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Evaluation of Different IPM Modules againest Insect Bests and Natural Enemies in Direct Seeded Rice

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ABSTRACT

A field experiment to "Evaluate of different IPM modules against insect pests and natural enemies in direct seeded rice" was conducted at Agricultural College Farm, Bapatla during *kharif,* 2022. Four different IPM modules such as IPM module, BIO IPM module, Ecological Engineering module and Farmers practice. Were evaluated. The insect pests observed during the crop season were leaf folder and BPH. Among all the modules, IPM module has recorded the lowest leaf folder (2.94) and BPH (1.58) incidence. The highest incidence of leaf folder (13.99) and BPH (8.77) were observed in Ecological engineering module. The natural enemies such as coccinellids, mirid bugs and spiders were recorded more in Ecological engineering module. Correlation analysis for different IPM modules revealed that insect pests such as leaf folder and BPH showed a positive correlation on natural enemy incidence. The results of correlation analysis showed values 0.878 for coccinellids, 0.969 for mirid bugs and 0.958, 0.922 for spiders with leaf folder and PBH respectively. Yield in different IPM modules ranged from 10167 kg ha^{-1} to 9366 kg ha^{-1}. The highest yield was recorded in IPM module (10167 kg ha^{-1} followed by Farmers practice (10088 kg ha^{-1}), BIO IPM (9768 kg ha^{-1}) and lowest was observed in Ecological engineering module (9366 kg ha^{-1}).

Keywords: *BPH, Coccinellids, IPM modules, Mirid bug and Spider.*

Rice (*Oryza sativa* L.) is a staple food for over half of the world's population (*IRRI, 2006*) and one of the important cereal crops that occupies the third position among common agricultural crops in the world, after sugarcane and maize (*FAO, 2017*). For the *kharif* season of 2022–2023, rice production in India was predicted to reach a record 124.0 million tonnes.

Rice is commonly grown during three seasons: autumn, winter, and summer in India. India is the world's second-largest producer of rice and the largest exporter of rice in the world. In Andhra Pradesh, rice is grown during the *kharif* with 60 per cent of total rice being cultivated during the season. Andhra Pradesh stood in third place in terms of rice production, with 22 lakh hectares area during *kharif* and *rabi* seasons and 128.95 lakh tonnes production in India. Andhra Pradesh is a leading rice producer with a production of 12% of total rice produced in the country (*MoA&FW, 2022*).

Rice is traditionally grown by transplanting method. Transplanting after repeated puddling is laborious process which requires intensive water use but also more amount of expenditure. Different problems like lowering water table, scarcity of labour during peak transplanting periods increase the overall expenditure on crop. Because of all these reasons many of the farmers are shifting their planting method from transplanting to Direct Seeded Rice (DSR).

The DSR demonstrated its superiority in terms of significant improvement in higher productivity with higher system net returns, increased water use efficiency and fertilizer use efficiency (*Kumar and Ladha, 2011*). More number of panicles, increased panicle length, more number of grains per panicle has been observed in Direct Seeded Rice.

Rice crop is vulnerable to a variety of pests like yellow stem borer, *Scirophaga incertulas,* leaf folder, *Cnaphalocrosis medinalis*, Brown plant hopper, *Nilaparvata lugens* and Rice gundhi bug , *Leptocorisa acuta* etc. Hence it is proposed to study the effect of pest and occurence of natural enemies in direct seeded rice with different IPM packages.

MATERIAL AND METHODS

The rice variety BPT 5204 (Samba Mahsuri) developed at Agricultural Research Station (ARS), Bapatla was used to evaluate different IPM modules

against insect pests in direct seeded rice during *kharif,* 2022 at Agricultural College Farm, Bapatla. The seeds were directly sown with 25 kg acre^{-1} seed rate for IPM, Bio IPM and Ecological engineering modules and 35 kg acre^{-1} seed rate for farmer's practice.

The experiment was laid out in a simple Randomized Block Design (RBD). Four modules of Integrated Pest Management (IPM) were taken as treatments each replicated five times. Three modules *i.e.,* IPM, BIO IPM and ecological engineering were sown directly and the fourth IPM module *i.e.,* farmer's practice was transplanted with seedlings grown in nursery for a month. The plot size of 10 x 10m was marked using markers, seed was sown in lines at spacing of 30 x 15cm. To achieve a homogenous plant population, gap filling was performed 25 days after sowing.

MODULE I(IPM):-

- Application of carbofuran along with seed during sowing.
- Alley ways formation
- Provision of bird perches @ 10 ha^{-1}
- Release of *Trichogramma chilonis* @ 1 lakh ha^{-1} starting from 20 DAS at 15-20 days interval**.**
- Neem oil sprays 3% @ 15lit ha^{-1}
- Chemical sprays (Need based application)

MODULE II (BIO IPM):-

- Seed treatment with *Trichoderma* @ 4gm/ kg seed
- Release of *Trichogramma chilonis* @ 1 lakh ha^{-1} starting from 20 DAS at 15-20 days interval
- Spray with *Pseudomonas* fluorescens@ 1kg ha^{-1}
- Spray with *Beauveria bassiana* for leaf folder @ 10ml/lit of water

MODULE III (ECOLOGICAL ENGINEERING):-

- Seed treatment with *Pseudomonas* fluorescens@ 10gm/kg seed
- Alley ways formation
- Alternate wetting and drying
- Planting of Marigold on field bunds to attract natural enemies.
- Application of Neem oil 3% @ 15lit ha^{-1}

MODULE IV (FARMER'S PRACTICE):-

- Seed rate:- 30kg acre^{-1}
- Scheduled spray – Application of Chlorantraniliprole at 15 DAT @ 30 g a.i. ha^{-1} till harvest.
- Spray at 15 days interval from 30 DAT with combination of 2 insecticides (Acephate @ 300 g a.i. + Chlorantraniliprole @ 30 g a.i. ha^{-1}) + one fungicide (Mancozeb 63% + Carbendazim 12% WP @ 750 g ha^{-1}) till harvest.

Observations on leaf folder damage, planthopper population and natural enemy population were recorded from 45 days after sowing at week days interval from 10 hills at random in each replication. To calculate per cent leaf folder damage total number of leaves and total number of infested leaves per hill were counted. The per cent leaf folder damage was calculated using the formula Leaf folder per cent damage

$$= \left(\frac{Number\ of\ damaged\ leaves\ per\ hill}{Total\ number\ of\ leaves\ per\ hill} \right) X100$$

The data obtained from various treatments were statistically analysed using Analysis of Variance (ANOVA). The per cent leaf folder damage and BPH was transformed to the corresponding square root transformation values and subjected to ANOVA. The yield data was collected and subjected to statistical analysis (*Gomez and Gomez, 1984*) to test the significance of mean yield in different treatments. Natural enemy data on Mirid bugs, Coccinellids and Spiders was also collected and subjected to statistical analysis using ANOVA.

RESULTS AND DISCUSSION

The mean per cent damage caused by leaf folder ranged from 2.94 to 13.99 per cent (Table 1). The lowest per cent damage of 2.94 was observed in T_1 (IPM module) followed by 2.96 in T_4 (Farmer's practice), 11.09 in T_2 (BIO IPM) and the highest damage recorded was 13.99 in T_3 (Ecological Engineering). Results indicated that IPM module has the lowest leaf folder damage in comparison with the Farmer's practice, BIO IPM and Ecological Engineering module. IPM module and Farmer's practice module are on par with each other. The lowest incidence of leaf folder in IPM module might be due

to release of egg parasitoid, *Trichogramma chilonis* in that module. The highest infestation was recorded in Ecological Engineering module. According to *Kumar et al. (2020)* IPM module has recorded the lowest leaf folder incidence and found to be superior to the farmer's practice. *Elakkiya and Sujeetha* (2011) also reported that IPM module has recorded the lowest leaf folder infestation compared to the chemical module, neem based module, chemical + non-chemical module and untreated control.

The mean population damage caused by BPH ranged from 1.58 to 8.77 per cent (Table 2). The lowest mean population damage of 1.58 was observed in T_1 (IPM module) fallowed by 2.41 in T_4 (Farmer's practice), 4.39 in T_2 (BIO IPM) and the highest damage recorded was 8.77 in T_3 (Ecological Engineering). Results indicated that IPM module has the lowest BPH damage in comparison with the Farmer's practice, BIO IPM and Ecological Engineering module. The lowest incidence of BPH in IPM module might be due to the formation of alley ways and need based chemical sprays in that module. IPM module and Farmer's practice module are on par with each other. The highest infestation was recorded in Ecological Engineering module. The results are in accordance with *Divya and Nethaji* (*2020*) who reported that IPM module has lowest BPH population than the Farmer's practice and Ecological Engineering module. *Jena et al.,* (*2012*) also reported that IPM module has recorded the lowest BPH population compared to farmer's practice, chemical based module and chemical + non-chemical based module.

The mean population of mirid bugs ranged from 3.23 to 5.67. Lowest mean population recorded was 3.23 in T_4 (Farmer's practice) followed by 3.83 in T_1 (IPM module) 4.88 in T_2 (BIO IPM) and the highest population of 5.67 was recorded in T_3 (Ecological Engineering) module (Table 3). *Zhu et al.* (*2014*) reported that the adults of mirid bugs increased in the presence of marigold plants planted in Ecological Engineering module and less population was observed in farmer's practice.

The mean population of coccinellids ranged from 4.01 to 8.19. Lowest mean population recorded was 4.01 in T_4 (Farmer's practice) followed by 5.04 in T_1 (IPM module) 7.23 in T_2 (BIO IPM) and the highest population of 8.19 was recorded in T_3 (Ecological Engineering) module (Table 4). The results are in accordance with *Shanmugam et al.* (*2022*) who reported that number of Coccinellids/hill were observed more in Ecological Engineering module when compared with the farmers practice due to the border crop sown in Ecological Engineering module which attracted more number of natural enemies.

The mean population of spiders ranged from 0.79 to 2.90. Lowest mean population recorded was 0.79 in T_4 (Farmer's practice) followed by 1.31 in T_1 (IPM module) 2.08 in T_2 (BIO IPM) and the highest population of 2.90 was recorded in T_3 (Ecological Engineering) module (Table 5). The results are in accordance with *Shanmugam et al.,*(*2022*) who reported that number of Spiders/hill were observed more in Ecological Engineering module when compared with the farmers practice due to the border crop sown in Ecological Engineering module which attracted more number of natural enemies.

Correlation between insect pests and natural enemies

Insect pests observed during the crop season in different IPM modules were leaf folder and BPH and the natural enemies observed were coccinellids, mirid bugs and spiders. The correlation studies carried out between insect pests and natural enemies were represented in the Table 6.

Correlation studies between insect pests (leaf folder, BPH) and natural enemies (coccinellids, mirid bugs, spiders) showed a positive correlation. Natural enemy population was higher when the pest incidence was at its peak and decreased when the pest population decreased. Leaf folder and BPH showed a highly significant and positive correlation of 0.958**, 0.922* with spiders respectively. BPH showed a significant and positive correlation with coccinellids (0.878*) and mirid bugs (0.969**).

The results are in accordance with *Samrit et al.* (*2019*) who reported that leaf folder showed a positive correlation with spider. The results are in accordance with *Vinoth Kumar* (*2014*) who reported that leaf folder and BPH has showed positive correlation with spiders. *Parasappa et al.* (*2017*) also reported that BPH showed a positive and significant correlation with spiders, mirid bugs and coccinellids whereas leaf folder showed significant positive correlation with spider.

Yield (kg ha^{-1})

The yield data collected from different IPM modules under DSR ranged from 9366 kg ha^{-1} to 10167 kg ha^{-1} (Table 7). The highest yield recorded was 10167 in T_1 (IPM module) followed by 10088 in T_4 (Farmer's practice), 9768 in T_2 (BIO IPM) and the lowest yield was 9366 in T_3 (Ecological Engineering) module. IPM module recorded highest yield compared to other modules which may be due to release of egg parasitoid, *Trichogramma chilonis* along with need based chemical control. The results are in accordance with *Divya and Nethaji* (*2020*) who reported that IPM module has recorded highest yield than the Farmer's practice and Ecological Engineering module. *Jena et al. (2012)* also reported that IPM module has recorded the highest yield compared to farmer's practice, chemical based module and chemical + non-chemical based module. *Kumar et al.* (*2020*) reported that IPM module has recorded the highest yield and found to be superior to the farmer's practice. *Elakkiya and Sujeetha* (*2011*) also reported that IPM module has recorded the highest yield compared to the chemical module, neem based module, chemical + non-chemical module and untreated control.

CONCLUSIONS

- Among the four different Integrated Pest Management modules (IPM module, BIO IPM, Ecological Engineering module and Farmer's practice) the IPM module was found to be the best module when compared to the other modules based on the lowest mean per cent damage (2.94) of rice leaf folder ,*C. medinalis* and the lowest mean population damage (1.58) of BPH, *N. lugens*.
- Among the different IPM modules the natural enemies like mirid bugs, spiders and coccinellids were recorded. The highest population of coccinellids (8.19), mirid bugs (5.67), spiders (2.90) was observed in T_3 (Ecological Engineering) module. The lowest population of coccinellids (4.01), mirid bugs (3.23), spiders (0.79) was recorded in T_4 (Farmer's practice) due to the chemical sprayings.
- Correlation analysis conducted between insect pests and natural enemies in IPM modules revealed that leaf folder and BPH showed a significant and positive correlation of 0.958**, 0.922* with spiders respectively. BPH showed a significant and positive correlation with coccinellids (0.878*) and mirid bugs (0.969**).
- Highest yield of 10167 kg ha^{-1} was recorded in IPM module which was on par with farmers practice with 10088 kg ha^{-1} yield, while a lesser yield of 9366 kg ha^{-1} was recorded in Ecological Engineering module.

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Table 1. Evaluation of different IPM modules against rice leaf folder *C.medinalis* in Direct Seeded Rice under field conditions during *kharif*, 2022-23

T. No.	Module	per cent leaf damage at							MEAN
		45 DAS 1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	
T_1	IPM	1.82 (1.67)^{b}	5.40 (2.52)^{b}	6.30 (2.70)^{d}	2.50 (3.87)^{c}	2.36 (1.83)^{d}	1.07 (1.43)^{d}	1.16 (1.46)^{d}	2.94 (1.98)^{c}
T_2	Bio IPM	2.64 (1.90)^{b}	16.72 (4.20)^{a}	11.20 (3.49)^{b}	17.55 (4.30)^{a}	11.10 (3.47)^{b}	12.78 (3.71)^{b}	5.70 (2.58)^{b}	11.09 (3.47)^{b}
T_3	Ecological engineering	5.15 (2.47)^{a}	18.21 (4.38)^{a}	13.25 (3.77)^{a}	20.67 (4.65)^{a}	14.00 (3.87)^{a}	16.49 (4.18)^{a}	10.21 (3.34)^{a}	13.99 (3.87)^{a}
T_4	Farmers practice	2.08 (1.75)^{b}	3.43 (2.10)^{c}	3.52 (2.06)^{c}	5.27 (2.50)^{b}	3.54 (2.13)^{cd}	1.33 (1.52)^{c}	1.58 (1.60)^{cd}	2.96 (1.99)^{c}
	SEm±	0.92	0.67	0.40	1.10	0.72	0.82	0.43	1.34
	Fcal	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
	CD (P= 0.05)	2.77	2.03	1.20	3.31	2.18	2.48	1.29	4.15
	CV%	17.16	6.71	4.34	10.8	9.39	10.48	6.87	11.67

Figures in paranthesis are square root transformed values Mean with same letter are not significantly different at 5 % level by Duncan's Multiple Range test

Table 2. Evaluation of different IPM modules against rice BPH, *N.lugens* in Direct Seeded Rice under field conditions during *kharif*, 2022-23

T. No.	Module	BPH (no. / hill) at							MEAN
		45 DAS 1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	
T_1	IPM	0.25 (1.12)^{b}	2.22 (1.79)^{c}	2.48 (1.86)^{c}	0.75 (1.32)^{c}	1.58 (1.60)^{c}	2.23 (1.79)^{c}	1.53 (1.59)^{c}	1.58 (1.60)^{c}
T_2	Bio IPM	0.25 (1.12)^{b}	5.24 (2.49)^{b}	6.02 (2.64)^{b}	4.50 (2.34)^{b}	4.39 (2.32)^{b}	5.95 (2.63)^{b}	4.38 (2.31)^{b}	4.39 (2.32)^{b}
T_3	Ecological engineering	1.63 (1.62)^{a}	11.81 (3.57)^{a}	10.75 (3.42)^{a}	8.75 (3.12)^{a}	8.67 (3.10)^{a}	10.62 (3.40)^{a}	8.45 (3.07)^{a}	8.77 (3.12)^{a}
T_4	Farmers practice	1.00 (1.41)^{b}	2.63 (1.90)^{c}	3.40 (2.09)^{c}	2.09 (1.75)^{c}	2.28 (1.81)^{c}	3.23 (2.05)^{c}	2.23 (1.79)^{c}	2.41 (1.84)^{c}
	SEm±	1.15	0.81	0.63	0.95	0.75	0.53	0.48	0.53
	Fcal	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
	CD (P= 0.05)	3.47	2.45	1.89	2.88	2.29	1.59	1.45	1.65
	CV%	14.5	9.73	7.39	12.51	9.52	5.88	6.08	5.95

Figures in paranthesis are square root transformed values Mean with same letter are not significantly different at 5 % level by Duncan's multiple range test.

Table 3. Incidence of mirid bug population in different IPM modules in Direct Seeded Rice under field conditions during *kharif* , 2022-23

T. No.	Module	Occurence (no. / hill) at							MEAN
		45 DAS 1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	
T_1	IPM	2.46^{c}	3.52^{c}	4.04^{c}	4.63^{c}	4.74^{b}	4.13^{b}	3.28^{c}	3.83^{c}
T_2	Bio IPM	4.88^{b}	4.61^{b}	4.66^{b}	5.74^{b}	4.35^{c}	5.05^{a}	4.86^{b}	4.88^{b}
T_3	Ecological engineering	5.39^{a}	5.15^{a}	5.96^{a}	6.57^{a}	5.42^{a}	5.31^{a}	5.92^{a}	5.67^{a}
T_4	Farmers practice	2.03^{d}	3.13^{c}	3.55^{d}	4.12^{c}	3.34^{d}	2.96^{c}	3.47^{c}	3.23^{d}
	SEm±	0.06	0.11	0.13	0.07	0.07	0.09	0.08	0.06
	Fcal	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
	CD (P= 0.05)	0.19	0.33	0.38	0.21	0.22	0.25	0.24	0.19
	CV%	8.25	12.81	13.55	7.41	8.02	9.38	8.92	6.85

Mean with same letter are not significantly different at 5 % level by Duncan's Multiple Range test

Table 4. Incidence of coccinellid population in different IPM modules in Direct Seeded Rice under field conditions during *kharif*, 2022-23

T. No.	Module	Occurence (no. / hill) at							MEAN
		45 DAS 1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	
T_1	IPM	3.95^{c}	4.23^{c}	4.67^{c}	5.84^{c}	5.52^{c}	5.33^{c}	5.75^{b}	5.04^{c}
T_2	Bio IPM	6.54^{b}	6.75^{b}	6.92^{b}	7.97^{b}	7.64^{b}	7.18^{b}	7.58^{a}	7.23^{b}
T_3	Ecological engineering	7.63^{a}	7.82^{a}	8.51^{a}	8.95^{a}	8.63^{a}	8.42^{a}	7.35^{a}	8.19^{a}
T_4	Farmers practice	3.32^{c}	3.45^{d}	3.96^{d}	4.63^{d}	4.43^{d}	4.21^{d}	4.05^{c}	4.01^{d}
	SEm±	0.11	0.08	0.10	0.09	0.09	0.13	0.08	0.12
	Fcal	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
	CD (P= 0.05)	0.32	0.24	0.29	0.27	0.26	0.38	0.25	0.35
	CV%	9.67	7.09	7.71	6.45	6.33	9.85	6.48	9.22

Mean with same letter are not significantly different at 5 % level by Duncan's Multiple Range test

Table 5. Incidence of spider population in different IPM module in Direct Seeded Rice during *kharif,* 2022-23

T. No.	Module	Occurence (no. / hill) at							MEAN
		45 DAS 1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	
T_1	IPM	1.25[c]	1.35[c]	1.28[c]	1.46[c]	1.44[b]	1.31[b]	1.09[c]	1.31[c]
T_2	Bio IPM	1.91[b]	1.62[b]	1.75[b]	2.95[b]	2.42[a]	2.02[a]	1.87[b]	2.08[b]
T_3	Ecological engineering	3.23[a]	3.15[a]	3.02[a]	3.57[a]	2.88[a]	2.62[a]	1.81[a]	2.90[a]
T_4	Farmers practice	0.43[c]	0.68[c]	0.76[c]	1.98[c]	0.81[b]	0.48[c]	0.37[c]	0.79[c]
	SEm±	0.03	0.03	0.04	0.07	0.03	0.04	0.03	0.03
	Fcal	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
	CD (P= 0.05)	0.08	0.10	0.12	0.21	0.10	0.11	0.09	0.08
	CV%	7.81	9.31	11.35	13.75	8.57	10.81	11.57	7.45

Mean with same letter are not significantly different at 5 % level by Duncan's Multiple Range test

Table 6. Correlation between insect pests and natural enemies in different IPM modules in Direct Seeded Rice

Variable	Correlation co-efficient		
	Coccinellids	Mirid bugs	Spiders
Leaf folder	------	-------	0.958**
BPH	0.878*	0.969**	0.922*

*Correlation is significant at 0.05 level (2 tailed)

**Correlation is significant at 0.01 level (2 tailed)

Table 7. Yield from different IPM modules under Direct Seeded Rice during *kharif*, 2022-23

Different Modules	Yield (kg ha^{-1})
T_1 - IPM	10167
T_2 - Bio IPM	9768
T_3 - Ecological engineering	9366
T_4 - Farmers practice	10088
SEm±	72.64
CD (P= 0.05)	223.81
CV (%)	8.25

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