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Field efficacy of some insecticides, neem oil and spinosad against shoot and fruit borer, *Leucinodes orbonalis* (Guen.) on brinjal

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Abstract
A field experiment was conducted during *Kharif* season of 2018 at the central research farm of Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. The percent infestation of brinjal shoot and fruit borer on third, seventh and fourteenth days after spraying revealed that all the treatements were superior over control. Among all the treatments, the treatment with recommended insecticide Spinosad 45 SC was found to be the most effective treatment followed by Chloropyriphos 50EC + Cypermethrin 5EC and Emamectin benzoate 5SG. The next best treatments were found to be Cypermethrin 25EC, Chloropyriphos 20EC and Flubendamide 20WG. Neem oil was the least effective against *Leucinodes orbonalis* (Guen.). The highest Benefit cost ratio was recorded in Spinosad (1:6.70) followed by Chloropyrifos 50EC + Cypermethrin 5EC (1:6.21), Emamectin benzoate (1:5.40), Cypermethrin (1:5.02), Chloropyrifos (1:4.38), Flubendamide (1:3.88) and Neem oil (1:3.22).

Keywords: Brinjal, (*Leucinodes orbonalis*), cost benefit ratio, insecticides, infestation

Introduction

Brinjal, also known as eggplant or Aubergine (*Solanum melongena* Linnaeus), belongs to the Solanaceae family. It is a native of Indo-Burma region, and was known to be grown in India since ancient times. Amongst the solanaceous vegetables, brinjal is one of the most common, popular, principle annual crop grown in all the three seasons and economically important vegetable among small-scale farmers as it is a source of cash income for resource poor farmers. The major brinjal growing states in India are, Andhra Pradesh, Karnataka, West Bengal, Tamil Nadu, Maharashtra, Orissa, Uttar Pradesh, Bihar and Rajasthan. In India, West Bengal contribute highest area 181.5 million hectare and production 2877 million tones, Karnataka has highest productivity 25.4 million tonnes per hectare. In Uttar Pradesh, the area under cultivation of brinjal is 3430 hectare producing 111.70 MT and the productivity is 8 MT/ha. (Yadav *et al.*, 2015) [13]

Several biotic and abiotic factors influence the yield reduction in brinjal. Among the various biotic factors, insect pests are most important because they greatly affect both the quality and quantity ie., productivity of brinjal crop by imposing a direct damage (Gupta *et al.*, 1987) [5]. The pests found attacking in the brinjal field are Jassids (*Amrasca biguttula*), Hadda beetle (*Epilachna vigintioctopunctata*), White fly (*Bemisia tabaci*), Aphids (*Aphis gossypii*), Leaf roller (*Eublemma olivacae*), Leaf webber (*Psara bipunctalis*) and Grass hopper (*Chrotogonus spp*.). Among them, brinjal shoot and fruit borer is recorded as the major and serious insect pest of brinjal crop. It is considered as the major constraint as it damages the crop and causes severe yield losses throughout the year. This pest is reported from all brinjal growing countries of the world including Germany, Burma, USA, Srilanka, Pakisthan and India. It infests both the vegetative as well as reproductive stages which cause heavy losses in the yield to the extent of 70-92percent. The larvae of this pest initially bore into the terminal shoots damaging the growing points and cause wilting and dead heart and it is also reported to infest the petiole and midrib of leaves (Alpureto, 1994) [1]. Later these larvae bore into fruits and feed inside the contents resulting in the destruction of the fruit's tissue rendering them unfit for consumption. The feeding tunnels are often clogged with fress. This makes even slightly damaged fruit unfit for market. The losses caused by this pest vary from season to season because moderate temperature and high humidity favour the population build-up of brinjal shoot and fruit borer Shukla and Khatri, 2010) [11].

Damage to fruits particularly in autumn, is very severe and the whole crop can be destroyed (Anwar *et al.,* 2015) [2]. It alone causes damage as high as 85.90% and even up to 100% damage is also recorded.

Application of insecticides for the control of shoot and fruit borer of brinjal is a common practice of farmers. Since the use of insecticides have several health hazardous effects, there is a need for continuous evaluation of such chemicals, botanicals which fit well in the pest management programme and to use less number of sprays and doses of insecticides. Keeping these in view, the present study was undertaken with the objective of evaluating the field efficacy of some insecticides, neem oil and spinosad on the percentage infestation of shoot and fruit borer on brinjal and the cost benefit ratios of these different treatments.

Materials and Methods

Field experiment was conducted at the Central research farm of Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, U.P. during *kharif* season 2018. Trail was laid out in randomised block design consisting of eight treatments including control. Each treatment was replicated thrice and Banarasi Gole brinjal seeds were sown and transplated at a spacing of 60 x 45cm. Standard agronomic practices were followed to ensure a good crop stand. Seven insecticides i.e Cypermethrin 25EC, Chloropyriphos 20EC, Spinosad 45SC, Neem oil 2%, Emamectin benzoate 5SG, Chloropyriphos 50EC + Cypermethrin 5EC, Flubendamide 20WG were tested along with a control. The observations on count of damaged shoots and fruits were recorded on five randomly selected plants per treatment. First count was done one day before insecticide application and post treatment counts were made after 3,7,14 days. Two sprays were given with an interval of 15 days. In order to assess the percent shoot damage, infested shoots on five randomly selected and tagged plants were counted as against total number of available shoots on the observed plants and likewise, to assess the percent fruit damage, infested fruits on five randomly selected plants were counted as against total number of available fruits on the observed plants. The percentage of the shoot and fruit infestation were calculated according to the following equations respectively:

Percent Shoot infestation = [No. of infested shoots / Total no. of shoots] x 100

(Yadav *et al.,* 2015) [13]

Percent Fruit infestation = [No. of infested fruits / Total no. of fruits] x 100

(Yadav *et al.,* 2015) [13]

All the data obtained in the present study were subjected to statistical analysis following standard procedure (Gomez and Gomez (1976)[6].The percentage infestation of shoot and fruit borer population over control was worked out to find the efficacy of the respective treatments against shoot and fruit borer.The percentage infestation of the population of brinjal shoot and fruit borer over control plot were later subjected to statistical analysis.The fruits were harvested from each plot separately and the yield per plant in each picking were recorded in kg. The total yield was worked out by adding the yields of each picking. The yield per plot was then converted to quintals per hectare.

Results and Discussion

The data on Percent shoot infestation showed that all the treatments were found significantly superior over control. Pooled analysis (Table.1) showed that among all the treatments, lowest percent infestation of shoot and fruit borer was recorded in Spinosad (9.07%),these findings are in support with Singh and Sachan (2015)[10] and Tayde and Simon (2010)[12],followed by Chloropyriphos + Cypermethrin (9.59%) which is in line with the findings of Kumar *et al.*, (2011) [7], Emamectin benzoate (10.79%) which is in line with the findings of Anwar *et al.*,(2009)[2], Cypermethrin(13.13%), Chloropyriphos (15.12%) which are in line with the findings of Singh and Sachan (2015)[10], Flubendamide (15.90%) and Neem oil (18.04%). Flubendamide among all the treatments and Neem oil is found to be least effective but comparatively superior over the control and these results are in support with Bhagwan and Kumar (2017)[3].The treatments Spinosad, Chloropyriphos + Cypermethrin (T_3, T_6); Chloropyriphos + Cypermethrin, Emamectin benzoate (T_6, T_5); Chloropyriphos, Flubendamide (T_2,T_7) were statistically at par with each other.

The data on Percent fruit infestation showed that all the treatments were significantly superior over control. Pooled analysis of second spray showed that among all the treatments, the lowest percent infestation of fruit was recorded in Spinosad (9.22%), these findings are in support with Singh and Sachan (2015) [10] and Tayde and Simon (2010) [12]. Chloropyriphos + Cypermethrin (10.95%) is found to be the next best treatment which is in line with the findings of Kumar *et al.*, (2011) [7]. Emamectin benzoate (11.40%) is found to the next best treatment which is in line with the findings of Anwar *et al.*, (2015) [2] and Patra *et al.*, (2014) [9]. Cypermethrin (11.86%), Chloropyriphos (12.45%) are found to the next best treatments which are in line with the findings of Singh and Sachan (2015)[10].Flubendamide (13.27%), among all the treatments Neem oil (14.51%) is found to be least effective but comparatively superior over the control, these results are in support with Bhagwan and Kumar (2017)[3].The treatments Chloropyriphos + Cypermethrin, Emamectin benzoate, Cypermethrin (T_6,T_5,T_1); Cypermethrin, Chloropyriphos (T_1,T_2) and Chloropyriphos, Flubendamide (T_2,T_7) were statistically at par with each other.

The Cost Benefit Ratio from Table.1 that the yields among the present treatments were significant. The highest yield was recorded in insecticides, Spinosad 45SC (266.52/ha), followed by Chloropyriphos + Cypermethrin (241.10q/ha), Emamectin benzoate (210.20 q/ha), Cypermethrin (194.60 q/ha), Chloropyriphos (170.20 q/ha), Flubendamide (150.66 q/ha), Neem oil (125.30 q/ha) as compared to control (91.25q/ha). When cost benefit ratio was worked out, interesting result was achieved. Among the treatments studied, the best and most economical treatment was Spinosad 45SC (1:6.70), followed by Chloropyriphos + Cypermethrin (1:6.21),Emamectin benzoate (1:5.40), Cypermethrin (1:5.02), Chloropyriphos (1:4.38), Flubendamide (1:3.88), Neem oil (1:3.22) as compared to control (1:2.41). The highest yield and cost benefit ratio was recorded in Spinosad as 266.52q/ha and 1:6.70 respectively. This result is supported by Singh and Sachan (2015) [10].

Table 1: Efficacy of some insecticides, neem oil and spinosad against shoot and fruit borer, Leucinodes orbonalis (Guenee.) on brinjal. (First Spray: % Shoot Infestation) & (Second Spray: % Fruit infestation)

Treatments		% Shoot Infestation					% Fruit Infestation					Yield (q/ha)	CB Ratio
		1DBS	3DAS	7DAS	14DAS	Mean	1DBS	3DAS	7DAS	14DAS	Mean		
T_1	Cypermethrin 25EC	24.39 (29.59)	13.88 (21.86)	11.61 (19.92)	13.92 (21.90)	13.13 (21.23)	20.70 (27.06)	12.29 (20.52)	09.88 (18.30)	13.62 (21.65)	11.86 (20.11)	194.60	1:5.02
T_2	Chloropyriphos 20EC	24.10 (29.37)	15.67 (23.31)	13.58 (21.62)	16.12 (23.67)	15.12 (22.87)	26.15 (30.50)	12.32 (20.54)	10.62 (19.02)	14.42 (22.31)	12.45 (20.62)	170.20	1:4.38
T_3	Spinosad 45SC	22.39 (28.23)	09.08 (17.52)	08.35 (16.78)	09.80 (18.24)	09.07 (17.52)	25.44 (30.26)	11.01 (19.37)	07.36 (15.73)	10.17 (18.58)	09.22 (17.63)	266.52	1:6.70
T_4	Neem oil 2%	21.26 (27.45)	18.72 (25.64)	17.08 (24.41)	18.34 (25.35)	18.04 (25.13)	23.49 (28.98)	13.75 (21.75)	14.43 (22.32)	15.36 (23.07)	14.51 (22.38)	125.30	1:3.22
T_5	Emamectin benzoate 5SG	22.49 (28.32)	11.08 (19.44)	10.10 (18.53)	11.17 (19.52)	10.79 (19.17)	23.00 (28.62)	12.02 (20.25)	09.58 (18.00)	12.59 (20.76)	11.40 (19.70)	210.20	1:5.40
T_6	Chloropyriphos 50EC + Cypermethrin 5EC	22.39 (28.23)	09.87 (18.31)	08.82 (17.27)	10.08 (18.50)	09.59 (18.03)	23.52 (28.92)	11.59 (19.89)	09.51 (17.94)	11.75 (20.03)	10.95 (19.30)	241.10	1:6.21
T_7	Flubendamide 20WG	23.76 (29.17)	16.04 (23.60)	15.28 (23.01)	16.39 (23.88)	15.90 (23.50)	23.06 (28.66)	13.64 (21.66)	11.75 (20.03)	14.42 (22.31)	13.27 (21.34)	150.66	1:3.88
T_8	Untreated /Control	22.39 (28.23)	23.69 (29.12)	25.30 (30.19)	23.33 (28.88)	24.01 (29.34)	27.84 (31.84)	25.32 (30.20)	22.16 (28.08)	25.81 (30.53)	24.43 (29.60)	91.25	1:2.41
	F- test	NS	S	S	S	S	NS	S	S	S	S	-	-
	S. Ed. (±)	1.256	0.366	0.226	0.269	0.582	2.156	0.922	0.434	0.562	0.561	-	-
	C. D. (P = 0.05)	NS	0.892	0.485	0.571	1.249	NS	1.691	0.933	1.206	1.204	-	-

*Figures in parenthesis are arc sin transformed values
DBS = Day before spraying, DAS = Days after spraying.
Cost of yield per quintal is Rs.1150

Conclusion

As far as both shoot and fruit infestations are concerned, the two sprays revealed that Spinosad 45SC was the most effective among all the treatments with 9.08% shoot infestation and 9.22% fruit infestation respectively which is followed by Chloropyriphos 50EC + Cypermethrin 5EC - (10.08%) and (10.95%) respectively, Emamectin benzoate 5SG - (11.17%) & (11.40%) respectively, Cypermethrin 25EC - (13.13%) & (11.86%) followed by Chloropyriphos 20EC - (15.12%) & (12.45%) respectively and Flubendamide 20WG - (15.90%) & (13.78%) respectively. Neem oil 2% with (18.04%) and (14.51%) shoot and fruit infestations respectively was found to be the least effective treatment.

Among all the treatments studied, treatment T_3 Spinosad 45SC (1:6.70) was concluded to be the best and most economical treatment, followed by T_6 Chloropyriphos 50EC + Cypermethrin 5EC with (1:6.21) C:B ratio, followed by T_5 Emamectin benzoate 5SG (1:5.40), T_1 Cypermethrin 25EC (1:5.02), T_2 Chloropyriphos 20EC (1:4.38), T_7 Flubendamide (1:3.88), T_4 Neem oil (1:3.22) as compared to control (1:2.41).

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