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Farmer Participatory Assessment of Integrated Pest Management Strategies against the Insect Pest of Lowland Rice in Coastal Odisha

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Abstract

On-farm testing was conducted at farmers' field to assess the efficacy of IPM technology against the major insect pest of lowland rice during *kharif* 2010 and 2011. IPM module I comprising of nursery treatment with Carbofuron 3G @ 120 g/1 cent nursery area, release of bioagent *Trichogramma chilonis* @ 0.1 million ha^{-1} 4 times at 10 days interval, foliar spraying of neem oil @ 1.5 l ha^{-1} at 45 and 75 DAT and fipronil 5 SC @ 1 l ha^{-1} at 60 DAT, rope dragging for dislodging pest in kerosinised water and need based spraying of Ethofenprox 10 EC @ 500 ml ha^{-1} at 90 DAT recorded the lowest yellow stem borer infestation (4.55% mean dead heart, 3.81% mean white ear head), leaf folder damage (7.29% mean leaf damage), case worm incidence (11.50% mean leaf damage) and plant hopper incidence (8.27 mean population/hill) and was found to be significantly superior to the farmers' practice of indiscriminate application of 4 to 5 insecticides. A significantly higher natural enemy (spiders and mired bugs) population was retained in both the IPM modules. The highest mean grain yield (45.9 q ha^{-1}), net rerun (₹ 18780.00) and B:C ratio (1.65) was obtained from the IPM module I justifying the economic superiority of this IPM module

Keywords: IPM, insect pest, lowland rice

1. Introduction

Lowland rice based cropping system is the predominate farming situation in the coastal ecology of Odisha. Besides, the various abiotic constraints like submergence, nutrient deficiency, iron toxicity, the lowland rice is subjected to different biotic stresses like insect pest, disease, weed infestation and algal blooms contributing towards substantial yield loss. Among them, insect pest infestation continues to be the important production constraint in lowland rice ecology. Zhimomi and Ao (2011) reported that the incidence of major insect pests of rice is the highest in lowland as compared to upland paddy ecosystem. Nearly 300 species of insect pests attack the rice crop at different stages and among them 23 species cause notable damage (Pasalu and Katti, 2006) resulting in 30-35% yield loss. (Prakash et al., 2007). Yellow stem borer (*Scirpophaga incertulas* Walker) is one of the most destructive pests of this crop and is widely distributed monophagous pest in the Indian subcontinent (Atwal and Dhaliwal, 2008) with an estimated yield loss of 27-34% every year (Prasad et al., 2007) and has assumed status as national pest (Pasalu et al.,

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2002). The rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) has gained the major pest status with the extensive cultivation of high yielding varieties, reduced genetic variability in crop ecosystem, multiple cropping patterns, higher dose of nitrogenous fertilisers and prophylactic use of pesticides (De Kraker et al., 2000) . It can cause leaf infestation up to 61.9% (Chhavi et al., 2016) and can contribute yield loss to the extent of 5 to 25% (Kulgagod et al., 2011). Leaf folder infestation at maximum tillering stage can lead to 20% unfilled grains, whereas flag leaf damage at flowering stage can contribute to 50% unfilled grains (Padmavathi et al., 2013). Similarly, case worm, *Nymphula depunctalis* Guenee though earlier considered as a minor and localised pest cause extensive damage to the lowland rice where prolonged water stagnation is a problem. In late transplanted lowland rice crop case worm caused up to 18.60% leaf damage (Prasad et al., 2018). Plant hoppers (Brown plant hopper, BPH, *Nilaparvata lugens,* Stal. and White backed plant hopper, WBPH, *Sogatella furcifera* Horváth.) assumed serious significance in the recent years and cause widespread damage to the wet season rice of coastal areas due to favourable ecological niche and injudicious use of chemical insecticides resulting in insecticide resistance and resurgence. Generally the yield losses due to hoppers ranges from 10 to 90% but if timely control measures are not taken up, there may be possibility of total crop loss within a very short period (Seni and Naik, 2017). Besides, the direct damage through hopper burn, BPH transmits viral diseases like grassy stunt, ragged stunt and wilted stunt (Bhanu et al., 2014) and therefore often considered as the most destructive insect pest of wet season rice. Application of chemical pesticides is the most preferred plant protection strategy adopted by the farmers to reduce pest infestation. However, injudicious and excessive use of insecticides not only cause undesirable consequences in the agro-ecosystem but has serious adverse effect on human health. Besides, most of these chemicals are expensive and there by increases the cost of production for the resource poor farmers. Keeping this in view, some Integrated Pest Management (IPM) modules were evaluated for their efficacy against the major insect pest of lowland rice with respect to the existing farmers practice.

2. Materials and Methods

On-farm tastings were conducted in Gopalpur village of Bonth block ($21^0 7^1 23.394^{11}$ N latitude $86^0 23^1 47.8392^{11}$ E longitude), Odisha state, India during *Kharif*, 2010 and 2011 to assess the efficacy IPM modules against the major insect pest of lowland rice. The experiments were laid out in randomised block design with three treatments (two IPM modules compared with farmers practice) and eight replications with individual plot size of 25 cent each. Each participating farmers was considered as one replication. Rice variety "CR-1009" was sown in the nursery during 3rd week of June and 30 days old seedlings were transplanted in the main field with a spacing of 20x15 cm^2. The crop was grown with recommended agronomic package of practices and standard intercultural operations to ensure optimum plant growth. Treatment wise IPM components (Table 1) were imposed during the crop growth period. Treatment and replication wise observations on the incidence of insect pest were recorded at ten days interval commencing from 30 DAT from 5 randomly selected quadrants of 1 m^2 area in each plot. Stem borer infestation was recorded as percentage dead heart (DH) during the vegetative stage and as percentage white ear head (WEH) during the reproductive stage. While, the damage of leaf folder and case worm was recorded as percentage leaf damage, the population of plant hoppers (BPH & WBPH) was recorded as average numbers/ hill. The cumulative damage incidence and pest population counts during the crop season were subjected to analysis for comparison. The data on grain yield was also recorded from each treatment and converted to q ha^{-1} for analysis. The economics of the IPM modules were calculated based on the net return and B:C ratio.

3. Results and Discussion

The lowest dead heart incidence was observed in the IPM module I (4.73 and 4.38% in 2010 and 2011, respectively) closely followed by IPM module II (5.35 and 5.12% in 2010 and 2011, respectively) and both the modules were statistically comparable with each other. In contrast the highest DH percentage was recorded in the farmers' practice (9.11 and 8.88% during 2010 and 2011, respectively) despite of the wilful application of insecticides. The stem borer damage in the reproductive stage of the crop was found to be significantly minimum in the module I with 3.90 and 3.72% WEH in 2010 and 2011, respectively. A comparatively higher WEH incidence was recorded in the IPM module II (5.18 and 4.95% in 2010 and 2011, respectively), whereas the maximum ear head damage was found in the farmers' practice (8.64% in 2010 and 8.14% in 2011). Both the IPM modules had a statistically comparable effect in suppressing the leaf folder infestation with the minimum damage in module I (6.32 and 8.26% during 2010 and 2011, respectively) closely followed by module II with 7.15 and 8.83% leaf damage during 2010 and 2011, respectively. In contrast the highest leaf folder infestation (11.17 and 13.15% during 2010 and 2011, respectively) was observed in the farmers' practice. Among the treatments the lowest case worm infestation was noticed in the module 1 (10.21 and 12.78% leaf damage during 2010 and 2011, respectively), which was found to be significantly superior to module 2 (13.73 and 14.85% leaf damage in 2010 and 2011, respectively) and farmers' practice (19.75 and 20.90% damaged leaf during 2010 and 2011, respectively). Similarly, the IPM module I retained its superiority in lowering the plant hopper population (7.28 and 9.26 plant hoppers/ hill during both the users of investigation, respectively) as against IPM module II (10.36 and 14.25 plant hoppers/ hill during 2010 and 2011, respectively) and farmers' practice (28.64 and 33.38 plant hoppers/ hill in 2010 and 2011, respectively). In both the

Table 1: Effect of IPM modules on the insect pest of lowland rice

T	Stem borer incidence (% DH)*			Stem borer incidence (% WEH)*			Leaf folder incidence (% infested leaf)*			Case worm damage (% damaged leaf)*			Plant hopper incidence **(BPH & WBPG population/ hill)		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
T_1	4.73 (2.28)	4.38 (2.20)	4.55 (2.24)	3.90 (2.09)	3.72 (2.05)	3.81 (2.07)	6.32 (2.61)	8.26 (2.95)	7.29 (2.79)	10.21 (3.27)	12.78 (3.64)	11.50 (3.46)	7.28 (0.86)	9.26 (0.97)	8.27 (0.92)
T_2	5.35 (2.41)	5.12 (2.36)	5.23 (2.39)	5.18 (2.38)	4.95 (2.33)	5.06 (2.36)	7.15 (2.76)	8.83 (3.05)	7.99 (2.91)	13.43 (3.72)	14.85 (3.91)	14.14 (3.82)	10.36 (1.02)	14.25 (1.15)	12.31 (1.09)
T_3	9.11 (3.10)	8.88 (3.06)	9.00 (3.08)	8.64 (3.02)	8.14 (2.94)	8.39 (2.98)	11.17 (3.41)	13.15 (3.69)	12.16 (3.55)	19.75 (4.49)	20.90 (4.62)	20.32 (4.56)	28.64 (1.46)	33.38 (1.52)	31.01 (1.49)
SEm±	0.072	0.058	0.048	0.048	0.042	0.034	0.070	0.071	0.045	0.096	0.079	0.067	0.042	0.051	0.034
CD*	0.22	0.18	0.15	0.15	0.13	0.104	0.21	0.22	0.14	0.29	0.24	0.20	0.13	0.15	0.10

Treatments; T_1: IPM module I (seedling treatment with the application of carbofuron 3G @ 120 g /1 decimal nursery, release of bioagent *T. chilonis* @ 40000/acre 4 times at 10 days interval, foliar sparyng of neem oil formulation 300 ppm @ 1.5 l ha^{-1} at 45 and 75 DAT and fipronil 5 SC @ 1 l ha^{-1} of water at 60 DAT, rope dragging for dislodging pest in kerosinised water and need based spraying of ethofenprox 10 EC @ 500 ml ha^{-1} at 90 DAT; T_2: IPM module II (Seedling treatment through root dip with chlorpyriphos 20 EC for 6 hours, release of bioagent *T. chilonis* @ 40000 acre^{-1} 4 times at 10 days interval, foliar spraying of neem oil formulation 300 ppm @ 1.5 l ha^{-1} at 45 and 75 DAT and Cartap hydrochloride 50 SP @ 750 g ha^{-1} at 60 DAT, installation of bird pearh for avian predation of foliage feeders, need based spraying of Acephate+Imidacloprid @ 1 kg ha^{-1} at 90 DAT; T_3: Farmers practice (Granular application of Carbofuran 3 G @ 30 kg ha^{-1}, foliar application of insecticides like Monocrotophos, chlorpyriphos+Cypermethrin, Cypermethrin, triazophos 4 times); CD*: CD (p=0.05); *: Figures in the parenthesis are √ (X+0.5) transformed values; **: Figures in the parenthesis are log10 (x) transformed values

IPM modules a significantly higher natural enemy population was retained (13.49 and 11.12 mean spider population/ 10 hills in module I and II, respectively and 18.78 and 14.18 mean Mirid bug population/ 1o hills in module I and II, respectively) as against only 5.61 and 7.70 spiders and Mired bugs/ 10 hills, respectively in the farmers' practice indicating the serious adverse effect of excessive use insecticides on the natural enemies in rice ecosystem. The lower pest infestation in the IPM plots contributed to higher mean crop yield (45.9 and 43.9 q ha^{-1} in module I and II, respectively), whereas, a significantly lower mead yield was recorded in farmers' practice (37.6 q ha^{-1}), despite of the insecticide based plant protection measures. IPM also resulted in higher economic benefits with a mean net return of ₹ 18780.00 ha^{-1} and ₹ 17277.00 ha^{-1} in module I and II, respectively as against ₹ 11817.00 ha^{-1} in the existing farmers' practice. Besides, higher B:C ratio was obtained from the IPM adopted plots (1.65 and 1.61 in module I and II, respectively) in comparison to the farmers' practice (1.43) (Table 2 and 3). The present findings are in agreement with Karthikeyan et al. (2010) who reported that pest management module comprising alternate spraying with neem-based formulation coupled with release of egg parasitoids significantly reduced incidence of dead hearts, white ear heads and damaged leaves. Seedling treatment with the application of carbofuran 3G in rice nursery reduced the insect pest incidence in rice including leaf folder (DRR, 2004). The superior efficacy of fipronil 5 SC and cartap hydrochloride 50 SP against rice stem borer and leaf folder reported by Kulagod et al., 2011

Table 2: Effect of IPM modules on the natural enemy population in low land rice

Treatments	Avrage spider population/ 10 hills*			Av. Mirid Population/ 10 hills*		
	2010	2011	Mean	2010	2011	Mean
T_1	11.62 (1.07)	15.35 (1.18)	13.49 (1.13)	16.45 (1.22)	21.08 (1.32)	18.78 (1.27)
T_2	9.40 (0.97)	12.84 (1.11)	11.12 (1.05)	12.20 (1.08)	16.15 (1.21)	14.18 (1.15)
T_3	4.85 (0.69)	6.36 (0.80)	5.61 (0.75)	6.26 (0.80)	9.14 (0.96)	7.70 (0.89)
SEm±	0.046	0.035	0.028	0.040	0.033	0.022
CD (p=0.05)	0.14	0.11	0.08	0.12	0.10	0.07

* Figures in the parenthesis are log10 (x) transformed values

Table 3: Effect of IPM modules on grain yield and economics

Treatments	Yield (q ha^{-1})			Net return (₹ ha^{-1})**			B:C ratio		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
T_1	42.3	49.5	45.9	14200.00	23360.00	18780.00	1.51	1.78	1.65
T_2	41.0	46.8	43.9	13360.00	21194.00	17277.00	1.48	1.72	1.61
T_3	35.9	39.3	37.6	9650.00	13984.00	11817.00	1.37	1.49	1.43
SEm±	1.34	1.73	1.02						
CD (p=0.05)	4.05	5.24	3.09						

** Calculated based on the MSP of rice (₹ 1000.00 during 2010 and ₹ 1080.00 during 2011)

was in line with the present findings. Mishra et al., 2013 observed cartap hydrochloride as the second best economical treatment after fipronil in reducing stem borer infestation in rice. Yadav, 2018 also revealed that neem based formulations (0.03% Azadirachtin) @ 2500 ml ha^{-1} proved to be the most effective in reducing the incidence of the prevailing major insect pests of rice. Chhetry, 2009 informed that dragging of rope impregnated with kerosene in standing water reduced the damage of case worm in rice. Further, Krishnaiah, 2018 opined that ethofenprox is one of the effective insecticides recommended for BPH management in rice and it also exhibits moderate efficacy against other insect pests on rice like leaf folder and stem borer. Ethofenprox has very low toxicity to mammals, fish, predators and other aquatic organisms and therefore, can be safely integrated in the IPM strategy against the major insect pest of rice. The results of the investigation derived ample support from the findings of Sharma et al., 2018, who reported that IPM practices involving installation of bird perches, augmentative releases of *Trichogramma* spp and spraying of Neem oil 1% not only reduced the infestation of stem borer and leaf folder but also retained a higher populations of natural enemies like spiders, dragonflies and damselflies.

4. Conclusion

Integrated pest management) approach comprising the components namely seedling treatment, inundative release of egg parasitoids *Trichogramma chilonis* , spraying of neem based formulations and need based application of effective pesticides proved highly effective in minimizing the pest infestation in to a substantial level in lowland rice. This pest management strategy not only conserved the natural enemies like spiders and mired bugs in rice ecosystem but also increased the crop productivity and profitability.

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