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PEST MANAGEMENT MODULES FOR BASMATI RICE AND FARMER'S PERCEPTION

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ABSTRACT

The experimental trials were conducted to evaluate four IPM modules viz., M1-Integrated pest management, M2-Chemical module, M3-Farmer's practice, and M4-untreated control against major insect pests viz., brown planthopper (BPH) *Nilaparvata lugens* (Stål), white backed planthopper (WBPH) *Sogatella furcifera* (Horvath), yellow stem borer (YSB) *Scirpophaga incertulus* (Walker), leaf folder (LF) *Cnaphalocrocis medinalis* L, in basmati rice in farmer fields at Hapur, Uttar Pradesh. These experiments were conducted in during kharif 2017 and 2018. The observations were made on the mean number of hoppers (plant and leafhoppers), % leaf damage, % dead heart and white earhead. Similarly, occurrence of spiders was also monitored. The results revealed that the M1- IPM module was observed as the best with minimum pest damage, and higher yield. This study concludes that integration of ecofriendly sustainable IPM practices not only minimize insecticide use and other input costs, but also increases the crop yield by safeguarding the natural enemy (spiders). Pre-season skill-oriented extension training programs, field demonstration-based farmer-first participatory approach, as well as regular communication through social media, would enhance their adoption in basmati rice production.

Key words: Basmati rice, insecticide, IPM module, insect pests, *Nilaparvata lugens*, *Sogatella furcifera*, *Scirpophaga incertulus*, *Cnaphalocrocis medinalis*, management, pheromone trap, spiders

Basmati rice has higher demand in the global market, and it is cultivated in a small geographical region of the Indian subcontinent (Sharma, 2017). Currently, India accounts for over 70% of the world's basmati rice production and leading exporter of basmati rice (APEDA, 2019). The subtropical climate of India is suitable for rice cultivation, and also conducive to the survival and proliferation of insects (Rana et al., 2017). More than 100 insect pests are recorded in the rice ecosystem (Heinrichs and Muniappan, 2017). Among these, yellow stem borer (YSB) *Scirpophaga incertulus* Walker, leaf folder (LF) *Cnaphalocrocis medinalis* L, and brown planthopper (BPH) *Nilaparvata lugens* (Stål) are considered major pests (Prakash et al., 2014). Rice yield gets a significant boost by the reduction of insect pests with the use of insecticides (Mishra and Panda, 2004; Dhuyo and Soomro, 2007; Chakraborty, 2010). The wrong use of insecticides has a negative impact on natural enemies (Guan-Soon, 1990; Debach and Rosen, 1991; Raguraman and Karan, 1996). These also invite other problems like insecticide resistance (Khan and Khaliq, 1989), pest resurgence (Kushwaha, 1995), and residues in the harvested produce (Dodan and Roshanlal, 1999; Kaul and Sharma 1999). Due to the maximum pesticide residue limit, a total of 444 import refusals were reported for basmati rice alone by the United States between January 2014 and May 2017 (ICIER, 2021). European Union also declined the basmati rice import as could be seen from 2017-18 to 2019-20 (Nanda, 2021). In this context, there is an urgent need to minimize the usage of pesticides. Therefore, the present study to demonstrate, a commercially viable and ecofriendly safe alternative IPM method for basmati rice in farmer's fields along with evaluation of farmers' attitude orientation towards environmental-friendly IPM.

MATERIALS AND METHODS

Field experiments were conducted to demonstrate and validate the efficacy of pest management modules against insect pests of basmati rice in farmer fields at Peernagar Soodna Hapur (28.72°N, 77.78°E, 213 masl), Uttar Pradesh, for two consecutive years in kharif, 2017 and 2018. The basmati rice (cv Pusa basmati 1121) was grown in farmer fields and all the recommended agronomic practices (except plant protection sprays) were followed for cultivation. Three IPM modules viz., M1(YSB Pheromone traps @ 5/acre, Neem oil 1000ppm @5ml/lit; straw bundles charged with spiders and egg masses @ 10/acre, Bird perches @ 10/acre and need based use of insecticides (Fenobucarb 50% EC@1ml/l;

Cartap hydrochloride 50% SP@1g/l), M2 (Imidacloprid 17.8% SL@0.3ml/l; Fenobucarb 50% EC@1ml/l; Carbosulfan 25% EC@1ml/l; Chlorpyrifos 20% EC@1ml/l based on ETL), M3 (Lambda-cyhalothrin 05% EC@0.5ml/l; Monocrotophos 36% SL@1ml/l; Oxydemeton-methyl 25% EC@1ml/l; Quinalphos 25% EC@1ml/l) routine application, and M4 (Untreated control) were laid in a two-acre area (i.e. 8000 sq m), and divided into five equal replications. Treatments were allotted randomly to the plot in each replication.

Observations were made on % leaf damage by leaf folder at 30 and 40 days after transplanting (DAT), hoppers/hill at 45 and 60 DAT, and % dead hearts and white ears head infestation of yellow stem borer at 60 and 70 DAT. The observations were taken from 20 randomly selected plants from the inner rows in each plot. Observations on spider population were made by visually counting the spiders from hills within 7 to 8-meter radius around each installed bundle in the IPM module and 5 randomly selected spots in other modules at 30, 40 and 60 DAT. The yield of different modules was pooled, and avoidable loss (%) was also calculated with benefit-cost ratio. All the data obtained were subjected to statistical analysis using Analysis of variance (ANOVA) after transformation (Gomez and Gomez,1984) with SPSS software (version 16.0). Further, for the purposive study of sustainable IPM, current modules were assessed for the farmers level perception about their sustainable adoption behaviour. The study assessed the adopter farmers' knowledge and their active participation in acceptance and willingness to implement in their fields level. In this regard, along with the IPM module evaluation the ex post facto research study was carried out after two successful adoption seasons.

Total of 60 IPM adopted farmers and their profile characteristics were analysed with the support of a scheduled based survey through an ex-post-facto research design (Kerlinger, 1978). The study also emphasized the role of farmers' knowledge and attitude orientation towards the adoption of IPM in basmati rice. There were several training and capacity building programmes were conducted for farmers with respect to the IPM in basmati rice. Hence to assess the farmers' knowledge, a standardized modified knowledge test was utilized. To measure the attitude orientation towards adoption of IPM in basmati rice, a modified attitude scale has utilized. The five attributes of innovativeness given by Rogers (1983) have been taken to assess the importance of the attributes of the IPM module for adoption in basmati rice production.

RESULTS AND DISCUSSION

A perusal of data on the insect pests, their infestation, and spiders observed in modules of basmati revealed that the IPM module was significantly superior (Table 1). The leaf folder damage (%) revealed, significant differences in different modules. The leaf damage was found to be minimum in the IPM module (6.97%) at 30 days after transplanting followed by the chemical module (8.11%) and farmer practices (9.45%) as compared to untreated control (12.05%). Whereas at 40 days after transplanting, IPM module (3.61%) and chemical module (4.04%) records were at par with each other, significantly lower than that of farmer's practices (6.33%) while maximum leaf damage was recorded in the untreated control (12.34%). During kharif 2018 also, the chemical (4.65%) and IPM (5.33%) module resulted in the least leaf damage followed by farmers practices (7.34%) at 30 days after transplanting. Considering the overall observations, the IPM module (0.95%) and chemical module (1.04%) were equally effective followed by farmer practices (5.58%) at 40 days after transplanting. These results derive support from previous results on using IPM practices with similar components (Elakkiya et al.,2012; Nayak et al., 2015).

During kharif 2017, data on % deadheart and white earheads of YSB in IPM module (3.43% and 2.67%) and chemical control (3.54% and 3.84%) were statistically at par at 45 and 60 days after transplanting respectively. It was followed by the farmer practice module (7.69% and 5.04%) and the untreated control module (11.96% and 7.53%) at 45 and 60 days after transplanting respectively. However, during the second season (kharif 2018) similar trends were observed in the IPM module (3.75% and 3.13%) and found statistically on par with chemical control (4.19% and 3.46%), followed by farmer practice (6.78% and 5.78%) as compared to untreated control module (10.18% and 8.18%) at 45 and 60 days after transplanting respectively. During kharif 2017, least hopper incidence was recorded in chemical module (3.09 and 1.99/ hill) and IPM module (3.13 and 2.54/ hill) and were on par with each other. Number of hoppers were comparatively less in farmers practice (7.33 and 5.32/ hill) at 45 and 60 DAT, respectively. During kharif 2018, similar results were obtained (Table 1). Kenmore (1997) revealed that significantly minimum hopper incidence in rice was observed with IPM module, and it was also found safe to natural enemies (Rajak et al., 1997; Garg et al., 2008). The present study also revealed the superiority of the IPM module in increasing spiders. These results are in conformity with the previous findings (Pathak and

Table 1. Evaluation of different pest management modules against insect pests of basmati rice

Particulars	% LD leaf folder	No. of hoppers/ hill		%DH YSB	%WEH YSB	Number of spider/ 5 hills			Yield (q/ acre)	C:B ratio
	40DAT	45DAT	60DAT	60DAT	70DAT	30DAT	40DAT	60DAT		
Kharif 2017										
Integrated pest management module	03.61± 0.30$_a$	03.13± 0.31$_a$	02.54± 0.12$_a$	03.43± 0.19$_a$	02.67± 0.61$_a$	01.11± 0.09	01.82± 0.33$_b$	02.89± 0.05$_c$	21.15	1:80
Chemical control	04.04± 0.22$_a$	03.09± 0.18$_a$	01.99± 0.19$_a$	03.54± 0.19$_a$	03.84± 0.29$_a$	00.57± 0.12	00.98± 0.17$_a$	00.81± 0.07$_a$	19.78	1:30
Farmers practice	06.33± 0.60$_b$	07.33± 0.23$_b$	05.32± 0.10$_b$	07.69± 0.35$_b$	05.04± 0.31$_b$	00.85± 0.06	01.20± 0.21$_{ab}$	01.18± 0.13$_b$	19.67	1:20
Control	12.34± 1.18$_c$	10.56± 0.40$_c$	11.90± 0.39$_c$	11.96± 1.13$_c$	07.53± 0.59$_c$	01.22± 0.15	02.12± 0.22$_c$	03.26± 0.16$_d$	14.78	00
CD (p=0.05)	1.63	0.96	0.65	1.99	1.62	0.32	0.68	0.28		
SE(m)	0.46	0.27	0.18	0.56	0.46	0.09	0.19	0.07		
Kharif 2018										
Integrated pest management module	00.95± 1.03$_a$	03.48± 0.18$_a$	00.93± 0.08$_a$	03.75± 0.59$_a$	03.13± 0.51$_a$	01.53± 0.13	02.04± 0.07$_c$	03.37± 0.48$_b$	20.21	1:90
Farmers practice	05.58± 0.16$_b$	08.36± 0.21$_c$	05.84± 0.26$_b$	06.78± 0.69$_b$	05.78± 0.56$_b$	0.43± 0.04	00.87± 0.06$_a$	00.67± 0.10$_a$	18.02	1:33
Chemical control	01.04± 0.57$_a$	05.04± 0.15$_b$	01.73± 0.13$_a$	04.19± 0.14$_a$	03.46± 0.64$_a$	0.62± 0.05	01.45± 0.08$_b$	00.73± 0.13$_a$	17.40	1:24
Control	10.22± 0.10$_c$	12.11± 0.48$_d$	13.04± 0.54$_c$	10.18± 1.12$_c$	08.18± 0.32$_c$	01.50± 0.23	02.51± 0.09$_d$	03.95± 0.34$_b$	12.95	00
CD (p=0.05)	1.53	1.01	1.05	1.99	2.03	0.53	0.28	1.21		
SE(m)	0.43	0.28	0.29	0.56	0.57	0.15	0.08	0.34		

DAT-Days after transplanting; LD-Leaf damage; DH-Deadhearts; WEH-White ear head

Tiwari, 2006; Ramandeep et al., 2007; Karthikeyan et al. 2010). Data on rice grain yield revealed that all three modules gave statistically significant grain yield and were superior over untreated control; maximum grain yield was obtained with the IPM module followed by chemical control module, and farmer practice. The IPM module ranked 1st with the highest cost-benefit ratio (1:80; 1:90) followed by the chemical module (1:30; 1:33) and farmer's practice (1:2;1.24) (Table 1).

It could be observed from Table 2 that, the majority of the farmers had medium level desired profile characteristics such as training undergone (76.66%), educational status (58.34), contact with an extension agency (53.34%), information-seeking behaviour (48.34%), economic motivation level (45%) and innovativeness (43.33%). With respect to farmers' experience, the majority of the farmers had many years of experience. So, these characters were highly supportive to enhance the adoption of IPM in basmati rice production. At the same time, the lower level of scientific orientation (48.33%) and perception on the environmental conservation (45%) require more attention. In this context, periodical training, and exposure visits with much-needed follow-up activities may be required. More focused training programs related to IPM module and non-formal educational strategies supported the wider adoption of IPM module under field conditions. The training programmes also improved the farmer's analytical skills, eco-friendly crop management skills, knowledge regarding negative externalities of pesticide-use, for continued adoption of IPM module in basmati rice. This finding was supported by the findings of Singh et al. (2008). It was observed that 65% of the farmers belonged to the medium level of knowledge category. With respect to attitude orientation, 53.34% of the farmers belonged to the moderately favourable attitude category. The medium level of knowledge and moderately favourable attitude orientation enhanced their adoption of IPM in basmati rice. Further, the agricultural scientists played important roles in both extension and field level activities. Particularly in the participation in farmer's group and community organization meetings with farmer's field school-related field activities. It gave social learning about the IPM Module in basmati rice to the farmers. Further, it also supported technology-led farmer-to-farmer extension delivery approaches, related to the IPM practice, with effective extension services; the higher frequency of meetings with extension personnel lead to the sustained and continued adoption of IPM practices in basmati rice. These findings were supported by Aggarwal (2015).

Table 2. Farmer's response to the adoption of integrated pest management modules in basmati rice cultivation (n=60)

Profile characteristics of the IPM adopted farmers			
Characteristics	%		
	Low	Medium	High
Educational Status	23.33	58.34	18.33
Farming experience	10.00	21.66	68.34
Economic motivation	13.34	45.00	41.66
Scientific orientation	48.33	30.00	21.67
Information seeking behaviour	35.00	48.34	16.66
Training undergone status	10.00	76.66	13.34
Perception on the environmental conservation	45.00	40.00	15.00
Innovativeness	30.00	43.33	26.67
Contact with extension Agency	36.66	53.34	10.00
Distribution of respondents based on their knowledge and attitude orientation			
Behavioural component	%		
	Low/less favourable	Medium/ moderately favourable	High/ highly favourable
Knowledge	21.67	65.00	13.33
Attitude	18.33	53.34	26.33
Distribution of respondents based on the attributes			
Factors	Respondents	%	
Relative advantage	38	63.34	
Compatibility	25	41.66	
Complexity	19	31.67	
Trialability	42	70.00	
Observability	17	28.34	

* - Multiple responses

It could be observed from Table 2, that the attributes of trialability (70%), relative advantage (63.34%), and compatibility (41.66%) were supported well for the adoption of IPM module. At the same time, other attributes like observability (28.34%) require a certain degree of improvement, and complexity (31.67%) that can be minimized with the enhanced IPM Module adoption process, accessing Information and Communication Technologies (ICTs) and Mass media tools for providing awareness about the IPM module in basmati rice. Establishing farmer's discussion groups in every village and promotion of farm leadership for demonstration of IPM module in basmati rice at the farm field level and organizing pre-season skill-oriented training programmes help to improve the farmer's confidence in the adoption of IPM practice. Thus, development of farming systems-based participatory farmer first extension approach for successful implementation of the IPM module in basmati rice at the farm field level supports sustainable adoption.

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