Vegetable Science (2016) 43 (1) : 19-23

Sustainable management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.)

Shailendra Pratap Singh[1], Paras Nath[2], Akhilesh Kumar[3], S. Chakravorty[4], Ram Subhag Singh[5]

Received: December 2015 / Accepted: March 2016

Abstract

Insecticidal control of Brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenn.) has become a cause of concern as this highly damaging pest of brinjal is wide spread and known to attack other crops and therefore is a reason for heavy insecticide use in brinjal crop leading to contamination of food chain and increased pesticide related health risk. To protect this popular crop a combination of intercrop with coriander and fennel and different spray schedules of crude and commercial neem formulation on main crop of brinjal was tested to evaluate the level of percent shoot damage and fruit damage (both by number) and per cent fruit damage (by weight). Minimum loss on all the three parameters (21.57%, 19.79% and 23.33 %, respectively) were found in brinjal + coriander with NSKE 5% spray followed by brinjal + fennel and 0.03% spray of commercial azadirachtin formulation (24.17%, 21.79% and 22.59%, respectively) whereas the maximum shoot damage (50.60%), fruit damage (61.67 %)and fruit weight loss (64.84 %) were observed in sole Brinjal + Water Spray followed by Brinjal + NSKE 5 % which recorded 35.60 % shoot damage and 47.50 % weight loss. Almost all the treatments were significantly superior to control i.e. sole crop of brinjal sprayed with water) though some of them were not significantly different to the other. In most cases, combinations of intercrop supplemented the need of application of neem formulations as combinations of intercrop or application of neem formulations on lone brinjal crop were found to be at par regarding difference in shoot damage, fruit damage and fruit weight loss.

Keywords: NSKE, Azadirachtin, Coriander, Fennel, Brinjal, *Leucinodes orbonalis*

[1]Maharashtra Hybrid Seed Company Ltd., Jalna, Aurangabad, Maharashtra
[2]College of Agriculture, Fisheries and Forestry, Fiji National University, Koronivia, Fiji
[3]JNKVV-Krishi Vigyan Kendra, Rewa, MP
[4]Division of Entomology, IARI, Pusa, New Delhi
[5]Brahmanand P. G. College, Rath, Hamirpur, UP

Introduction

Brinjal or Eggplant, *Solanum melongena* L. is a popular solanaceous vegetable crop grown throughout the world. Brinjal is attacked by 142 species of insects, 4 species of mites and 3 species of nematodes in different countries of the world (Sohi, 1966). Among the array of insect pests infesting brinjal, shoot and fruit borer (BSFB) is the most destructive pest. The yield loss due to the attack of this pest varies from 37% to 63% in various states of India (Dhankar, 1988, Rai *et al.*, 2014 (a) (b)). In India including Eastern Uttar Pradesh, the damage caused by brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* is the most important bottleneck in brinjal cultivation. Its infestation persists for a very long period which tempts growers to opt for multiple application of insecticides leading to contamination of food chain. The impact of intercropping on population build up of crop pests is influenced by the changes in crop canopy, changed micro-climate and adverse olfactory regime. Such ecological maneuvering has considerably delayed the appearance and lowered the pest population on crops (Singh and Singh, 1978). Changes in the micro-climate of an intercrop also influence the behaviour of insect pests. Usually temperature and humidity in the intercrop will differ from those of sole crop, thereby affecting pest colonization (Mehto *et al.,* 1988). Therefore, it was prioritized to find out alternate pest management methods based on brinjal intercropped with coriander and fennel that can cause repellent action for BSFB management.

Materials and Methods

The experiments conducted at Agricultural Research Farm of Banaras Hindu University, Varanasi, Uttar Pradesh during *Kharif* season. The experiment was laid out in randomized block design with three replications. The plot size was 3.75 x 3.0 m^2 and 3.75 x 3.6 m^2 respectively. The fennel and coriander crops have been taken as intercrop along with two NSKE (5%) and Achook

neem products in the following combinations e.g. Brinjal + Fennel and one spray of NSKE (5%) (T_1), Brinjal + Fennel and one spray of achook (T_2), Brinjal + Fennel (T_3), Brinjal + Coriander and one spray of NSKE (5%) (T_4), Brinjal coriander + and one spray of Achook (T_5), Brinjal + Coriander (T_6), Brinjal and one spray of NSKE 5% (T_7), Brinjal and one spray of Achook (T_8) and Brinjal sole crop (Cotrol) (T_9). Five plants were randomly selected from the plots for recording the healthy and damaged shoots and fruits at weekly intervals as soon as the infestation started. Freshly infested terminal shoots and the fruit having entry hole of brinjal shoot and fruit borer larvae were treated as damage. The observations on fruit borer were recorded with its 1st appearance on the crop and thereafter at 7 days interval till final harvest of the fruits. The healthy and damage fruits were harvested separately plot wise to record the percentage of avoidable loss in fruit yield due to brinjal shoot and fruit borer. On the basis of shoot and fruit damage per cent shoot and fruit infestation were worked out. Healthy and damage fruits were counted and weighed separately for each treatment plot from which fruit damage per cent on number and weight basis were calculated by using the following formula:

$$\text{Shoot damaged by number \%} = \frac{\text{Number of infested shoots}}{\text{Total number of shoots}} \times 100$$

$$\text{Fruit damaged by number \%} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

$$\text{Fruit damaged by weight \%} = \frac{\text{Weight of infested fruits}}{\text{Total weight of fruits}} \times 100$$

The total and marketable yield of each treatment was determined cumulatively from all the harvests and expressed as quintal per ha. The shoot and fruit damage per cent in each observation and mean of all observations were transformed through Arc-sine transformation as suggested by Gomez and Gomez (1976) and statistically analyzed by analysis of variance applicable for Randomized Block Design.

Treatments	Crop combination	Bio-pesticides
T_1 (F+B)	Fennel + Brinjal	NSKE (5%)
T_2 (F+B)	Fennel + Brinjal	Azadirachtin
T_3 (F+B)	Fennel + Brinjal	Control
T_4 (C+B)	Coriander + Brinjal	NSKE (5%)
T_5 (C+B)	Coriander + Brinjal	Achook
T_6 (C+B)	Coriander + Brinjal	Control
T_7 (B)	Brinjal	NSKE (5%)
T_8 (B)	Brinjal	Achook
T_9 (B)	Brinjal	Control

Result and Discussion

The minimum shoot damage (21.57 %), fruit damage (19.79 %) and fruit weight loss (23.33 %) was observed with T_5 (Brinjal + Coriander and spray of Azadirachtin 0.03 % @ 2.5 ml/l) (Table-1, 2 and 3) followed by T_2 (Brinjal + Fennel and spray of Azadirachtin 0.03 % @ 2.5 ml/l) with 24.17%, 21.79% and 22.59% shoot damage, fruit damage and weight loss, respectively. Almost all the treatments had significant difference over control (T_9, Brinjal as sole crop + water spray) while T_1 (Brinjal + Fennel with NSKE 5 % @ 7 ml/l) and T_4 (Brinjal + Coriander + NSKE 5 % @ 7 ml/l) were at par. Though T_2 and T_4 had non-significant difference among themselves regarding shoot damage and fruit weight loss, they differed significantly from remaining treatments, this was true also for T_5 and T_2 regarding fruit damage. T_3 (Fennel + Brinjal + Water Spray), T_6 (Coriander + Brinjal + Water Spray), T_7 (Brinjal + NSKE 5% @ 7ml/l) and T_8 (Brinjal + Azadirachtin 0.03 % @ 2.5 ml/l) were at par regarding shoot damage like T_3 (Fennel + Brinjal conjugation with Control (Water Spray), T_7 (Brinjal + NSKE 5 % @ 7 ml/l) T_8 (Brinjal + Azadirachtin 0.03 % @ 2.5 ml/l) for fruit damage and T_3 (Fennel + Brinjal with Water Spray), T_6 (Coriander + Brinjal conjugation with Control (Water Spray), T_7 (Brinjal + NSKE 5 % @ 7 ml/l) and T_8 (Brinjal + Azadirachtin 0.03 % @ 2.5 ml/l) for fruit weight loss. The maximum shoot damage (50.60%) and fruit weight loss (64.84 %) were observed in T_9 (Brinjal + Water Spray) followed by T_7 (Brinjal + NSKE 5 % @ 7 ml/l) which recorded 35.60 % shoot damage and 47.50 % weight loss (Table -1 and -3) whereas, maximum fruit damage (61.67 %) was observed in T_9 (Brinjal + Control (Water Spray) followed by T_6 (44.92 %)(Coriander + Brinjal conjugation with Control (Water Spray) (Table - 2).

The intercrop of coriander and the botanical insecticide NSKE crudely made from neem seed kernel are two cheap and easy options for the management of insect pests of many crops. The crude extract of neem seed kernel contains a host of insecticidally active molecules other than the highly exploited tri-terpenoid Azadirachtin. Azadirachtin with its numerous isomers and other limonoids work as an ideal antifeedant in the first hand. On the other hand they work as hormone mimics in long run. Commercial formulations works as well with their added advantage of adjuvants making them more efficient in penetrating the physic-chemical hurdles on the plant surface. However, the cheap and easy to prepare NSKE is always more cost effective. Coriander and other nectar-pollen rich plants are important addition to otherwise monotonous stretch of mono-cropping. They are important energy food source of predators and both pro-ovigenic and synovigenic parasitoids as all of them requires energy food like nectar and protein nutrition from pollen grain for active search and

Table 1: Effect of intercropping and bio-pesticides on the shoot damage (%) of brinjal shoot and fruit borer, Leucinodes orbonalis Guen. during Kharif, 2003 and 2004 (Pooled)

Intercrop	Treatments	Shoot Damaged (%)						
		24th Oct.	31st Oct.	7th Nov.	14th Nov.	21st Nov.	28th Nov.	Mean
Brinjal + Fennel	T_1 (01 spray of NSKE)	35.36 (36.42)	29.70 (32.76)	29.26 (32.74)	30.97 (33.81)	25.24 (30.03)	11.79 (20.06)	27.05 (31.34)
	T_2 (01 spray of Achook)	31.43 (34.10)	28.83 (32.40)	25.48 (30.30)	29.11 (32.65)	20.09 (26.56)	10.07 (18.44)	24.17 (29.08)
	T_3	45.98 (42.68)	31.98 (34.39)	32.23 (34.51)	34.89 (36.20)	38.72 (38.47)	13.15 (21.24)	32.83 (34.95)
Brinjal + Coriander	T_4 (01 spray of NSKE)	39.30 (38.80)	22.51 (28.31)	28.18 (31.98)	36.70 (37.27)	29.89 (33.11)	11.60 (19.90)	28.03 (31.56)
	T_5 (01 spray of Achook)	29.80 (33.07)	20.57 (26.97)	25.85 (30.53)	24.60 (29.66)	21.10 (27.17)	7.51 (15.89)	21.57 (27.67)
	T_6	43.33 (41.15)	37.70 (37.85)	28.39 (31.87)	37.00 (37.43)	36.33 (37.06)	14.65 (22.49)	32.90 (35.00)
Brinjal	T_7 (01 spray of NSKE)	46.91 (43.22)	36.03 (36.83)	34.18 (35.73)	37.94 (38.01)	44.14 (41.53)	14.38 (22.28)	35.60 (36.63)
	T_8 (01 spray of Achook)	43.15 (41.06)	28.78 (32.39)	33.20 (35.12)	37.20 (37.57)	37.67 (37.78)	31.46 (33.25)	35.24 (36.20)
	T_9	54.47 (47.65)	59.04 (50.29)	51.02 (45.58)	50.00 (45.01)	60.59 (51.14)	28.46 (32.19)	50.60 (45.31)
	Mean	41.08 (39.79)	32.79 (34.69)	31.98 (34.26)	35.38 (36.40)	34.86 (35.87)	15.90 (22.86)	
Difference between the treatments							C.D.(P = 0.05) = 2.20	
Difference between the periods of observations							C.D.(P = 0.05) = 2.70	
Difference between the treatments x periods of observation							C.D.(P = 0.05) = 6.61	

Figures in parentheses are arc-sine transformed values

Table 2: Effect of intercropping and bio-pesticides on the fruit damage (%) of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.) during *Kharif*, 2003 and 2004 (Pooled)

Intercrop	Treatments	Fruit Damaged (%)						
		24th Oct.	31st Oct.	7th Nov.	14th Nov.	21st Nov.	28th Nov.	Mean
Brinjal + Fennel	T_1 (01 spray of NSKE)	29.31 (32.77)	33.70 (35.47)	46.67 (43.08)	50.69 (45.40)	13.79 (21.80)	8.18 (16.46)	30.39 (33.45)
	T_2 (01 spray of Achook)	23.89 (29.24)	24.64 (29.73)	32.23 (34.50)	29.11 (32.60)	13.34 (21.40)	7.52 (15.84)	21.79 (27.22)
	T_3	30.49 (33.45)	45.79 (42.53)	56.04 (48.50)	50.30 (45.18)	19.76 (26.32)	14.41 (22.26)	36.13 (36.95)
Brinjal + Coriander	T_4 (01 spray of NSKE)	26.68 (31.03)	53.56 (47.10)	41.38 (40.00)	35.88 (36.77)	17.01 (24.29)	5.09 (12.96)	29.93 (33.17)
	T_5 (01 spray of Achook)	16.58 (23.87)	27.20 (31.43)	33.34 (35.10)	25.63 (30.41)	11.75 (20.03)	4.22 (11.67)	19.79 (26.41)
	T_6	31.08 (33.85)	54.10 (47.37)	59.58 (50.53)	53.25 (46.88)	21.67 (27.74)	11.72 (19.90)	44.92 (42.09)
Brinjal	T_7 (01 spray of NSKE)	46.21 (42.79)	65.62 (54.30)	66.52 (54.83)	57.52 (49.34)	15.95 (23.42)	17.71 (24.78)	39.66 (39.09)
	T_8 (01 spray of Achook)	40.36 (39.29)	63.86 (53.13)	62.39 (52.25)	47.00 (43.27)	11.87 (20.10)	12.47 (20.64)	40.92 (38.89)
	T_9	67.98 (55.60)	74.55 (60.27)	77.32 (62.42)	76.34 (61.11)	38.79 (38.48)	35.03 (36.21)	61.67 (52.35)
	Mean	34.73 (35.77)	49.22 (44.59)	52.83 (46.80)	47.30 (43.44)	18.21 (24.84	12.93 (20.08)	
Difference between the treatments								C.D.(P = 0.05) = 2.57
Difference between the periods of observation								C.D.(P = 0.05) = 3.07
Difference between the treatments x periods of observation								C.D.(P = 0.05) = 7.53

Figures in parentheses are arc-sine transformed values

sustenance. The synomonal effect of plant volatiles emanated from feeding site of insects attracts natural enemies visiting nectar bearing flowers of intercrops. The tritrophic interaction thus benefits the growers.

In this experiment the flowering spice crops as intercrops and application of crude and commercial formulation of neem limonoids modified the oriented movements of insect population and perhaps encouraged the activity of natural enemies that was manifested in lower fruit and shoot borer attack in crops accompanied with coriander and protected by 0.03 % Azadirachtin

Table 3: Effect of intercropping and bio-pesticides on the weight loss (%) of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. during *Kharif*, 2003 and 2004 (Pooled)

Intercrop	Treatments	Weight Loss (%)						
		24th Oct.	31st Oct.	7th Nov.	14th Nov.	21st Nov.	28th Nov.	Mean
Brinjal + Fennel	T_1 (01 spray of NSKE)	27.86 (31.83)	36.86 (37.36)	36.62 (37.08)	36.20 (36.92)	20.22 (26.64)	11.25 (19.58)	28.17 (31.57)
	T_2 (01 spray of Achook)	21.68 (27.73)	29.26 (32.71)	31.30 (33.20)	29.50 (32.83)	12.98 (21.07)	10.85 (19.23)	22.59 (27.79)
	T_3	36.36 (37.03)	48.01 (43.85)	41.99 (40.02)	39.55 (38.91)	25.34 (30.21)	17.88 (24.96)	34.86 (35.83)
Brinjal + Coriander	T_4 (01 spray of NSKE)	23.20 (28.79)	43.54 (41.25)	40.89 (39.69)	37.97 (38.02)	16.08 (23.57)	12.02 (20.25)	28.95 (31.93)
	T_5 (01 spray of Achook)	19.89 (26.42)	30.69 (33.51)	34.71 (35.98)	32.50 (34.72)	11.43 (19.71)	10.76 (19.09)	23.33 (28.24)
	T_6	38.71 (38.29)	48.82 (44.32)	58.13 (49.69)	52.06 (46.20)	39.77 (39.03)	24.80 (29.82)	43.71 (41.23)
Brinjal	T_7 (01 spray of NSKE)	39.04 (38.66)	65.34 (54.14)	68.37 (56.07)	63.92 (53.25)	41.33 (40.00)	18.60 (25.50)	46.75 (42.94)
	T_8 (01 spray of Achook)	45.03 (42.14)	64.02 (53.38)	64.28 (53.40)	50.56 (45.32)	29.29 (32.71)	15.71 (23.25)	47.50 (43.36)
	T_9	71.22 (57.73)	81.01 (64.87)	77.00 (62.32)	76.97 (61.54)	52.24 (46.29)	30.58 (33.51)	64.84 (54.38)
	Mean	35.89 (36.51)	49.73 (45.04)	50.37 (45.27)	46.58 (43.08)	27.63 (31.03)	16.94 (23.91)	
Difference between the treatments								C.D.(P = 0.05) = 2.72
Difference between the periods of observation								C.D.(P = 0.05) = 3.33
Difference between the treatments x periods of observation								C.D.(P = 0.05) = 8.17

Figures in parentheses are arc-sine transformed values

spray @ 2.5 ml L^{-1} . The treatments varied in their effectiveness in reducing the percent fruit and shoot damage and fruit weight loss, yet they were significantly superior to control plot i.e. sole crop of brinjal with water spray, obviously without any reason for the insect pest to avoid it. The use of intercrops, sometimes mentioned to be 'contaminant' crop works according to the 'resource concentration hypothesis', and it dilutes the food and shelter resource of the pest. Moreover, it also works as physical barrier and sometimes as 'decoy' plants which hampers the host searching ability of the insect pests. Enhanced searching exposes them more to the biotic and abiotic population limiting factors than those inside closely placed host plants. The kairomonal effect of insects presence must have been well utilized by the foraging natural enemies. Application of neem formulation in intercropped plants might have forced the young and adults to search for suitable spot for host utilization which in turn might have made them more vulnerable to natural enemies. The positive effect of intercrop has been reported by Amin *et. al.* (2005) and Prasad, (2001) and among them Amin *et. al.* (2005) reported the species richness of intercropped field which is very much essential for sustenance of natural enemies in time of paucity of preferred prey, however, inter crop of coriander was superior to the brinjal and fennel intercrop. It can be corroborated from the findings of Ali *et. al.* (1996), Khorseduzzaman *et al.* (1997), David *et. al.* (2001).

सारांश

बैंगन का तना एवं फल बेधक कीट का प्रकोप बैगन की फसल में ज्यादा होता है जिसके प्रबन्धन के लिए अधिक से अधिक कीटनाशक रसायनों का प्रयोग होता है जो मनुष्यों के स्वास्थ्य पर कुप्रभाव डाल रहा है। इस प्रभाव से बचने के लिए इस शोध कार्यक्रम में नीम के उत्पाद के साथ–साथ अन्तर्वती फसलों धनिया एवं सौफ की फसल को बैगन के साथ विभिन्न प्रकार से प्रयोग एवं लगाकर मूल्यांकन किया गया। जिसमें प्रयोग के तौर पर यह देखा गया कि बैगन के तना एवं फल की क्षति (संख्या एवं प्रतिशतता) पर क्या प्रभाव रहा। इसमें सबसे कम देखा गया कि जब बैंगन व धनिया के साथ एन. एस. के. ई. 5 प्रतिशत का छिड़काव करने पर 21.57 प्रतिशत क्षति तना, 19.79 प्रतिशत फल में और 23.33 प्रतिशत फल के वजन में पाया गया जबकि अधिकतम क्षति जब बैगन व सौफ के साथ 0.03 प्रतिशत नीम उत्पाद (एजीडीरेक्टीन) का छिड़काव करने पर पाया गया जिसमें 24.17 प्रतिशत तना में 21.79 प्रतिशत फल में और 22.59 प्रतिशत फल के वजन में क्षति आंकी गयी जबकि केवल बैगन वाले प्रक्षेत्र में यह क्षति सबसे ज्यादा 50.60 प्रतिशत तने में, 61.67 प्रतिशत फल में एवं 64.84 प्रतिशत फल के वजन में कमी देखी गयी। इसके उपरान्त जब केवल एन. एस. के. ई 5 प्रतिशत का छिड़काव बैगन में किया गया तो यह क्षति 35.60 प्रतिशत तना में एवं 47.50 प्रतिशत कमी फल में पायी गयी। जो केवल बैगन लगाए जाले वाले प्रक्षेत्र में होने वाली क्षति से कम था। इस प्रकार इस प्रयोग में देखा गया कि अगर हम बैगन + धनिया की अन्तवर्ती खेती के साथ एन. एस. के. ई. का 5 प्रतिशत छिड़काव करे तो बैगन में तना एवं फल बेधक कीट का प्रकोप कम होगा एवं हमारे स्वास्थ्य पर कोई बुरा प्रभाव नहीं पड़ेगा।

References

Ali MI, Khorsheduzzaman AKM and Karim MA (1996) Effect of intercropping onion, garlic and coriander with brinjal on the infestation of brinjal shoot and fruit borer. Bangladesh Agril Sci 21(1): 58-63.

Amin SMR, Kundu R, Rahman MM and Islam MS (2005) Effect of Intercropping on the diversity on insect community in brinjal. Bulletin of the Institute of Tropical Agriculture, Kyushu University 28(2): 25-31.

David ARB, Balasubramanian G, Rabindra RJ and Veeraraghunatham (2001) Effect of intercropping coriander with brinjal on the incidence of shoot and fruit borer, *Leucinodes orbanalis* Guenee on brinjal. In: National Symposium on Emerging trends in pests and diseases and their management. October 11-13, 2001, CPPS, TNAU, Coimbatore, pp 65-68.

Dhankhar BS (1988) Progress in resistance studies in the eggplant (*Solanum melongena* L.) against shoot and fruit borer (*Leucinodes orbonalis* Guen.) infestation. Tropic Pest Manag 34: 343-354.

Gomez KA and Gomez AA (1976) Statistical procedure for agricultural Research (2nd ed.) John Wiley & Sons, Inc. New York.

Khorsheduzzaman AKM, Ali MI, Mannan MA, Ahmed A (1997) Brinjal-coriander intercropping: an effective IPM component against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. (Pyralidae: Lepidoptera). Bangladesh J Ent 7(1-2): 85-91.

Mehto DN, Singh KM and Singh RN (1988) Influencing of intercropping on succession and population build up of insect pests in chickpea, *Cicer arietinum* Linn. Indian J Ent 50 (3): 257-275.

Rai AB, Halder J and Kodandaram MH (2014) Emerging insect pest problems in vegetable crops and their management in India: An appraisal. Pest Manage Hortic Ecosys 20 (2):113-122.

Rai AB, Loganathan M, Halder J, Venkataravanappa V and Naik PS (2014a) Eco-friendly Approaches for Sustainable Management of Vegetable Pests. IIVR Technical Bulletin-53, Published by Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh, pp 104.

Singh RN and Singh K M (1978) Influence of intercropping on succession and population build up of insect pests in early variety of red gram. Indian J Ent 40(4): 361-375.

Sohi AS (1966) Studies on brinjal little leaf virus and its vector. M.Sc. Thesis PAU, Ludhiana, pp 74.