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Assessing efficacy level of some modified farmers' practices against the important pests of paddy (*Oryza sativa* L.) under new alluvial zone of West Bengal

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Abstract
The present experiment was carried out at Dean's Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Mohanpur, Nadia, West Bengal to identify the important insect pests and diseases of the zone and assessment of the performance of some safer pest management modules against the important pests of paddy and their safeness to natural enemies in paddy ecosystem on kharif/wet season paddy both during 2018 and 2019. The treatment included: three modified farmers' practices (MFP), one farmers' practice (FM) with an untreated check. Results revealed that modified farmers' practices effectively checked the growth and development of the pest populations and their resultant damages registering fairly good yields (5.03 – 5.24t/ha) and in general, were significantly superior to farmers' practice besides found quite safe to natural enemies found in paddy ecosystem.

Keywords: insect, paddy, modified farmers' practice, economics

Introduction

Rice, the staple food of about half of the world population, is known to suffer huge yield losses due to different insect pests and diseases (Anonymous, 2015) [1]. A number of factors appear as hindrance to rice production limiting the potential yield and insect pests are accounted as the important reason behind this. About 800 insect pest species have been recorded to feed on rice (Grist and Lever, 1969) [6]. In India, about 100 insect pests have been reported as pests of rice and 20 of these are considered to be of major significance (Cramer, 1967; Pathak and Dhaliwal, 1981 [16]; Atwal and Dhaliwal, 2005) [2]. The major insect pests of rice are yellow stem borer (*Scirpophaga incertulas* Walker; Pyralidae; Lepidoptera), brown plant hopper (*Nilaparvata lugens* Stal.; Delphacidae; Hemiptera), white backed plant hopper (*Sogatella furcifera* Horváth; Delphacidae; Hemiptera), green leaf hoppers (*Nephotettix spp*.; Cicadellidae; Hemiptera), gundhi bug (*Leptocorisa acuta* Thunberg; Alydidae; Hemiptera), gall midge (*Orseolia oryzae* Wood-Mason; Cecidomyiidae; Diptera) and leaf folder (*Cnaphalocrocis medinalis* Guenee; Pyralidae; Lepidoptera) etc (Prakash, *et al*., 2014) [19]. The annual crop loss in India of about 30 - 36% due to insect pests was reported by a number of workers (Cramer, 1967; Pathak and Dhaliwal, 1981 [16]; Atwal and Dhaliwal, 2005) [2]. Yield loss ranging from 21.0 to 51.0 per cent were reported by some others (Pasalu *et al*., 2004 [14]; Prakash *et al*., 2005) [21]. The insect pest caused maximum loss in seed yield 27.9% in West Bengal. Yellow stem borer, gall midge and brown plant hopper were the key pests in rice causing 10 to 70, 15 to 60 and 25 to 30 per cent loss, respectively. Severe infestation of leaf folder led to as high as 60.0 to 70.0 per cent leaf damage and inflicted significant yield losses to the extent of 80.0 per cent (Prabal *et al*., 1999) [18]. Incidence of both pests and natural enemies directly depend on some abiotic factor like temperature, relative humidity, rain fall etc (Singh *et al*., 2012 [24]; Seni and Naik, 2018) [23]. The important predators of insect pests in rice ecosystem are Ophionea spp. (carabid beetles), Staphylinids, coccinellid beetles, mirid bug, predatory orthopteran, aquatic and terrestrial predatory bugs and dragonflies, damselflies and a variety of spiders (Heinrichs, 1994) [7].

Various management strategies including biorational sustainable approaches have been developed and successfully implemented in different countries (Kalode and Krishnaiah, 1991 [11]; Weber and Parada, 1997 [25]; Pathak *et al*., 1998 [17] Heong and Escalada, 1998 [8]; Pasalu and Katti, 2004 [14]; Huan *et al*., 2005 [9]; Prakash *et al*., 2007 [20]; Litsinger, 2008) [12]. However, a large section of the paddy growers in India still prefers to rely solely on chemical method of protection in spite of being well-aware of its adverse effects and think to eradicate the pests rather than managing them (Dubey, 2003 [4]; Pasalu and Katti, 2004) [14].

An important reason behind this is the biased emphasis towards insect pests or diseases; quite naturally, the integrated approach in many cases failed to produce expected results at field level and this generated strong apathy amongst rice growers to adopt integrated management strategy to combat the rice pests. In this backdrop, some safer pest management modules were designed keeping focus on farmers' practice and emphasizing on both insect pests and diseases and were evaluated in the present investigation.

Materials and Methods

The present experiment was carried out at Dean's Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya located at Jaguli, Mohanpur, Nadia, West Bengal, during the kharif/wet season of both 2018 and 2019. The experiment was set out in randomized block design with five treatments including untreated check and four replications for each treatment. Each plot measured 3m x 3m. Standard irrigation and intercultural operations were followed to help raise a good crop stand except the plant protection measures. Treatment comprising here are

T1 – 2 sprays with ready-mix Emamectin benzoate 0.9% + Novaluron 5.25% (SC) at mid-tillering and ear head-stage, 1 spray with carbendazim @ 3g a.i.//L + mancozeb @ 1 g a.i.//L at maximum tillering stage and 1 spray with NSKE @ 5ml a.i.//L at panicle initiation stage.

T2 – modified farmers' practice (MFP II)– 2 sprays with ready-mix Cartap hydrochloride 25% + Emamectin benzoate 1% (SG) at mid-tillering and ear head-stage, 1 spray with carbendazim @ 3g a.i.//L + mancozeb @ 1 g a.i./L at maximum tillering stage (needbased) and 1 spray with NSKE @ 5ml a.i.//L at panicle initiation stage (prophylactic).

T3 – modified farmers' practice (MFP III)– 2 applications with cartap hydrochloride @ 1000g a.i.//ha at mid-tillering and earhead-stage (need-based), 1 spray with carbendazim @ 3g a.i.//L + mancozeb @ 1 g a.i.//L at maximum tillering stage (need-based), 1 spray with NSKE @ 5ml a.i.//L at panicle initiation stage (prophylactic).

T4 - Farmers' practice with thiamethoxam + rynaxypyr + tricyclazole + carbendazim at their recommended dose with proper time.

T5 - Untreated check.

Observations on the number of insect pests and predators were taken from randomly selected 10 hills/plot. Observations on the damage due to insect pests and diseases were also taken from 10 hills/plot. All the observations were taken at an interval of 10 days starting with 20 DAT and the mean values were worked out. Collected data were then subjected to analysis of variance following F-test to compare the treatment effects on the basis of critical difference values with the assistance of SPSS® version 25.

Results and Discussion

Results indicated that all the treatments were effective in checking the growth and development of the pest populations and their subsequent damages (Tables 1). Results also showed that the treatments effectively checked the disease progression and restricted the damage due to diseases as well. However, the treatments differed in their efficacy levels and modified farmers' practices (T1, T2, T3) were significantly superior to farmers' practice (Treated check, T4) at most of the times as observed against the important pests that were encountered in the present study. Data revealed that yellow stem borer (YSB), leaf folder (LF), paddy bug (PB) were the important insect pests in the area and gall midge and green leaf hopper (GLH) appeared only in small numbers. Sheath blight was found to be the most important disease problem and small infections of bacterial leaf blight were also noticed in plots. The lowest dead heart (DH) score of 6.2% was recorded by T1 and other two modified farmers' practices (T2, T3) also recorded low dead-heart score (6.7 – 6.8%). The white-head formation was also quite low in modified farmers' practices (T1, T2 and T3) ranging in between 4.1 – 4.3% while both the dead-heart and white heads were quite higher in farmers' practice (T4), white head – 6.3%, dead-heart – 11.4%.

Farmers' practice (T4), however, was found to be more effective against leaf roller and recorded significantly less damage as compared to modified farmers' practices (% rolled leaves: T1 – 8.3, T2 – 9.4, T3 – 9.2, T4 – 2.5).

The lowest number of GLH was recorded by Farmers' practice (T4) (3.4/hill) while in modified farmers' practices (T1, T2, T3) the population varied in between 4.2 – 4.6/hill. The lowest number of paddy gall midge was recorded in T4 (0.07/hill) and in modified farmers' practices it varied in between 0.08 – 0.14/hill. T4 also recorded the lowest percentage of silver shoots (0.66%) and in modified farmers' practices it ranged in between 0.72 – 0.94%. Higher number of paddy bugs (0.78/hill) and its subsequent damage (8.5% chaffy grains) was recorded in Farmers' practice (T4) as compared to modified farmers' practices (T1, T2, T3) (bug: 0.59 – 0.71/hill; chaffy grains: 3.5 – 3.9%) but only the damage level was statistically significant. Sheath blight was the only serious disease that was encountered in experimental plots and modified farmers' practices effectively suppressed the disease progression (T1: 6.2%, T2: 6.8 and T3: 7.1% sheath blight infection) and the performance was significantly superior to farmers' practice or treated check (T4) (8.8% sheath blight infection). Population of both insect pests and diseases grew to quite high levels in untreated check (T5) and recorded 3.42 leaf rollers/hill, 16.4% rolled leaves, 2.31 paddy bugs/hill, 18.2% chaffy grains, 11.6 GLH/hill, 0.64 gall midge/hill, 2.36% silver shoots and 16.2% sheath blight infested plants and all the treatments were significantly superior to untreated check in terms of all the parameters studied.

Table 1: Effect of the treatments on the incidence and damage of the pests on kharif/wet season paddy at Mohanpur (pooled data of 2018-19)

Treatments	Mean dead heart (%)	Mean white head (%)	Mean Leaf roller/ hill (number)	Mean rolled leaves (%)	Mean paddy bug/hill (number)	Mean chaffy grains (%)	Mean GLH/ Hill (number)	Mean Gall midge/ Hill (number)	Mean silver shoot/ hill (%)	Mean sheath blight infested hills (%)
T1	6.2	4.2	0.69	8.3	0.59	3.5	4.2	0.08	0.72	6.2
T2	6.8	4.1	0.78	9.4	0.65	3.7	4.6	0.12	0.85	6.8
T3	6.7	4.3	0.75	9.2	0.71	3.9	4.5	0.14	0.94	7.1
T4	11.4	6.3	0.35	2.5	0.78	8.5	3.4	0.07	0.66	8.8
T5	18.4	19.6	3.42	16.4	2.31	18.2	11.6	0.64	2.36	16.2
SEm ((±)	0.72	0.76	0.32	0.69	0.28	0.56	0.37	0.18	0.29	0.34
CD at 5%	2.16	2.28	0.98	0.98	0.83	1.67	1.12	0.54	0.87	1.02

GLH = green leafhopper.

Table 2: Effect of the treatments on the physical parameters of the kharif/wet season paddy plants at Mohanpur (pooled data of 2018-19)

Treatments	Mean no. of tillers/ hill	Mean no. of panicles/ hill	Mean length of panicle (cm)	Mean no. of spikelets/ pani cle	Mean no. of grains/ pani cle	Mean well filled grains (%)	Mean weight of single grain (g)	Mean weight of 1000 grains (g)	Mean yield (t/ha)	Benefitcost ratio (BCR)
T1	16.8	12.6	24.3	15.2	256.2	95.2	0.026	26.78	5.24	9.4:1
T2	17.2	13.1	23.8	14.7	252.5	96.1	0.027	27.14	5.03	8.9:1
T3	16.9	12.9	24.1	14.8	254.2	95.4	0.027	26.89	5.16	9.1:1
T4	14.5	9.8	22.4	13.6	204.7	87.3	0.024	24.95	4.82	4.5:1
T5	10.6	6.4	16.4	10.8	81.4	73.4	0.023	21.84	1.42	-
SEm ((±)	0.34	0.54	0.68	0.55	1.94	1.21	NS	0.21	0.34	
CD at 5%	1.03	1.62	2.04	1.65	5.82	3.62	NS	0.62	1.03	

T1 (MFP I) = ready-mix Emamectin benzoate 0.9% + Novaluron 5.25% (SC) + NSKE + carbendazim-mancozeb mixture. T2 (MFP II) = ready-mix Cartap hydrochloride 25% + Emamectin benzoate 1% (SG) + NSKE + carbendazim-mancozeb mixture. T3 (MFP III) = cartap hydrochloride + NSKE + carbendazim-mancozeb mixture. T4 (FP) = thiamethoxam + rynaxypyr + tricyclazole + carbendazim. T5 = untreatedcheck.

Table 3: Effect of the treatments on populations of the natural enemies found in kharif/wet season paddy at Mohanpur (pooled data of 2018-19):

Treatments	Coccinellids/hill (mean number)[1]	Spider/hill (mean number)[2]	Praying mantid/hill (mean number)[3]	Carabids /hill (mean number)[4]	Staphylinids /hill (mean number)[5]
T1	2.6	4.3	0.7	1.8	6.2
T2	2.4	4.5	0.8	1.6	5.6
T3	2.5	4.3	0.6	1.9	5.5
T4	1.3	0.6	0.2	1.2	0.2
T5	3.2	5.8	1.2	2.2	6.5
SEm ((±)	0.35	0.36	0.21	0.32	0.28
CD at 5%	1.07	1.08	0.64	0.96	0.84

[1]mixed population of 5 spp., [2]mixed population of 6 spp., [3]mixed population of 3 spp., [4] Paederus sp., [5] Ophionea sp

Effects of the treatments were quite well-reflected on the physical parameters and yield attributes of the paddy plants (Table 2). Modified farmers' practices (T1, T2, and T3) supported higher number of tillers (16.8 – 17.2 tillers/hill), panicles (12.6 – 13.1/hill), longer panicles (23.8 – 24.3 cm), higher spikelets (14.7 – 15.2/panicle) and grains (252.5 – 256.2/panicle). Higher proportions of well-filled grains were also recorded in these treatments (95.2 – 96.1%). Farmers' practice (T4), on the other hand, recorded significantly lower number of tillers (14.5/hill), panicles (9.8/hill), shorter panicles (22.4 cm), spikelets (13.6/panicle), grains (204.7/panicle) and well-filled grains (87.3%). Weight of individual grain was at par for all the treatments as well as untreated check but in the scale of 1000 grain weight, modified farmers' practices (26.78 – 27.14g/1000 grains) were significantly superior to farmers' practice (24.95g/1000 grains) and eventually, superior yields were recorded in those treatments (5.03 – 5.24 t/ha) over farmers' practice (4.82 t/ha) though the difference in yield was not statistically significant. Results (Table 3) showed that all the modified farmers' practices (T1, T2 and T3) were quite safe to the natural enemies recorded in the present study and statistically at par with untreated check (T5). These treatments supported higher populations of coccinellids (2.4 – 2.6/hill), spiders (4.3 – 4.5/hill), praying mantids (0.6 – 0.8/hill), carabids (1.6 – 1.9/hill) and staphylinids (2.2 – 2.6/hill) than farmers' practice (T4) which recorded very low populations of coccinellids (1.3/hill), spiders (1.6/hill), praying mantids (0.2/hill), carabids (1.2/hill) and staphylinid (1.2/hill) and it emerged as the most unsafe treatment. In terms of safety to natural enemies, modified farmers' practices and untreated check were at par with each other and in more cases all were significantly superior to farmers' practice (treated check) Neem has got diverse biological activities (Schmutterer, 1987) [22] which include repellent, antifeedant, growth regulatory and reproduction suppressive activities, apart from its direct and systemic toxicity (Gill and Lewis, 1971) [5]. Activity of neem cake should be attributed to phenolic compounds released during its degradation which disrupts the permeability in fungi (Hendrix, 1970) and adversely affects the availability and digestibility of proteins which insects obtain from plants, apart from its stimulatory effect on root growth. Adverse effects of synthetic pesticides on natural enemies are well-documented. In the present case also, FP was highly detrimental to predatory complex of rice ecosystem and actually, a very low population of them survived. Synthetic pesticides used in MFPs had certainly impacted the predatory populations but probably the treatment complements under it allowed better re-colonization/migration of the predators and it might had made a little contribution in keeping the insect pest populations at lower levels. Untreated check received complements of neem cake and fertilizers like that in MFPs but it recorded reduced number of tillers, panicles, spikelets, grains and well-filled grains. This obviously happened due to pest invasion and resultant damage. Sheath blight did not spread alarmingly in check and impact of neem cake may be one of the reasons behind it. Successful management of the paddy pests in farmers' field have been reported by Heong and Escalada (1998) [8] and Huan *et al*. (1999, 2005) [9]. Results of the present study are also consistent with the observations of Kalode and Krishnaiah (1991) [11].

Conclusion

Modified farmers' practices (MFPs) effectively checked the growth and development of the pest populations and their resultant damages registering fairly good yields (5.03 – 5.24t/ha) and in general, were significantly superior to farmers' practice (FP). FP received much higher quantity of synthetic pesticides but still behind to offer adequate protection with an output (yield 4.82t/ha) which is not statistically significant with modified farmers practices. Besides MFPs were found quite safe to natural enemies found in paddy ecosystem comprising of spiders, coccinellids, praying mantids, carabids and staphylinids, at par with untreated check.

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