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EVALUATION OF SOME INTEGRATED PEST MANAGEMENT MODULES AGAINST SHOOT AND FRUIT BORER (*LEUCINODES ORBONALIS* GUENEE) IN BRINJAL (*SOLANUM MELONGENA* L.)

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Abstract

A field study was carried out for two consecutive years *i.e. Zaid*, 2009 and 2010 to evaluate some integrated pest management modules against shoot and fruit borer (*Leucinodes orbonalis* G.) in brinjal. The eight treatments included 6 bio-intensive integrated pest management modules comprised of various mechanical, cultural, physical, biological and chemical control methods in various combinations, one farmers practice prevalent in the area and an untreated control. Module-V consisting bio-intensive + mechanical + chemical method had the least shoot infestation and fruit infestation of *L. orbonalis* followed by Module-VI (bio-intensive (II) + Mechanical + chemical). The efficacy of modules in respect of fruit yield, the Module-V reported maximum yield (248.42 q/ha) followed by Module-VI (240.72 q/ha). While in 2010 the maximum yield (247.44 q/ha) was found in Module-V followed by Module-VI (236.83 q/ha). As regards the cost benefit ratio of modules, Module-V had the maximum C : B ratio (1: 8.13) followed by Module-VI (1: 6.26), respectively.

Key words : IPM modules, brinjal, brinjal shoot and fruit borer, cost benefit ratio.

Introduction

Among the different vegetables, brinjal (*Solanum melongena* L.) is one of the most important solanaceous annual vegetable crop. It occupies a key position on account of its high yield potential, low input cost and ability to grow under diverse agro climatic conditions, especially in tropical and sub-tropical environment. Among several biotic and abiotic stresses affecting brinjal, incidence of insect pests is one of the major yield reducing prime factors. Twenty two different insect species are known to attack this vegetable crop, inflicting qualitative and quantitative losses. Predominant among them is shoot and fruit borer, *Leucinodes orbonalis* G., jassid, *Amrasca biguttula biguttula* and whitefly, *Bemisia tobaci* causing considerable damage at both vegetative and reproductive stages and act as major constraints in production of marketable fruits (Butani and Verma, 1978). It is very essential to develop with cost effective strategies for sustainable pest management, without disrupting the agro-ecosystem especially in vegetables. Due to export potential of brinjal fruit, it is imperative to develop alternate plant protection measures towards minimizing the use of insecticides. Considering to this, it is enviable to make the judicious use of pesticides in combination with bio-rational methods of pest management. In the sequence, scattered information on insecticidal efficacy and some IPM modules are there on record in different parts of the country. However, available modules are reasonable to be assessed to derive a best-fit module, which could be proved economically viable, environmentally safe and socially acceptable. Taking all above facts in to consideration, the present studies were undertaken to evaluate some IPM modules against shoot and fruit borer, *L. orbonalis* of brinjal.

Materials and Methods

The present study was carried out during *Zaid*, season of the year 2009 and 2010 at Crop Research Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, (U.P.), India. A good crop of brinjal variety Pusa Purple Round was maintained by transplanting in the month of March 2009 and 2010 and following all the improved agronomic practices recommended for the area except insect pest's

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management. The experiment was conducted in randomized block design with three replications, each containing eight treatments with a plot size of 20 m^2. The eight treatments included six different IPM modules, one farmers practice and one untreated control (table 1). The observations were recorded in both the season regarding infestation of brinjal shoot and fruit borer. The shoot and fruit infestations were recorded by counting total number of healthy and infested shoot and fruits on randomly selected and tagged five plants in each treatment after weekly interval. The data were statistically analyzed by following the procedure given by Panse and Sukhatme (1985). The replication wise yields of brinjal fruits was recorded from all the eight treatments. the yield per plot was converted into yield per hectare. The per cent infestation of shoot and fruit borer was subjected to the same procedure of Analysis of Variance (ANOVA), so that differential per cent infestation in the treatment could be assessed separately. While comparing the yield from different treatments, the per cent increase in yield over control was calculated by following the procedure given by Pradhan (1969).

$$\text{Increase in yield over control (\%)} = \frac{(T - C)}{C} \times 100$$

Where,

T = Yield from treated plot.

C = Yield from control plot.

The ultimate goal was to find out a suitable management strategy against brinjal shoot and fruit borer infested brinjal, with the most favourable cost : benefit ratio. The cost : benefit ratio for all the treatments was worked out considering the prevailing market price of inputs like insecticides, labour charges, rent of sprayer, market rate of brinjal, etc. as shown in table 3.

Results and Discussion

Efficacy of IPM modules on shoot infestation

In the present study, bioefficacy of different modules against the brinjal shoot and fruit borer was measured in terms of mean infestation of this insect over the crop plants. The results indicate that during both the crop seasons, all the treatment were significantly effective in reducing the infestation of this insect as compared to the untreated control (table 2). The infestation was started for 14^{th} standard week and remained upto 19^{th} standard week during both years of experimentation. Application of IPM module-V (installations of pheromone trap @ 5 traps/acre for monitoring the population of *L. orbonalis* + six release of egg parasitoid, *Trichogramma chilonis*

Table 1 : Treatment combinations and their respective symbols.

Modules	Treatments combinations
Module-I	**Bio – intensive (I)**
	Installations of pheromone trap @ 5 traps/acre for monitoring the population of *L. orbonalis*. + six release of egg parasitoid, *Trichogramma chilonis* @ 1.0 Lakh/ha against *L. orbonalis*, initiated with flowering and subsequent at 10 days intervals. + three sprays of NSKE (5%) at 60, 80 and 90 days after transplanting (DAT). + one spray of Bt @ 1500 ml/ha at 70 days after transplanting.
Module-II	**Bio – intensive (II)**
	Module-I Bio – intensive (I) + one spray of entomopathogenic nematode @ 1500 IJ's /ha at 70 days.
Module-III	**Bio – intensive (I) + Mechanical**
	Module I + mechanical clipping of infested terminal shoots at weekly intervals.
Module-IV	**Bio – intensive (II) + Mechanical**
	Module II + mechanical clipping of infested terminal shoots at weekly interval.
Module-V	**Bio – intensive + Mechanical + chemical**
	Module III + one spray of imidacloprid 17.8 SL @ 0.5 ml/litre at 100 days after transplanting.
Module-VI	**Bio – intensive (II) + Mechanical + chemical**
	Module IV + one spray of imidacloprid 17.8 SL @ 0.5 ml/litre at 100 days after transplanting.
Module-VII	**Farmers practices**
	First spray of monocrotophos 36 SL @ 0.05% at 45 days + second spray of cypermethrin @ 0.005% at 60 days + third spray of profenophos @ 0.1% at 75 days + fourth spray of Imidacloprid @ 0.5 ml/ lit at 90 days.
Module-VIII	**Untreated control.**

Table 2 : Evaluation of crop protection modules against shoot infestation of brinjal shoot and fruit borer (*Leucinodes orbonalis*) in brinjal (*Solanum melongena*) during, *Zaid* 2009 and 2010.

IPM Modules	Infested shoot (%)											
	Standard Week											
	14		15		16		17		18		19	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Module-I	1.46(6.92)	1.21(6.31)	2.78(9.59)	3.09(10.09)	4.82(12.68)	5.51(13.49)	6.52(14.78)	6.29(14.45)	7.36(15.69)	7.85(16.25)	8.50(16.95)	8.78(17.22)
Module-II	1.76(7.51)	1.94(7.99)	2.58(9.23)	2.83(9.66)	5.26(13.25)	5.93(14.08)	8.23(16.65)	7.32(15.66)	8.92(17.32)	8.71(17.12)	9.81(18.24)	9.93(18.34)
Module-III	1.32(5.25)	1.46(6.90)	1.83(7.76)	1.81(7.72)	1.99(8.12)	1.99(8.09)	2.61(9.26)	2.47(8.86)	1.99(8.09)	2.11(8.35)	2.13(8.38)	2.42(8.87)
Module-IV	1.58(7.12)	1.67(7.37)	2.10(8.29)	2.08(8.28)	1.82(7.66)	1.85(7.80)	1.77(7.52)	2.08(8.20)	2.50(9.09)	2.73(9.49)	2.98(9.90)	3.13(10.18)
Module-V	0.42(2.14)	0.31(3.09)	0.87(4.36)	0.62(4.48)	0.62(3.69)	0.26(2.38)	0.26(1.68)	0.83(5.18)	0.96(5.61)	0.99(5.66)	1.07(5.90)	1.29(6.51)
Module-VI	0.74(4.04)	0.69(3.88)	1.24(6.35)	1.11(5.96)	0.83(5.24)	1.73(7.54)	1.11(5.98)	0.74(4.92)	1.08(5.89)	1.42(6.83)	1.29(6.39)	1.53(7.08)
Farmers Practice	0.93(5.52)	0.98(5.64)	2.08(8.26)	2.47(9.03)	3.46(10.67)	3.79(11.20)	2.47(8.91)	2.99(9.85)	3.98(11.47)	4.24(11.79)	3.42(10.65)	3.89(11.35)
Untreated control	2.08(8.09)	2.38(8.85)	3.88(11.33)	3.53(10.81)	6.76(15.07)	6.93(15.24)	9.36(17.71)	9.51(17.94)	10.96(19.31)	11.69(19.93)	12.43(20.63)	12.66(20.82)
SE (m)±	**1.668**	**0.750**	**0.884**	**0.466**	**0.780**	**0.663**	**1.051**	**0.764**	**0.585**	**0.727**	**0.515**	**0.535**
CD at 5%	**N.S.**	**2.297**	**2.707**	**1.427**	**2.390**	**2.030**	**3.218**	**2.340**	**1.790**	**2.228**	**1.578**	**1.640**

*Figures in parentheses are angular transformed values.

@ 1.0 Lakh/ha initiated with flowering and subsequent at 10 days intervals + three sprays of NSKE (5%) at 60, 80 and 90 days after transplanting + one spray of Bt @ 1500 ml/ha at 70 days after transplanting + one spray of imidacloprid 17.8 SL @ 0.5 ml/litre at 100 days after transplanting) showed the lowest shoot infestation ranged from 0.26 per cent in 17th standard week to 1.07 per cent in 19th standard week during 2009, 0.26 per cent in 16th standard week to 1.29 per cent in 19th standard week during 2010 followed by IPM module-VI where shoot infestation was ranged from 0.74 per cent in 14th standard week to 1.29 per cent in 19th standard week during 2009, and 0.69 per cent in 14th standard week to 1.73 per cent in 16th standard week during 2010. Under the farmer practice, the shoot infestation was ranged from 0.93 per cent in 14th standard week to 3.98 per cent in 18th standard week during 2009 and 0.98 per cent in 14th standard week to 3.89 per cent in 19th standard week during 2010.

The highest shoot infestation ranged from 2.08 per cent in 14th standard week to 12.43 per cent in 19th standard week during 2009 and 2.38 per cent in 14th standard week to 12.66 per cent in 19th standard week during 2010 was recorded under control treatments.

Removal and destruction of infested twigs/fruits and fallen leaves twice in a week + *Bt* @ 0.5 kg/ha showed minimum infestation of shoots (1.07% and 1.29%) and fruits (1.03% and 1.79%) and produced maximum healthy fruits. It might be attributed due to successive reduction in carryover of the pest in shoots, fruits and fallen leaves. These findings are in close agreement with the findings of Naitam and Mali (2001); Rath *et al*. (2005) and Yadav *et al*. (2005). The findings of present study get supported by the finding of Rath *et al*. (2005) and Yadav *et al*. (2005), who also reported that NSKE @ 5% to be the effective treatment against shoot and fruit borer. Removal and destruction of infested twigs/fruits and fallen leaves twice in a week + Neem gold @ 2.0 ml/l showed minimum infestation of shoots (3.15% and 2.18%) and fruits (3.06% and 2.98%) in present investigation had also been recommended for the management of this pest by several workers (Chakraborty, 2001; and Rath *et al*., 2005).

Efficacy of IPM modules on fruit infestation

It is evident from the data that fruit infestation was low in IPM module-III, Module-IV, Module-V and module-VI as compared to the IPM module-I and module-II during both the years of experimentation. The fruit infestation recorded under farmers' practices module-VII (first spray of monocrotophos 36 SL @ 0.05% at 45 days + second spray of cypermethrin @ 0.005% at 60

Table 3 : Evaluation of crop protection modules against fruit infestation of brinjal shoot and fruit borer (*Leucinodes orbonalis*) in brinjal (*Solanum melongena*) during, *Zaid* 2009 and 2010.

IPM Modules	Infested fruit (%)															
	Standard Week															
	19		20		21		22		23		24		25		26	
	2009	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**
Module-I	4.05 (11.59)	3.84 (11.27)	3.99 (11.28)	4.92 (12.78)	6.61 (14.82)	5.43 (13.45)	6.34 (14.54)	6.98 (15.31)	7.77 (16.07)	7.85 (16.26)	8.56 (16.99)	8.32 (16.73)	9.14 (17.57)	9.48 (17.91)	9.98 (18.37)	9.74 (18.17)
Module-II	5.84 (13.93)	5.62 (13.66)	6.26 (14.30)	6.71 (14.99)	7.94 (16.35)	7.57 (15.95)	8.17 (16.59)	8.09 (16.51)	8.74 (17.07)	8.61 (17.04)	9.84 (18.24)	9.74 (18.17)	10.49 (18.86)	10.11 (18.49)	12.60 (20.77)	12.43 (20.60)
Module-III	1.67 (7.43)	1.83 (7.69)	1.83 (7.76)	1.21 (6.18)	1.96 (8.04)	1.67 (7.36)	1.35 (5.44)	1.29 (6.48)	2.89 (9.67)	2.98 (9.92)	2.32 (7.17)	2.59 (9.15)	1.57 (5.89)	1.32 (6.58)	2.24 (8.59)	2.16 (8.26)
Module-IV	2.30 (8.68)	2.17 (8.43)	1.77 (7.62)	1.93 (7.94)	2.57 (9.19)	2.43 (8.17)	2.91 (8.03)	2.95 (9.88)	2.47 (8.82)	2.26 (8.44)	1.95 (8.02)	2.57 (9.17)	2.11 (8.32)	2.47 (8.92)	2.80 (9.60)	2.65 (9.33)
Module-V	1.22 (5.18)	1.51 (7.02)	1.62 (7.32)	1.69 (7.45)	1.03 (4.76)	1.14 (5.61)	1.69 (6.10)	1.45 (5.51)	1.39 (5.50)	1.08 (5.96)	1.51 (5.71)	1.22 (6.28)	1.45 (5.62)	1.36 (6.62)	1.79 (6.27)	1.93 (7.93)
Module-VI	1.92 (7.94)	1.39 (6.67)	1.67 (7.43)	1.11 (6.05)	1.18 (5.08)	1.91 (7.84)	1.90 (7.91)	1.26 (6.37)	1.79 (6.27)	1.76 (7.59)	1.11 (3.51)	1.19 (6.25)	1.91 (6.48)	1.49 (6.97)	1.94 (6.54)	1.57 (7.16)
Farmers Practice	3.13 (10.12)	3.68 (11.02)	4.53 (12.25)	4.89 (12.75)	3.89 (11.37)	3.73 (11.12)	5.75 (13.85)	5.68 (13.75)	6.68 (14.97)	6.31 (14.48)	4.69 (12.23)	4.83 (12.67)	5.68 (13.76)	5.79 (13.91)	4.77 (12.61)	4.98 (12.88)
Untreated control	35.96 (36.81)	31.92 (34.38)	33.85 (35.56)	29.82 (33.08)	35.58 (36.59)	34.57 (35.99)	37.08 (37.49)	36.96 (37.42)	34.57 (35.99)	37.81 (37.93)	36.61 (37.22)	35.58 (36.60)	29.93 (33.18)	30.39 (33.44)	31.21 (33.95)	32.69 (34.85)
SE (m)±	**1.144**	**0.722**	**0.984**	**0.603**	**1.380**	**0.969**	**2.054**	**1.178**	**1.859**	**0.666**	**2.291**	**0.570**	**1.962**	**0.458**	**1.710**	**0.757**
CD at 5%	**3.504**	**2.211**	**3.013**	**1.848**	**4.225**	**2.967**	**6.290**	**3.607**	**5.694**	**2.041**	**7.017**	**1.746**	**6.009**	**1.404**	**5.238**	**2.317**

*Figures in parentheses are angular transformed values.

Table 4 : Cost benefit ratio of different IPM modules for the management of *L. orbonalis* of brinjal during *Zaid*, 2009 and 2010.

IPM Modules	Yield (q/ha) 2009	Yield (q/ha) 2010	Average yield (q/ha)*	Additional yield over untreated control (q/ha)	Additional income (Rs/ha)	Cost of treatments	Net income (Rs/ha)	Cost benefit ratio (C: BR)
Module-1	213.14	211.18	212.16	20.78	18702.00	2730.00	15972.00	1:5.85
Module-2	206.83	203.67	205.25	13.87	12483.00	2930.00	9553.00	1:3.26
Module-3	224.55	222.57	223.56	32. 18	28962.00	4575.00	24387.00	1:5.33
Module-4	219.57	218.55	219.06	27.68	24912.00	4875.00	20037.00	1:4.11
Module-5	248.42	247.44	247.93	56.55	50895.00	5575.00	45320.00	1:8.13
Module-6	240.72	236.83	238.76	47.38	42642.00	5875.00	36767.00	1:6.26
Module-7	232.39	229.88	231.14	39.76	35784.00	5020.00	30764.00	1:6.13
Module-8 Untreated control	193.59	189.18	191.38	-	-	-	-	-

*Average yield of 2009 and 2010, **Cost of fresh brinjal @ Rs.900/q
*** Based on the marketable price of brinjal and market cost of treatments included cost of insecticides, spray rent and labour charges etc. during 2009 and 2010.

days + third spray of profenophos @ 0.1% at 75 days + fourth spray of Imidacloprid @ 0.5 ml/ lit at 90 days) was lower as compared to IPM module-I and module-II during both the years.

It is further noted that adoption of IPM module-V recorded the lowest values of fruit damage during both the year of experimentation which was followed by IPM module-VI. Control treatment showed the highest values of fruit infestation (37.08 per cent) in 22nd standard week in 2009 and 37.81 per cent in 23rd standard week in 2010 damage as compared to rest of the treatments during both the years.

The fruit infestation in number basis was increased from 19th standard week to 26th standard week in IPM module-I and module-II having highest fruit damage *i.e.* 12.60 per cent and 12.43 per cent in respective years under IPM module-II. It had also been recommended for the management of this pest earlier by Bhargava *et al*. (2003) and Mishra *et al*. (2004).

Effect of IPM modules on fruit yield

During *Zaid*, 2009 and 2010

Data pertaining to yield of brinjal showed that all the treatments were effective and superior to the untreated check during both the years. The highest fruit yield of 248.42 & 247.44 q/ha was found in Module-V during both the years. The second highest yield of 240.72 & 236.83 q/ha was found in Module-VI followed by Module-VII (224.55 & 222.57 q/ha), Module-III (232.39 & 229.88 q/ha), Module-IV (219.57 & 218.55 q/ha), Module-I (213.14 & 211.18 q/ha) and Module-II (206.83 & 203.67q/ha), respectively. Similar results were also obtained by various workers (Chakraborty, 2001; Bhargava *et al*., 2003 and Mishra *et al*., 2004).

Cost benefit ratio of different IPM modules

The economics of IPM Modules were evaluated on the basis of incremental return obtained, per cent increase yield over control and cost of application of treatments to get cost benefit ratio. The net returns in all the treatments were higher in comparison to untreated check. On the basis of cost: benefit ratio, the performance of various treatments applications was found different. Module-V provided the higher cost: benefit ratio (1: 8.13), followed by Module-VI (1: 6.26). The cost: benefit ratio of Module-VII also good (1: 6.13), which was fairly higher than those of Module-I (1: 5.85), Module-III (1: 5.33), Module-IV (1: 4.11) and Module-II (1: 3.26). It is obvious from the results that application of Module-V was found more economical than rest of the treatments, for obtaining high returns with high cost: benefit ratio.

The literature available on a cost: benefit ratio is limited because the labour charges and market price of brinjal fruits may vary from place to place and year to year, therefore, cost: benefit ratio recorded in preset findings could not be compared as such with the cost: benefit ratio calculated by other workers. However, the findings of Deshmukh and Bhamare (2006) could be compared with the results of present investigation.

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