Biological Forum – An International Journal **15(8): 435-438(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Evaluation of Bio-efficacy of different bio-pesticides against Maize Stem Borer, *Chilo partellus* (Swinhoe) in Udaipur Region

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(Received: 06 June 2023; Revised: 25 June 2023; Accepted: 24 July 2023; Published: 15 August 2023)
(Published by Research Trend)

ABSTRACT: The field experiment was conducted to evaluate "Bio-efficacy of different bio-pesticides in maize stem borer at Rajasthan college of Agriculture, Udaipur during Kharif 2018. The efficacy study revealed that all the treatments significantly reduced leaf injury and percent dead heart and increased grain yield over untreated check. The treatment, spinosad 35 % EC @ 0.3 ml/l was found effective with that minimum leaf injury rating (2.20) and percent dead heart (10.0) followed by *Bt,* NSKE 5%, *Beauveria bassiana, Metarhizium and Azadiractin* 1500 ppm 2%as compared to untreated control [7.90 (LIR) & 43.90 (percent dead heart)]. Similarly, spinosad 35 % EC gave significant result with the highest grain yield (42.00 Q/ha) followed by Bt, NSKE 5%, *Beauveria bassiana, Metarhizium* and Azadiractin 1500 ppm 2% as compared to untreated control (28.00 Q/ha).

Keywords: Stem borer, Maize, Spinosad, Dead heart, Leaf Injury Rating, Beauveria, Cereal.

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop belonging to the grass family, Poaceae and is a native to South America. It is the third most important cereal crop next to rice and wheat in the world as well as in India. It is also considered as "Queen of cereal" due to its high production potential and wider adoptability (Ramesha and Krishna 2017). In India, maize is the third most important food crop after rice and wheat. The production of maize varies between 10-14 million tons, with 80-90% of the production being in the Kharif season. Karnataka and Madhya Pradesh have the highest area under maize (15% each) among Indian states followed by Maharashtra (10%), Rajasthan (9%), Uttar Pradesh (8%), Bihar (7%), Telangana State (6%), Gujarat (5%), Tamil Nadu (4%), J&K (3%) and others (18%). Bihar produces highest maize after Karnataka and Madhya Pradesh. Andhra Pradesh is having the highest state productivity (Anonymous, 2021). In Rajasthan, area under cultivation during *Kharif* was highest compared to other maize growing states. It is grown in Udaipur, Rajsamand, Bhilwara, Chittorgarh, Ajmer, Sirohi, Banswara and Dungarpur districts mainly during *Kharif* season.

Maize contains about 10.5 per cent protein, 4.0 per cent oil, 70 per cent carbohydrates, 2.3 per cent crude fibers, 10.4 per cent albuminoides, 1.4 per cent ash (Khan *et al*., 2014). The maize protein called "Zein" is deficient in the two essential amino acids tryptophan and lysine. It has significant quantities of vitamin A, nicotinic acid, riboflavin and vitamin E. Maize is low in calcium, fairly high in phosphorus. It can be used for manufacturing starch, alcohol, acetic acid, lactic acid, syrup, vinegar, resin powder, fuel for torpedoes, artificial leather, boot polish etc. The green cobs are roasted and consumed by the people with great interest. Maize grains are milled into broken grits for making grovel for human consumption.

Chilo partellus is considered as principle pest in lowland areas (Yonow *et al.,* 2017). It has been reported to cause damage to the extent of 42.29% (Dejen *et al.,* 2014). In case of severe damage, it can cause yield reduction up to 75% (Sharma and Gautam 2010). The larvae of maize stem borer after hatching feeds on soft surface of the leaves and then enters the stem through whorls for feeding on the pith of the stem. The growth of the plants becomes stunted which results in dead hearts at their initial stages. The pest makes exit holes for emergence of adult prior to pupation which takes place inside the stem. A single stem borer has been reported to cause a loss of about 8–10 per cent of potential yield and the pest also has been reported as the most dominant one comprising 89.5 per cent of all stem borers (Songa *et al*., 2001). A yield loss of 24-74 per cent has been reported alone by this pest in India (Kumar and Mihm 1996).

MATERIALS AND METHODS

The present investigation was conducted at the experiment filed of Department of Entomology, Rajasthan College of Agriculture, Udaipur (Rajasthan) during 2018. The experimental location was located in

between 23.4°N longitudes and 75°E latitude at an elevation of 579.5 MSL (*Mean Sea Level*) in the state of Rajasthan. Experiment was laid out in Randomized Block Design with seven treatments including one untreated control and three replications. The crops were planted in the main field using appropriate agronomic packages and techniques, with each plot measuring 4.5 × 3.0 m^2 and a gap of 75 × 20 cm^2 between two rows of plants.

OBSERVATIONS

The larval population observation was taken on five randomly selected plants in each plot. In order to evaluate the bio-efficacy of bio-pesticides against maize stem borer, the artificial infestation was made by releasing 10-12 neonates in the whorl of maize plants after 12 days of germination. The bio-pesticides were sprayed two times during the crop season starting from after 2 days of infestation and second spray was applied 10 days after first application. Pre-treatments observation on population of maize stem borer was recorded and post-treatment observation was recorded in terms of leaf injury rating (LIR) on 1-9 scale according to Chatterji *et al.* (1969) and dead heart formation at 30 days after infestation. There were 7 treatments *viz.*, T_1- *Beauveria bassiana* @10 ml/l, T_2- *Metarhizium* @10ml/l, T_3- *Bacillus thuringiensis* @5 g/l, T_4- NSKEi(5i%) @ 50 ml/l, T_5- *Azadirachtin* 1500ippmi(2i%) @ 5 ml/l, T_6- Spinosadi35i%iE.C @ 0.3 ml/land T_7- Untreated control.

RESULT AND DISCUSSION

A. Leaf injury rating (LIR) and dead heart

A field experiment for management of maize stem borer using bio-pesticides was conducted during *Kharif* 2018. Post –treatment data was recorded after 30 days of artificial infestation and 10 days after first application of bio-pesticides. The initial leaf injury rating and dead heart formation at 30 days after infestation presented in Table 1.

All the bio-pesticides were significantly superior over untreated check at 30 days after infestation, it is evident from the data on leaf injury rating at 30 days after infestation during *Kharif*, 2018 that the minimum leaf injury rating of 2.20 was recorded in plot treated with spinosad 35 % @ 0.3 ml/l, which was significantly superior over the other bio-pesticides, followed by *Bt.* @ 5g/l, NSKE 5% @ 50 ml/l, *Beauveria bassiana* @ 10 ml/l, *Metarhizium* @ 10 ml/l and *Azadirachtin* 1500 ppm 2% @ 5 ml/l with leaf injury rating of 2.80, 4.87, 5.23, 5.67 and 6.17, respectively. The maximum leaf injury rating (7.90) was recorded with untreated control. The dead hearts were counted at 30 days after infestation (Table 1). The percentage of statistically analyzed data on dead hearts varied from 10.00 to 33.33 in different bio-pesticides treatments at 30 days after infestation during *Kharif*, 2018, while it was 43.33 in control treatment. All the treatments were found significantly superior as compared to untreated control. The lowest per cent (10.00) dead hearts was recorded with the treatment of with spinosad 35 % @ 0.3 ml/l, which was significantly superior over the other bio-pesticides, followed by *Bt.* @ 5g/l, NSKE 5% @ 50 ml/l, *Beauveria bassiana* @ 10 ml/l, *Metarhizium* @ 10 ml/l and *Azadirachtin* 1500 ppm 2% @ 5 ml/l with per cent dead hearts of 13.33, 16.67, 20.00, 23.33 and 33.33, respectively. The highest (43.33) per cent dead hearts was found with untreated control, which was significantly higher than rest of the treatments.

B. Grain yield

Statistical analysis of data showed that spinosad 35 % EC gave significant result with the highest grain yield (42.00 Q/ha) followed by *Bt*, NSKE 5%, *Beauveria bassiana*, *Metarhizium* and *Azadiractin* 1500 ppm 2% as compared to untreated control (28.00 Q/ha) (Table 2).

This result is comparably similar with the results of Sudha *et al.*, (2018) also observed that the efficacy of treatments in reduction of per cent leaf injury by stem borers was T_7: Carbofuran 3G (68.36 and 73.30) > T_6: Chlorantran l prole 0.4 % GR (65.58 and 67.26) > T_5: Chlorantran l prole 18.5 % SC (61.63 and 63.58) > T_4: Novaluron 10 % EC (48.44 and 52.23) > T_1: *Azadirachtin* (29.37 and 38.35) > T_2: *B. bassiana* (21.44 and 16.97) >T_3: *B. thuringiensis* (11.11 and 7.63) at 7^{th} and 10^{th} DAT. Similarly, according to Rameash *et al*. (2012) found that foliar application of spinosad (0.002 per cent) and emabectin benzoate (0.002 per cent) significantly reduced damage of *C. partellus* and the bio-efficacy of different natural pesticides were found to be at par with that of monocrotophos @ 0.05 %. Pavani *et al*. (2013) evaluated the efficacy of different insecticides and bio agents against *Sesamia inferens* Walker in maize. Among the bio-pesticides, the fungal pathogen *Beauveria bassiana* resulted in an LIR of 5.75; whereas, bacterial pathogen, *Bacillus thurengensis* recorded L R of 6.30 and it was found to be maximum of 8.50 in untreated control. Among bio-pesticides, percent dead hearts of *B. bassiana* and *B. thuringiens* were 36.25 per cent and 41.25 per cent respectively. Similar trend was observed at 28 days after germination. The bio-pesticides, *B. bassiana* has resulted in 0.43 cm/m stem tunneling followed by *B. thuringiensis* with 0.42 cm at 14 DAG; where, as untreated control has resulted in stem tunneling of 0.47 cm/m stem. Saraswat *et al*. (2016) conducted experiments on management of *C. partellus* in maize using conventional pesticides. The lowest percentage damage (5.3 per cent) with higher crop yield (4.52 t/ha) and lowest insect score (1.00) was observed in plots sprayed with spinosad 45 % EC at 0.5 ml/l water. The following year higher percentage damage control (79.06 per cent) was observed at the plot sprayed with spinosad 45 % EC at 0.5 ml/l water with higher crop yield (4.58 /ha) and lowest insect score (1.00). The highest percentage damage (20.63 per cent) was observed in the control plot with lower yield (0.95 t/ha) and highest insect score (6.00). Over the years, spinosad 45 % EC at 0.5 ml/l water was effective bio-pesticide to control maize stem borer damage and also increase the yield. Saranya and Samiayyan (2016) found that among the different botanicals tested as

ovicide against *Chilo partellus* eggs, neem oil (5 %) was most effective in inhibiting hatching of eggs up to 95 per cent followed by chlorpyriphos 0.2 % (per cent), neem oil 1.0 % (per cent), NSKE (5 %) and Jatropha leaf extract 5% (78 per cent). As oviposition deterrents, neem leaf extract (5 %) showed higher efficacy in deterring the oviposition by *C. partellus* adults recording only 16.6 % oviposition followed by Jatropha leaf extract 5 % (19.2 per cent) and neem oil 5 % (22.6 per cent), neem oil 1.0 % (28.3 per cent) and NSKE 5 % (28.7 per cent). Notch leaf extract 5 % was found to be ineffective both as an ovicide and oviposition deterrent. Hegde *et al.* (2017) studied the effect of application of bio−pesticides and insecticides on stem borers and yield of maize. The overall mean larval population per plant revealed that chlorpyriphos seed treatment + foliar spray was found to be significantly super or by registering lowest (2.57) number of larvae per plant. *Azadirachtin* (4.01), *B. bassiana* (4.11), *B. thuringiensis* (4.35), chlorpyriphos seed treatment (4.52) and fipron l (4.71) were found to be equally effective by recording lower number (4.01− 4.71) of larvae per plant. *M. anisopliae* (5.29) and imidacloprid seed treatment (5.60) were found to be same in terms of their effectiveness being statistically at par with each other; whereas, untreated check has maximum (7.11) larval population per plant.

Table 1: Bio-efficacy of different bio-pesticides against maize stem borer.

Treatments	Dose (ml/l.)	30th Days after infestation	
		Mean LIR	Percent dead heart
Beauveria bassiana	10	5.23	20.00
Metarhizium	10	5.67	23.33
Bt	5g/l	2.80	13.33
NSKE (5%)	50	4.87	16.67
Azadirachtin 1500 ppm (2%)	5	6.17	33.33
Spinosad 35% E.C.	0.3	2.20	10.00
Control	-	7.90	43.33
S. Em. ±		**0.07**	**0.79**
CD at 5%		**0.21**	**2.37**

Table 2: Grain Yield in maize during *Kharif*, 2018.

Sr. No.	Treatments	Dose (ml/g./lit.)	Yield Q/ha	Increased yield over control Kg/ha
1.	*Beauveria bassiana*	10	35.00	7.00
2.	*Metarhizium*	10	33.00	5.00
3.	*Bacillus thuringiensis*	5	39.00	11.00
4.	NSKE (5%)	50	38.00	10.00
5.	*Azadirachtin* 1500 ppm (2%)	5	30.00	2.00
6.	Spinosad 35 % EC	0.3	42.00	14.00
7.	Control	-	28.00	

CONCLUSIONS

The findings of this investigation revealed that the lowest leaf injury rating and percent dead heart (2.20 and 10 per cent, respectively) was observed with spinosad 35 % EC @ 0.3 ml/l treated plots followed by *bt*@ 5 g/l where leaf injury rating was 2.80 and percent dead heart was 13.33 observed. The highest leaf injury rating and percent dead heart (7.90 and 43.33, respectively) were found in untreated plots. Similarly, the highest grain yield (42.00 Q/ha) was observed with spinosad 35 % EC @ 0.3 ml/l treated plots followed by *bt* @ 5 g/l (39.00 Q/ha). The lowest grain yield (28.00 Q/ha) was found in untreated plots.

Acknowledgements. The authors would like to express sense of gratitude to Department of Entomology, Rajasthan College of Agriculture, Udaipur to provide important tools and services during this investigation.
Conflict of Interest. None.

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How to cite this article: Gagandeep Singh, Amit Kumar, Vijay Kumar, Ashok Kumar Meena and Bhuvnesh Nagar (2023). Evaluation of Bio-efficacy of different bio-pesticides against Maize Stem Borer, *Chilo partellus* (Swinhoe) in Udaipur Region. *Biological Forum – An International Journal*, *15*(8): 435-438.