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Original Research Article

Relative Efficacy of Some Insecticides against Brinjal Fruit and Shoot Borer and their Impact on Fruit Yield

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NSKE, Insecticides, Shoot and Fruit damage of brinjal

A B S T R A C T

A field trial was conducted to evaluate the efficacy of some synthetic and plant based insecticides against brinjal shoot and fruit borer at the Dumka and Jama block of Dumka district during kharif season of 2008 and 09. Two foliar sprays of insecticides viz., Quinolphos 25EC,0 g a.i/ ha, *Bacillus thuringiensis* (Bt) and NSKE 5% were evaluated and it was found that all the insecticides proved significantly superior (at 5% level) to control (untreated) in reducing the damage of shoot and fruit borer in brinjal. Among all, NSKE proved most effective in reducing shoot damage (70.82%) and fruit damage, on weight basis over control. NSKE recorded the highest marketable fruit yield of 326.8q/ha and lowest was found in case of control (107.20 q/ha). Highest (1:5.3) cost to benefit ratio was also recorded in NSKE followed by Bt (4.9) and Quinolphos 25 EC (1: 3.9). From these findings, it was concluded that NSKE 5% being the most effective and economic over other insecticides, may be incorporated in IPM practices followed against brinjal shoot and fruit borer.

Introduction

Vegetable cultivation is one of the most profitable and dynamic branch of agriculture. It has become an important source of income for both farmers and field labours, serving as a vehicle for reducing poverty in rural areas. The eggplant or brinjal (*Solanum melongena* L.) is one of the most important solanaceous vegetables in South-East Asian countries. The major brinjal growing states in India are Andhra Pradesh, Karnataka, West Bengal, Tamil Nadu, Maharashtra, Orissa, Uttar Pradesh, Bihar and Rajasthan. Globally, India ranks second and China ranks first in the production of brinjal and accounting for almost 50% of the world's area under its cultivation (Alam *et al.*, 2003).

Production of brinjal in India was estimated to be 12706 thousand tones over an area 680 thousand hectare for the year 2014-15. It contains vitamins A, B and C and has ayurvedic medical properties as well, the fruit being good for diabetic patients. It is grown throughout the year under irrigated condition and is attacked by a number of insect pests right from the nursery stage till harvesting. Several biotic and abiotic factors are responsible for lowering down the yield of brinjal. Among them, insect pests are the important factors which greatly affect the quality and productivity of brinjal crop. Among the insect pests infesting brinjal, the major ones are fruit and shoot borer, *Leucinodes orbonalis* Guen., white fly, *Bemisia tabaci* Genn., leaf hopper, *Amrasca bigutella bigutella* Ishida, *Epilachna* beetle, *Henosepilachna vigintioctopunctata* Fab (Regupathy *et al.,* 1997). Among these, the brinjal fruit and shoot borer is considered to be the main constraint as it damages the crop to a great extent throughout the year both at vegetative and reproductive stage. Mall *et al.,* (1992) reported that the shoot and fruit borer (on shoot) were more prevalent during vegetative phase of the crop. However, Singh *et al.,* (2000) reported that the borer infestation was 78.66% on top shoots in vegetative phase and then shifted to flowers and fruits with infestation reaching 66.66% in fruiting phase. The yield loss due to this pest is to the tune of 70-90% (Reddy *et al.,* 2004); 4.33 to 6.54 % shoot damage and 52.3% fruit damage having been recorded irrespective of the planting month (Tripathy *et al.,* 1997). The small moth with dirty whitish wings and speckled marking lays eggs on young leaves/ flowers/ calyx of the fruits. After hatching (with in 6 hrs) the young larvae bores into the petiole/ midrib of leaves/ growing shoots/ flower buds/ fruits and closes the bore hole with frays, after entering it will feed inside the midribs/ flower/ ovary of flower and in the pulp of fruit. The damaged shoots and the damaged flowers droop down and the damaged fruits get rotten from inside. The entry hole on the fruit is not visible as this is covered with frays and only the faded depression of entry hole is seen. The large one or more round exit holes are visible on the fruits. Such fruits lose their market value. A number of insecticides have been reported to be effective in reducing pest infestation level and increasing fruit yields, but some insecticides leads to several problems like toxic residues, elimination of natural enemies, environmental disharmony and development of resistance. In the context of this, it was planned to study the efficacy of some insecticidal treatments to manage *L. orbonalis*, under agro-climatic conditions. Several insecticides belonging to various groups such as synthetic pyrethroides, organophosphate, organochlorine and carbamate have been recommended for management of this pest in various part of country (Khaire *et al.,* 1986; Pawar *et al.,* 1987). However, their indiscriminate use have created several problems to ecosystem resulted in environmental pollution, pest resistance, pest resurgence, residual toxicity etc. (Kuppuswamy and Balasubramanian, 1980). Keeping in view the quantum of pesticides applied in brinjal crop in this region, the investigations were undertaken on evaluation of validity of efficacy of insecticides against shoot and fruit borer of brinjal with the objective, to find out the efficacy of different pesticides against shoot and fruit borer (*L. orbonalis*) of brinjal as well as constraints associated with its cultivation.

Materials and Methods

It is quite natural that a change in the system of agriculture in a country of more than a million people should be a well thought out process, which requires utmost care and caution. There may be several impediments on the way. An understanding of these problems and prospects will go a long way in decision making. The study was carried out in Dumka district of Jharkhand. Information regarding the problems faced by the farmers in brinjal cultivation was identified in consultation with the cultivator and farmers were being asked to rank the problems proposed to them. Garrett's Ranking Technique provides the change of orders of constraints and advantages into numerical scores. The prime advantage of this technique over simple frequency distribution is that the constraints are arranged based on their severity from the point of view of respondents. Hence, the same number of respondents on two or more constraints may have been given different rank. Garrett's formula for converting ranks into percent is:

Percent position = 100 * (Rij – 0.5)/Nj

Where,

Rij = rank given for ith constraint by jth individual;

Nj = number of constraint ranked by jth individual.

The per cent position of each rank was converted into scores referring to the table given by Garrett and Woodworth (1969). For each factors, the scores of individual respondents were added together and divided by the total number of the respondents for whom scores was added. These mean scores for all the constraints were arranged and the constraints were accordingly ranked. The constraints were categorized into 3 categories i.e. input related constraints, technical constraints and personal socio-psychological constraints. The identified constraints were administered through a three point continuum as strongly agree, Agree and disagree.

A field trial was conducted to evaluate the efficacy of some synthetic and plant based insecticides against brinjal shoot and fruit borer at the Dumka and Jama block of Dumka district during kharif season of 2008 and 09. The crop was transplanted in the 1st week of May in the field at spacing 75 cm × 60 cm from row to row and plant to plant. The crop was raised as per recommended agronomical practices. There were four treatments viz., TO 1: Farmer's Practice, TO 2: Quinolphos 25 EC @ 1.5 ml/lt. of water, TO 3: Bt @1g/lt. of water and TO 4: NSKE 5% @ 5 ml/lt. of water and each treatment was replicated ten times in a randomized block design (Gomez and Gomez, 1984). Two foliar sprays of insecticides were given when incidence was noticed in the field at 21 days interval. Spraying was done by pneumatic knapsack sprayer using spray fluid @ 500 litre ha-1. No sprays were given in untreated control (TO1). Five plants were randomly selected from the each plot and tagged for recording the intensity of infestation of borer in shoots and fruits. The first in star larvae enter the growing shoots resulting into dropping down of the shoots. The damaged shoots attacked by brinjal shoot and fruit borer gave wilting symptoms. In this way, the wilted or damaged shoots and healthy shoots were counted in each plot and per cent infested shoots were calculated. Observations were recorded from five randomly selected plants from each plot on 1 day before and 7, 14 and 21 days after each spray for shoot infestation. Picking of fruits was done at weekly interval. Fruit infestation was recorded after each picking by counting total number of harvested and damaged fruits. Healthy and damaged fruit yield was recorded from each plot separately. The total numbers of healthy and damaged shoots were recorded at monthly interval till the end of all the insecticidal applications. At the onset of fruits, they damage the fruits by feeding inside it. The entry hole on the infested fruit is not visible as either the hole is recovered or it is covered with frays and only the faded depression of the entry hole is seen. The large one or more rounded holes are visible on the fruits, which are called exit holes. The damaged and healthy fruits were counted and weighed at every picking. The data were converted into per cent damage on number and weight basis. The marketable fruit yield was also recorded and calculated on hectare basis. Per cent shoot and fruit infestation reduction over untreated check in different treatments was calculated using modified Abbott's formula (Abbott, 1925). Finally, the benefit cost ratio for each treatment was calculated. The data on fruit damage was recorded by following the method of Ragini *et al.,* (2006) and Bhushan *et al.*, (2011).

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

$$\%\ \text{Fruit damage (Number basis)} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

$$\%\ \text{Fruit damage (Weight basis)} = \frac{\text{Weight of infested fruits}}{\text{Total weight of harvested fruits}} \times 100$$

$$\%\ \text{Reduction of shoot And fruit damage (Abbott's formula)} = \frac{\text{Control plot infestation} - \text{Treatment plot infestation}}{\text{Control plot infestation}} \times 100$$

$$\text{Cost benefit ratio} = \frac{\text{Net benefit over control}}{\text{Total cost of insecticidal spray}}$$

All the data generated in the present study were subjected to statistical analysis following standard procedure. The percent infestation of shoot and fruit borer population over control was worked out in order to judge and express the efficacy of the respective treatments against shoot and fruit borer infesting the crop.

The data on percent infestation in shoot and fruit borer population over control were later subjected to statistical analysis. Fruits were harvested from each plot separately and yield per plant each picking was recorded in kg. Total yield was worked out by adding the yield of each picking. The yield per plot was converted to quintals per hectare. All the data were subjected to the statistical analysis following standard methods.

Results and Discussion

The data, presented in table 1, reflects that the most important constraints related to inputs as perceived by brinjal growers were unavailability of quality plant protection measures and chemicals for cultivation of brinjal crop. Its mean value was 84.91 and ranked in first followed by supply of inferior quality seeds by the input dealers with its mean value 80.16 and ranked in second place.

Unavailability of quality seed at the time of sowing, having mean value was 60.211 was ranked in seventh place. However, the data related to technical constraints as perceived by brinjal growers were having lack of knowledge regarding plant protection measure. Its mean was 72.32 and ranked in first followed by lack of knowledge regarding recommended package of practices. Its mean value was 71.90 and ranked in second place. Lowest mean value of 64.21 was observed by brinjal growers of the category of related to operational difficulty in application of the technological tools due to unavailability of skilled labour.

The data related to personal socio-psychological constraints as perceived by brinjal growers shows that there was lack of motivation and education related to brinjal cultivation and has highest mean value i.e. 74.44 followed by lack of co-ordination among the beneficiary. Local leaders were less interested to organize rural development activities. The effect of the selected insecticides on brinjal fruit and shoot borer is reported in Tables 4 and 5 are presented below.

Table.1 Constraints faced by the brinjal growers regarding inputs

Sl. No.	Constraints	S.A.	A.	D.A.	Garrett ranking	
					Mean value	Rank
1.	Lack of money to purchase requisites.	40	27	13	78.91	III
2.	Supply of inferior quality seeds by the input dealers.	41	30	09	80.16	II
3.	Unavailability of quality plant protection measures.	49	25	06	84.91	I
4.	Unavailability of fertilizer and micro nutrients in proper time.	31	43	06	76.85	IV
5.	Reduction of soil fertility with use of higher dose of chemical fertilizers.	27	46	07	74.33	V
6.	High price of hybrid seeds, fertilizers and chemicals.	25	43	12	72.91	VI
7.	Unavailability of quality seed at the time of sowing.	23	42	15	69.21	VII

Table.2 Technical constraints faced by the brinjal growers

Sl. No	Constraints	S.A.	A.	D.A.	Garrett ranking	
					Mean value	Rank
1.	Operational difficulty in application of the technological tools due to unavailability of skilled labour.	20	45	15	64.21	VIII
2.	Lack of knowledge regarding recommended package of practices.	32	44	04	71.90	II
3.	Lack of knowledge about balance use of fertilizers.	22	52	06	65.75	VI
4.	Lack of knowledge regarding plant protection measure.	37	38	05	72.32	I
5.	Application of technology is highly technical.	29	46	05	69.70	III
6.	Lack of knowledge about plant growth regulator.	28	44	08	68.56	IV
7.	Poor confidence in recommended newly technology.	21	46	13	73.25	VII
8.	Application of plant protection measure is risky due to lack of knowledge.	27	42	11	66.58	V

Table.3 Socio-Psychological constraints faced by the brinjal growers

Sl. No.	Constraints	S.A.	A.	D.A.	Garrett ranking	
					Mean value	Rank
1.	Lack of co-ordination among the beneficiary.	29	47	04	72.32	II
2.	Inadequate extension activities were conducted by the Govt. Department.	16	35	29	60.41	V
3.	Field functionaries go through formalities to cover the targeted area.	17	54	09	55.59	IV
4.	Lack of motivation and education.	32	45	03	74.44	I
5.	Local leaders were less interested to organize rural development activities.	22	47	11	69.70	III

Table.4 Effect of test insecticides on shoot infestation

Treatment	Pre-treatment damage	Percent shoot infestation (days after each spray)						Mean infestation (%)	Protection over control (%)
		Spray-I			Spray-II				
		7 days	14 days	21 days	7 days	14 days	21 days		
TO 1: Farmer's Practice	11.25	8.12 (16.27)	9.64 (17.76)	10.85 (18.85)	7.84 (10.04)	8.10 (16.27)	8.36 (16.53)	8.81	-
TO 2: Quinolphos 25 EC @ 1.5 ml/lt. of water	9.52	2.82 (9.56)	3.65 (10.94)	3.98 (11.40)	2.62 (9.22)	3.35 (10.48)	3.60 (10.82)	3.33	62.20
TO 3: Bt 1g/lt. of water	10.21	4.15 (11.63)	4.58 (12.26)	4.91 (12.66)	3.24 (10.31)	3.45 (10.59)	4.50 (12.14)	4.13	53.12
TO 4: NSKE 5% @ 5 ml/lt. of water	9.07	2.30 (8.65)	2.70 (9.45)	3.27 (10.31)	2.01 (8.07)	2.12 (8.30)	3.01 (8.07)	2.57	70.82
SE. m ±	-	0.06	0.11	0.14	0.14	0.26	0.09	-	-
CD at 5%	-	0.11	0.33	0.43	0.43	0.80	0.31	-	-

Figures in the parenthesis are angular transformed values.

Table.5 Effect of test insecticides on fruit infestation and yield

Treatment	Mean percent fruit infestation at monthly intervals			Cumulative mean %	Protection over control%	Yield of Un-damaged fruits (q ha-1)	Weight of damaged (q ha-1)	Total (gross) fruit yield (q ha-1)	B:C ratio
	First	Second	Third						
TO 1: Farmer's Practice	35.23 (33.97)	37.11 (34.89)	28.60 (30.59)	33.64	-	147.20	17.80	165.00	2.5
TO 2: Quinolphos 25 EC @ 1.5 ml/lt. of water	26.33 (29.39)	27.71 (30.13)	24.10 (28.07)	26.04	22.59	267.80	15.20	283.00	3/9
TO 3: Bt 1g/lt. of water	18.90 (24.86)	17.81 (24.17)	15.10 (22.23)	17.27	48.66	290.80	11.80	302.60	4.9
TO 4: NSKE 5% @ 5 ml/lt. of water	14.64 (21.88)	14.23 (21.60)	13.01 (20.62)	13.96	58.50	326.80	10.50	337.30	5.3
SE. m ±	1.30	1.09	0.38	-	-	-	-	-	-
CD at 5%	3.89	3.26	1.17	-	-	-	-	-	-

Figures in the parenthesis are angular transformed values.

Shoot damage

The data pertaining to the efficacy of various insecticides on shoot damage are presented in Table 4. It is evident from this table that the shoot damage before spray in all the treatments including control ranged from 9.07 to 11.25 per cent. The pooled mean shoot damage of all the two spray varied between 2.57 to 8.81 per cent and indicates that all the treatments were significantly superior over control in reducing the shoot damage. The lowest damage was found in TO 4: NSKE 5% which was significantly superior (at 5%) to all other treatments in lowering down the shoot damage followed TO 2: Quinolphos 25 EC, where as TO 3: Bt, however, was significantly better than control but inferior to all other insecticides.

Fruit damage (on number basis)

From pooled mean (Table 5), it was found that the fruit damage ranged from 13.96 to 33.64% in all the treatments. The lowest damage was found in TO 4: NSKE 5% @ 5 ml/lt. of water which was significantly superior to all other treatments in lowering down the fruit damage.

It is evident from the table that all the treatments were significantly different from each other. Among all the treatments NSKE performed better than other insecticides. Maximum damage was observed in TO 3: Bt insecticide, however it was significantly better than control at 5% level, but inferior to all other treatments.

Highest per cent reduction over control in fruit infestation on number basis was found in case of TO 4 followed by TO 2.

Fruit damage (on weight basis)

The overall information (Table 5) came out from pooled mean of all the three pickings indicate that the fruit damage on weight basis in all the treatments varied between 10.50 to 17.80 q ha^{-1}.

All the treatments were significantly different from each other but better than control. The lowest fruit damage was found in TO: 4, which was significantly superior (at 5% level) than all other insecticides. TO: 3 was found inferior to all other insecticides but better than control.

The per cent reduction over control in fruit infestation on weight basis was recorded maximum in plots treated with NSKE (58.50%) followed by Bt (48.68.32%) and least in case of Quinolphos 25 EC (22.59%). The present studies are in conformity with the findings of Agnihotri *et al.,* (1990). Findings of Sharma and Chhibber (1999) are also in agreemen with the results of present investigations. These are also slightly supported with the findings of Basha *et al.,* (1982) and Sajjad *et al.,* (2015).

Yield and economics

At the end of the experiment, the marketable fruit yield (Table 5) of all the pickings was added and transformed into quintals on hectare basis. Among all the treatments two spray of NSKE proved to be the best in producing highest marketable yield (326.8 q/ha) followed by Bt (290.80 q/ha) and Quinolphos 25 EC (267.80 q/ha). The lowest fruit yield was recorded in control (147.20 q/ha). NSKE was found significantly superior (at 5%) over all other treatments in giving the highest yield. The highest (1:5.3) cost to benefit ratio was also recorded in NSKE followed by Bt (1:4.9) and Quinolphos 25 EC (1: 3.9) over control (1:2.5). Highest yield and cost-benefit ratio in case of botanical insecticides were also indicated by Agnihotri *et al.,* (1990) which is in conformity with the present findings.

It is concluded that unavailability of quality plant protection measures and chemicals for cultivation of brinjal crop is the major constraint of inputs required. However, lack of knowledge regarding plant protection measures was major technical constraint for brinjal cultivation.

A personal socio-psychological constraint for brinjal cultivation was lack of motivation and education as perceived by brinjal growers. It can also be concluded from the results that NSKE attributed better management over other group of insecticides and showed the maximum effect on the shoot and fruit borer when the insecticidal spray was done at 21 days interval starting from fruit initiation stage. The overall superiority of NSKE in comparison to other insecticide treatments has marked effect on reduction of pest damage in the shoot (70.80%) and fruit on weight basis (58.50%) over control. Thus, resulting in higher yield (326.8 q/ha) and economic returns (1: 5.3). Hence NSKE may be incorporated in IPM practices followed against shoot and fruit borer.

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