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Economic assessment of different bio pesticides against maize stem borer (*Chilo partellus* Swinhoe) on Kharif maize in Udaipur region of Rajasthan

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ABSTRACT: Maize *Zea mays* L., 1753 (Poaceae) has worldwide enormous economic importance because of its use in food for humans and livestock. Considering the effects of maize stem borer on maize crop yield reduction, health risks associated with chemical insecticides, and the high cost of chemical insecticides, a field experiment was conducted at the Agronomical Instructional farm and Department of Entomology, Rajasthan College of Agriculture, Udaipur, during *Kharif*, 2018 to compare the performance and economic efficacy of various bio pesticides against maize stem borer, as well as their impact on maize yield performance. The highest grain yield was recorded in spinosad 35 % EC (42.00 q/ha) followed by *Bt* (39.00q/ha), NSKE 5% (38.00 q/ha), *Beauveria bassiana* (35.00 q/ha), *Metarhizium* (33.00 q/ha) and *Azadirachtin*1500 ppm (30.00 q/ha), while, highest B: C ratio (22.87) was recorded in spinosad followed by *Bt* (17.68), *Beauveria bassiana* (10.31), NSKE 5% (8.77) and *Metarhizium* (6.99) and lowest in *Azadirachtin* 1500 ppm (2.34).

Keywords: Maize, Maize Stem Borer, Bio Pesticides, Economic, B: C ratio, *Azadirachtin*.

INTRODUCTION

"Maize (*Zea mays* L.) become a staple food in many parts of the world, with total production surpassing that of wheat or rice. It is an important staple food crop in Asia and Africa. Maize occupies a pride place among cereal crops in India and due to its high yield potential is called the queen of cereals" (Kumar & Kumar 2017). "Maize grain has elevated nutritive value as it contains about 72% starch, 10% protein, 4.8%oil, and 5.8% fiber and 3% sugar. At present, out of the total maize produced, 55% is used for food purpose, about 14% for livestock, 18 % for poultry feed, 12 % for starch and one percent as seed" (Krishna & Kumar 2018). Out of 66 insects reported in maize field, there are 14 major pests such as Maize stem borer *Chilo partellus* (Swinhoe), Fall Armyworm (*Spodoptera frugiperda* (J. E. Smith), White grub etc. Among which Maize stem borer *Chilo partellus* ismore complex now a days". (Parajuli *et al*., 2021). "Out of them, *Chilo Partellus* (Swinhoe) is a serious pest of maize throughout India during *Kharif* season causing grain yield loss of 24.3 to 36.3 percent. Almost 75% damage of the crop occurs due to attack of maize stem borer" (Dinesh *et al.*, 2018). During severe infestation, the larvae, either in the leaf whorl or in the stem, can cut through the meristematic tissues; the central leaves dry up to produce the 'dead heart' symptom, resulting in the death of the plant (Groote, 2002). Various control strategies have been adopted to check insect pest of maize, use of synthetic insecticides is a common method of pest control. However, the indiscriminate uses of insecticides have resulted in a number of undesirable side effects such as the development of resistant strain of insects; environmental pollution and health hazards to farmers (Hassall, 1990). Pesticides have also entered into the food chain and have bio accumulated in the higher tropic level. More recently, several human acute and chronic illnesses have been associated with pesticides exposure. Therefore, it has now become necessary to search for the alternative means of pest control, which can minimize the use of synthetic pesticides. Bio-pesticides are the important alternatives to minimize or replace the use of synthetic pesticides. Bio pesticides with different modes of action may minimize insecticide resistance and pest resurgence problems while being safe and ecologically acceptable. Bio pesticides are a good alternative to the synthetic pesticide.

METHOD AND MATERIALS

The field experiment was conducted under artificial infestation conditions. The experiment was laid out in Randomized Block design (RBD) with seven treatments including one untreated control and each treatment was replicated three times in a plot having 4.5 m X 3.0 m size. Where middle two rows of each plot of each plot was utilized for artificial infestation by releasing 10-12 newly hatched larvae in the whorl of maize plants after 12 DAG. The culture of stem borer eggs or larvae was obtained from the Maize laboratory of the department. The treatments comprising of bio-pesticides were applied after two days of infestation and second spray was applied 10 days after first application. There were

seven treatments including control (untreated plot) to check the field efficacy of different bio pesticides treatments against maize stem borer. The bio pesticides were applied on incidence of maize stem borer as, *Beauveria bassiana* @10 ml/g./lit., *Metarhizium* @10 ml/g./lit., Bacillus thuringiensis @5 ml/g./lit., NSKE (5%) @50 ml/g./lit. , *Azadirachtin* 1500 ppm (2%) @5 ml/g./lit., Spinosad 35 % EC @ 0.30 ml/g./lit and the seventh treatment were applied to check the efficacy of botanical treatments as control (untreated).

The benefit cost ratio was computed to better understand the economics of bio pesticides treatments and pest population management like maize stem borer with the assistance of recorded data. The total weight of the seeds was recorded after they were harvested. The gross benefit for each treatment was estimated after subtracting the cost of bio pesticides and labour costs. For each treatment, extra profit from the use of bio pesticides was estimated by subtracting the value realized in the control plot from the gross benefit. The percent increase over control was calculated by dividing extra profit by the value realized in control and multiplying by a hundred. To calculate the benefit-cost ratio, the additional revenue gained over the control plot was divided by the extra cost charged for pest management.

BC ratio

BC ratio was be calculated as given by Biswas, (2015)
BCR = Net Income/ Management Costs

RESULTS AND DISCUSSION

There were seven treatments including control (untreated plot) to check the field efficacy of different bio-pesticides treatments against stem borer. The bio pesticides were applied on incidence of stem borer as, *Beauveria bassiana* @ 10 g/lit./ha, *Metarhizium* @ 10 g/ha, *Bacillus thuringiensis* @ 5 ml/lit./ ha, NSKE (5%) % @ 50 ml/litre / ha, *Azadirachtin* 1500 ppm @ 5 litre/ha, Spinosad 35 % EC @ 0.3 ml/liter/ha and the seventh treatment were applied to check the efficacy of botanical treatments as control (untreated). These 7 treatments were applied in three replications to check the individual effect of each botanical insecticide. All the treatments were applied twice keeping scheduled interval in between them to check the efficiency and persistence whenever the population crossed the economic threshold level. The first spray was given at 15 days after transplanting to manage the incidence of Stem borer of maize, the second spray was done at 45 days after showing. The data pertaining to the economic parameters and the increased grain yield over control is represented in Table 1.

Table 1. Economic and cost benefit ratio of different treatments in maize during Kharif, 2018.

Sl. No.	Treatments	Dose (ml/g./lit.)	Yield Q/ha	Increased yield over control Kg/ha	Price of Increased yield over control Rs/ha	Cost of insecticides and labour Rs/ha	Net profit over control Rs/ha
1.	*Beauveria bassiana*	10	35.00	7.00	14350.00	1268.97	13081.03
2.	*Metarhizium*	10	33.00	5.00	10250.00	1283.30	8966.70
3.	*Bacillus thuringiensis*	5	39.00	11.00	22550.00	1207.14	21342.86
4.	NSKE (5%)	50	38.00	10.00	20500.00	2097.78	18402.22
5.	*Azadirachtin* 1500 ppm (2%)	5	30.00	2.00	4100.00	1227.10	2872.90
6.	Spinosad 35 % EC	0.3	42.00	14.00	28700.00	1202.48	27497.52
7.	Control	-	28.00				

* Labour cost: - 2 labour day @ Rs 300. Per day; Total labour cost (two sprays):- Rs 1200; Price of maize: - Rs 2050 per

The field efficacy of different bio-pesticides tested by application of foliar sprays and the economics of treatments on maize estimated which revealed the net returns are obtained which varied from 2872.90 Rs/ha to 27497.52 Rs/ha and the highest net returns obtained from the treatment Spinosad 35 % EC @ 0.3 ml/litre/ha (27497.52 Rs/ha) followed by *Bacillus thuringiensis* @ 5 litre/ha. (21342.86 Rs/ha) after that NSKE 5 % @ 50 kg/ha (18402.22 Rs/ha) followed by *Beauveria bassiana* @10 litre/ha (13081.03 Rs/ha) after that *Metarhizium* @ 10 litre/ha (8966.70 Rs/ha). The lowest net returns obtained from *Azadirachtin* 1500 ppm @ 5 lit/ ha (2872.90 Rs/ha). The net profits calculated by deducting the initial cost of land preparation, botanical insecticidal cost and the labour charge the after that the economics of various treatments the highest Cost: Benefit ratio was obtained from the treatment Spinosad 35 % EC @ 0.3 ml/litre/ha (1**:**22.87) followed by *Bacillus thuringiensis* 5 kg/ha (1**:**17.68) after that *Beauveria bassiana* @ 10 litre/ha. (1**:**10.31) followed by NSKE 5% @10 litre/ha (1**:**8.77) after that *Metarhizium* @ 10 litre/ha (1**:**6.99) and the *Azadirachtin* 1500 ppm was recorded (1**:**2.34). These findings are conformity close with findings of the treatment with the highest recommended insecticide cost benefit ratio and yield is Imidacloprid 200 SL (T7) (1:5.01) (40.49q/ha), followed by *Beauveria bassiana* (2 CFU108 ml) (T1) (1:4.53) (38.45q/ha), *Bacillus thuringiensis* (108 CFU/ml) (T4) (1:4.41) (37.7q/ha), *Metarhizium anisopliae* (T2) Control (T0) (1:3.52)

(28.4q/ha) produced the lowest monetary return and yield. Kumar *et al.* (2022) also reported that the highest per cent reduction in larval population after 14th day was observed in treatment T4 – *Azadirachtin* 1.5% @ 15 ml/l (67.18) was significantly superior over other treatments followed by T1- Neem oil 2% @ 20 ml/l (63.76), T2- NSKE 5% @ 50 g/l (53.65), T3- Karanj oil 2% @ 20 ml/l (48.67) followed by T5- Castor oil 2% @ 20 ml/l (48.36) whereas, least per cent reduction in pest population after 14th day of spray was recorded in T6- Tobacco decoction 5% @ 50 g/l (43.39). These findings are partially agreement with the findings of Rani *et al.*, (2018) who reported that the insecticidal treatment with carbofuran 3G (1:1.35 & 1:1.21) had the highest cost: benefit ratio, followed by chlorantraniliprole 0.4% GR (1:1.14 & 1:1.11). As a result, an insecticidal schedule that includes the use of Carbofuran 3G -Azadirachtin (10000ppm) - Chlorantraniliprole 0.4% GR/ Chlorantraniliprole 18.5% SC will attack the pest infestation and may provide excellent control.

CONCLUSION

It can be concluded from the present investigation that Spinosad was highly effective for Stem borer population control and highest net returns as well (21342.86 Rs/ha /) the BC ratio is highest in case of Spinosad (1**:**22.87) followed by *Bacillus thuringiensis* (1**:**17.68). It should be advised to the maize growing area of Udaipur as well India to use Spinosad and *Bacillus thuringiensis* based products for maximum reduction of Maize stem borer population without residual effect in dry matter of basil plant parts. Bio pesticides could be applied when stem borer are few *Beauveria* can be suggested for a better yield without using chemical pesticide. It can be also suggested in case the farmers look for a more cost-effective control owing to their high BC ratio. Therefore, Spinosad and *Beauveria bassiana* might be used as insecticide for ecofriendly and cost-effective management of maize stem borer.

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