



Assessing the Efficacy and Economics of Selected Insecticides against Pod Borer [*Helicoverpa armigera* (Hubner)] on Cowpea [*Vigna unguiculata* (L.) Walp]

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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 present field investigation was carried out in the Prayagraj district of Uttar Pradesh. The experiment was conducted in Kharif season 2023-2024 at Central Research Farm (CRF), SHUATS, Naini, Prayagraj district. The field layout chosen was RBD with seven treatments and controlled plot. To check the "Efficacy and economics of selected insecticides against pod borer, *Helicoverpa armigera* (Hubner) on cowpea *Vigna unguiculata* (L.) Walp". The result of the efficacy of the treatments after first spray showed that the Chlorantraniliprole (1.66) found out to be most effective. Followed by Spinosad (1.95) and Indoxacarb (2.22). Treatments Imidacloprid (2.33) and Fipronil (2.44) was found to be average. Bacillus thuringiensis (2.55) and Azadiractin (Neem Oil) (2.64) found to be less effective in managing the larval population of *Helicoverpa armigera*.

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According to the second spray of showed that Chlorantraniliprole (1.02) was found to be the most effective. Followed by Spinosad (1.42) and Indoxacarb (1.64). Treatments Imidacloprid (1.95) and Fipronil (2.1) was found to be average. *Bacillus thuringiensis* (2.31) and Azadiractin (Neem oil) (2.44) found out to be less effective in managing the larval population of *Helicoverpa armigera* but comparatively superior over control. In another parameter higher yield was recorded in Chlorantraniliprole (24.08 q/ha) followed by Spinosad (22.50 q/ha), Indoxacarb (17.20 q/ha), *Bacillus thuringiensis* (13.70 q/ha) and Azadiractin (Neem oil) (12.60 q/ha) as compared to control (10.50 q/ha). The highest cost benefit ratio was obtained in treatment of Chlorantraniliprole (1:3.51), followed by Spinosad (1:2.85), respectively.

Keywords: Cost benefit ratio; Efficacy; *Helicoverpa armigera*; treatments.

1. INTRODUCTION

“Cowpea (*Vigna unguiculata* (L). Walp.) (2n= 2x = 22) is a member of the Phaseoleae tribe of the Leguminosae family. Members of the Phaseoleae include many of the economically important warm season and legumes, such as soybean (*Glycine max*), common bean (*Phaseolus vulgaris*), and mung bean (*Vigna radiata*). The name cowpea probably originated from the fact that the plant was an important source of hay for cows in the southeastern United States and in other parts of the world. Some of the important local names for cowpea around the world include Liebe,” “wake” and “Ewa” in much of West Africa and “coup” in Brazil. In the United States, other names used to describe cowpea include “southern peas,” “black-eyed peas,” field peas” “pinkeye” and crowders. These names effect traditional seed and market classes that developed over time in the southern United States” [1].

“The grain contains 26.61 percent protein, 3.99 percent lipid, 56.24 percent carbohydrates, 8.60 percent moisture, 3.84 percent ash, 1.38 percent crude fiber, 1.51 percent gross energy, and 54.85 percent nitrogen free extract. Rough estimates indicate that annual global production is around 2 mt from an area of 5m.ha. India accounts for about 0.5 mt production from around 1.5 m.ha. In India, the major area under grain cowpea is mainly confined to the states of Uttar Pradesh, Karnataka, Tamil Nadu, Andhra Pradesh and Kerala where, it is mainly sown as a mixed crop with other pulses and cereals” (Phani and Kumar 2023).

“*Helicoverpa armigera* is a cosmopolitan and widely distributed insect pest in the world. It is a serious pest of all legumes. *Helicoverpa armigera* is found in Palearctic oriental Ethiopian and Australian Provinces, south of a line at approximately 52°N. The range occupied by the

species including tropical, dry, and temperate climates. The currently reported global distribution of *Helicoverpa armigera* suggests that the pest may be most closely associated with deserts and xeric shrub lands; Mediterranean scrub; temperate broadleaf and mixed forests; tropical and sub-tropical grass lands, savannas and shrub lands; and tropical and sub-tropical broadleaf forest” [2].

2. MATERIALS AND METHODS

The experiment was conducted at the experiment field of Department of Entomology, Central Research Farm, Sam Higginbottom University of Agriculture Technology And Sciences, during the *rabi* season of 2023-2024. The Research field is situated at Prayagraj at an elevation of 78 meters above sea level at 25.87 North latitude and 81.15°E longitudes. This region has a sub-tropical climate prevailing in the South-East part of U.P. with both the extremes in the temperature, i.e., the winter and the summer. In cold winters, the temperature sometimes is low as 32°F in December-January and very hot summer with temperatures reaching upto 115°F in the months of May and June. The experimental design used was Randomized Block Design with 7 treatments and one control Plot with three replications. With plot size of 2m x 1m. The treatments taken were- Chlorantraniliprole 18.5 SC, Indoxacarb 14.5 SC, Azadiractin (Neem oil) 5%, Imidacloprid 17.8 SL, Spinosad 45 SC, Fipronil and *Bacillus thuringiensis* 4%WSP and Control.

The larva were calculated on 5 randomly selected plants in each plot. The larva was once counted 1 day before spray, and then after spray the data was recorded on 3rd, 7th, 14th days after each spray. The larval population of pod borer was determined after 3 mean observations of first and second spray recorded at 3rd, 7th, 14th days after spray.

3. RESULTS AND DISCUSSION

3.1 Efficacy of Different Insecticides and Some Bio-Pesticides on Pod Borer after First Spray

3.1.1 Third days after first spray

The data on larval population of gram pod borer on 3rd day after 1st spray revealed that all the treatments were significantly superior over control. The minimum larval population was recorded in Chlorantraniliprole (1.86) and it is followed by Spinosad (2.13). Both these treatments were significant to each other and superior over other treatments. The next treatments viz. Indoxacarb (2.33), Imidacloprid (2.53), Fipronil (2.6), *Bacillus thuringiensis* (2.73) and Azadiractin (Neem oil) (2.8) recorded larval population respectively. The treatment *Bacillus thuringiensis* (2.73) and Azadiractin (Neem oil) (2.8) recorded maximum among all treatments.

3.2 Seven Days after First Spray

The data on larval population of gram pod borer on 7th day after 1st spray revealed that all the treatments were significantly superior over control. The minimum larval population was recorded in Chlorantraniliprole (1.46) and it followed by Spinosad (1.8), Indoxacarb (2.13), Imidacloprid (2.2), Fipronil (2.33), *Bacillus thuringiensis* (2.4), Azadiractin (Neem oil) (2.53) recorded larval population respectively. The treatments *Bacillus thuringiensis* (2.4) and Azadiractin (Neem oil) (2.53) shows maximum larval population among all the treatments.

3.3 Fourteen Days after First Spray

The data on larval population of gram pod borer on 14th day after 1st spray revealed that all the treatments are significantly superior over control. The minimum population was recorded in Chlorantraniliprole (1.66) and it is followed by Spinosad (1.93). Both the treatments were significant to each other and superior over other treatments. The next treatment viz. Indoxacarb (2.2), Imidacloprid (2.26), Fipronil (2.4), *Bacillus thuringiensis* (2.53) and Neem oil (2.6) recorded larval population respectively treatment *Bacillus thuringiensis* (2.53) and Azadiractin (Neem oil) (2.6) shows maximum larval population among all the treatments.

3.4 Overall Mean of First Spray

The data of overall mean analysis on larval population indicated that all the insecticidal treatments were significantly effective in reducing the larval population of gram pod borer (*Helicoverpa armigera*) as compared to control plots. The minimum larval population was recorded in Chlorantraniliprole (1.66) and it was followed by Spinosad (1.95). Both these treatments were significant to each other and superior over other treatments. The next treatments viz. Indoxacarb (2.22), Imidacloprid (2.33), Fipronil (2.44), *Bacillus thuringiensis* (2.55) and Azadiractin (2.64) recorded larval population respectively. The treatments *Bacillus thuringiensis* (2.55) and Azadiractin (2.64) show maximum larval population among all other treatments.

3.5 Third Days after Second Spray

The data on larval population of gram pod borer on 3rd day after 2nd spray revealed that all the treatments were significantly superior over control. The minimum larval population was recorded in Chlorantraniliprole (1.26) and it was followed by Spinosad (1.6). Both these treatments were significant to each other and Superior over other treatments. The next treatments viz. Indoxacarb (1.8), Imidacloprid (2.13), Fipronil (2.46), *Bacillus thuringiensis* (2.6) and Azadiractin (Neem oil) (2.66) recorded respectively. The treatments *Bacillus thuringiensis* (2.6) and Azadiractin (Neem oil) (2.66) shows maximum larval population among all other treatments.

3.6 Seven Days after Second Spray

The data on larval population of gram pod borer on 7th day after 2nd spray revealed that all the treatments were significantly superior over control. The minimum larval population was recorded in Chlorantraniliprole (0.8) and it was followed by Spinosad (1.13). Both the treatments were found significant to each other and superior over other treatments. the next treatments viz. Indoxacarb (1.26), Imidacloprid (1.66), Fipronil(1.73), *Bacillus thuringiensis* (1.93) and Azadiractin (Neem oil) (2.13) recorded larval population respectively. The treatments *Bacillus thuringiensis* (1.93) and Azadiractin (Neem oil) (2.13) shows maximum larval population among all treatments.

Table 1. Comparative efficacy of different insecticides against larval population of pod borer, *Helicoverpa armigera* (Hubner) on Cowpea (1st Spray)

Treatments	Larval Population/ 5 Plants				
	1DBS	3 DAS	7 DAS	14 DAS	Mean
T1 Chlorantraniliprole 18.5% SC	2.66	1.86	1.46	1.66	1.66
T2 Indoxacarb 14.5 SC	2.8	2.33	2.13	2.2	2.22
T3 Azadiractin 5% (Neem oil)	3.06	2.8	2.53	2.6	2.64
T4 Imidacloprid 17.8% SL	2.86	2.53	2.2	2.26	2.33
T5 Spinosad 45 % SC	2.73	2.13	1.8	1.93	1.95
T6 Fipronil 5% SC	2.93	2.6	2.33	2.4	2.44
T7 <i>Bacillus thuringiensis</i> 4% WP	3	2.73	2.4	2.53	2.55
T0 Untreated	3.13	3.33	3.26	3.53	3.37
F- test	NS	S	S	S	S
S. Ed. (±)		0.13	0.13	0.12	0.06
C. D. (P = 0.05)		0.29	0.38	0.25	0.14

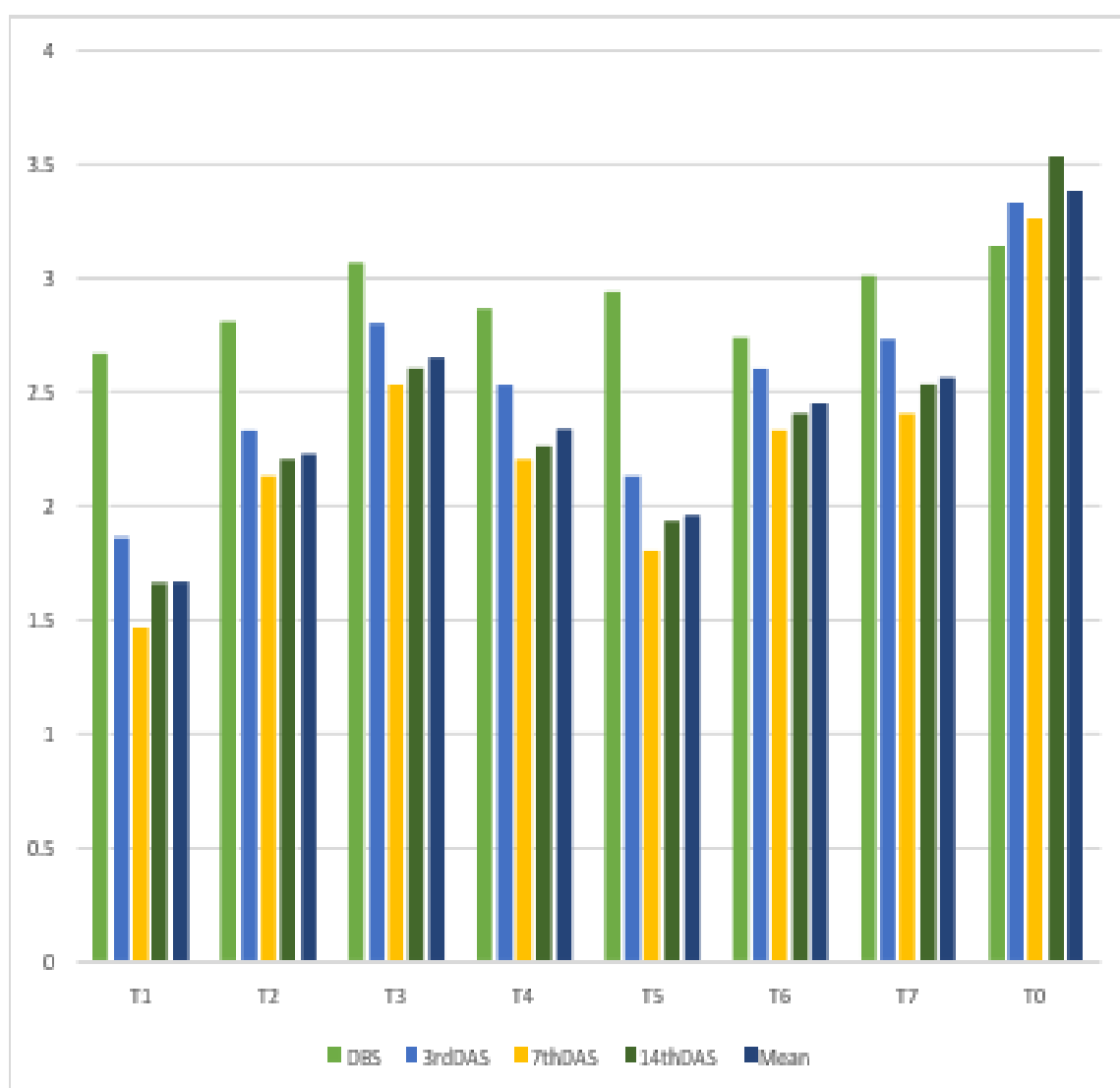


Fig. 1. Graphical representation of comparative efficacy of different insecticides against pod borer, *Helicoverpa armigera* (Hubner) on Cowpea (1st Spray) (larval population)

Table 2. Comparative efficacy of different insecticides against larval population of pod borer, *Helicoverpa armigera* (Hubner) on Cowpea (2nd spray)

Treatments	Larva Population / 5 Plants			
	3 DAS	7 DAS	14 DAS	Mean
T1 Chlorantraniliprole 18.5% SC	1.26	0.8	1	1.02
T2 Indoxacarb 14.5 SC	1.8	1.26	1.86	1.64
T3 Azadiractin 5% (Neem oil)	2.66	2.13	2.53	2.44
T4 Imidacloprid 17.8% SL	2.13	1.66	2.06	1.95
T5 Spinosad 45 % SC	1.6	1.13	1.53	1.42
T6 Fipronil 5% SC	2.46	1.73	2.13	2.10
T7 <i>Bacillus thuringiensis</i> 4% WP	2.6	1.93	2.4	2.31
T0 Untreated	3.66	4.13	4.4	4.06
F- test	S	S	S	S
S. Ed. (±)	0.11	0.14	0.14	0.17
C. D. (P = 0.05)	0.23	0.29	0.29	0.37

Table 3. Comparative efficacy of different insecticides against gram pod borer, *Helicoverpa armigera* (Hubner) on Cowpea (*Vigna unguiculata*) Overall larval population)

Treatments	Larval Population/ 5 Plants		
	1 st Spray	2 nd Spray	Mean
T1 Chlorantraniliprole 18.5% SC	1.66	1.02	1.34
T2 Indoxacarb 14.5 SC	2.22	1.64	1.93
T3 Azadiractin 5%(Neem oil)	2.64	2.44	2.54
T4 Imidacloprid 17.8 %SL	2.33	1.95	2.14
T5 Spinosad 45 %SC	1.94	1.42	1.68
T6 Fipronil 5%SC	2.44	2.10	2.27
T7 <i>Bacillus thuringiensis</i> 4% WP	2.55	2.31	2.43
T0 Control	3.53	4.06	3.71
F- test	S	S	S

3.7 Fourteen Days after Second Spray

The data on larval population of gram pod borer on 14th day after 2nd spray revealed that all the treatments were significantly superior over control. The Minimum larval population was recorded in Chlorantraniliprole (1) and it was followed by Spinosad (1.53). Both these treatments were significant to each other and superior over other treatments. The next treatments viz. Indoxacarb (1.86), Imidacloprid (2.06), Fipronil (2.13), *Bacillus thuringiensis* (2.4) and Neem oil (2.53) reduction was recorded. The treatments *Bacillus thuringiensis* (2.4) and Neem oil (2.53) show the maximum larval population among all other treatments.

3.8 Overall Mean after Second Spray

The data of overall mean indicated that all the insecticidal treatments were significantly effective in managing the larval population of gram pod

borer (*Helicoverpa armigera*) as compared to control plots. The minimum larval population was recorded in Chlorantraniliprole (1.02) and it was followed by Spinosad (1.42). Both the treatments are significant to each other and superior over other treatments. The next treatments viz. Application of Indoxacarb (1.64), Imidacloprid (1.95), Fipronil (2.10), *Bacillus thuringiensis* (2.31) and Azadiractin (Neem oil) (2.44) recorded maximum larval population respectively. The treatments *Bacillus thuringiensis* (2.31) and Azadiractin (Neem Oil) (2.44) shows least effectiveness among all other treatments.

3.9 Overall Mean after First and Second Spray

The overall mean data on the larval population of pod borer after both sprays revealed that all the treatments are found significantly superior over control. Among all the treatments the minimum larval population was recorded in

Chlorantraniliprole (1.34) and it is followed by Spinosad (1.68). Both the treatments are significant to each other and superior over other treatments. The next treatments viz. Indoxacarb (1.93), Imidacloprid (2.141), Fipronil (2.27), *Bacillus thuringiensis* (2.43) and Azadiractin (Neem oil) (2.54) recorded maximum population. The treatments *Bacillus thuringiensis* (2.43) and Azadiractin (Neem oil) (2.54) shows least effectiveness among all other treatments.

4. DISCUSSION

In the experiment seven treatments were taken viz. Chlorantraniliprole 18.5 SC, Indoxacarb 14.5 SC, Azadiractin (Neem oil) 5%, Imidacloprid 17.8 SL, Spinosad 45 SC, Fipronil and *Bacillus thuringiensis* 4%WSP and a control plot, to check the comparative efficacy of different insecticides and bio pesticides against pod borer *Helicoverpa armigera* larval population and the yield of Cowpea.

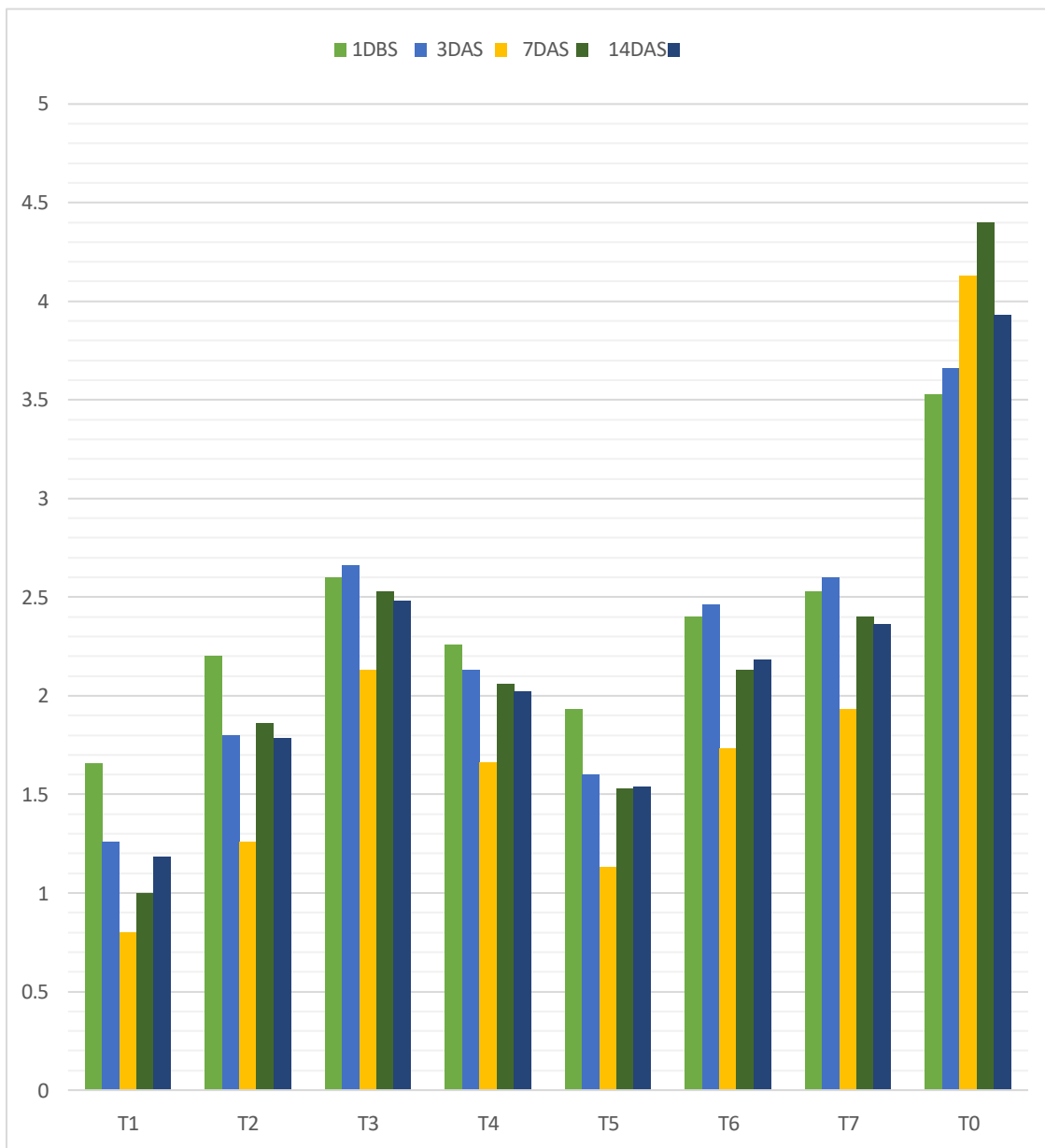


Fig. 2. Graphical representation of (2nd spray) (Larval population)

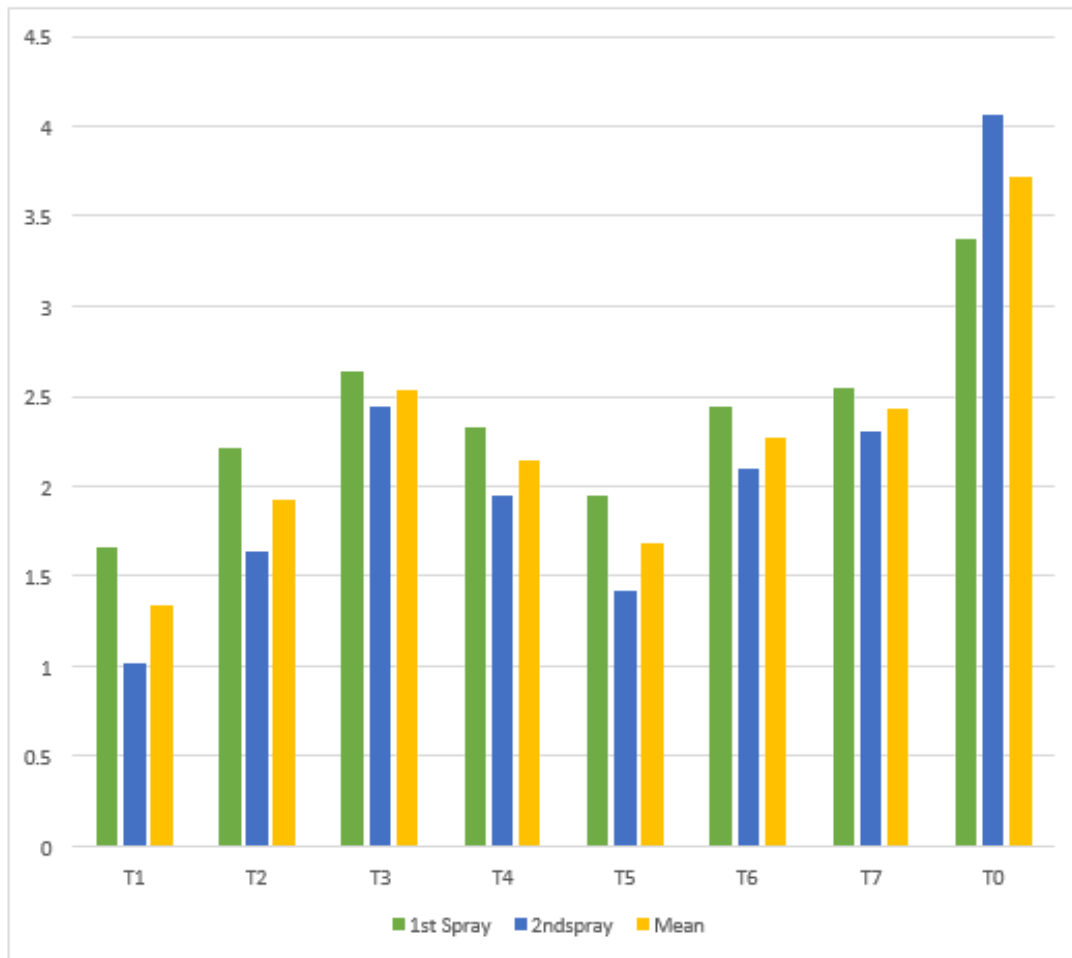


Fig. 3. Graphical representation of (Overall larval population)

Table 4. Economics of cultivation

T.No	Treatment	Yield of q/ha	C: B ratio
T1	Chlorantraniliprole 18.5 SC	24.08	1:3.51
T2	Indoxacarb 14.5 SC	17.20	1:2.77
T3	Azadiractin 5%	12.60	1:2.11
T4	Imidacloprid 17.8%SL	17.10	1:2.73
T5	Spinosad 45 % SC	22.50	1:2.85
T6	Fipronil 5%SC	14.50	1:2.41
T7	<i>Bacillus thuringiensis</i> 4% WSP	13.70	1:2.28
T0	Control	10.50	1:1.92

The over all mean data on the larval population of pod borer after both sprays revealed that all the treatments are found significantly superior over control. Among all the treatments the minimum larval population was recorded in Chlorantraniliprole (1.34) and it is followed by Spinosad (1.68). Both the treatments are significant to each other and superior over other treatments. The next treatments viz. Indoxacarb

(1.93), Imidacloprid (2.141), Fipronil (2.27), *Bacillus thuringiensis* (2.43) and Azadiractin (Neem oil) (2.54) recorded maximum population (.). The treatments *Bacillus thuringiensis* (2.43) and Azadiractin (Neem oil) (2.54) shows least effectiveness among all other treatments.

The data after over all mean analysis of 3rd, 7th and 14th days after 1st insecticidal application

indicated that all the insecticidal treatments were significantly effective in managing the larval population of *Helicoverpa armigera* as compared to untreated plots. Chlorantraniliprole (1.66) was found to be significantly superior these findings are supported by Sharma and Tayde [3] followed by Spinosad (1.95) similar findings also reported in Cowpea by Narayna et al [4]. The next best treatment for managing the larval population was Indoxacarb (2.22) which was also supported by Narayna et al., [4]. The treatment Imidacloprid (2.33) was found to be effective controlling gram pod borer similar findings were reported by Farooq et al., [5]. The treatment Fipronil (2.44) was also effective in controlling the larval population as supported by Satish et al., [6]. *Bacillus thuringiensis* (2.55) is the next best treatment in managing the larval population of pod borer which is reported by Satish et al., [6] followed by Azadiractin (Neem oil) (2.64) which is less effective against gram pod borer similar results are recorded by Sharma and Tayde [3].

Coming to 2nd spray overall mean analysis of 3rd, 7th and 14th days after insecticidal application indicated that all the insecticidal treatments were significantly effective in managing the larval population of *Helicoverpa armigera* as compared to control plots. Chlorantraniliprole (1.02) was found significantly superior these findings are supported by Sharma and Tayde [3]. Followed by Spinosad (1.42) similar findings are also reported in cowpea by Narayna et al., [4] Indoxacarb (1.64) is the next best treatment for managing the population of gram pod borer similar findings were found in the Narayna et al., [4]. The treatment Imidacloprid (1.95) found to be effective in controlling the pod borer which is also reported by Farooq et al. [5], the next best treatment Fipronil (2.10) which is in line findings of Satish et al. [6] *Bacillus thuringiensis* (2.31) is the next effective treatment supported by Satish et al., [6] followed by Neem oil (2.44) in controlling gram pod borer similar results are recorded by Sharma and Tayde [3].

When the cost benefit ratio was worked out the highest and cost benefit ratio was recorded in Chlorantraniliprole (24.08 q/ha) and (1:3.51) as respectively. This result is supported by Barwa and Kumar [7], followed by Spinosad (22.50 q/ha) and (1:2.85) this result is supported by Barwa and Kumar [7]; followed by Indoxacarb (17.20) and (1:2.77) this findings is supported by Lavanya and Kumar [8], Followed by Imidacloprid (17.10) and (1:2.73) this result is supported by, followed by Fipronil (14.50) and

(1:2.41) supported by Narayna et al., [4], followed by *Bacillus thuringiensis* (13.70) and (1:2.28) this result is supported by Mohenty and Tayde [9], Followed by Neem oil (12.60) and (1:2.11) similar findings are supported by Yerrabala et al. [10].

5. CONCLUSION

Based on the current findings' analysis, it can be concluded that, out of all the treatments tested, chlorantraniliprole proved to be the most successful in controlling the Gram pod borer, with Spinosad coming in second. A larger yield was obtained using indoxacarb. Neem oil and *Bacillus thuringiensis* were found to be the least effective in controlling *Helicoverpa armigera*, while imidacloprid and fipronil ranked in the middle. Integrated pest management can help prevent the careless use of pesticides that pollute the environment and do little harm to beneficial insects. Among the treatments studied T1- Chlorantraniliprole gave the highest cost benefit ratio (1:3.51) and marketing yield (24.08q/ha) followed by T5 Spinosad which gave the cost benefit ratio of (1:2.85) and marketing yield of (22.50 q/ha).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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