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Evaluation of management techniques for the control of insect-pests of *Basmati* rice in Punjab

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ABSTRACT

Integrated pest management techniques based on scientifically proven component for the control of stem borer and leaf folder were evaluated in large scale field trails at farmer's field in village Sudhar (Distt. Ludhiana). In rice crop, IPM model-I (Traps + chemical control) gave higher economic returns than IPM model-II (Traps + trichocards + chemical control). In both the models the incidence of leaf folder (0.12-0.38 %) and stem borer (0.30-1.22 %) was lower than farmer's practice 1.19 per cent leaf folder damage and 1.29-3.42 per cent stem borer damage. In Basmati rice, IPM model-II (Traps + trichocards + chemical control) gave higher economic returns than IPM model-I (Traps + chemical control). In both the models the incidence of leaf folder (0.38-0.53 %) and stem borer (1.52-4.02 %) was lower than farmer's practice 3.35 per cent leaf folder damage and 14.42-15.97 per cent stem borer damage. In both, rice and basmati rice IPM farmers get low pest incidence and higher economic returns.

Key words: *Basmati rice, yellow stem borer, leaf folder, pheromone trap, rice, trichocard, management*

India has the largest area under rice in the world and ranks second among the rice producers, accounting for above 20 per cent of global rice exports (Garibay *et al.* 2003). From India, 80 per cent of the total of 8-9 lakh tones of *basmati* production has been exported to other countries (APEDA 2008). In Punjab, rice is cultivated on an area of 26.10 lakh hectare with production of 104.89 lakh tons, with an average yield of 4.01 t ha^{-1}, whereas *Basmati* occupies only 4-5 per cent area (Anonymous 2009). Among various insect-pests infesting *basmati* rice yellow stem borer, *Scirpophaga incertulas* (Walker) is predominant and economically important insect-pest (Chelliah *et al*. 1989; Geddes and IIes 1991; Krishnaiah *et al*. 2004). Female lays eggs in masses near the tip of the leaves. Larva after hatching enters the stem near the nodal portion. Damage symptoms appeared as dead heart, in which central leaf of the culm drys up in vegetative stage. When attack appeared in the panicle bearing stage then unfilled grains appear and such panicles are called white ears or white heads. The rice plant cannot compensate for this loss and causes reduction in the yield. Rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) is another important pest, where larvae feed by scrapping green mesophyll from within the folded leaves. In case of severe, attack infested plants give scorched whitish appearance and greatly reduced the general vigour and photosynthetic activity of the plant. Later on, infested leaves dry up, causing yield loss.

Bio-rational/ bio-control techniques, *viz.* pheromone traps and bio-agents are environment friendly and reduce pest pressure. Pheromone and bio-agents, are species-specific, have no adverse effect on the non-targets and hence would be fully compatible with other management approaches to control yellow stem borer and leaf folder (Katti *et al.* 2001; Garg *et al*. 2002; Kaur *et al.* 2003; Ignacimuthu 2005; Mahal *et al.* 2006). The present study, therefore, was under taken to evaluate the efficacy of pheromone traps for monitoring, bio-control agents and chemicals in two models in comparison to various practices adopted by the rice and *Basmati* rice growing farmers.

MATERIALS AND METHODS

Experiments were conducted in farmer's field at village Sudhar in district Ludhiana, Punjab. Nine farmers were

selected as IPM farmers with 53 acres of non-Basmati rice and *Basmati* rice and five farmers as Non-IPM farmers with 28.5 acres of rice crop. IPM farmer's carried out transplanting of rice from 10-20 June, while transplanting of *Basmati* was done from July 20-30 July, 2004. IPM farmer's followed agronomic practices (fertilizers, herbicide and transplanting) as per the PAU package recommendation (Anonymous 2004). Whereas, in case of farmer's practice farmers applied higher dose of nitrogenous fertilizers in both the crops. Cultivars grown in IPM farmer's fields were PR 118, Pusa 44, PR 116, Hybrid 6111 and Basmati 386, while it was PR 114, PR 118, Pusa 44 and Basmati 386 in non-IPM farmer's fields.

Sleeve type traps were used to assess the population of male yellow stem borer, *S. incertulas*. Traps were fixed @ 3 tarps acre^{-1} and installed 60 m apart in triangular layout. Septa were replaced on an average after every 21 days and trap catch data was collected once in every week. Population of yellow stem borer was monitored throughout the crop season. Seven augmentative releases of *Trichogramma chilonis* and *T. japonicum* were done @ 1 lakh ha^{-1} at weekly interval starting 30 days after transplanting for the control of stem borer and leaf folder. Trichocards were tagged seven times in the fields.

In model-I (chemical control + pheromone trap) treatment, two sprays of insecticides, *viz*. chlorpyriphos 20EC (Dursban®) and imidacloprid 200 SL (Confidor®) were applied on rice, whereas in *Basmati* two applications of cartap hydrochloride (Padan 4G®) along with one spray of insecticide, *viz*. chlorpyriphos 20EC (Dursban®) was done. Three pheromone traps per acre were fixed for stem borer monitoring. In model-II (chemical control + pheromone trap + trichocards) treatment, one spray of imidacloprid 200 SL (Confidor®) was applied on rice, whereas in *basmati* sprays of chlorpyriphos 20EC (Dursban®) was done. In case of Non-IPM (farmer's practice) treatment, farmer followed his own practices, such as one application of Padan 4 G and four sprays of Dursban 20 EC and Confidor 200 SL on rice and two applications of Padan 4 G and three sprays of Dursban 20 EC and Confidor 200 SL on *Basmati*.

The leaf was considered to be damaged by the leaf folder if at least 1/3rd of its area had damage symptoms. Leaf damage was recorded from 30 hills and data were converted to per cent damage. Similarly, observations on stem borer damage (dead heart and white ear) were recorded from 30 hills selected randomly and per cent damage was worked out. Each treatment was divided into six blocks to record observations. The data on per cent infestation were converted to arcsine transformation and then statistically analyzed using analysis of variance. The different treatment means were separated by least significant difference test (LSD) at p=0.05 (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The incidence of stem borer in the form of dead hearts and white ears was low on the rice crop. Dead heart damage in model I (0.47 %) and model II (0.30 %) was on a par but significantly less than the farmer's practice (1.29 %) (Table 1). White ears damage in model I (1.22 %) and model II (0.40 %) was on a par but significantly less than the farmer's practice (3.42 %) (Table 1).

Leaf folder damage in model I (0.38 %) and model II (0.12 %) was on a par but significantly less than the farmer's practice (1.19 %) (Table 1). The leaf folder damage in the fields of IPM farmer's was significantly less than the farmer's practice who used two sprays of Dursban 20 EC on rice crop against leaf folder. In model II, where augmentative releases of *Trichogramma chilonis* and *T. japonicum* were done against against leaf folder and stem borer, the incidence of these pests was less and no chemical was applied for the control of these insect-pests. Bentur *et al*. (1994) also successfully reported the effectiveness of *Trichogramma japonicum* against *C. medinalis*. Yield was statistically on a par in IPM models and farmers practice.

The incidence of stem borer in the form of dead hearts and white ears was high on the *basmati* crop. Dead hearts damage in model I (4.02 %) and model II (2.29 %) was on a par but significantly less than the farmer's (14.42 %) (Table 1). White ear damage in model I (2.17 %) and model II (1.52%) was on a par but significantly less than the farmer's practice (15.97 %) (Table 1). These studies are supported by the earlier findings of Balasubramanian *et al*. (1994) who suggested that integration of biocontrol agents with insecticides was effective for the management of leaf

Table 1. Insect-pest damage in IPM and farmer's practice in non-Basmati and Basmati rice

Treatment	Folded leaves (%)	Dead hearts (%)	White ears (%)	Mean yield (t ha^{-1})
Non-Basmati rice				
Traps + chemical control (IPM model-I)	0.38 (6.62)	0.47 (6.77)	1.22 (5.84)	6.62
Traps + trichocards + chemical control (IPM model-II)	0.12 (6.05)	0.30 (6.47)	0.40 (3.60)	6.48
Farmer's practice	1.19 (8.18)	1.29 (8.44)	3.42 (10.56)	6.85
CD (p=0.05)	(0.87)	(1.34)	(4.03)	NS
Basmati rice				
Traps + chemical control (IPM model-I)	0.38 (6.69)	4.02 (12.70)	2.17 (8.16)	4.06
Traps + trichocards + chemical control (IPM model-II)	0.53 (7.04)	2.29 (9.99)	1.52 (6.99)	4.31
Farmer's practice	3.35 (11.52)	14.42 (22.23)	15.97 (23.03)	3.67
CD (p=0.05)	(2.02)	(3.68)	(8.36)	NS

Figures in parentheses are arcsine-transformed values

folder and stem borer. Mahal *et al*. (2007) reported that incidence of yellow stem borer in terms of dead hearts and white ears was very low (1.41-4.30 and 1.70-2.75 %) in pheromone trap based IPM fields than in the non-IPM farmer's fields (4.49-7.40 and 4.50-15.94 %), respectively.

The incidence of leaf folder was high on *basmati* crop. Folded leaf damage in model I (0.38 %) and model II (0.53 %) was on a par but significantly less than the farmer's practice (3.35 %) (Table 1). The leaf folder damage in the fields of IPM farmer's was significantly less than the farmer's practice who used one spray of Dursban 20 EC on *basmati* against leaf folder. These studies corroborate earlier findings of Arasumallah *et al*. (1984) also reported that release of *japonicum* gave higher yield as parasitization of *Cnaphalocrocis medinalis* (Guenee) eggs reduced the

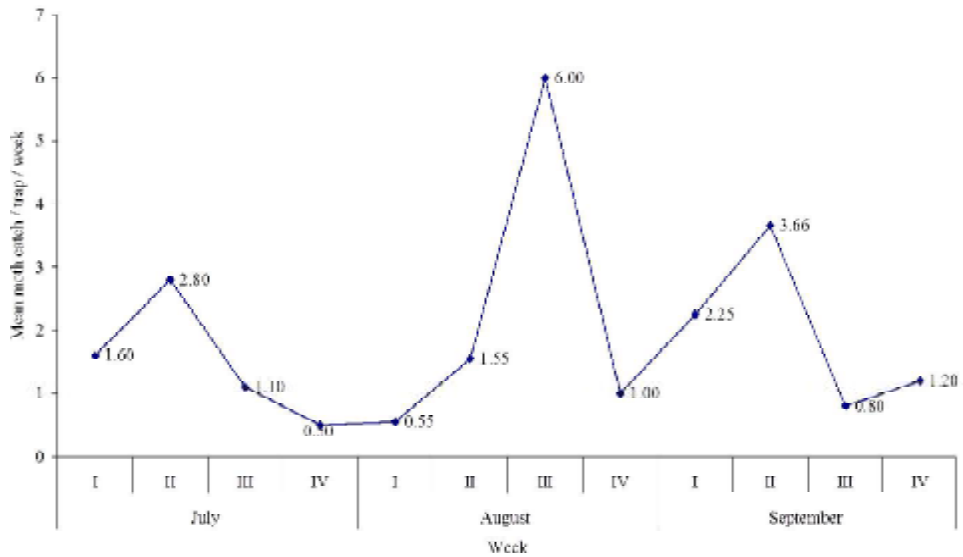

Fig. 1. Moth catch of stem borer in sex pheromone traps from rice crop at village Sudhar, Dist. Ludhiana during wet season, 2004

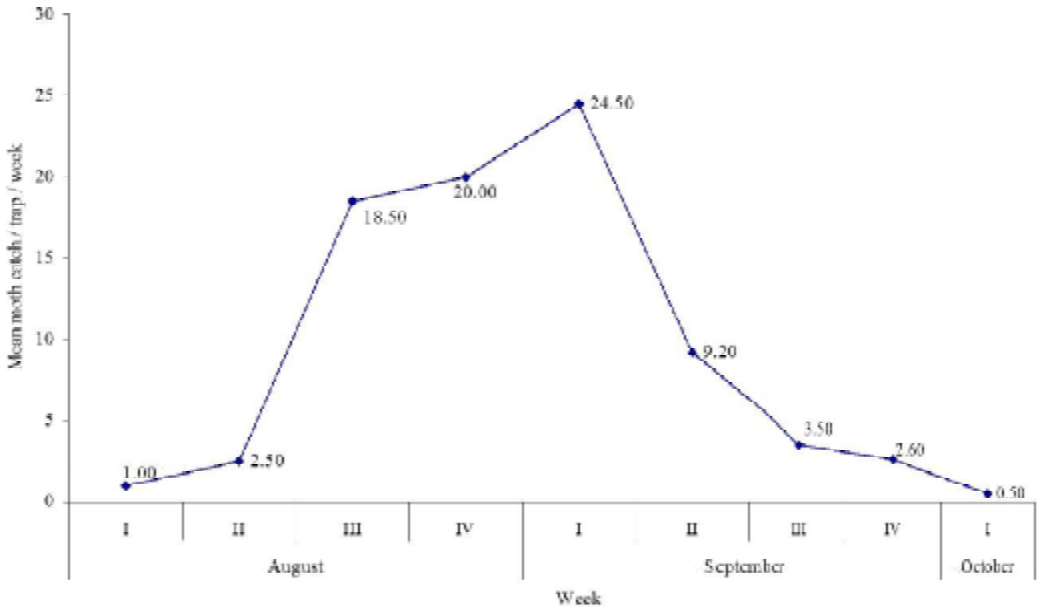

Fig. 2. Moth catch of stem borer in sex pheromone traps from Basmati crop at village Sudhar, Distt. Ludhiana during wet season, 2004

leaf damage. Mahal *et al*. (2007) reported that incidence of leaf folder was low (0.35-8.10 %) in IPM fields than in the non-IPM farmer's fields (0.94-9.70 %), respectively. Yield was statistically on a par in IPM models and farmers practice.

The population of stem borer in rice crop was monitored through the use of pheromone traps in the crop season starting from third week of April to last week of September. The moths were first observed in traps in the week of July. The maximum mean moth catch per trap per week was observed to be 6 during the third week of August and minimum (0.50) during the last week of July (Fig. 1).

In case of basmati crop, moth catch was first observed during the first week of August. The moth catch reached the peak of 24.40 in the first week of September and it remained high from third week of August to second week of September (Fig. 2). Singh et al., (2006) substantiate the studies by the findings of two peaks, first during 3rd week of August and second during 2nd week of September. Earlier, workers also reported the use of sex pheromone for monitoring and management of pest species through mating disruption (Cork *et al*. 1985; Rao *et al*. 1994; Cork and Basu 1996; Cork *et al*. 1996; Swant *et al*. 1996; Pushpakumari and Tiwari 2005).

In IPM model-I strategy (pheromone traps + chemical control) farmers, had to apply one spray of each chlorpyriphos 20 EC and imidacloprid 200 SL to check leaf folder and whitebacked planthopper incidence on rice crop. Mean incidence of stem borer remained below the ETH level of 5 per cent and so no application of granular insecticides / spray was done. Similarly in case of IPM model II strategy (pheromone traps + bioagents + chemical control) one application of imidacloprid 200 SL was done to check whitebacked planthopper incidence on rice crop. On the other hand, Non-IPM farmers (farmer's practice) used cartap hydrochloride 4G along with three sprays (Two sprays of chlorpyriphos 20 EC and one spray of imidacloprid 200 SL) for the management of insect-pests of rice crop. Mean yield obtained by the IPM farmers in model I & II was 66.25 and 6.48 t ha^{-1}, respectively, as compared to 6.85 t ha^{-1} by non-IPM farmers. The IPM farmers invested much less in plant protection practices (Rs. 1617.50 in IPM model I) and (Rs. 2822.50 in IPM model II) on insecticidal application and fixing pheromone traps as compared to Non-IPM farmers (Rs. 4445.00) on insecticides alone. Similarly, IPM farmers in model I & II invested Rs. 3965.00 each as production cost as compared to Rs 4445.00 in case of farmer's practice. Hence net income gained by IPM

Table 2. Economics for IPM technology and farmer's practice in non-Basmati and *Basmati* rice

Parameter	IPM model-I	IPM model-II	Farmer's practice
Non-Basmati rice			
Number of insecticide applications			
Leaf folder	1(Rs. 650.00)	0	2 (Rs. 1300.00)
Stem borer	0	0	1 (Cartap hydrochloride) + 1 (Rs. 2350.00)
Whitebacked planthopper	1 (Rs. 405.00)	1(Rs. 405.00)	1(Rs. 405)
Cost of pheromone trap assembly + lures (4 times)	Rs. 562.50	Rs. 562.50	0
Total cost of chemical application + trap fixing	Rs. 1617.50	-	Rs. 4055.00
Cost of chemical application + trap fixing + Trichocard tagging	-	2822.50	
Production cost	Rs. 3965.00	Rs. 3965.00	Rs. 4445.00
Yield (q/ha)	66.25	64.80	68.50
Total income	Rs. 39087.50	Rs. 38232.00	Rs. 40415.00
Gain	Rs. 33505.00	Rs. 31444.50	Rs. 31915.00
Net gain	Rs. 1590.00	Rs. 470.50	
Basmati rice			
Number of insecticide applications			
Leaf folder	1 (Rs. 650)	0	1(Rs. 650)
Stem borer	2 (Cartap hydrochloride) (Rs. 3400.00)	2 (Rs. 1300.00)	2(Cartap hydrochloride)+ 1(Rs. 4050.00)
Whitebacked planthopper	0	0	1 (Rs. 405.00)
Cost of pheromone trap assembly + lures (4 times)	Rs. 562.50	Rs. 562.50	0
Total cost of chemical application + trap fixing	Rs. 4612.50	-	Rs.5105.00
Cost of chemical application + trap fixing + Trichocard tagging	-	Rs. 3717.50	
Production cost	Rs. 3077.00	Rs. 3077.00	Rs. 3545.00
Yield (q/ha)	40.62	43.12	36.78
Total income	Rs. 48,744.00	Rs. 51744.00	Rs. 44,136.00
Gain	Rs. 41,054.50	Rs. 44949.50	Rs. 35486.00
Net gain for IPM farmers	Rs. 5568.50	Rs. 9463.50	

Price of produce = Rs. 590.00 (Rice); Rs. 1200 (Basmati); Cartap hydrochloride = Rs. 59.00/kg, Cost of labour @ Rs. 90/day/application; Chlorpyriphos = Rs. 170/litre, Cost of labour @ Rs. 90/day/application; Imidacloprid = Rs. 1800/litre, Cost of labour @ Rs. 90/day/application; Trichocard : based on 7 taggings @ Rs. 35/card/ha, Cost of tagging @ Rs. 90.00 per 7 taggings; Production cost: Urea @ 275 kg/ha (Rs. 480/q), DAP @ 50 kg/ha (Rs. 920/q), Machete @ 3.0 l/ha (Rs. 228/l), transplanting @ 1500/ha

farmers in model I was Rs. 1590.00 per hectare and in model II it was Rs. 470.50 per hectare over the non-IPM farmers (Table 2).

IPM farmers had to give two applications of cartap hydrochloride 4G along with one application of spray in model I and only two spray applications in model II to check the stem borer damage as its incidence remained quite high. On the other hand, non-IPM farmers used cartap hydrochloride 4G twice along with three sprays (chlorpyriphos 20 EC, monocrotophos 36 SL and imidacloprid 200 SL) for the management of insect-pests of *Basmati rice*. The mean yield obtained by the IPM farmer was 4.06 t ha^{-1} as compared to 3.67 t ha^{-1} by Non-IPM farmers. The IPM model I and model II farmers invested much less in plant protection (Rs. 4612.50 and Rs. 3717.50) over the non-IPM farmers (Rs. 5105.00). Similarly, IPM farmers in model I and II invested Rs. 3077.00 each as production cost as compared to Rs 3545.00 in case of farmer's practice. Hence net income gained by IPM farmers in model I was Rs. 5568.50 per hectare and in model II it was Rs. 9463.50 per hectare over the non-IPM farmers (Table 2). Garg *et al.* (2002) worked out economics of IPM and non-IPM practices and found that adoption of IPM technology gave higher cost : benefit ratio. Sharma *et al.* (2008) indicated that IPM practice

adopted farmers get higher yield and better cost : benefit ratio. Economic data indicated that IPM treatments resulted in higher yield and net returns than Non-IPM practices.

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