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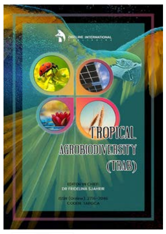

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RESEARCH ARTICLE

EFFICACY OF COMMERCIAL INSECTICIDES AGAINST FRUIT AND SHOOT BORER, *LEUCINODES ORBONALIS* GUENEE OF BRINJAL, *SOLANUM MELONGENA* L. IN DHADING, NEPAL

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ABSTRACT

A study was conducted from January to June 2019 in Dhading district to identify the effective commercial insecticide against fruit and shoot borer of brinjal (*Leucinodes orbonalis*). A field experiment was conducted in Randomized Completely Block Design with five treatments (T1: Spinosad @ 1 ml/ 3 liters, T2: Chlorantraniliprole 1 ml/ 3 liters, T3: Cypermethrin 3 ml/ 1 liter, T4: Neem 3 ml/ 1 liter and T5: Control) and four replications. Result indicated that the fruit infestation percent and shoot damage reduction percent, fruit infestation reduction percent were highly significant with the application of insecticides. The shoot damage percent and fruit damage percent was the lowest with spinosad followed by chlorantraniliprole, cypermethrin and Neem. Thus, spinosad is the most effective insecticides for the management of fruit and shoot borer of brinjal in field conditions.

KEYWORDS

Brinjal, borer, insecticides, infestation

1. INTRODUCTION

Brinjal *(Solanum melongena*) belonging to the family Solanaceae is one of the major crops in south and southeast Asia and is known by different names such as brinjal, aubergine etc. (Thapa, 2010). Longer fruiting and harvesting period, resistance to adverse conditions like drought and higher yield are the featured characters that engage farmers in brinjal production (Ghimire, 2011). Fruit and shoot borer of brinjal (*Leucinodes orbonalis)* is considered to be the major key pest of brinjal (Javed et al., 2017). Lepidopteran borer of crambidae family shows the variation in infestation pattern depending on the season, location, varieties sown and age of the plant and yield loss is noted to the extent of 70-92 percent (Javed et al., 2017; Reddy and Srinivas, 2004).

Alike the other lepidopteran insect, BFSB has four stages of the lifecycle; egg, larva, pupa and adult and seems to feed on the brinjal crop sowing its monophagous behavior however in some articles, it is reported that besides brinjal it feeds on other solanaceous plants in negligible amount (Shaukat et al., 2018; CABI, 2007). Through the minute entrance, larvae get into shoots as well as in fruits but remain unnoticed until the excreta of feeding larvae is evident (Alam et al., 2006). After the flower initiation and fruit development in the crop, shoot infestation percent condenses abruptly or stops (Kumar and Singh, 2013).

Substantial reduction in the productivity as well as the quality of the crop due to diseases, insects and other pests is the main basis that farmers are dispirited towards brinjal cultivation (Mainali et al., 2013). Measures like the use of resistant varieties, sex pheromones, cultural methods, use of physical as well as mechanical barriers, use of bio-pesticides, botanical pesticides, chemical methods can be practiced in the field to target the pest population level below the threshold level (Mainali, 2014). In Dhading district, major problem seen in the vegetable production is of insect's pests and diseases. Inappropriate pesticides selection results in increase in pest population that leads to the irrational and non- judicious use of insecticide too and hampers the environment, so researches are to be carried in proper selection of the pesticides. Therefore, a study was carried out to identify the most effective insecticides against fruit and shoot borer of brinjal.

2. METHODS AND METHODOLOGY

The research was conducted on the Benighat Rorang-5, Bishaltar near the PMAMP, Project Implementation Unit, Vegetable Zone, Bishaltar Dhading. Research was conducted in the spring season. Five treatments were selected including the untreated control. Insecticides were selected on the basis of literature review, availability in the location and economic feasibility. Precautions were taken to avoid drift to the adjacent plots.

Hybrid variety of brinjal No. 183 was selected for research. Three to five true leaf stage seedling of six-week age was transplanted in main field. The research was conducted on RCBD design with five treatments which was replicated four times. The individual plot area was of 5.4 m^2 with the spacing of 60 cm* 45 cm in the field. The insecticides were applied after the 5th week of transplanting and subsequent applications were made at 7 days intervals with the help of knapsack sprayer (Awal et al., 2017).

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Table 1: Name of the treatment, their trade name and dose			
S.N.	**treatment**	**Trade name**	**dose**
1	Spinosad	Spintor 45% SC	1 ml/3 l of water
2	Chlorantraniliprole	Allcora 18.5% SC	1 ml/3 l of water
3	Cypermethrin	Cyper 10 10%EC	3 ml/1 l of water
4	Neem	Neemix 1500 ppm	3 ml/1 l of water
5	Control	-	-

For the calculation of damage infestation in the field and for the comparison of the effectiveness of the treatment on the fruit and shoot borer of brinjal, data on total shoots, total infested shoots, total fruits, total no. of infested fruits and marketable yield was recorded on the field one day before the application of treatment. To take the data from all plots, data were taken from third harvest only, as in first and second harvest no fruiting was seen in some plots.

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

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

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

% Reduction of shoot and fruit damage (Abbott's formula) =

$$\frac{\text{Control plot infestation - Treatment plot infestation}}{\text{Control plot infestation}} \times 100$$

The obtained data were tabulated in Microsoft Excel. The shoot infestation percentage, fruit infestation percentage on number and weight were transformed by square root transformation (SQRT(X+0.5)) and arc sine transformation method (ASIN (SQRT (X/100) *57.296). The GEN-STAT was used to find the coefficient of variance, grand mean and develop ANOVA table. Duncan's Multiple Range Test (DMRT) was employed to find out the significant differences between the mean values at a 5% level of significance.

3. Results and Discussion

3.1 Effect on shoot infestation

Table 2: shoot infestation percent on a different date of sprays at Dhading, Nepal				
	Shoot infestation percent			
Treatment	1st spray	2nd spray	3rd spray	4th spray
Spinosad	0.781 (1.006 ^{c})	0.00 (0.707 ^{c})	1.02 (1.149 ^{d})	0.00 (0.707 ^{c})
chlorantraniliprole	3.04 (1.880 ^{b})	3.64 (2.015 ^{b})	2.80 (1.794 ^{c})	3.26 (1.904 ^{b})
Cypermethrin	4.51 (2.220 ^{b})	6.12 (2.524 ^{b})	4.47 (2.197 ^{bc})	6.91 (2.604 ^{a})
Neem	4.74(2.261 ^{b})	7.16 (2.740 ^{b})	6.13 (2.566 ^{ab})	6.36 (2.611 ^{a})
Control	8.60 (3.007 ^{a})	12.49 (3.520 ^{a})	8.00 (2.905 ^{a})	9.96 (3.195 ^{a})
Grand mean LSD	(4.3) 2.07 0.4667(1.741) ***	(5.88) 2.30 0.732(4.673) ***	(4.484) 2.122 0.5469(2.183) ***	(5.298) 2.5785 0.6527(3.992) ***
SEm (±)	0.1514	0.237	0.1775	0.2118
C.V.%	14.6	20.6	16.7	19.2

The figure in the parentheses represent the transformed value by square root transformation (sqrt (x +0.5)). SEm ±- standard error of the mean, CV - coefficient of variation, LSD - Least Significant Difference, ***- highly significance, same letter in the subscript indicate a similar effect

The result above shows that shoot infestation percentage by BFSB was found to be influenced by the application of different insecticides. After 7 days of the first spray, the highly shoots damage was found in the control plot (8.60) followed by neem (4.74), cypermethrin (4.51) and chlorantraniliprole (3.04) whereas the lowest infestation of shoot was found in spinosad (0.741). Similarly, after 7 days of the second spray, similar results were obtained as that of the first spray with the highest infestation at the control plot (12.49) and the lowest shoot infestation was in spinosad (0.00). The trend was similar in third and fourth spray too i.e. spinosad has the lowest shoot infestation and highest was found in the control plots followed by neem. The mean shoot infestation percentage reduced to 0.74 % and 0.42 % at fifth and sixth spray respectively which clearly shows that the shoot infestation percentage reduced abruptly after the flower and fruit initiation.

3.2 Effect on shoot infestation reduction percentage

Table 3: Shoot infestation reduction percentage by different insecticides at Dhading, Nepal				
Treatment	1st spray	2nd spray	3rd spray	4th spray
Spinosad	91.62	100	88.5	100
Chlorantraniliprole	63.8	61.6	63.3	64
Cypermethrin	47.8	50.3	42.9	35.8
Neem	45.4	32.5	22.2	32.6
Control	-	-	-	-

Figure in the parentheses indicate the Arcsine transformed value (ASIN (SQRT (X/100)) *57.296)
SEm ±- standard error of the mean, CV - coefficient of variation, LSD- Least Significant Difference, ***- highly significance, same letter in the subscript indicate a similar effect

From the above table no. 3, at 7 days after the first spray, Spinosad (91.6) had reduced the shoot infestation followed by chlorantraniliprole, cypermethrin and neem as compared to the control plots. Also, after the second spray, the result was similar i.e. spinosad treated plots (100) showed full control over shoot infestation followed by chlorantraniliprole and cypermethrin. The trend was similar in third and fourth spray too. Neem showed effectiveness against shoot infestation compared to control plots but was inferior to the other three treatments.

3.3 Effect on fruit infestation percentage by number

Table 4: Fruit infestation percentage by number at different days of picking at Dhading Nepal

Total fruit infestation percentage (by number)			
Treatment	3rd harvest	4th harvest	5th harvest
Spinosad	7.4 (13.99 ᶜ)	4.1 (8.94 ᵈ)	11.2 (19.17 ᵈ)
Chlorantraniliprole	26.6 (30.98 ᵇᶜ)	32.6 (27.46 ᶜ)	29.6 (32.78 ᶜ)
Cypermethrin	40.4 (39.27 ᵃᵇ)	22 (34.37 ᵇᶜ)	35.6 (36.49 ᶜ)
Neem	31 (33.62 ᵇ)	44 (41.49 ᵃᵇ)	66.4 (52.68 ᵇ)
Control	64.9 (57.35 ᵃ)	62.8 (52.50 ᵃ)	76.6 (61.20 ᵃ)
Grand mean	34.06 (41.898)	33.1 (32.952)	43.88 (40.464)
LSD	18.59(21.66) ***	11.79(16.48) ***	6.065(9.02) ***
Sem	6.03	3.83	1.968
C.V.%	34.4	23.2	9.6

Figure in the parentheses indicate the Arcsine transformed value (ASIN (SQRT (X/100)) *57.296) SEm ±- standard error of the mean, CV - coefficient of variation, LSD- Least Significant Difference, ***- highly significance, same letter in the subscript indicate a similar effect

Above table no. 4 demonstrates that the fruit infestation by fruit and shoot borer is highly influenced by the application of different insecticides. Only after third harvest complete data were taken from the field so the analysis was done after third harvest data. On the third harvest, the control plot had the highest infestation of 64.9 % which was statistically similar to the cypermethrin (40.04) whereas the shoot infestation was lower in spinosad (7.4) treated plots which was at par the chlorantraniliprole (26.6). On the fourth harvest, the highest infestation was seen in the control (62.8) which was statistically similar to the neem treated plots (44), whereas the fruit infestation percentage was lower in spinosad treated plots (4.1). Similarly, on the fifth harvest, fruit infestation was seen higher in the control plot (76.6) followed by and lowest infestation was seen in the spinosad treated plots (11.2).

3.4 Effect on fruit infestation reduction percentage

Table 5: Fruit infestation reduction percent by number at different days of picking at Dhading Nepal

Total fruit infestation reduction percent (by number)			
Treatment	3rd harvest	4th harvest	5th harvest
Spinosad	86	94	85.4
Chlorantraniliprole	56.2	63.2	61.6
Cypermethrin	31.9	48.5	53.3
Neem	45.8	30.8	21.33
Control	-	-	-

SEm ±- standard error of the mean, CV - coefficient of variation, LSD- Least Significant Difference, highly significance, same letter in the subscript indicate a similar effect

The above table no. 5 shows that spinosad reduced the fruit infestation from 85.4 to 94. In the third harvest, spinosad (86) was found to be the most effective insecticide in the increase of the number of healthy fruits followed by chlorantraniliprole (56.2), cypermethrin (31.9), neem (45.8) in the reduction of fruit infestation which was superior as compared to control. In the fourth harvest also spinosad (94) was highly significant difference on the reduction of fruit damage against fruit and shoot borer of brinjal. Chlorantraniliprole (63.2) had a significant difference in the reduction followed by cypermethrin (48.5) as compared to control. Neem (30.8) had shown the least significance in the reduction of fruit damage as compared to other treatments. In the fifth harvest also spinosad (85.4) was highly significant in the fruit damage reduction by a number followed by Chlorantraniliprole (61.6), cypermethrin (53.3). Neem (21.33) was least significant as compared to other plots but was superior to the control plot.

3.5 Effect on fruit infestation percentage (by weight)

Table 6: Fruit infestation percentage by weight at different days of picking

Total fruit infestation percent (by weight)			
Treatment	3rd harvest	4th harvest	5th harvest
Spinosad	4.23 (11.85 ᶜ)	2.90 (5.90 ᶜ)	10.8 (19.02 ᶜ)
Chlorantraniliprole	23.88 (28.73 ᵇ)	25.04 (29.94 ᵇ)	32.12 (34.34 ᵇ)
Cypermethrin	34.01 (35.55 ᵇ)	30.49 (33.22 ᵇ)	31.45 (33.87 ᵇ)
Neem	31.2(33.85 ᵇ)	40.50 (39.33 ᵃᵇ)	58.6 (50.13 ᵃ)
Control	61.0(55.09 ᵃ)	60.7 (51.71 ᵃ)	70.1 (57.12 ᵃ)
Grand mean	30.864 (26.244)	31.926 (32.02)	40.614 (38.896)
LSD	15.86(19.76) ***	12.40(17.98) ***	8.70(14.04) ***
Sem	5.15	4.02	2.82
C.V.%	31.2	25.1	14.6

Figure in the parentheses indicate the Arcsine transformed value (ASIN (SQRT (X/100)) *57.296)
SEm ±- standard error of the mean, CV - coefficient of variation, LSD- Least Significant Difference, ***- highly significance, same letter in the subscript indicate a similar effect

In table no. 6, it is shown that the fruit infestation percentage by weight is affected by the application of insecticides. In the third harvest, highest fruit infestation weight was of control plot (61.0) followed by chlorantraniliprole (23.88), cypermethrin (34.01) and neem (31.2) whereas the lowest infestation weight was of spinosad (4.23). In the fourth harvest, the control plot (60.7) which was statistically similar to neem (40.50) has the highest infestation and the lowest infestation was seen in spinosad plots (2.90) followed by Chlorantraniliprole (25.04) and cypermethrin (30.49). In the fifth harvest, the highest fruit infestation percentage by weight was seen in control plots (70.1) which was statistically similar to neem (58.6). The fruit infestation by weight was lower in spinosad treated plots (10.8) followed by cypermethrin (31.45) and chlorantraniliprole (32.12).

3.6 Effect on fruit infestation reduction percentage (by weight)

Table 7: Fruit infestation reduction percentage by weight on a different date of picking at Dhading Nepal

Total fruit infestation reduction percentage (by weight)			
Treatment	3rd harvest	4th harvest	5th harvest
Spinosad	92.13	96.63	84.8
Chlorantraniliprole	58.88	56.75	52.53
Cypermethrin	41.78	45.31	54.73
Neem	43.26	29.82	16.04
Control	-	-	-

SEm ±- standard error of the mean, CV - coefficient of variation, LSD- Least Significant Difference

The above table indicates that the total fruit infestation percentage by weight is highly influenced by the application of different insecticides. From the table in the third harvest, it was found that that spinosad (92.13) is highly significant in the total fruit infestation reduction (by weight) followed by Chlorantraniliprole (58.88), Cypermethrin (41.78) and neem (43.26). In the fourth harvest, the reduction pattern was similar to the third harvest i.e. spinosad (96.63) was most effective against fruit and shoot borer to reduce the fruit damage. Also, in fifth harvest spinosad (84.8) was highly significant in fruit infestation reduction percentage by weight followed by Chlorantraniliprole (52.53), cypermethrin (54.73). Neem (16.04) which were higher as compared to the control.

4. Discussion

The shoot infestation was reduced after flowering and fruiting in brinjal which is similar to some researchers who reported abrupt reduction on shoot infestation after the flower initiation and fruit development (Kumar and Singh, 2013). From table no. 2 and 3, it was observed that the spinosad had the lowest shoot and fruit damage percentage which was similar to the experiment carried out by many researchers. A group researchers in the research concluded spinosad (Tracer- 45 SC) as the effective insecticide against fruit and shoot borer of brinjal and also helps in getting highest yield (Awal et al., 2017). Also in their study reported that spinosad was found best in reducing the shoot and fruit damage in brinjal (Singh and Sachan, 2015). Kalaawate and Dethe also found spinosad as the effective insecticides against borer (Kalaawate and Dethe, 2011).

A group researchers also mentioned spinosad as the most effective insecticides for control of fruit and shoot borer in his study (Yousafi et al., 2015). In the research conducted, chlorantraniliprole was found to be more effective against fruit and shoot borer as compared to Spinosad (Mainali et al., 2015; Rajavel et al., 2013). But the result seems reverse in my research which may be due to the pest resistance as farmers were using Chlorantraniliprole for more than 3 years. A group researchers also found that *Leucinodes orbonalis* develop resistance to chlorantraniliprole in the brinjal field in the span of two years (Konamdaram et al., 2017). Bhagwan and Kumar reported that cypermethrin was the most effective and economical insecticide to reduce fruit as well as shoot damage (Bhagwan and Kumar, 2017). But in this research, the shoot infestation percentage reduced from 35.8 to 50.3 % and also the resurgence of aphids was seen in the Cypermethrin treated plots which were accordance to where it was reported that with the application of three concentrations of pyrethroids on cotton shows the high percentage of a resurgence of aphids due to the greater accumulation of total sugar, protein, and depletion of phenol in the plant (Ravindhran and Xavier, 1996).

Also, some researcher found that cypermethrin increased the quantity of soluble protein by 6.2 %, quantity of reducing sugar to 51.5 % over the control and also reduced the terpenoid contents to 40% (Asrorov et al., 2015). Due to the increase in the nutritional quality of leaves of the pyrethroids treated plots as compared to control plots, there occurs the increase in the population of sucking pests such as aphids. Latif found that Nimbicidine was the least effective insecticide in controlling the BSFB and resulted in the lowest yield and the same result was found in this research too (Latif, 2007).

5. Conclusions

Fruit and shoot borer, *Leucinodes orbonalis* is key pest of brinjal and reduces the fruit production both in quantity as well as the quality in Dhading district. All commercial insecticides reduce the shoot as well as fruit infestation to some extent but effectiveness varies among them. From the research, spinosad was found to be the most effective insecticide followed by chlorantraniliprole and these are the relatively safe insecticides compared to other second-generation insecticides. Therefore, spinosad is recommended for effective management of fruit and shoot borer in brinjal.

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