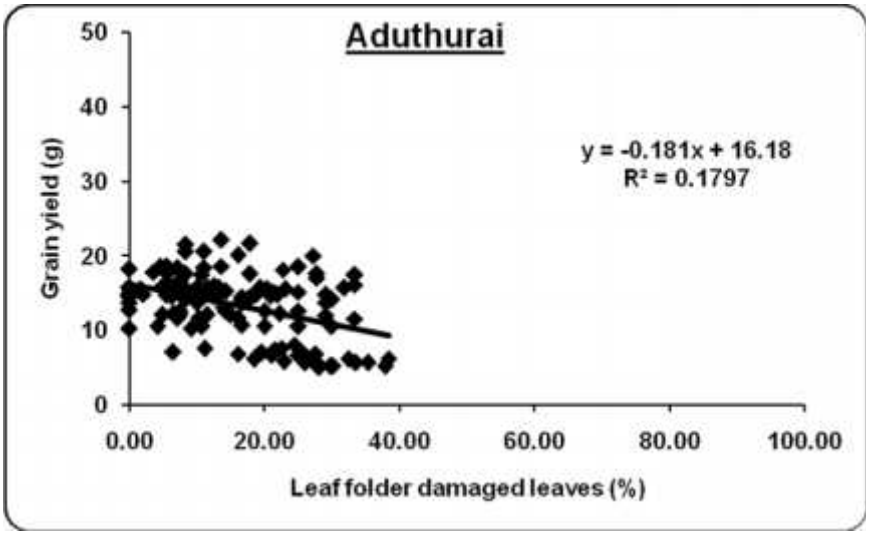


At **Pattambi**, white ear damage ranged from 0 to 33.33% resulting in 9.87 to 36.32 g grain yield per hill. The relationship between white ears and grain yield was negative but not significant.




**Target pest: Leaf folder**

At **Aduthurai**, leaf folder damage ranged between 0 and 38.37% resulting in grain yield of 4.98 to 22.10 g per hill. Linear regression analysis revealed a negative relationship between damaged leaves and grain yield, however it was not significant ($R^2$ = 0.1797).




*Yield loss estimation trial was conducted at three locations viz, Aduthurai, Chinsurah and Pattambi during Rabi 2016-17. Regression analysis revealed a significant negative relationship between white ears and grain yield at Chinsurah ($R^2$ = 0.5978) resulting in 2.2 g reduction in grain yield for every 10% increase in white ears. At Aduthurai and Pattambi, relationship between white ears and grain yield was negative but not significant.*

**Integrated Pest Management special Trial (IPMs)**

IPM special trial was carried out at two locations *viz.*, Aduthurai and Maruteru during *Rabi* 2016-17. Location wise details are discussed below:

**Aduthurai:** The trial was conducted in 6 farmers' fields in 6 villages of Thanjavur district in Tamilnadu state. Particulars of farmers and villages include i) Sri Kanabiran of Ombathuvelli village, ii) Sri Mahalingam of Thirukkarukavur village, iii) Sri RS Kanabiran of Saliamangalam village, iv) Sri Shanmugam of Kalanchery village, v) Sri Vaduganathan of Irumbuthalai village and vi) Sri Thiyagarajan of Poondi village.

**Practices followed in IPMs trial at Aduthurai, *Rabi 2016*-17**

| Practices adopted | IPM block | Farmers practices |
|---|---|---|
| Variety | BPT 5204 | BPT 5204 |
| Nursery | • Seed treatment with Pseudomonas @ 10 g/ kg seed | |
| Main field | • NPK @ 100-75-50 kg/ha<br>• Soil application of Pseudomonas @ 2.5 kg/ ha<br>• Bund cropping with cowpea<br>• Monitoring YSB with pheromone traps @ 12/ ha<br>• Application of Azadirachtin 10000 ppm @ 500 ml/ ha<br>• Release of egg parasitoids, Trichogramma sp @ 5 cc/ ha<br>• Erection of bird perches | • NPK @ 100-100-70 kg/ha<br>• Application of 3 rounds of insecticides viz., Rynaxypyr 0.4 G @ 12.5 kg/ ha, profenophos 50 EC @ 1000ml/ ha and copper hydroxide @ 1000g/ ha.<br>• Cartap hydrochloride 4 G applied at 50 DAT<br>• Zinc sulphate applied twice i.e as basal and foliar spray |

Incidence of stem borer, gall midge, leaf folder, whorl maggot, hispa, BPH and GLH was observed in all the farmers' fields in both IPM and FP plots. Incidence of stem borer crossed ETL in Sri Thiyagarajan's field in both IPM (10.4% DH) and FP plots (11.4% DH) at 22 DAT as compared to all other locations **(Table 2.82)**. However at 71 DAT, stem borer damage crossed ETL in FP blocks of Sri Mahalingam of Thirukkarukavur village (11.2%), Sri Vaduganathan of Irumbuthalai village (12.5%) and Sri Thiyagarajan of Poondi village (12.9%). Gall midge damage was low to moderate in farmer practices blocks and crossed ETL in Sri Kanabiran of Ombathuvelli village (10.8% SS), Sri Shanmugam of Kalanchery village (11.5% SS) and Sri Thiyagarajan of Poondi village (12.3% SS). Leaf folder damage was significantly high in farmer practices plot (35.0% LFDL) as compared to IPM block (18.3% LFDL) of Sri Kanabiran of Ombathuvelli village. Incidence of whorl maggot, hispa, BPH and GLH was low in both the treatments in all the locations. Grain yield was significantly high in IPM plots as compared to FP plots across villages resulting in relatively high BC ratio ranging from 3.17 to 3.77 as against FP blocks (2.47-3.01) **(Table 2.83)**

**Table 2.82 Pest incidence and grain yield in IPMs trial at Aduthurai, *Rabi* 2016-17**

| Treatments/ Villages | | % DH | % DH | % SS | % LFDL | Yield |
|---|---|---|---|---|---|---|
| | | 22 DAT | 71 DAT | 57 DAT | 57 DAT | kg/ ha |
| IPM | | 6.4(2.5)b | 4.0(2.1)b | 5.0(2.3)b | 4.5(1.9)b | 5629a |
| FP | | 9.1(3.1)a | 8.4(2.9)a | 8.5(2.8)a | 7.8(2.4)a | 5041b |
| **LSD (0.05)** | | **0.20** | **0.16** | **0.12** | **0.10** | **35** |
| V1 -Ombathuveli | | 8.4(2.9)b | 4.7(2.3)b | 8.0(2.9)b | 26.6(5.1)a | 5888a |
| V2 - Thirukarukavur | | 8.4(2.9)b | 8.4(2.9)a | 7.8(2.9)b | 2.0(1.6)bc | 5276c |
| V3 - Saliyamangalam | | 7.8(2.9)b | 2.8(1.8)c | 0.9(1.1)d | 2.7(1.8)b | 5484b |
| V4 - Kalancheri | | 4.0(1.8)c | 3.3(1.9)c | 9.6(3.1)a | 1.6(1.4)c | 5200c |
| V5 - Irumbuthalai | | 6.8(2.6)b | 9.0(3.0)a | 6.2(2.6)c | 1.6(1.4)c | 4952d |
| V6 - Poondi | | 10.9(3.4)a | 8.8(2.9)a | 7.9(2.8)bc | 2.1(1.6)c | 5212c |
| **LSD (0.05)** | | **0.39** | **0.33** | **0.28** | **0.21** | **143** |
| V1 -Ombathuveli | IPM | 7.3(2.7)bcd | 3.5(2.0)cde | 5.1(2.4)e | 18.3(4.3)b | 6200a |
| | FP | 9.6(3.1)abc | 6.0(2.5)b | 10.8(3.4)ab | 35.0(5.9)a | 5576bc |
| V2 - Thirukarukavur | IPM | 7.6(2.8)bcd | 5.6(2.5)b | 6.4(2.6)de | 2.1(1.6)def | 5576bc |
| | FP | 9.1(3.1)abc | 11.2(3.4)a | 9.2(3.1)bc | 1.9(1.5)def | 4976f |
| V3 - Saliyamangalam | IPM | 7.1(2.7)cd | 2.7(1.8)ef | 1.8(1.5)g | 2.8(1.8)cd | 5720b |
| | FP | 8.6(3.0)abcd | 2.8(1.8)def | 0.0(0.7)h | 2.6(1.7)cde | 5248e |
| V4 - Kalancheri | IPM | 0.0(0.7)e | 1.7(1.4)f | 7.7(2.8)cd | 1.1(1.3)gh | 5440cd |
| | FP | 7.9(2.9)bcd | 4.8(2.3)bcd | 11.5(3.4)ab | 2.1(1.6)def | 4960f |
| V5 - Irumbuthalai | IPM | 5.8(2.5)d | 5.6(2.4)bc | 5.4(2.4)e | 1.5(1.4)fgh | 5256de |
| | FP | 7.8(2.8)bcd | 12.5(3.6)a | 7.1(2.7)cde | 1.8(1.5)efg | 4648g |
| V6 - Poondi | IPM | 10.4(3.3)ab | 4.7(2.2)bcde | 3.5(1.9)f | 0.9(1.2)h | 5584bc |
| | FP | 11.4(3.4)a | 12.9(3.6)a | 12.3(3.6)a | 3.2(1.9)c | 4840fg |
| **LSD (0.05)** | | **0.55** | **0.47** | **0.39** | | **203** |

**Table 2.83 Returns and BC ratio in IPMs trial at Aduthurai, *Rabi* 2016-17**

| Villages | Treatments | Yield q/ ha | Gross returns (Rs.) | Cost of cultivation (Rs.) | Net returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|
| V1 -Ombathuveli | IPM | 62.00 | 129580 | 34990 | 94590 | 3.70 |
| | FP | 55.76 | 116538 | 39660 | 76878 | 2.94 |
| V2 - Thirukarukavur | IPM | 55.76 | 116538 | 34500 | 82038 | 3.38 |
| | FP | 49.76 | 103998 | 38845 | 65153 | 2.68 |
| V3 - Saliyamangalam | IPM | 57.20 | 119548 | 31725 | 87823 | 3.77 |
| | FP | 52.48 | 109683 | 36415 | 73268 | 3.01 |
| V4 - Kalancheri | IPM | 54.40 | 113696 | 36212.5 | 77484 | 3.14 |
| | FP | 49.60 | 103664 | 38790 | 64874 | 2.67 |
| V5 - Irumbuthalai | IPM | 52.56 | 109850 | 34645 | 75205 | 3.17 |
| | FP | 46.48 | 97143 | 39397.5 | 57746 | 2.47 |
| V6 - Poondi | IPM | 55.84 | 116706 | 34082.5 | 82623 | 3.42 |
| | FP | 48.40 | 101156 | 38172.5 | 62984 | 2.65 |

Price of paddy = Rs. 2090/ q

**Maruteru:** MTU 3626 variety was grown in both IPM and FP blocks. Practices followed in each of these blocks are given below:

**Practices followed in IPMs trial at Maruteru, *Rabi 2016*-17**

| Practices adopted | IPM block | Farmers practices |
|---|---|---|
| Variety | MTU 3626 | MTU 3626 |
| Fertilizers | NPK @ 180-90-60 kg/ha | NPK @ 230-50-60 kg/ha |
| Nursery | • Seed treatment with Carbandezim @ 10g for 10 kg seed (wet seed treatment)<br>• Monocrotophos sprayed once and Carbofuran 3G applied once. NPK applied in the soil. | • Monocrotophos sprayed once and Carbofuran 3G applied.<br>• NPK applied in the soil. |
| Main field | • 200 Kg SSP, 40 Kg MOP, 125 Kg Urea/acre<br>• Weedicide applied (pretilachlor) + one hand weeding<br>• Propiconazole sprayed once against sheath blight<br>• Sprayed Coragen at 20 DAT @ 60 ml/acre<br>• Sprayed Cartap hydrochloride 50 SP @ 600 g /ha<br>• Zinc sulphate applied twice i.e as basal and foliar spray<br>• Pheromone traps installed and *Trichogramma* released | • 135 Kg urea, 40 Kg MOP, 50 Kg DAP/acre. 75 kg 28-28-0/acre<br>• Rifit (Pretilachlor) @ 400 ml/acre and Sathi @ 100 ml/acre<br>• Propiconazole sprayed twice<br>• Monocrotophos @ 1.6 ml/l sprayed<br>• Coragen (Chlorantraniliprole) 4 G applied at 30 DAT<br>• Pymetrozine @ 120 g/acre and coragen @ 60 ml/acre at 70 DAT<br>• Cartap hydrochloride 4 G applied at 50 DAT<br>• Zinc sulphate applied twice i.e as basal and foliar spray |

Gall midge incidence was observed from 20 DAT onwards in both IPM and FP plots and crossed ETL at 50 DAT with maximum damage of 16.02% in IPM plot **(Table 2.84)**. Similarly, BPH population was found high in IPM plot (65 hoppers/5hills) compared to FP plot (50hoppers/5 hills) at 70 DAT and decreased thereafter. Low incidence of stem borer, leaf folder, whorl maggot, hispa and GLH was observed in both IPM and farmer practices blocks. Grain yield was relatively low in FP block resulting in low BC ratio (3.45) due to low returns and high cost of cultivation.

**Table 2.84 Pest incidence, grain yield & BC ratio in IPMs trial at Maruteru, *Rabi* 2016-17**

| Treatments | % DH | % SS | | BPH | | Yield | Gross returns (Rs.) | Cost of cultivation (Rs.) | Net returns (Rs.) | BC ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| | 50 DAT | 50 DAT | 70 DAT | 70 DAT | 80 DAT | kg/ ha | | | | |
| IPM | 0.24 ± 0.24 | 12.52 ± 1.00 | 16.02 ± 2.11 | 65.4 ± 6.5 | 48.0 ± 6.3 | 8580 | 171600 | 42700 | 128900 | 4.02 |
| FP | 2.06 ± 1.24 | 12.01 ± 1.24 | 11.26 ± 0.51 | 49.4 ± 5.8 | 41.8 ± 11.8 | 8350 | 167000 | 48475 | 118525 | 3.45 |

Price of Paddy = Rs 1500/75 kg

*Integrated Pest Management special (IPMs) trial was conducted at two locations, Aduthurai and Maruteru during Rabi 2016-17. Incidence of stem borer (1.7-5.6% DH) and leaf folder (0.9-19.3% LFDL) was low in IPM plots compared to FP plots( 2.8-12.9% DH & 1.8-35.0% LFDL) at Aduthurai in all the six farmers fields in six villages. Gall midge damage was low in IPM plots (1.8-7.7% SS) compared to FP plots (0-12.3% SS) at Aduthurai while the damage was high in IPM plot (12.52-16.02% SS) than FP plot (11.26-12.01% SS) at Maruteru. 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 (3.17 – 3.77) than farmer practice plots (2.47-3.01).*

**APPENDIX-I**

## Scientists involved in coordinated programme

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

Cooperating centres

| Sl. No. | State | Location | Code | Name of the cooperator, Designation |
|---|---|---|---|---|
| 1 | Andhra Pradesh | Bapatla* | BPT | Dr. C. V. Rama Rao, Pr.Scientist(Ento.)& Head |
| 2 | | Maruteru | MTU | Dr. N. Mallikarjuna Rao, Sr. Scientist (Ento.) |
| 3 | | Nellore* | NLR | Dr. P. Rajashekhar, Pr. Scientist(Ento.) |
| 4 | | Ragolu* | RGL | Dr. Visalakshmi, Sr.Scientist (Entomology) |
| 5 | Assam | Titabar | TTB | Dr. Mayuri Baruah, Junior Scientist |
| 6 | Bihar | Pusa | PSA | Dr. A. K. Misra, Professor (Entomology) |
| 7 | Chattisgarh | Jagdalpur | JDP | Dr. A. K.Gupta, Scientist, Entomology |
| 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 | Position vacant |
| 12 | | Navsari | NVS | Dr. P. D. Ghoghari, Assoc. Res. Scientist (Ento.) |
| 13 | Haryana | Kaul | KUL | Dr. Lakhi Ram, Consultant Entomologist |
| 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. Umashankar, Entomologist |
| 18 | | Gangavathi | GNV | Dr. G.S. Guru Prasad, Scientist (Entomology) |
| 19 | | Brahmavar | BRM | Dr. S. U. Patil, Assoc. Professor |
| 20 | Kerala | Moncompu | MNC | Dr. Shanas Sudheer, Asst. Prof. (Entomology) |
| 21 | | Pattambi | PTB | Dr. K. Karthikeyan, Assoc. Prof. of Entomology |
| 22 | M.P | Rewa | REW | Dr. M. R. Dhingra, Sr. Scientist |
| 23 | Maharashtra | Karjat | KJT | Dr. Vinayak Jalgaonkar, Entomologist |
| 24 | | Sakoli | SKL | Dr. B. N.Chaudhari, Jr. Entomologist |
| 25 | Manipur | Iroisemba* | IRS | Dr. K.I.Singh, Assoc. Professor (Entomology) |
| 26 | | Wangbal | WBL | Dr.Kuber Singh, Jr. Entomologist. |
| 27 | Odisha | Cuttack* | CTC | Dr. Mayabini Jena,P.S(Ent.) & Head CPS |
| 28 | | Chiplima$ | CHP | Dr. Atanu Seni, Jr Entomologist |
| 29 | Punjab | Ludhiana | LDN | Dr. P. S. Sarao, Sr. Entomologist |
| 30 | Tamil Nadu | Aduthurai | ADT | Dr. V.G. Mathirajan, Asst. Prof (Agril. Ento.) |
| 31 | | Coimbatore | CBT | Dr. R. P. Soundararajan, Asst. Prof. (Ag. Ento.) |
| 32 | Tripura | Arundhutinagar* | AND | Dr. Dhrubajyoti Pal, Entomologist. |
| 33 | Telangana State | Jagtial* | JGT | Dr. Omprakash, Scientist (Entomology) |
| 34 | | Rajendranagar | RNR | Dr. N. Ramagopala Verma, Sr. Scientist (Ento.) |
| 35 | | Warangal | WGL | Dr. S. Malathi, Sr. Scientist (Entomology) |
| 36 | U. Territory | Karaikal* | KRK | Dr. K. Kumar, Prof. & Head,(Agril. Entomology) |
| 37 | | Kurumbapet@ | KBP | Dr. J Krishna Kumar, Entomologist |
| 38 | Uttaranchal | Pantnagar | PNT | Dr. S. N. Tiwari, Prof. of Entomology |
| 39 | Uttar Pradesh | Masodha | MSD | Dr. Kumud Singh, Entomologist |
| 40 | | Ghaghraghat | GGT | Position vacant |
| 41 | West Bengal | Chinsurah | CHN | Dr. Bijoy Choudhary, Entomologist |

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

**Appendix-II**

| State | Location | Rabi 2016-17 | | Kharif 2017 | |
|---|---|---|---|---|---|
| **Funded co-operating centres** | | Sent | Recd. | Sent | Recd. |
| Andhra Pradesh | Maruteru | 4 | 4 | 13 | 13 |
| Assam | Titabar | 2 | 0 | 8 | 6 |
| Bihar | Pusa | | | 7 | 5 |
| Chattisgarh | Jagdalpur | | | 13 | 13 |
| | Raipur | 1 | 1 | 11 | 11 |
| Gujarat | Navsari | | | 8 | 8 |
| | Nawagam | | | 8 | 8 |
| Haryana | Kaul | | | 9 | 9 |
| Himachal Pradesh | Malan | | | 10 | 10 |
| Jammu & Kashmir | Chatha | | | 7 | 6 |
| | Khudwani | | | 6 | 6 |
| Jharkhand | Ranchi | | | 8 | 8 |
| Karnataka | Brahmavar | | | 8 | 0 |
| | Gangavathi | 2 | 0 | 13 | 12 |
| | Mandya | | | 9 | 9 |
| Kerala | Moncompu | 3 | 3 | 13 | 9 |
| | Pattambi | 3 | 3 | 11 | 11 |
| Madhya Pradesh | Rewa | | | 6 | 5 |
| Maharashtra | Karjat | 1 | 1 | 8 | 8 |
| | Sakoli | | | 11 | 11 |
| Manipur | Wangbal | | | 3 | 1 |
| Odisha | Chiplima | 2 | 2 | 11 | 11 |
| Puducherry | Kurumbapet | 2 | 2 | 8 | 6 |
| Punjab | Ludhiana | | | 15 | 14 |
| Tamil Nadu | Aduthurai | 9 | 9 | 3 | 3 |
| | Coimbatore | 3 | 3 | 14 | 14 |
| Telangana State | Rajendranagar | 3 | 3 | 11 | 11 |
| | Warangal | 1 | 1 | 13 | 12 |
| Uttar Pradesh | Ghaghraghat | | | 5 | 4 |
| | Masodha | | | 9 | 9 |
| Uttaranchal | Pantnagar | | | 14 | 12 |
| West Bengal | Chinsurah | 7 | 6 | 12 | 12 |
| | | | | | |
| | | | | | |
| | Total | 43 | 38 | 305 | 277 |
| **Voluntary centres** | | | | | |
| Andhra Pradesh | Bapatla | | | 5 | 3 |
| | Ragolu | 1 | 1 | 10 | 10 |
| | Nellore | | | 8 | 8 |
| Manipur | Iroisemba | | | 6 | 3 |
| New Delhi | New Delhi | | | 4 | 4 |
| Odisha | Cuttack | 2 | 0 | 9 | 5 |
| Puducherry | Karaikal | | | 6 | 4 |
| Telangana State | Jagtial | | | 5 | 3 |
| Tripura | Arundhutinagar | | | 5 | 2 |
| Total trials in funded coop. & voluntary centres | | 46 | 39 | 363 | 319 |
| % Receipt of data | | 84.78261 | | 87.87879 | |
| Grand totals for *kharif*& *rabi* | | 409 | | 358 | |
| % Receipt of data (overall) | | 87.53056 | | | |

**APPENDIX-III**

## List of abbreviations

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

# ACKNOWLEDGEMENTS

**Our thanks are due to the scientists located at different centres for the conduct of trials as a part of the Coordinated Entomology Program. Thanks are also due to Dr. B. Sailaja, Principal Scientist, for helping in the statistical analysis of data. Thanks are due to Drs. N. Somasekhar, Principal Scientist and Satish Chavan, Scientist of Entomology section for their assistance and technical staff of Entomology Section, Sri. P. M. Chirutkar, Sri. A. Narsing Rao, Sri. T. Venkaiah and Sri. K. Shravan Kumar for their efforts in conduct of the trials and/or preparation of the report at IIRR. We acknowledge the efforts of Mr. M. Ayyappa Das, SRF for his involvement in the gall midge screening programme. We thank Smt. Rekha Rani, Personal Assistant, for her help in coordination work. Special thanks are due to Sri. Amudhan Srinivasan, Sr.Technical Officer, Entomology Section, for support in conduct of the trials, preparation of the report and printing of the report.**