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Efficacy of insecticides against infestation of brinjal fruit borer, *Leucinodes orbonalis* Guenee (Pyralidae: Lepidoptera) under field conditions

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Abstract
The present study was carried out at Agricultural research institute, Tarnab, Peshawar during 2011 to study the efficacy of different insecticides against Brinjal fruit borer. The insecticides tested were: spinosad, emamectin benzoate, chlorpyrifos, profenofos, fenvalerate and cypermethrin and were compared with a control. Results showed that emamectin benzoate was most effective against brinjal fruit borer and resulted in lower infestation (40.1%) followed by cypermethrin (40.43%), whereas fenvalerate offered moderate control (41.31%) of borers. The study recommended the use of emamectin benzoate for effective control of brinjal fruit borer.

Keywords: Brinjal fruit borer, Efficacy, Insecticides, field experiment

1. Introduction

Brinjal fruit borer, *Leucinodes orbonalis* Guenee (Pyralidae: Lepidoptera) is found throughout the topics in Asia and Africa and is a minor pest in America. It is monophagus and very important pest of brinjal, however other plants belonging to family Solanaceae are reported to be hosts of this pest. They include tomato (*Lycopersicon esculentum*), potato (*Solanum tuberosum*) and turkey berry (*S. torvum*). It is an internal borer which damages the tender shoots and fruits. Attack of this pest causes considerable damage to brinjal crop each year, affecting the quality and yield of the crop. The Larvae of this pest cause 12-16% damage to shoots and 20-60% damage to fruits [1, 2]. The pest is very active during rainy and summer season and often causes more than 90% damage in Bangladesh [3, 4] and up to 95% in India [5]. It is also reported that the infestation of fruit borer causes reduction in Vitamin C content to an extent of 68 % in the infested fruits [6].

Soon after hatching from eggs, young caterpillars search for and bore into tender shoots near growing points into flower buds or into the fruits. Caterpillars prefer fruits over other plant parts. Larvae go through at least five instars [7] and there are reports of the existence of six larval instars. Larval period lasts from 12 to 15 days in the summer and up to 22 days in winter. Climatic conditions are important in the life cycle of the borer. As temperature increases and humidity decreases fecundity increases and duration of life cycle decreases [8].

Within one hour after hatching, the larvae bore into the nearest tender shoot, flower or fruit, they plug the entrance hole with excreta. In young plants, caterpillar bores midrib of large leaves. As a result, the affected leaves may drop off [9]. Larvae feeding inside shoots result in wilting of young shoots. Presence of wilted shoots in a brinjal field is a symptom of damage by this pest. The damaged shoots ultimately wither and drop off. This reduces plant growth, which in turn, reduces fruit number and size. New shoots can arise but this delays crop maturity and the newly formed shoots are also subjected to larval damage. Larval feeding in flowers is a relatively rare occurrence resulting in failure to form fruits from damaged flowers. Larval feeding inside the fruit results in destruction of fruits tissue. The feeding tunnels are often clogged with frass. This makes even slightly damaged fruit unfit for marketing. The yield loss varies from season to season and from location to location. Damage to fruits particularly in autumn, is very severe and the whole crop can be destroyed [7]. Based on the mentioned facts the present study was initiated to check the efficacy of different novel insecticides for controlling this devastating insect pest.

2. Materials and Methods

The present study was conducted at Agricultural research institute (ARI) Tarnab during the years 2011 and 2012 to study the efficacy of six insecticides against *L.orbonalis* under field conditions.

Brinjal was sown under field conditions in which spacing was provided by keeping plant to plant distance of 30 cm and row to row distance of 60 cm. Six insecticides i.e spinosad (Tracer 240 SC), emamectin benzoate (Proclaim 19 EC), cypermethrin (Trycord 10 EC), chlorpyrifos, profenofos and Fenvalerate were tested along with a control. The field experiment was laid out in randomized complete block design (RCBD) and each treatment was replicated three times. Spraying was done by using air compressing knapsack sprayer.

The observations on count of damage fruits were recorded on three randomly selected plants per treatment. First count was done one day before insecticide application and post treatment counts were made after 24, 48, 72, 168 and 240 hours. In order to assess the percent fruit damage, infested fruits on three randomly selected plants were counted as against total number of available fruits on the observed plants.

Statistical Analysis: The values of mean percent damage were then statistically analyzed by analysis of variance. Least significance differences (LSD) was determined at the probability level of $P<0.05$ to decide the significance of individual treatment effect.

3. Results

Data collected on damaged fruits before spraying indicated no significant difference among the percent fruit damage in all the treatments (Table 1). Data recorded before the spray application showed a mean percent damage of 69.53, 57.3, 51.63, 57.93, 51.63, 56.53 and 52.16% on different treatments. Control treatment showed a percent fruit damage of 59.73%. Data recorded after one day of application of insecticides revealed lowest percentage of fruit damage in emamectin benzoate which reduced the percent damage from 57.3% to 39.1% followed by profenofos 43.3%, fenvalerate 44.43%, chlorpyrifos 46.33%, cypermethrin 46.40% and spinosad 48.66% (Table 1). The percent fruit damage in treated plots of chlorpyrifos, cypermethrin, fenvalerate, profenofos were not significantly different from each other but significantly different from emamectin benzoate and control. During 2012, the minimum pest infestation was recorded in fenvalerate treated plots followed by emamectin benzoate one day after application of insecticides. The maximum pest infestation was recorded in control plot (Table 2).

Data on percent fruit damage after 2nd day of application indicated no significant difference among all the treatments. The percent fruit damage in emamectin benzoate was on par with profenofos, fenvalerate and cypermethrin, while they were significantly different from the control. Spinosad, chlorpyrifos and control treatments were not significantly different from each other. Lowest percentage of damage fruits was found in emamectin benzoate i.e. 43.66% and profenofos 43.10% followed by fenvalerate i.e 43.2% cypermethrin 44.03%, chlorpyrifos 45.56%.The highest percentage of damaged fruits was found in plots treated with spinosad i.e 49.36% (Table 1). There was significant difference in insecticide efficacy two days after application of insecticides in the year, 2012. The minimum pest infestation was recorded in fenvalerate treated plots (Table 2).

The percent fruit infestation after 3rd day of application was not significantly different from each other in treated but significantly different from the control. Highest percent fruit infestation was recorded in plots treated with chlorpyrifos i.e. 44.46% followed by spinosad and profenofos (42.40 and 41.16%), whereas the lowest (40.20%) damage was record in emamectin benzoate followed by cypermethrin and Fenvalerate i.e., 40.60 and 40.56% (Table 1). Fenvalerate was the most effective insecticide showing the minimum pest infestation three days after spray in 2012.

Data recorded after 7th day of spraying revealed lowest percent fruit infestation in emamectin benzoate i.e. 26.93% which was followed by spinosad, cypermethrin, fenvalerate and profenofos i.e. 32.66, 30.90, 36.6 and 39.60%. The highest (43.16%) damage was recorded in chlorpyrifos. The percent fruit infestation in emamectin benzoate treated plots was significantly different from profenofos, chlorpyrifos fenvalerate and control treatments, while it was on par with spinosad and cypermethrin. There was no significant difference in percent fruit damage in chlorpyrifos, profenofos and fenvalerate treated plots (Table 1).The seventh day post treatment data showed that fenvalerate was most effective insecticide in second spray compared with other insecticides (Table 2).

After 10th day of application table revealed lowest percent fruit infestation of 29.23% was recorded in emamectin benzoate followed by cypermethrin, spinosad, fenvalerate and chlorpyrifos i.e. 29.43, 32.20, and 43.03%, respectively. The highest (43.03%) fruit infestation was recorded in profenofos. No significant difference was recorded in percent fruit damage among emamectin benzoate, spinosad, cypermethrin and fenvalerate treatments, while they were significantly different from chlorpyrifos, profenofos and control. Percent damage in chlorpyrifos treated plots was significantly different from rest of the treatments as well as from the control after 10 day of pesticide application (Table 1). Chlorpyrifos showed maximum residual toxicity and minimum pest infestation ten days post treatment compared with other insecticides (Table 2).

Overall mean of the data indicated a significant difference among the treatments and control. The lowest (40.1%) fruit infestation was recorded in emamectin benzoate. The highest percent fruit infestation of 58.15% was recorded in control. The result showed that emamectin benzoate was found to be the most effective in suppressing the fruit infestation by brinjal fruit borer, while fenvalerate offered moderate control of brinjal fruit borer. The overall mean of second spray showed that fenvalerate was the most effective insecticide followed by spinosad and emamectin benzoate in reducing pest infestation.

Table 1: Percent infestation of brinjal fruit borer after application of insecticides during 2011 under field conditions

Treatments	Pre Spray Data	Time Interval					Mean
		1st Day	2nd Day	3rd Day	7th Day	10th Day	
Spinosad	69.53	48.66b	49.36ab	42.40b	32.66de	29.23c	45.31b
Emamectin Benzoate	57.30	39.10d	43.06b	40.20b	26.93c	32.10c	40.1c
Chlorpyrifos	57.93	43.33bc	45.56ab	44.46b	43.16b	43.03b	46.75b
Profenofos	56.53	43.40c	43.10b	41.16b	39.60bc	56.03a	46.64b
Fenvalerate	52.16	44.43c	43.20b	40.60b	36.60de	32.13c	41.31c
Cypermethrin	51.63	46.40bc	44.03b	40.56b	30.90de	29.03c	40.43c
Control	59.73	58.7a	53.33a	60.90a	54.93a	61.30a	58.15a
LSD Value		3.06	7.95	8.01	6.53	9.17	1.76

Means within a column followed by different letters are significantly different from each other at 5% level of significance (LSD Test)

Table 2: Percent infestation of brinjal fruit borer after application of insecticides during 2012 under field conditions

Treatments	Pre Spray Data	Time Interval					Mean
		1st Day	2nd Day	3rd Day	7th Day	10th Day	
Spinosad	60.45	50.81ab	49.54bc	45.53sb	46.56bc	38.77bc	46.24bc
Emamectin Benzoate	50.30	42.09ab	45.53bc	56.59ab	39.44bc	51.93b	47.11bc
Chlorpyrifos	53.93	52.17ab	67.37abc	48.54ab	50.81b	35.89c	50.95bc
Profenofos	50.53	53.47ab	79.38a	49.54ab	42.07bc	38.29bc	52.55b
Fenvalerate	45.16	31.27b	42.09c	42.09b	33.91c	50.95bc	40.06c
Cypermethrin	49.63	51.65ab	60.03abc	50.81ab	43.89bc	39.42bc	49.16bc
Control	69.53	60.01a	69.07ab	65.03a	73.98a	67.82a	67.18a
LSD Value		24.95	25.36	22.02	16.72	15.71	12.07

Means within a column followed by different letters are significantly different from each other at 5% level of significance (LSD Test)

4. Discussion

The present observations on the effectiveness of emamectin benzoate are in conformity with those of Anil and Sharma (2010) [10]. These results also coincide with Kalawate and Dethe (2012) [11] who stated that emamectin benzoate and spinosad are efficient in reducing the population and the subsequent damage caused by brinjal fruit borer.

Insecticides are currently the main method of control for *Leucinodes orbonalis*. Contact insecticides are the most commonly used and show varying degrees of an efficacy against the pest. Deltamethrin and endosulfan were the most effective insecticides used in South Asia [12]. In field experiments, triazophos and methomyl were applied when more than 20 % of brinjal fruits were infested. The highest fruit yields were obtained with triazophos [13]. Babu *et al.*, (2002) found that the most commonly used insecticides in the field were carbaryl, followed by endosulfan, carbofuran and cypermethrin in India [14]. A combination of cypermethrin/deltamethrin and triazophos/endosulfan sometimes combines with cartap hydrochloride and diflubenzuron gave higher yields than non-treated plots; cypermethrin/deltamethrin mixtures were the most effective [15, 16].

Studies made by Kalawate and Dethe (2012) on the bio efficacy of spinosad and emamectin benzoate in comparison to cypermethrin and self formulated neem extract for two cropping seasons against brinjal fruit and shoot borer indicated that spinosad was found to be the most effective against *Leucinodes orbonalis* although the corresponding yield recorded in cypermethrin (check treatment) was higher but it was not significantly different than that noticed in spinosad and emamectin benzoate [11].

Anil and Sharma (2010) observed the bio efficacy of insecticides against brinjal shoot and fruit borer. The result showed that in terms of shoot infestation, emamectin benzoate (0.002%), endosulfan (0.005%), novaluron (0.01%) and lambda-cyhalothrin (0.004%) were found superior. The total number of drooping shoots was minimum in emamectin benzoate followed by endosulfan and novaluron as compared to spinosad, deltamethrin and *Bacillus thuringiensis*, in terms of reduction in fruit infestation, emamectin benzoate (0.002%) was highly effective followed by endosulfan (0.05%) agrospray oil T (0.2%) and spinosad (0.002%). However, cost benefit ratio was highest in agro spray oil T (0.2%) followed by lambda-cyhalothrin (0.004%) endosulfan (0.05%) and deltamethrin (0.0028%). Rosaiah (2001) sprayed the plant products against brinjal shoot and fruit borer, neemazol at 0.5 per cent was significantly superior in reducing shoot and fruit damage and contributed to maximum yield. The next best treatments were neemazol 0.25 per cent, NSKE (neem seed kernel and jatropha were poor in their effectiveness against brinjal shoot and fruit borer [10].

Patel *et al.*, (2001) found that one spray of monocrotophos 0.04 percent at 9 weeks after transplanting followed by three sprays of spark (triazophos + deltamethrin) 0.036 per cent at 11, 13 and 15 weeks after transplanting effectively managed the brinjal fruit borer and gave significantly higher fruit yield (238.8 q/ha) percent on fruits, respectively [17].

5. Conclusion

Results showed that emamectin benzoate was most effective in suppressing the pest population as lowest mean percent fruit infestation was recorded after its application i.e. 40.1% followed by cypermethrin in which percent fruit infestation was recorded 40.43%. Fenvalerate and spinosad gave moderate control of brinjal fruit borer in which the mean percent fruit infestation was 41.31% and 45.31%. It is suggested that emamectin benzoate should be used for controlling this pest. However, in case of unavailability of this insecticide cypermethrin may be applied.

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7. Competing Interest

The authors declare that they have no competing interests.

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