Determining the Effect of biopesticides and chemicals against pod borer [*Helicoverpa armigera* (L.)] on chickpea (*Cicer arietinum* L.)

ABSTRACT

The field investigation was carried out in the Prayagraj district of Uttar Pradesh. The experiment was conducted in *rabi* 2022 at Central Research Farm (CRF), SHUATS, Naini, Prayagraj district. The field was laid in RBD with three replication and eight treatments viz., *Beauveria bassiana* (2×10^8 CFU/gram) (2ml/liter), *Metarhizium anisopliae* (2×10^8 CFU/gram) (2g/liter), *Bacillus thuringiensis* (1×10^9CFU/ml) (2ml/liter), *Ha* NPV (1×10^9 POB's/ml) (1ml/liter), Azadirachtin 0.3EC (5ml/liter), Spinosad 45% SC (0.5ml/liter), Neem seed kernel extract 5% (5ml/liter), and untreated controlled plot to check the efficacy of biopesticides against pod borer, on chickpea. The result on the efficacy of treatments the least larval population was recorded in Spinosad 45% SC (0.96) followed by *Ha NPV* (1.20), *Bacillus thuringiensis* (1×10^9CFU/ml) (1.84), *Beauveria bassiana* (2×10^8 CFU/gram) (1.91), *Metarhizium anisopliae* (2×10^8 CFU/gram) (2.02), Azadirachtin 0.3EC (2.22), Neem seed kernel extract 5% (2.48) and the highest larval population of pod borer was found in control treatment (4.02). In another parameter higher yield and cost benefit ratio was recorded in Spinosad 45% SC (20.33 q/ha) (1:2.84), followed by *Ha* NPV (1×10^9 POB's/ml)(18.60 q/ha) (1:2.59), *Bacillus thuringiensis* (1×10^9CFU/ml) (17.65 q/ha) (1:2.46), *Beauveria bassiana* (2×10^8 CFU/gram) (15.68 q/ha) (1:2.19), *Metarhizium anisopliae* (2×10^8 CFU/gram) (14.58 q/ha) (1:2.03), Azadirachtin 0.3% EC (13.81 q/ha) (1:1.92) and Neem seed kernel extract 5% (13.58 q/ha) (1:1.89) as compared to control (10.83 q/ha) (1:1.54).

Keywords: Bio-Pesticides, Cost benefit ratio, Efficacy, *Helicoverpa armigera*, Chickpea

INTRODUCTION

"Chickpea (*Cicer arietinum* L.), a member of Fabaceae, is a self-pollinated crop and is second most important food legume crop after common bean. It is an ancient cool season foodlegume crop cultivated by man and has been found in middle eastern archaeological sites dated7500- 6800 BC" **(Gayathri and Kumar, 2021).**

"It is one of the most important food legume plants in a sustainable agriculture system because of its low production cost, wider adaptation, abilitery to fix atmospheric nitrogen and fit in various crop rotations. Nutrional value per 100g of chickpea contains carbohydrates (27.42 g), protein (8.86g), total fat (2.59 g), dietary fibre (7.6g), folates (172 mcg), niacin (0.526 mg),pantothenic acid (0.245 mg), pyridoxine (0.215 mg), riboflavin (0.063), thiamine (0.200 mg), vitamin C (1.3 mg), vitamin A (27 IU), vitamin E (0.35 mg), vitamin K (4.0 mcg), sodium (7.0mg), potassium (291 mg), calcium (49 mg), iron (2.89 mg), magnesium (48 mg), phosphorous(168 mg), zinc (1.53 mg)". **(Hanumant and Kumar, 2022)**.

"Globally, Chickpea is grown in an area of 137 million hectares with a production of 142.4 million tonnes and productivity of 1038 kg/ha. India contributes 70 per cent of total world Chickpea production of 116.2 million tonnes cultivated under 112 million hectares with productivity of 1036 kg/hectare in 2020-21. India is the largest producer of world gram production followed by Australia, Myanmar and Ethiopia" **(Mohanty and Tayde, 2022)**. "In India, Chickpea takes first position in total pulse production followed by Black gram. Madhya Pradesh ranked first contributing an area of 30.76 million ha, production 33.98 million tonnes and productivity 1105 kg/ha (34.46% and 40.62% of total area and production of country). Maharashtra is one of the second rank for area 15.41 million hectares (17.26%) and third for production 11.98 million tones (14.32%). Whereas, Rajasthan stood second in production (14.47%) and third in area (15.37%). The highest yield was recorded in the state of Telangana (1459 kg/ha) followed by Gujarat (1201 kg/ha) and West Bengal (1163 kg/ha). The lowest yield was recorded in Karnataka (578 kg/ha)". **(Anil and Kumar, 2022)**

"The various ecological factors, responsible for low yield of chickpea in India, the insectpests are most important. listed 54 species of insect pests on chickpea of these the gram pod borer, *Helicoverpa armigera* (Hub), a pest of national importance in India, is one of the limitingfactors in the successful cultivation of chickpea. Pod borer larvae feed on both foliage and podsof chickpea, yield losses are mainly due to pod damage". **(Kumar *et al.*, 2018).**

"The gram pod borer, *Helicoverpa armigera* is a potential and polyphagous pest, with various characteristic features like high fecundity, migratory behavior, high adaptations to various agro climatic conditions and development of resistance to various insecticides, extensively damaging many crops including chickpea" **(Kambrekar *et al.*, 2009)**. "The caterpillar not only defoliates the tender leaves but also makes holes in the pods and feed upon the developing seeds the anterior body portion of the caterpillar remains inside the pod and rest half or so hanging outside. When seeds of one pod are finished, it moves to the next. Unless the pest is controlled in the initial stages of infestation it takes the heavy loss of the crop. Worldwide losses due to *Helicoverpa armigera* have been estimated over US $300 million annually" **(Kaur *et al*., 2007)**. "In India, yield losses caused by *Helicoverpa armigera* are in the range of 20-30 percent and sometimes rise to 75 percent in chickpea which is increased even to 90 percent in Bangladesh. In Nepal, it is increasingly becoming a severe threat of spring season tomato for the last few years". **(Gayathri and Kumar, 2021).**

MATERIALS AND METHODS

The experiment was conducted at the experimental research plot of the Department of Entomology, Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences during *Rabi* season of 2022 in Randomized Block Design withthree replications and eight treatments using a variety Pusa- 362 with 2 × 1 m plot size. The crop of Chickpea (*Cicer arietinum* L.) was used for sowing by maintaining 45 cm inter-row and 15 cm intra-row distance with the seed rate of 70-100 kg/ha. "The soil of the experimental site was well drained and medium high. Research field situated at 25°27‶ North latitude 80°05‶East longitudes and at an altitude of 98 meter above sea level the maximum temperature reachesup to 42°C in summer and drops down to 4°C in winter. Agronomical practices were followedto raise the crop. Each treatment was sprayed twice at when larval population reaches its ETL level (3 to 5 larvae per plant). The observation on population of *Helicoverpa armigera* were recorded visually per plant from five randomly selected and tagged plants in each plot". [14]

The Biopesticides used for spraying are *Beauveria bassiana* (2×10^8 CFU/gram) (2ml/liter), *Metarhizium anisopliae* (2×10^8 CFU/gram) (2g/liter), *Bacillus thuringiensis* (1×10^9CFU/ml) (2ml/liter), *Ha* NPV (1×10^9 POB's/ml) (1ml/liter), Azadirachtin 0.3EC (5ml/liter), Spinosad 45% SC (0.5ml/liter), Neem seed kernel extract 5% (5ml/liter) were sprayed at and total two sprays were given. The spray solution was applied with the help of a hand compression sprayer. Spraying was done at dawn and dusk time and there must not be much wind currents.

The numbers of larva were counted on 5 randomly selected plants in each plot. The pre-treatment count was made a day before the both sprays whereas, the post- treatment counts were made on 3rd, 7th and 14th day after each spray. The larval population of gram pod borer was calculated by considering the mean of three observations recorded at 3rd, 7th, and 14th day after both sprays.

Preparation of Insecticidal Solution

"The desired concentration of insecticidal spray solution for each treatment was freshly prepared each and every time at the site of the experiment, just before the start of spraying operations. The number of spray materials required for crop gradually increased as the crop advanced in age". [14] The spray solution of desired concentration was prepared by adopting the following formula:

$V = (C \times A) / \%\ a.i.$

Where,

V= Volume of a formulated pesticide required.

C= Concentration required.

A= Volume of total solution to be prepared.

% a.i. = Given Percentage strength of a formulated pesticide.

Observations

Observation was recorded on the number of larvae per 5 plants in 2m row length at 5 different locations of all treatments were randomly selected and total number of larvae were recorded 1day before spraying (DBS) and 3^{rd} 7^{th} and 14^{th} days after spraying (DAS) in each treatment. The result obtained was with following formula.

$$\text{Larval Population count} = \frac{\text{Total no of larvae}}{\text{5 randomly selected plant}} \times 100$$ **(Mohanty and Tayde, 2022)**

Cost benefit Ratio of Treatments

Gross returns was calculated by multiplying total yield with market price of the produce. Cost of cultivation and cost of treatments was deducted from the gross returns, to find out returns and cost benefit of ratio by following formula,

$$\text{C: B Ratio} = \frac{\text{Gross returans ₹/ha}}{\text{Cost of Plant Cultivation ₹/ha}}$$ (**Lavanya and Kumar, 2022)**

Where,

C: B Ratio = Cost Benefit Ratio

Table 1. Larval population of gram pod borer (*H. armigera*)

Treatments		Larval population of gram pod borer (*H. armigera*) (Number)/plot										Yield (q/ha)	C: B Ratio
		1st spray					2nd spray						
		One day before spray	3DAS	7DAS	14DAS	Mean	3 DAS	7 DAS	14 DAS	Mean	Overall mean (1&2 spray)		
T_1	*Beauveria bassiana* (2×10^8 CFU/gram) (2ml/liter)	2.80	2.33^{bc}	1.93^{bc}	2.20bc	2.15^{cd}	2.13^{bc}	1.33^{cd}	1.53^{bc}	1.66^{d}	1.91^{bc}	15.68	1:2.19
T_2	*Metarhizium anisopliae* (2×10^8 CFU/gram) (2g/liter)	2.66	2.46^{b}	2.06^{b}	2.33^{b}	2.28^{cd}	2.26^{b}	1.40^{cd}	1.60^{b}	1.75^{cd}	2.02^{b}	14.58	1:2.03
T_3	*Bacillus thuringiensis* (1×10^9CFU/ml) (2ml/liter)	2.93	2.26^{bc}	1.86^{bc}	2.13^{bc}	2.08^{d}	2.06^{bc}	1.26^{d}	1.46^{bc}	1.60^{d}	1.84^{bc}	17.65	1:2.46
T_4	*Ha* NPV (1×10^9 POB's/ml) (1ml/liter)	2.80	1.66^{cd}	1.26^{cd}	1.53cd	1.48^{e}	1.46^{cd}	0.53^{e}	0.73^{cd}	0.91^{e}	1.20^{cd}	18.60	1:2.59
T_5	Azadirachtin 0.3EC (5ml/liter)	2.93	2.53^{b}	2.13^{b}	2.40^{b}	2.35^{c}	2.33^{b}	1.86^{bc}	2.06^{b}	2.08^{bc}	2.22^{b}	13.81	1:1.92
T_6	Spinosad 45% SC (0.5ml/liter)	2.46	1.40^{d}	1.00^{d}	1.33^{d}	1.24^{f}	1.20^{d}	0.33^{e}	0.533^{d}	0.68^{e}	0.96^{d}	20.33	1:2.84
T_7	Neem seed kernel extract 5% (5ml/liter)	3.06	2.80^{ab}	2.33^{b}	2.66^{b}	2.60^{b}	2.53^{b}	2.20^{b}	2.40^{b}	2.37^{b}	2.48^{b}	13.58	1:1.89
T_8	Control	3.20	3.46^{a}	3.66^{a}	3.86^{a}	3.66^{a}	4.20^{a}	4.40^{a}	4.53^{a}	4.37^{a}	4.02^{a}	10.83	1:1.54
Overall Mean		2.85	2.36	8.11	2.49	2.23	2.27	1.66	1.85	1.92	2.08		
F- test		NS	S	S	S	S	S	S	S	S	S		
S. Ed. (±)		0.17	0.34	0.33	0.32	0.10	0.35	0.23	0.23	0.18	0.18		
C. D. (P = 0.05)		N/A	0.72	0.70	0.69	0.20	0.72	0.49	0.69	0.38	0.72		

RESULT AND DISCUSSION

The data after first spray table 1, reveled that all the treatment were significantly superior over control. Among the treatments most effective treatment in controlling larval population of gram pod borer was recorded in Spinosad 45% SC (1.24 larvae per 5 plants) followed by *Ha* NPV (1×10^9 POB's/ml) (1.48), *Bacillus thuringiensis* (1×10^9CFU/ml) (2.08), *Beauveria bassiana* (2×10^8 CFU/gram) (2.15), *Metarhizium anisopliae* (2×10^8 CFU/gram) (2.28) and Azadirachtin 0.3% EC (2.35) respectively. Neem seed kernel extract 5% (2.60). was found to be least effective among all the treatments but superior over control (3.66).

The data after second spray reveled that all the treatment were significantly superior over control. Among the treatments most effective treatment in controlling larval population of gram pod borer was recorded in Spinosad 45% SC (0.68 larvae per 5 plants) followed by *Ha* NPV (1×10^9 POB's/ml) (0.91), *Bacillus thuringiensis* (1×10^9CFU/ml) (1.60), *Beauveria bassiana* (2×10^8 CFU/gram) (1.66), *Metarhizium anisopliae* (2×10^8 CFU/gram) (1.75) and Azadirachtin 0.3% EC (2.08) respectively. Neem seed kernel extract 5% (2.37). was found to be least effective among all the treatments but superior over control (4.37).

The highest yield was recorded in Spinosad 45% SC (20.33 q/ha) of chickpea as against (10.83 q/ha) in untreated control. Whereas the *Ha* NPV (1×10^9 POB's/ml) (18.60 q/ha) yield of chickpea followed by *Bacillus thuringiensis* (1×10^9CFU/ml) (17.65 q/ha), *Beauveria bassiana* (2×10^8 CFU/gram) (15.68 q/ha), *Metarhizium anisopliae* (2×10^8 CFU/gram) (14.58 q/ha) Azadirachtin 0.3% EC (13.81 q/ha) and Neem seed kernel extract 5% (13.58 q/ha).

When the treatment studied, the best and most economical treatment found was in Spinosad 45% SC (1:2.84) followed by *Ha* NPV (1×10^9 POB's/ml) (1:2.59), *Bacillus thuringiensis* (1×10^9CFU/ml) (1:2.46), *Beauveria bassiana* (2×10^8 CFU/gram) (1:2.19), *Metarhizium anisopliae* (2×10^8 CFU/gram) (1:2.03), Azadirachtin 0.3% EC (1:1.92), and Neem seed kernel extract 5% (1:1.89) was found minimum cost benefit ratio among the treatments over untreated control (1:1.54).

Conclution

The data on mean population after both sprays revealed that all the bio pesticides were found very effective and significantly superior over untreated control. Among all treatmentsminimum population of pod borer larva was found in Spinosad 45% SC (0.96) same results was reported by **Anil and Kumar (2022)**, **Reddy and Tayde (2022)**, **Kumar and Tayde (2022),** *Ha* NPV (1×10^9 POB's/ml) which was found to be the next effective treatment with larval number (1.20) also reported the efficacy of *Ha* NPV by **Barwa and kumar (2022)**, **Jagtap *et al.*,(2022)**, *Bacillus thuringiensis* (1×10^{9}CFU/ml) was found the next best effective treatments with the larval number (1.84) which is in supported by the findings of **Sai *et al.*, (2021), Reddy and Tayde (2022), Anil and Kumar (2022).**

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