



Comparative Efficacy of Selected Chemicals and Bio-pesticides Against Gram Pod Borer [*Helicoverpa armigera* (Hubner)] on Chickpea (*Cicer arietinum* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted at Central Research Farm (CRF), Sam Higgin bottom University of Agriculture Technology and Sciences, Prayagraj during *Rabi* season in 2023-24. The experiment was carried out in Randomized Block Design (RBD) with eight treatments viz., Neem oil 2% @ 2ml/lit, *Beauveria bassiana* 1×10^{10} conidia/ml @ 2gm/lit, Profenofos 40% + Cypermethrin 4% @ 3ml/lit, *Bacillus thuringiensis* @ 2gm/lit, Indoxacarb 14.5 SC @ 0.5ml/lit, Spinosad 45 SC @ 0.5ml/lit, Emamectin benzoate 5% SG @ 1gm/lit and untreated control, with three replications. The

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data recorded on larval population of pod borer (*Helicoverpa armigera*) on third, seventh and fourteen days after two sprays revealed that Emamectin benzoate 5% SG was superior among all treatments with larval population of 2.12 and with highest cost benefit ratio and marketable yield of 1:3.65 and 29.16q/ha, followed by Spinosad 45 SC with a larval population of 2.42 and cost benefit ratio and yield 1:3.14 and 26.66 q/ha, Indoxacarb 14.5 SC with a larval population, cost benefit ratio and yield of 2.57, 1:3.12 and 25.83 q/ha, Profenofos 40% + Cypermethrin 4% EC with a larval population, cost benefit ratio and yield of 2.79, 1:2.81 and 22.5 q/ha, *Bacillus thuringiensis* @ 5mg/ml with larval population, cost benefit ratio and yield of 3.04, 1:2.79 and 21.25 q/ha, *Beauveria bassiana* @ 1×10^{10} conidia/ml with a larval population, cost benefit ratio and yield of 3.25, 1:2.26, 17.08 q/ha.

Keywords: Bio-pesticides; chickpea; chemical; cost benefit ratio; efficacy; (*Helicoverpa armigera*); larval population; yield.

1. INTRODUCTION

Gram, commonly known as a 'chickpea' or chana, is a very important pulse crop that grows as a seed of a plant named *Cicer arietinum* in the Leguminosae family. India is the largest chickpea producer as well as consumer in the world. Chickpea is the world's third most important legume crop. However, the most important chickpea producing countries are India, Turkey, Pakistan, Iran, Mexico, Australia, Ethiopia, Myanmar, and Canada. Chickpea is currently grown on about 11 million hectares worldwide with 65 and 8 per cent share belonging to India and Pakistan, respectively. Average annual production of chickpea is about 9 million tons with 95 percent of chickpea cultivation and consumption occurring in developing countries.

Chickpea is the most largely produced pulse crop in India accounting to a share of 68 to 70 per cent of the total area (13.20 m ha), production of 11.62 mt and productivity of 995 kg/h respectively, this makes India, the leading chickpea producing country in the world. Chickpea ranks third among the pulse crops and accounts for 11.67 million tons annually. This ranking place chickpea behind beans (25.66 million tons) and peas (11.69 million tons) with mean annual production of 11.67 million tons from 2013 to 2017 (Singh et al., 2015).

Chickpea is attacked by 57 insect species, but (*Helicoverpa armigera*) (Hubner) (Lepidoptera: Noctuidae), is the most important pest of chickpea (Sarwar, 2012). *H. armigera*, commonly known as cotton bollworm or American bollworm, is a major noctuid pest in Asia, causing heavy damage to agricultural, horticultural and ornamental crops (Talekar et al., 2006). *H. armigera* is the most serious pest of chickpea and

other crop plants all over the world. In severe cases, it causes about 75 to 90 % losses in seed yield, and it was pointed out that gram pod borer damaged leaves, tender shoots, apical tips, floral buds and pods. Among these, the major damage is caused by gram pod borer which is polyphagous in nature; *Helicoverpa armigera* is one of the serious pests of chickpea, which feeds more than 150 crops throughout the world. Gram pod borer is widely distributed and a serious pest of chickpea causing heavy crop losses (20-60%) throughout the India. *Helicoverpa armigera* is the major and most devastating pest of chickpea which can cause crop loss up to 80 per cent under congenial weather conditions (Vikrant et al., 2018). While the later instars make a more or less circular hole in the pods and insert its head and former portion of body into it and feed upon the developing grains (Chitralkha et al., 2018). Gram pod borer, *Helicoverpa armigera* (Hub.) is the most damaging pest in most of areas where this pulse crop is grown. *H. armigera* is a charismatic and one of the most dominant insect pests in agriculture, accounting for half of the total insecticides usage in India for protection of crops. This pest damages the chickpea plants from seedling stage to crop maturity stage and its larvae can thrive on leaves, tender twigs, flowers and pods. In recent years, various types of insecticides belonging to different chemical groups have been used to manage the pests and excessive reliance on these chemicals has led to the problem of resistance, environmental pollution and health threat to the consumers thus it has become essential to use the insecticides in optimal dosage so as to reduce and control the damage to environment and human health as well as to reduce the pest incidence. Hence an investigation was undertaken to evaluate the performance of certain chemical insecticides and bio-pesticides at their recommended dosages against diamond back moth in cabbage.

2. MATERIALS AND METHODS

The experiment was conducted at the Central Research Farm, Sam Higginbottom University of Agriculture Technology and Sciences, during the *Rabi* season of 2023-24. The experiment was conducted in Randomized Block Design with eight treatments replicated three times. Variety PUSA 362 seeds was used in a plot size of 2m x 1m at the spacing of 45 cm x 15 cm, following a recommended package of practice excluding plant protection. The treatments were Neem oil 2% @ 2ml/lit, *Beauveria bassiana* 1×10¹⁰ conidia/ml @ 2gm/lit, Profenofos 40% + Cypermethrin 4%, @ 3ml/lit, *Bacillus thuringiensis* @ 2mg/lit, Indoxacarb 14.5 SC @ 0.5ml/lit, Spinosad 45 SC @ 0.5ml/lit, Emamectin benzoate 5% SG @ 1gm/lit.

The numbers of larvae were counted on 5 randomly selected plants in each plot. The pre-treatment count was taken a day before the first spray and second spray whereas, the post-treatment counts were taken on 3rd, 7th and 14th day after each spray. The larval population over control against gram pod borer was calculated by considering the mean of three observations of both sprays. The insect population was counted from randomly selected plants in every plot and population per 5 plants was noted. After that mean of three replications was calculated for each treatment and the same was done with the untreated plot. Healthy pods were harvested and their weight from each treatment was expressed as marketable yield in quintal per hectare. Ultimately, the cost benefit ratio was calculated on the basis of prevailing market price of yield, insecticides and spraying cost (Devi and Tayde, 2017). Gross return was calculated by multiplying total yield with the market price of the produce. Cost of cultivation and cost of treatment imposition deducted from the gross returns, to find out net returns and cost benefit ratio by following formula.

Benefit Cost Ratio = Gross Returns / Total Cost of Cultivation

(Thumar et al., 2020)

3. RESULTS AND DISCUSSION

The data recorded after 1st and 2nd spray revealed that all the treatments were significantly superior over the control. The data revealed that all the treatments were significantly superior over control after first spray. Among the different

treatments least number of larval population of gram pod borer was recorded in Emamectin benzoate 5 SG (2.57 larvae per 5 plants), followed by Spinosad 45 SC (2.79), Indoxacarb 14.5 SC (2.90), Profenofos 40% + Cypermethrin 4% (3.08), *Bacillus thuringiensis* @ 5mg/ml (3.33), and *Beauveria bassiana* @ 1×10¹⁰ conidia/ml (3.50), Neem oil 2% (3.88), was found to be least effective among all the treatments as compared to Control (5.11).

The data revealed that all the treatments were significantly superior over control after second spray. Among all the treatments the least larval population of pod borer, was recorded in Emamectin benzoate 5 SG (1.68), followed by Spinosad 45 SC (2.06), Indoxacarb 14.5 SC (2.24), Profenofos 40% + Cypermethrin 4% (2.50), *Bacillus thuringiensis* @ 5mg/ml (2.75), and *Beauveria bassiana* @1×10¹⁰/ml (3.00), Neem oil 2% (3.26) was found to be least effective among all the treatments as compared to Control (6.17).

The yields among the different treatment were significantly superior over control. The highest yield was recorded in Emamectin benzoate 5% (29.16 q/ha), followed by Spinosad (26.66 q/ha), Indoxacarb 14.5 SC (25.83 q/ha), Profenofos 40% + Cypermethrin 4% (22.5 q/ha), *Bacillus thuringiensis* (21.25 q/ha), and *Beauveria bassiana* (17.08 q/ha). The treatment Neem oil 2% (13.33 q/ha) was least effective among all the treatments as compared to Control (11.00q/ha).

Among the different treatment studied, the best and most economical treatment found was Emamectin benzoate 5% with a cost benefit ratio of (1:3.65), followed by Spinosad 45 SC (1:3.14), Indoxacarb (1:3.12), Profenofos 40% + Cypermethrin 4% (1:2.81), *Bacillus thuringiensis* (1:2.79), and *Beauveria bassiana* (1:2.26), Neem oil 2% (1:1.76) recorded minimum cost benefit ratio among all the treatments as compared to Control (1:1.54).

The data on mean population after first and second spray revealed that all the insecticides were found very effective and significantly superior over untreated control. Among all seven treatments minimum larval population was found in Emamectin benzoate 5% (2.12) similar findings were reported by (Kambrekar et al., 2012). Spinosad 45 SC was found the next effective treatment with larval population (2.42) similar finding was reported by Lavanya and Kumar (2022) and Gayathri and Kumar (2021)

Table 1. Efficacy of selected chemicals and bio-pesticides against gram pod borer on chickpea during Rabi 2023-2024

Treatment	Treatment Details	Mean Larval Population										Yield (q/ha)	BenefitCost Ratio
		First spray					Second spray						
		1DBS	3DAS	7DAS	14DAS	MEAN	1DBS	3DAS	7DAS	14DAS	MEAN		
T0	Control	4.60	5.00	5.13	5.20	5.11	5.11	5.60	6.53	6.40	6.17	11.00	1:1.54
T1	Neem oil 2% @ 2ml/lit	4.80	4.06	3.66	3.93	3.88	3.88	3.66	2.86	3.26	3.26	13.33	1:1.76
T2	<i>Beauveria bassiana</i> 1x10 ¹⁰ conidia/ml @2gm/lit	4.73	3.66	3.40	3.46	3.50	3.50	3.40	2.60	3.00	3.00	17.08	1:2.26
T3	Profenofos 40 % +Cypermethrin 4% EC@3ml/lit	4.93	3.20	2.93	3.13	3.08	3.08	3.00	2.06	2.46	2.50	22.50	1:2.81
T4	<i>Bacillus thuringiensis</i> @2gm/lit	4.80	3.60	3.13	3.26	3.33	3.33	3.20	2.33	2.73	2.75	21.25	1:2.79
T5	Indoxacarb 14.5 SC@0.5ml/lit	4.86	3.13	2.66	3.93	2.90	2.90	2.60	1.86	2.26	2.24	23.30	1:3.12
T6	Spinosad 45 SC@0.5ml/lit	4.93	3.06	2.53	2.80	2.79	2.79	2.40	1.66	2.13	2.06	26.66	1:3.14
T7	Emamectin benzoate5% SG@1gm/lit	5.06	2.80	2.33	2.60	2.57	2.57	2.20	1.20	1.66	1.68	29.16	1:3.65
	F- test	NS	S	S	S	S	S	S	S	S	S	-	-
	C. D. (P = 0.05)	-	0.381	0.111	0.224	0.204	0.204	0.177	0.255	0.22	0.569	-	-

* DBS - Day Before Spraying, DAS - Day After Spraying, NS - Non-Significant, S - Significant.

Indoxacarb 14.5 SC (2.57), Profenofos 40% + Cypermethrin 4% was found the next best effective treatments with the larval population (2.79) which was similarly to the findings of (Jadhav et al., 2021). Among all the treatments the higher cost benefit ratio was obtained from Emamectin benzoate (1:3.65) which is in support to the findings of (Shah et al., 2013), (Bharti et al., 2015) followed by Spinosad 45 SC with a cost benefit ratio of (1:3.14) similar finding was found by, (Keval et al., 2016) followed by Indoxacarb 14.5 SC (1:3.12).

4. CONCLUSION

various types of insecticides belonging to different chemical groups have been used to manage the pests and excessive reliance on these chemicals has led to the problem of resistance, environmental pollution and health threat to the consumers thus it has become essential to use the insecticides in optimal dosage so as to reduce and control the damage to environment and human health as well as to reduce the pest incidence.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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