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Comparing the efficiency of different pest management modules in rice ecosystem

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Abstract
Integrated Pest Management (IPM) module was evaluated with the ecological engineering and farmer practice (FP) based pest management of spraying different insecticides for management of major pest of rice under irrigated condition for paddy. During Kharif season 2017-18 in farmers' field at Perambalur district, Tamil Nadu. The findings revealed IPM practices was effective and significantly superior over ecological engineering based pest management and farmer practice in reducing the incidence of paddy leaf folder, stem borer and BPH (Brown Plant Hopper) with minimal effect on natural enemies viz., spider population (10.95/10 hill) and coccinellid population (9.95/ 10 hill) with reduced cost of cultivation Rs. 23,608/ ha and increased the net return Rs. 15.479/ha. Thus IPM practices proved to be an ideal management strategy against major pest of rice along with a benefit: cost ratio of 1.66.

Keywords: Integrated pest management, rice ecosystem, farmer practice

Introduction
India is the second largest producer and consumer of rice grown in the world after China. In 2011- 12, India produced about 104.3 million ton of rice which accounts for 22.81% of total global rice production. In India Rice production was associated with massive limiting factors, among them weed causes 12.5 per cent whereas insect 9.5 per cent and disease 6.5 per cent (Liu *et al.* 2016) [1]. In India, moreover loss incurred due to a different insects pests of rice which includes brown planthopper (BPH),*Nilaparvata lugens* (Stal.); white backed planthopper (WBPH), *Sogatella furcifera* (Horvath); green leafhopper(GLH), *Nephotettix virescens* (Distant); stem borer, *Scirpophaga incertulas* (Walker); leaf folder *Cnaphalocrocis medinalis* (Guenee) and gall midge,*Orseolia oryzae* (Wood-Mason) are reported to the tune of 15,120 million rupees which works out to be 18.60 per cent total losses (Chandramani *et al*., 2010) [2].

In Perambalur district Paddy covers an area of 3353 ha. Among the many limiting factors, losses caused by pests remained an important constraint for achieving high rice yields in Perambalur district. In Ayyarpalayam village of perambalur has the sizeable area under paddy cultivation but the productivity level is very low due to stem borer, leaf folder and BPH infestation. The magnitude of problem has been wide spread over the past years due to the monoculture. The farmers rely on using number of chemical insecticides for the management and leads to more cost of cultivation, environmental pollution, pesticide residue and reduced yield. Keeping the above point in view, the present study were under taken to evaluate the efficiency of IPM practices and ecological engineering modules of pest management practices for the control of major pest of rice in perambalur district to minimize misuse of hazardous pesticides and to reduce killing of different natural enemies and its impact on yield.

Materials and Methods
Krishi Vigyan Kendra, Perambalur conducted On Farm Trail (OFT) to find the efficiency of different modules in pest management in farmers field under real farming situation. Evaluation of three different modules for control of Paddy stem borer, leaf folder, BPH in rice was studied for variety Co51 during *Kharif* seasons of 2017- 2018 at village Ayyarpalayam, Perambalur district, Tamil Nadu state. The experiment was carried out with three modules i.e., i) IPM module ii) Ecological engineering module iii) Insecticide module (Farmer Practices) each in half an acre area separated with 2m buffer distance. The crop was grown under irrigated conditions in sandy clay loam soil at spacing of 20 x 30 cm following all recommended agronomic practices except plant protection measures.

IPM module includes ecofriendly strategies and ecological engineering module consist of raising of pulse crop and marigold flowering plants in bunds of the rice field and in chemical control (Farmers Practices) module comprised of chemical insecticidal sprays which are normally effective against Stem borer, leaf folder and BPH (Table1).

Experimental Design

Table 1: Treatment details of different pest management modules in Rice

Treatments	
Module 1	**Farmers practice** Only pesticide spray (Dimethoate, monocrotophos,cartaphydrochloride) without other management practices for pest
Module 2 (IPM)	Installation of Pheromone trap @ 12/ ha, Field release of *Trichogramma chilonis* @ 2 cc/ acre 3 release at weekly interval from 30 Days After sowing (DAS) Field release of *Trichogramma japonicum* @ 2 cc/ acre 3 release at weekly interval, interval from 30 Days After sowing (DAS) Foliar Spray of NSKE – 5 % Foliar spray of *Beauveria basiana* @ 2 Kg /acre
Module 3 (Ecological engineering)	Ecological Engineering – Raising combination of crops marigold and black gram in bunds Installation of Pheromone trap @ 12/ha

The crop was observed regularly for pest attack, natural enemies and yield were recorded for all the modules. The data on stem borer infestation was recorded at vegetative stage as Dead Heart (DH) and total tillers and per cent incidence was worked out. Similarly, White Ear (WE) on panicle bearing tiller were recorded near maturity of the crop and percent white ear infestation was worked out. Leaf folder damage was recorded from randomly selected 10 hills from each plot, for this total number of leaves per hill and infested leaves were recorded per cent incidence was worked out on 65 days after treatment. The Brown Plant Hopper (BPH) population / 10 hill was recorded one day before, 5 and 10 days after last spray. Finally the grain yield was recorded in plot basis and expressed in quintal/ha. Based on yield, cost benefit ratios of different treatments modules were also calculated. All the data recorded were pooled to arrive the seasonal mean.

Results and Discussions

A study was conducted to evaluate different modules for effective management of paddy stem borer, leaf folder and BPH in paddy during *kharif* 2017-18. Observations on incidence of yellow stem borer and leaf folder presented in Table-2, revealed that the incidence of yellow stem borer at the vegetative stage was 2.12, 11.72 and 22.83 % DH. The mean % white ear at pre harvest was 1.44, 5.99 and 12.95. A minimum leaf folder damage on leaves were recorded in IPM module. The per cent leaf folder damage observed at 60 DAT was 2.86, 26.06 and 9.80 in IPM, ecological engineering and farmers modules respectively.

Effect of different control approaches for management of brown plant hopper BPH

Based on field observation, an increased number of brown plant hopper population (13.3 nos./10 hills) was observed in farmers practices. The lowest population of BPH was observed (3.1 nos./10 hill) in IPM module and BPH population was (6.5 nos./10 hill) was observed in ecological engineering module (Table. 3). Similar result was found by Qinag *et al*. (1995) [3] and Murthy *et al*. (1990) [4].

Impact of natural enemy population on different modules

The results regarding the natural enemy was higher population were observed in ecological engineering followed by IPM and farmers practices. The presence of lady bird beetle was recorded with a mean population of 18.55, 10.95 and 2.65 whereas spider population of 16.66, 9.95 and 2.75 in ecological engineering, IPM and farmers practices respectively (Table. 2) and (Fig.1).

Table 2: Effect of different modules against major pest and natural enemies in paddy during Kharif 2017- 18.

Treatments	Per cent leaf folder incidence (65 DAT)	Per cent infestation of dead hearts (65 DAT)	Per cent infestation of white ear (at time of harvest)	Natural enemies population	
				Spider population/ 10 hill	Coccinellid population / 10 hill
Module 1	9.78	22.83	12.95	2.65	2.75
Module 2	2.86	2.12	1.44	10.95	9.95
Module 3	26.11	11.72	5.99	18.55	16.55

*Values in the table was the mean of ten replications

Table 3: Efficiency of different modules against BPH (*N. lugens*) in paddy during Kharif 2017-18

Treatment	DBS (No. of hopper/ 10 hill)	I st spray (BPH/10 hill)		Mean	II nd spray (BPH/ 10 hill)		Mean
		5 DAS	10 DAS		5 DAS	10 DAS	
Module 1	41.2	13.3	15.6	14.45	9.2	13.3	11.25
Module 2	37.95	23	17.4	20.2	17.1	3.1	10.1
Module 3	41	27.8	18.2	23.0	11.6	6.5	9.05
SEM	0.99	1.72	0.86	1.83	1.55	1.61	
CD (0.05%)	3.20	5.08	3.03	4.35	4.75	5.22	

*Values in the table was the mean of ten replications
Module 1: I st spray – Dimethoate, II nd Spray – Cartap hydrochloride
Module 2: I st spray – NSKE 5%, II nd Spray – *Beauveria bassiana*
Module 3: I st spray – Nil , II nd Spray – Nil

Table 4: Economics of different pest management modules of paddy

Yield (q/ha)			Gross cost (Rs./ha)			Gross return (Rs./ha)			Net return (Rs./ha)			B:C		
Module 1	Module 2	Module 3	Module 1	Module 2	Module 3	Module 1	Module 2	Module 3	Module 1	Module 2	Module 3	Module 1	Module 2	Module 3
40.95	46.41	32.76	31402	23608	22470.2	33600	38080	26880	2198	14472	4409.8	1.07	1.66	1.46

*Values in the table was the mean of ten replications

The adoption of IPM technologies resulted in higher net income in economic terms also which was exhibited by high incremental cost benefit ratio 1: 1.66 followed by 1:1.46 and 1: 1.07 in ecological engineering and farmers practices respectively (Table. 4). Similar finding was also reported by Dash *et al.*, 2005 [5], Dash *et al.*, 2006 [6], Karthikeyan *et al.*, 2010 [7].

The efficiency of *Trichogramma japonicum* and *T. chilonis* reported by Kumar suneel and Khanm (2005) [8] on tiller damage and folded leaves varied from 78.1 % to 81.6 % from 72.6 to 81.8 %, respectively, where egg parasitoids were released @ 1,00,000/ha in rice ecosystem.

Alice and Sujeetha (2008) [9] reported higher efficacy of NSKE at 5% against BPH in rice and noticed less survival, more developmental period, minimum growth index and lesser size and weight of adults of BPH. The Increased efficacy of *B. bassiana* with increase in the number of days after application against brown plant hopper in the present study was in conformity with the findings of Maoye *et al.* (2012) [10], Li Mao-Ye *et al.*, (2012) [11] and Rombach *et al.*, (1986.) [12]

The safety of Entomopathogenic fungi *B. bassiana* against spiders and coccinellid found in this study was in conformity with the findings of Chi *et al.* (2005) [13] who indicated that the population of predatory spiders and water bugs were higher in fungal treatments than in chemical treatments. The efficacy of Neem Seed Kernel Extract against plant hoppers in rice was reported by several other workers and the results of the present study was in conformity with the these findings. Rahman and Jahan, 2006 [14]. Reported that the highest population of spider (6.50/ 25 hills) and lady bird beetle (9.0 / five double sweep nets) were found in natural biological control due to no insecticide application and the lowest population of spider (3.27 /25 hills) and lady bird beetle (4.0 / five double sweep nets) were found in schedule based protection due to application of insecticide.

Even though pest population was very much reduced in chemical control the cost of plant protection was more compared to IPM modules and Even though the ecological engineering module was safe to natural enemies but the yield was low and benefit cost ratio was also lower compared to IPM fields. Similar results of reduction in pest incidence due to adoption of integrated pest management practices in brinjal were reported by Govardhan Rao, 2015 [15].

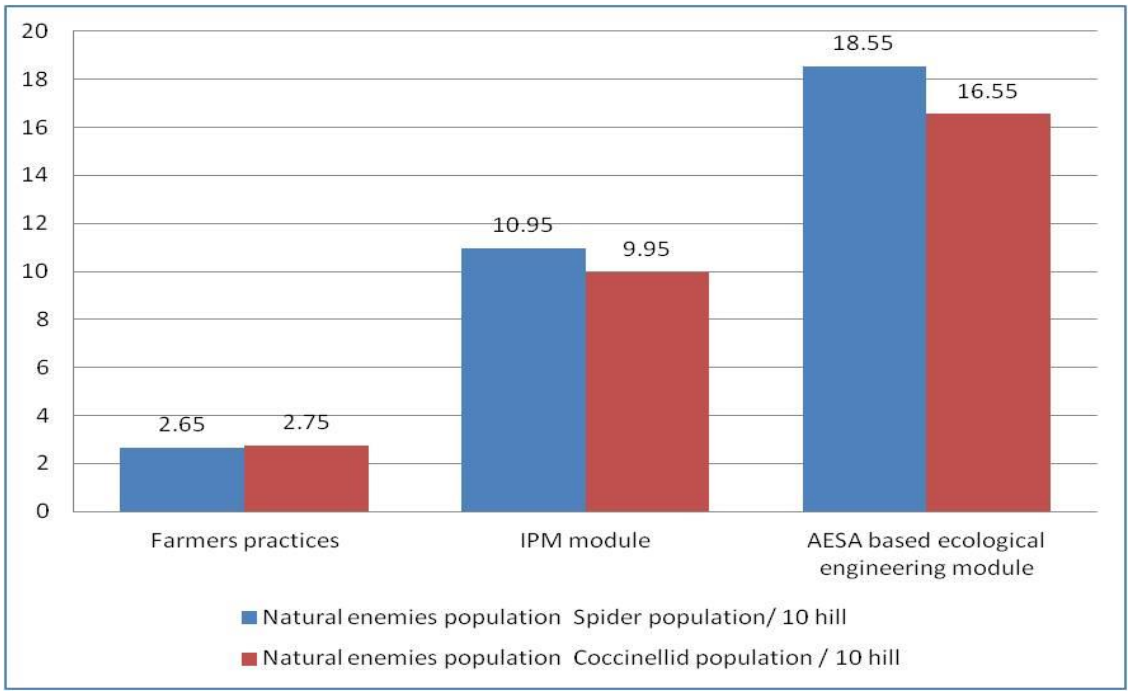

Fig 1: Impact of natural enemy population in Paddy ecosystem in different modules

Conclusion

The results of present study led to conclusion that yellow stem borer (*S. incertulas) and* leaf folder (*Cnaplocrosis medinalis* Guenee) and BPH is the major pest of rice in irrigated condition. The yield losses due to these pests can be managed effectively by the adoption IPM modules. It was also concluded that the demonstrated IPM module is eco-friendly with high benefit cost ratio and safer to non-targeted organism in comparison to conventional insecticides and ecological engineering methods for pest management.

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