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Evaluation of integrated pest management modules against shoot and fruit borer (*Leucinodes orbonalis* Guenee) infesting brinjal

Sharayu P Patil, UB Hole and SA Pawar

Abstract
A field study was carried out for two consecutive years *i.e. kharif* 2018 and *kharif* 2019 at the Post graduate institute farm of Mahatma Phule Krishi Vidyapeeth, Rahuri, to evaluate some integrated pest management modules against shoot and fruit borer (*Leucinodes orbonalis* Guenee) in brinjal. The four modules included 2 bio-intensive integrated pest management modules, one farmers practice and untreated control. Module-II (Installation of pheromone trap @ 5 traps/acre for monitoring the population of *Leucinodes orbonalis* + Six release of egg parasitoid, *Trichogramma chilonis* @ 1.0 Lakh/ha against *Leucinodes orbonalis*, initiated with flowering and subsequent at 10 days interval + four sprays of NSKE (5%) at 50, 60, 80 and 90 DAT + one spray of Bt @ 1500 ml/ha at 70 days after transplanting + mechanical clipping of infested shoot at weekly interval+ one spray of chlorantraniliprole 18.5 SC @ 0.3 ml/lit at 100 DAT) had least shoot damage and fruit damage. The highest average fruit yield (302.06 q/ha) was found in Module-II with benefit cost ratio (1:7).

Keywords: IPM modules, *Leucinodes orbonalis*, brinjal, benefit cost ratio

Introduction
Brinjal (*Solanum melogena* L.) is widely grown fruit vegetable of tropical and subtropical parts of the world. In India it is an important commercial vegetable grown in almost all parts of the country, expect high altitudes (Choudhary,1970) [3]. Maharashtra accounts 35 thousand hectares area and produces about 490 thousand tonnes of fruits annually with productivity of 14.00 tonnes/ha. (Anonymous, 2019) [1]. The yield loss due to the pest is to the extent of 70-92 per cent, (Chakraborti and Sarkar, 2011) [2].

In young plants, appearance of wilted drooping shoots is the typical symptom of damage by this pest; these affected shoots ultimately wither and die away. At later stage, the larvae bore into flower buds and fruits, entering from the base of calyx, they have no visible sign of infestation, but the larvae fed inside. The damaged flower buds shed without blossoming whereas, the fruits exhibit circular exit holes (Hami, 1955) [5]. The brinjal cultivators spray frequently, at times daily, to kill the larvae before they enter into the fruits. The indiscriminate use of pesticides creates problem of pest resistance, pest resurgence, pesticide residue in harvested produce and adversely affect the non-target species (Jat and Pareek, 2003) [6].

Insecticide resistance management (IRM) has become an important component in developing IPM package for brinjal crop in India. Several location specific IPM modules have been developed in the country. All the IPM packages mainly involve integration of biological agents with use of selective and effective pesticides on the basis of monitoring of insecticide resistance (Patil, 1998) [8]. The objective of present study was to evaluate different IPM modules against shoot and fruit borer of brinjal.

Materials and Methods
The present study was carried out during Kharif, season of the year 2018 and 2019 at Agricultural Entomology farm, PGI, MPKV, Rahuri, (M.S.), India. A good crop of brinjal variety Krishna was maintained by transplanting in the month of August 2018 and August 2019 and following all treatment combinations for the area expect untreated control. Four modules having different components were designed and tested for their efficacy with respect to incidence of brinjal shoot and fruit borer. Thus modules served as treatment and blocks served as replication satisfying one way ANOVA requirement. Each module was divided into five equal blocks to serve as replication. Area of each module was 500 m^2. In each module five

plants were randomly selected in each replication and tagged for observations. The mean per cent shoot and fruit damage was recorded by counting total number of healthy and infested shoot and fruits randomly selected and tagged five plants in each treatment. The total fruit yield of all the harvest were averaged and converted to hectare basis for statistical analysis. The cost of economics was worked out based on the average market price of brinjal. While comparing the yield from different modules, the per cent increase in yield over control was calculated by following the procedure given by Pradhan (1969) [9].

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

Where,
T = Yield from treated plot
C = Yield from control plot

The Cost Benefit ratio (CBR) for all modules was worked out.

Table 1: Treatment details

Modules	Treatments combinations
Module-I	Installation 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 interval + four sprays of NSE (5%) at 50, 60, 80 and 90 DAT + one spray of Bt @ 1500 ml/ha at 70 days after transplanting
Module- II	Module- I + mechanical clipping of infested shoot at weekly interval + collection and destruction of infested fruits + one spray of chlorantraniliprole 18.5 SC @ 0.3 ml/lit at 100 DAT
Module- III (Farmers practice)	First spray of chlorpyrifos 20 EC @ 2.0 ml/lit at 45 DAT + second spray of cypermethrin 10 EC @ 0.5 ml/lit at 60 DAT + third spray of profenophos 50 EC @ 1ml/lit at 75 DAT + fourth spray of emamectin benzoate 5SG @ 0.4 g/lit at 90 DAT + Fifth spray of chlorantraniliprole 18.5 SC @ 0.3 ml/lit at 105 DAT
Module- IV	Untreated control

Results and Discussion

The pooled mean data of shoot damage during *Kharif* 2018, clearly indicated that lowest incidence of shoot damage was noticed in Module-II (1.51%). It was followed by Module-III (2.81%) and Module-I (6.03%) respectively. The untreated plot recorded maximum per cent shoot damage (8.32%).

The pooled mean data of shoot infestation during *Kharif* 2019, clearly indicated that lowest incidence of shoot damage was noticed in Module-II (1.46%). It was followed by Module-III (2.71%) and Module-I (5.57%) respectively. The untreated plot recorded maximum per cent shoot damage (8.04%).

The pooled mean data of fruit infestation during *Kharif* 2018, clearly indicated that lowest incidence of fruit damage was noticed in Module-II (2.54%). It was followed by Module-III (4.55%) and Module-I (6.97%) respectively. The untreated plot recorded maximum per cent fruit damage (32.92%).

The pooled mean data of fruit infestation during *Kharif* 2019, clearly indicated that lowest incidence of fruit damage was noticed in Module-II (2.50%). It was followed by Module-III (4.42%) and Module-I (6.81%) respectively. The untreated plot recorded maximum fruit infestation (32.80%).

The economics of each IPM modules was worked out based on yield of marketable quality of marketable quality of brinjal fruits obtained in experiment conducted during *Kharif*, 2018 and 2019. Data pertaining to yield of brinjal showed that all the treatments were effective and superior over untreated control during both the years. The highest average fruit yield (302.06 q/ha) was found in Module-II. It was followed by Module-III (286.03 q/ha) and Module-I (263.73 q/ha). The lowest average fruit yield (219.91 q/ha) was found in untreated control.

On the basis of cost: benefit ratio, the performance of various treatments applications was found different. The higher Cost Benefit Ratio (CBR) was provided by Module-II (1: 7.24), followed by Module- III (1:6.19) and Module-I (1: 5.50). However, the findings of Deshmukh and Bhamare (2006) [4] and Niranjana *et al*. (2019) [7] could be compared with the results of present investigation.

Table 2: Per cent shoot damage in different IPM modules during *Kharif* 2018

Module name	Shoot damage (%)				
	50 DAT	60 DAT	70 DAT	80 DAT	Mean
Module-I	2.15 (8.43)*	5.88 (14.03)	7.19 (15.55)	8.91 (17.37)	6.03 (14.21)
Module-II	1.03 (5.82)	1.74 (7.58)	1.92 (7.96)	1.38 (6.75)	1.51 (7.06)
Module-III (Farmers practice)	1.73 (7.56)	3.74 (11.15)	3.48 (10.75)	2.27 (8.67)	2.81 (9.65)
Untreated control	4.13 (11.73)	6.89 (15.22)	10.08 (18.51)	12.16 (20.41)	8.32 (16.76)
SE ±	0.37	0.39	0.42	0.41	0.40
CD at 5%	1.14	1.20	1.28	1.26	1.22
CV %	9.84	10.32	11.08	10.84	10.52

Table 3: Per cent shoot damage in different IPM modules during *Kharif* 2019

Module name	Shoot damage (%)				
	50 DAT	60 DAT	70 DAT	80 DAT	Mean
Module-I	2.28 (8.68)*	5.48 (13.54)	6.37 (14.62)	8.13 (16.67)	5.57 (13.65)
Module-II	1.17 (6.21)	1.62 (7.31)	1.75 (7.60)	1.29 (6.52)	1.46 (6.94)
Module-III (Farmers practice)	1.49 (7.01)	3.96 (11.48)	3.29 (10.45)	2.09 (8.31)	2.71 (9.48)
Untreated control	3.98 (11.51)	7.02 (15.36)	9.73 (18.18)	11.44 (19.77)	8.04 (16.47)
SE ±	0.37	0.39	0.41	0.40	0.39
CD at 5%	1.14	1.21	1.26	1.24	1.21
CV %	9.80	10.38	10.92	10.75	10.46

Table 4: Per cent shoot damage in different IPM modules during *Kharif* 2018

Module name	Fruit damage (%) during each picking										
	I	II	III	IV	V	VI	VII	VIII	IX	X	Mean
Module-I	4.38 (12.08)*	4.96 (12.87)	5.18 (13.16)	5.92 (14.08)	6.59 (14.87)	7.24 (15.61)	7.71 (16.12)	8.41 (16.86)	9.13 (17.59)	9.61 (18.06)	6.97 (15.31)
Module-II	2.56 (9.21)	2.68 (9.42)	1.37 (6.72)	1.54 (7.13)	2.46 (9.02)	2.61 (9.30)	3.79 (11.23)	3.52 (10.81)	2.37 (8.86)	2.46 (9.02)	2.54 (9.17)
Module-III (Farmers practice)	4.09 (11.67)	4.72 (12.55)	4.29 (11.95)	3.68 (11.06)	3.84 (11.30)	4.89 (12.78)	5.94 (14.11)	4.53 (12.29)	5.31 (13.32)	4.24 (11.88)	4.55 (12.32)
Untreated control	29.83 (33.10)	31.82 (34.34)	33.21 (35.19)	34.23 (35.81)	35.28 (36.44)	37.08 (37.51)	36.02 (36.88)	32.16 (34.55)	30.18 (33.32)	29.34 (32.80)	32.92 (35.01)
SE ±	0.71	0.73	0.80	0.73	0.74	0.81	0.75	0.75	0.79	0.76	0.76
CD at 5%	2.18	2.23	2.44	2.23	2.27	2.48	2.24	2.30	2.41	2.32	2.31
CV %	10.02	10.22	11.21	10.25	10.40	11.39	10.30	10.54	11.04	10.63	10.60

Table 5: Per cent shoot damage in different IPM modules during *Kharif* 2019

Module name	Fruit damage (%) during each picking										
	I	II	III	IV	V	VI	VII	VIII	IX	X	Mean
Module-I	4.48 (12.22)*	4.91 (12.80)	5.09 (13.04)	5.82 (13.96)	6.31 (14.55)	7.11 (15.46)	7.59 (15.46)	8.21 (16.65)	9.18 (17.64)	9.35 (17.80)	6.81 (15.13)
Module-II	2.49 (9.08)	2.79 (9.62)	1.42 (6.84)	1.39 (6.77)	2.63 (9.33)	2.57 (9.23)	3.48 (10.75)	3.32 (10.50)	2.34 (8.80)	2.57 (9.23)	2.50 (9.10)
Module-III (Farmers practice)	4.23 (11.87)	4.58 (12.36)	3.83 (11.29)	3.36 (10.56)	4.99 (12.91)	4.80 (12.66)	4.63 (12.66)	5.02 (12.95)	4.13 (11.87)	4.61 (12.40)	4.42 (12.14)
Untreated control	29.73 (33.04)	30.92 (33.78)	32.40 (34.70)	33.82 (35.56)	35.71 (36.70)	36.90 (37.41)	34.74 (36.11)	32.87 (34.98)	31.38 (34.07)	29.59 (32.95)	32.80 (34.34)
SE ±	0.74	0.79	0.76	0.80	0.76	0.75	0.75	0.78	0.74	0.76	0.76
CD at 5%	2.25	2.42	2.34	2.45	2.33	2.30	2.29	2.38	2.27	2.32	2.34
CV %	10.32	11.09	10.72	11.24	10.68	10.57	10.49	10.91	10.41	10.63	10.71

Table 6: Cost benefit ratio of different IPM modules for the management of *L. orbonalis* of brinjal during *Kharif*, 2018 and 2019

Modules	Yield (q/ha) 2018	Yield (q/ha) 2019	Average yield (q/ha)	Additional yield over untreated control (q/ha)	Additional income (Rs/ha)	Cost of treatments	Net income (Rs/ha)	Net CBR
Module-I	258.38	269.07	263.73	43.82	52584	8090	44494	1:5.50
Module-II	297.87	306.24	302.06	82.15	98580	11965	86615	1:7.24
Farmers practice	281.19	290.87	286.03	66.12	79344	11038	68306	1:6.19
Untreated control	225.68	214.13	219.91	-	-	-	-	-

Plastic funnel trap- Rs. 30/trap
NSKE- Rs. 25/Kg
Chlorpyrifos 20EC- Rs. 370/lit
Profenophos 50EC-Rs. 850/lit
Leucilure- Rs. 12/lure
Labour charges- Rs 1425/ha
Cypermethrin 10EC- Rs 310/lit
Brinjal cost-Rs.1200/q
Trichocard (*Trichograma chilonis*)- Rs. 100/card
Bacillus thuringiensis var. kurstki- Rs. 640/lit
Chlorantraniliprole 18.5 SC- Rs. 16334/lit
Emmamectin benzoate 5SG- Rs.4200/kg

Conclusion

Module-II (Installation of pheromone trap @ 5 traps/acre for monitoring the population of *Leucinodes orbonalis* + Six release of egg parasitoid, *Trichogramma chilonis* @ 1.0 Lakh/ha against *Leucinodes orbonalis*, initiated with flowering and subsequent at 10 days interval + four sprays of NSE (5%) at 50, 60, 80 and 90 DAT + one spray of Bt @ 1500ml/ha at 70 days after transplanting + mechanical clipping of infested shoot at weekly interval + collection and destruction of infested fruits + one spray of chlorantraniliprole 18.5 SC @ 0.3 ml/lit at 100 DAT) emerged to be most effective IPM module against shoot and fruit borer, *Leucinodes orbonalis* on brinjal and producing quality fruits to get maximum economic benefits.

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