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Evaluation of integrated pest and diseases management (IPDM) package on basmati/aromatic rice

C. R. Prajapati[1]*, A. K. Gupta[2] and Shiv Dutt[3]

[1]Krishi Vigyan Kendra, Khekra, Baghpat, S. V. Patel University of Agriculture and Technology, Meerut-250110, India.
[2]Krishi Vigyan Kendra, Nangina, Bijnaor, S. V. Patel University of Agriculture and Technology, Meerut -250110, India.
[3]IP&TM Unit, KAB-1, ICAR, Pusa New Delhi-110012, India.

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Basmati/aromatic rice in the Mid Western Plain Zone of U.P., India is being attacked by a number of insects and diseases every year inspite of using pesticides. Integrated pest and disease management (IPDM) strategies blended with proven technologies including bio-agents was demonstrated on rice variety, Pusa Sugandha-4 at farmers field with the aim to reduce the production cost and pesticides load over the crop. All the activities of demonstrations were carried out in close co-ordination with scientists and farmers as well. In general, lower incidence of insects and diseases along with higher numbers of natural enemies and yield were recorded in all the IPDM adopted fields as compared to farmers practices (FP). The average yield of IPDM fields was higher by 10.70 q/h coupled with higher number of tillers/hill (12.72), grains per panicle (121) and higher test weight (25.10 g). Superiority of IPDM package was also evidenced by economic analysis as cost benefit ratio of 1: 2.90 and 1: 2.37 was obtained in IPDM and farmers practices, respectively.

Key words: Rice, integrated pest and disease management (IPDM), demonstration, farmers, participatory.

INTRODUCTION

Rice (*Oryza sativa* L.) is the predominant food for nearly half of the world's population supplying nearly 31% calories to Indian diet (Shobha et al., 2006). As far as basmati rice is concerned, India is one of the largest exporter in the world that contribute significantly in Indian economy.

In the quest for increasing rice production, peoples have resorted to intensive methods of cultivation by utilizing high-yielding cultivars, higher plant population per unit area and high doses of nitrogenous fertilizers which intensified the attack of several pests and diseases. Basmati rice from the Indian subcontinent is highly priced in the international market for its unique aroma and kernel quality which manifests after cooking. Mid Western Plain Zones falling under basmati zone of country are major areas of Uttar Pradesh state of India where basmati rice is grown in plenty. Pusa Basmati -1121 (Pusa Sugandh-4), Pusa Basmati-1, Pusa Sugandh-5 etc. are the chief varieties which have gained popularity among the farmers of region by fetching remunerative price in market and yielding foreign exchange as well. However, none of these varieties have been found depicting sign of resistance against insects and diseases in farmer's field. Though basmati/aromatic rice faces attack of several insects and diseases from its seeding to harvesting but major ones are stem borer (*Scirpophaga incertulas*), leaf folder (*Cnaphalocrocis medinalis*), gundhi bug (*Leptocorisa* spp.), brown plant hopper (*Nilaparvata lugens*) and whitebacked plant hopper (*Sogatella furcifera*), sheath blight (*Rhizoctonia*

*Corresponding author. E-mail: crprajapati@ymail.com.

solani), bacterial leaf blight (*Xanthomonas oryzae* p.v. *oryzae*), blast (*Pyricularia oryzae*) and false smut (*Claviceps oryzae*) in the region (Kushwaha, 1990). To ward-off threats posed by them, farmers are resorting for indiscriminate and injudicious application of hazardous pesticides which are even quite expensive and often lead to build-up of pesticide resistance in pests and pathogens, residual toxicity, reduced population and functioning of beneficial micro flora and fauna, fragility of ecosystem etc. Moreover, a big export consignment of basmati rice had also been rejected because of high pesticide residues (The Economic Times, Feb. 15, 2001).

In order to relieve the producers from burden cost of production and to avoid possible pesticide residues in the product, integrated pest and disease management (IPDM) is considered to be a viable option. The solution lies in the development and implementation of area-specific, cost effective and environment-friendly IPDM strategies (Misra et al., 1994; Nalini et al., 2013). Conversely, limited efforts have been made to transfer IPDM technologies to basmati rice producers. Pesticides still serve as an essential component of IPM strategies. It may not be possible to avoid chemical pesticides altogether, but integrating non-chemical methods (cultural, mechanical, botanicals, biological etc.) in pest management system can reduce our dependence on chemical pesticides (Matteson, 1996, 2000; Paul and Teng, 1994). The top-down extension of these packages did not give farmers the knowledge they needed to make the adjustments with local--specific conditions. Training and demonstrations also proved to be one of effective and vital approach in dissemination of IPM technologies (Ooi, 1996).

Considering the merits of IPDM, the present study was planned to train and demonstrate the optimum combinations of recommended practices to farmers of two villages at Krishi Vigyan Kendra, Baghpat (U. P.) in season-long participatory mode. A module consisting of proven technologies in the management of pests and diseases was up-scaled in MWPZ of U.P. from 2009 to 2010 by Krishi Vigyan Kendra, Baghpat (U.P.) with a popular aromatic rice variety Pusa Sugandh-4 through on-farm demonstrations at farmer's field in coordination with normal agronomic practices followed in the region.

MATERIALS AND METHODS

District Baghpat falls under mid western plain zone of Uttar Pradesh endowed with good soil and climate required for rice cultivation. Availability of irrigation water for whole rice growing season is also an added advantage to the tillers to embrace rice cultivation as rivers and canals passes through the area though ground water is depleting day by day. During the survey it was found that Pusa Sugandha -4 is a popular rice variety grown in the area with heavy dose of nitrogenous fertilizes (Urea). Despite the proven advantage of zinc and potassic fertilizers in rice, they are rarely been used. Because of imbalance fertilization and conducive climate the attack of insects and diseases are also more that pushes growers to apply heavy doses of pesticides for their management. Farmers generally spray the crop with old and broad spectrum pesticides like monocrotophos, phorate, carbofuran and sulphur compounds in an inappropriate doses and manner in high frequencies. Nevertheless, availability of spurious brand of pesticides in the area is also jeopardizing rice cultivation. Though the high doses of pesticides without other management strategies have been prevalent in area but some farmers have also harvested good crop with low doses of pesticides, indicating ample opportunity and possibilities for adoption of Integrated Pest and Disease Management strategies.

After recording all the facts, twenty rice farmers of two villages *viz*. Ratanpuri (Block-Pilana) and Lahchora (Block-Khekra) of district Baghpat were selected for IPDM training and demonstrations programme. All the programmes were carried out in participatory mode during 2009 and 2010. IPDM demonstrations were conducted in 20.0 ha area of both the villages on prevalent variety (Pusa Sugandha-4) of rice of area utilizing IPDM interventions mentioned in Table 1 along with standard practices required for the crop. Before harnessing the potential of pesticides, economic threshold level (ETL) described in Table 2 was adopted for deciding the time of use of pesticides. The incidence and/or severity of insect pests, diseases and natural enemies were regularly assessed by following standard evaluation system (IRRI) (Anonymous, 1996). The results of whole IPDM package was compared with farmer's pesticide ridden insect and disease management practice.

RESULTS AND DISCUSSION

An attempt was made to study the economic gain of IPDM module up-scaling and the results/benefits accrued at farmer's field. On-farm demonstrations of this IPDM technology was carried out during *Kharif* season of 2009 and 2010 at two villages of district Baghpat (U.P.). The continuous monitoring of pests showed moderate to high incidence of leaf folder and low to medium incidence of stem borer in the area. The incidence of sheath blight disease was also noticed but managed with IPDM package. However, timely field release of *Trichogramma* spp. in IPDM fields suppressed the incidence of leaf folder and stem borer to a bare minimum. Overall, results showed the superiority of IPDM over farmers' own practices (FP) as indicated by the yield data and economic analysis (Tables 3 and 4).

In general, lower number of insect-pests coupled with higher numbers of natural enemies and yield were recorded in all the IPDM fields as compared to farmers practices (FP). In IPDM adopted fields lower incidence of rice diseases and insects *viz.*, sheath blight (6.32%), sheath rot (2.47%), bacterial leaf blight (3.41%), false smut (2.15%), stem borer (2.23%), dead hearts and white ears (2.76%) and leaf folder (6.58%) were recorded. However, in farmers practices, higher incidence of these diseases and pests *viz.*, sheath blight (28.51%), sheath rot (42.30%), bacterial leaf blight (12.40%), false smut (19.42%), stem borer (9.63% dead hearts and white ears (13.20%) and leaf folder (27.54%) were noticed (Table 3 and Figure 1).

Observations on diseases revealed that bacterial leaf blight was observed in the first week of September and sheath blight started appearing in tillering stage of the crop while leaf blast was seen in traces on few plants in

Table 1. The details of the IPDM interventions and farmers practices.

Treatments	Main interventions
IPDM	
Seed and nursery treatment	(i) Seed treatment with streptocycline at 0.3 g + carbendazim at 1.0 g/kg seed (ii) *Trichoderma harzianum* + *Pseudomonas fluorescens* mixture- seed treatment (at 10 g/ Kg) + seedling dip (at 10 g/L) + soil application (at 2.5 kg/ha each) (iii) Spray of 3% neem oil in nursery after 15 DAS
Release of *Trichogramma* spp.	Release of egg parasitoid *Trichogramma japonicum* at 20 trichocards/ha twice (I after the appearance of adult stem borer/dead hearts in the field followed by II after 10 days interval)
Foliar spray of *Pseudomonas fluorescens*	Spray of *P. fluorescens* thrice at 0.2% concentration commencing from 45 days after transplanting at 10 days interval to manage sheath blight, blast and sheath rot diseases
Application of Botanicals	Three foliar sprays of Neem oil at 3% to manage diseases and insects
Bird Perches	Securing bird and owl perches at 16 to 20 nos. /acre
Application of herbicide	Butachlor at 1.5 kg a.i./ha as pre-em., 2-3 days after transplanting
Application of chemicals	Selective application of chemicals as a last option depending upon the pest attack (ETL based). (i) Spray of Quinolphos or Triazophos at 0.2% (4 acre) (ii) Spray of carbendazim+ mancozeb at 0.2% for sheath blight (6 acre) (iii) Spray of streptocycline 15g + copper oxychloride 500g/ha for bacterial leaf blight (5 acre)
Other Agric. Inputs Fertilizer application	N:P:K- 110: 60: 50, Zinc Sulphate 25 kg/ha as basal dose, Gypsum at 500 kg/ha as basal dose
Date of transplanting	Last week of June to I week of July
Age of seedling	21-25 days
Farmers practices (FP)	
Application of chemicals	1 application of phorate or carbofuran at 12 kg/ha 2-4 application of monocrotophos, endosulfan at lower doses (at 500 ml/ha) with frequent interval 1-3 application of fungicide carbendazim at 0.1%
Other Agri. Inputs Fertilizer application	N:P:K:Zn - 150: 60: 0:0 kg/ha
Date of transplanting	II to III week of July
Age of seedlings	30-35 days

Table 2. Economic threshold levels (ETL) for important insect-pests of rice.

S/N	Name of the insect-pest	Economic threshold level (ETL)
1	Stem borer	10% dead hearts or 1 egg masses/m^2 or 2% white ears during initial flowering.
2	Leaf folder	3 damaged leaves/ hill or 10% leaf damage during vegetative stage or 5% of flag leaf damage at flowering.
3	Brown plant hopper (BPH) Whitebacked plant hopper (WBPH)	10 insect/ hill at vegetative stage or 20 insect/ hill at later stage
4	Green leafhopper (GLH)	2 GLH/hill at vegetative stage or 10 GLH/hill at flowering stage
5	Gundhi bug	1 nymph/adult per hill or 2 bug/ hill

Table 3. Pooled data of various parameters of Pusa Sugandha - 4 observed in IPDM v/s farmers practices fields.

S/N	Observations	IPDM	Farmer's practice (FP)
1	Sheath blight (% plant height covered from soil level)	6.32	28.51
2	Sheath rot (% of tillers affected)	2.47	42.30
3	Blast	Rare	Rare
4	Bacterial leaf blight (% leaf area damage)	3.41	12.40
5	False smut (% infected panicle)	2.15	19.42
6	Stem borer (% dead hearts)	2.23	9.63
7	Stem borer (% white ears)	2.76	13.20
8	Leaf folder (% of damage plants)	6.58	27.54
9	No. of tiller/hills	12.72	7.31
10	No. of grains/panicle	121	92
11	Test Weight (g)	25.10	17.60
12	Grain Yield (q/ha)	54.20	43.50
	Natural enemies		
1	Spiders (No./hill)	1-4	0-2
2	Green mirids (Nos./hill)	3-4	1-2
3	Coccinellid beetles (Nos./hill)	3-5	1-2
4	Dragonflies	+	-
5	Wolf Spider	++	-

+ Present, - Absent.

Table 4. Analytical review of demonstration v/s farmers practices.

S/N	Description	IPDM	FP
1	Area under demonstration (ha)	20	05
2	Average yield (q/ha)	54.20	43.50
3	Per cent increase in yield over FP	24.6	-
4	Cost of cultivation (Rs./ha)	24250	23800
5	Gross return (Rs./ha)*	70460	56550
6	Net return (Rs./ha)	46210	32750
7	Mean C: B ratio	1: 2.90	1: 2.37

*Selling price at Rs. 1300 per qt.

IPDM and FP plots. However, in farmers practices, heavy infestations of diseases were encountered despite the spray of carbendazim (0.1%). Likewise, dead hearts produced by stem borer initially observed on 25 days after transplanting (DAT) and leaf folder infestation at 30-35 DAT in the fields while it got checked in IPDM fields. Regular monitoring of the insect pests and diseases in the year 2008 and 2009 revealed that stem borer and leaf folders as the major insect pests followed by sporadic and low incidence of gundhi bug, green leaf hopper and brown plant hopper. Among diseases, sheath blight was the major problem followed by bacterial leaf blight and false smut.

Large scale rice IPDM trainings, demonstrations and campaigns conducted during the *Kharif s*easons of 2009 and 2010 confirmed the munificence of natural enemies and lesser pests in IPDM tested fields than the farmer's practices. However, it is observed that inundative release of egg parasitoid, *Trichogramma japonicum* was really an effective approach to decrease the stem borer and leaf folder attack in rice crop. The results showed that the IPDM approach reduced the insects infestation effectively that resulted into higher numbers of natural enemies *viz.*, spiders (1-4 nos./hill), green mirid bugs (3-4 nos./hill) and coccinellid beetles (3-5 nos./hill) in IPDM fields as against to lesser numbers (0-2 and 1-2, respectively) in the FP. Garg et al. (2000) and Kalode and Krishnaiah (1991) had also reported higher population of natural enemies in IPM practiced fields as compared to farmer fields which supports the present findings.

Overall results showed the superiority of IPDM over farmers' own practices as indicated by the yield data

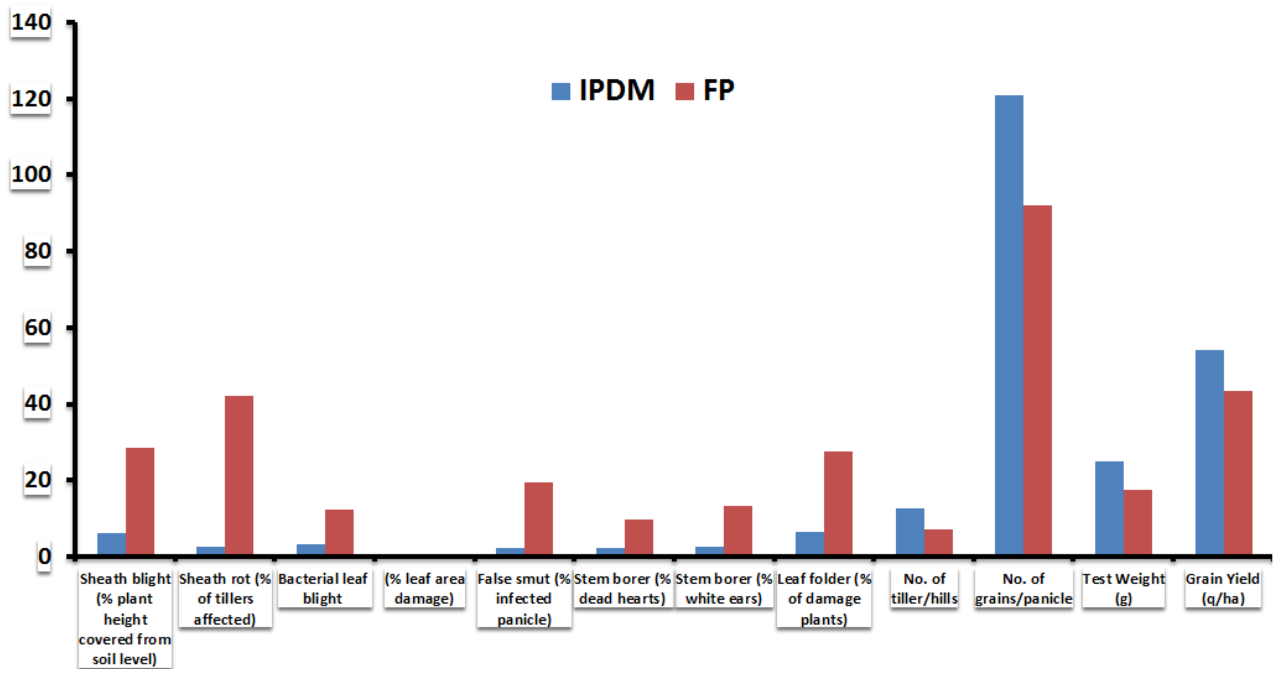

Figure 1. Pooled data of various parameters of Pusa Sugandha - 4 observed in IPDM v/s Farmers Practices fields.

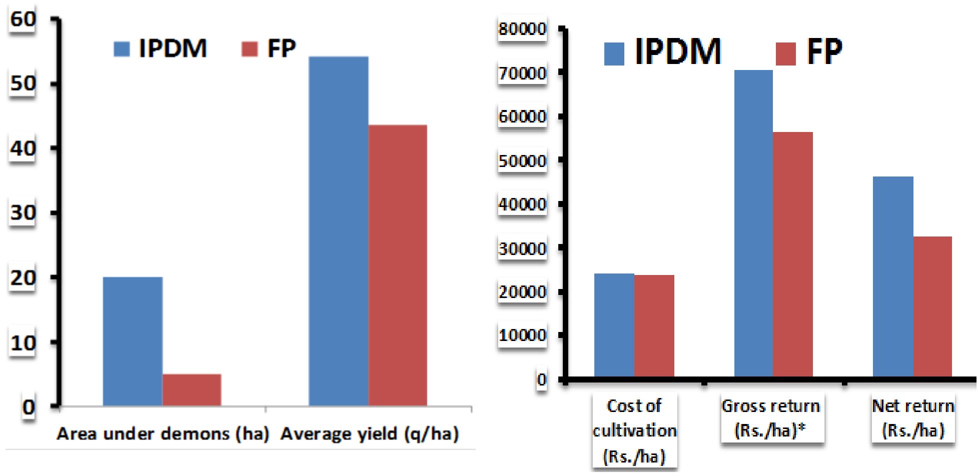

Figure 2. Analytical review of demonstrations v/s farmers practices.

and economic analysis (Table 4). The mean incremental yield obtained in IPDM adopted fields was significantly up by 24.6% over farmers practices. IPDM farmers harvested an average yield of 54.20 q/ha in contrast to the farmers practices (43.50 q/ha) inspite of 4-5 applications of pesticides (Figure 2). This treatment also had more yield contributing parameters like number of tillers/hill (12.72), grains per panicle (121) and higher test weight (25.10 g). The respective net return earned by the IPDM and non IPDM farmers practices (FP) was Rs.46210 and Rs.32750 per hectare which is significantly higher by Rs.13460 ha^{-1} than the farmers practices (Figure 2). Economic analysis also indicated the superiority of IPDM method over farmers practices as it showed mean cost benefit ratio of 1: 2.90 in IPDM as compared to 1: 2.37 in farmers' practices. The results obtained in the IPDM demonstration trials are in conformity with the findings of earlier works conducted by Garg et al. (2000), Katti et al. (2000), Samiayyan et al. (2010) and Sehgal et al. (2001).

It was also found in the study that some other crop management practices in addition to pest management also attributed to increase in grain yield. Timely and synchronous transplanting of 21- 25 days old seedling between 25th June and 10th July resulted more number of effective tillers, grain per panicle, higher test weight, better grain yield and escape and/or reduced occurrence of some insect pests and diseases. However, it was observed that late planting resulted low grain yield which indicates stress conditions during later growth of the plant, unfavourable weather conditions (less solar radiation) and insect pests. Farmers of the area had a practice of planting single plant/ hill while the IPDM farmers were advised to plant 2-3 seedlings /hill that helped in higher plant stand. Farmers applied higher doses of nitrogenous fertilizers and more number irrigation thus making plants susceptible to insects and diseases (*viz.*, plant hoppers, bacterial leaf blight etc.) and prone to lodging which resulted in yield losses. However, application of balanced fertilizers, proper weed and water management / irrigation schedules were advised under IPDM that helped in overcoming the above problems.

It has also been observed that farmers of area have not resorted for paddy seed treatment but used pesticides like phorate, carbofuran and monocrotophos in inappropriate doses that resulted in deleterious effect on natural enemies and also created resurgence and population build up of many minor insect pests and diseases. However, seed treatment was inserted as a mandatory practice in IPDM interventions which resulted in lower pests population from beginning to till harvesting of the crop. All these factors helped in improving the yield and economics in IPDM fields. It is reflected from the yield and other data obtained that IPDM is a Good Agricultural Practices (GAP) and a holistic approach for crop management. Hence, the IPDM adoption can help farmers to improve sustainability of the basmati/aromatic rice production system thus it can be conceded that IPDM approach adopted with proper motivation and involvement can change the face of basmati/aromatic rice growers.

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