

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

**Comment [sk1]:** should be corrected to "*Vigna unguiculata*" throughout the text

## 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 Azadirachtin (Neem Oil) (2.64) found to be less effective in managing the larval population of *Helicoverpa armigera*. 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 Azadirachtin (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 Azadirachtin (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.

**Comment [sk2]:** should be corrected to "Azadirachtin" in all occurrences.

**Comment [sk3]:** The word "thuringiensis" is misspelled

**Comment [sk4]:** should be corrected to "*Bacillus thuringiensis*" in all instances

**Comment [sk5]:** The abstract claims Chlorantraniliprole was the most effective insecticide, but the results section shows Spinosad had the highest yield. This seems contradictory.

**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 mungbean (*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," "blackeyed peas," "field peas" "pinkeyes" and "crowders." These names reflect traditional seed and market classes that developed over time in the southern United States. (Fang *et al.* 2007).

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 fibre, 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 5 m.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. This 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 shrublands; Mediterranean scrub; temperate broadleaf and mixed forests; tropical and sub-tropical grasslands, savannas and shrublands; and tropical and sub-tropical broadleaf forest. (Wubneh et al., 2016).

## 2. MATERIALS AND METHODS

The experiment was conducted at experiment field of Department of Entomology, Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, during the rabi season of 2023-2024. 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 temperature reaching up to 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 18.5SC, Indoxacarb 14.5SC, Azadiractin (Neem oil) 5%, Imidacloprid 17.8 SL, Spinosad 45 SC, Fipronil and *Bacillus thuringiensis* 4% WSP and Control.

The larvae were recalculated 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 3<sup>rd</sup>, 7<sup>th</sup>, 14<sup>th</sup> days after each spray. The larval population of pod borer was determined after 3 mean observation of first and second spray recorded at 3<sup>rd</sup>, 7<sup>th</sup>, 14<sup>th</sup> 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 3<sup>rd</sup> day after 1<sup>st</sup> 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 7<sup>th</sup> day after 1<sup>st</sup> 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

**Comment [sk6]:** The reference to Phani and Kumar 2023 is not included in the list of references at the end of the paper

**Comment [sk7]:** The abstract mentions the experiment was conducted in Kharif season 2023-2024, but the introduction states it was done in the rabi season of 2023-2024. This is an inconsistency.

The data on larval population of gram pod borer on 14<sup>th</sup> day after 1<sup>st</sup> 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

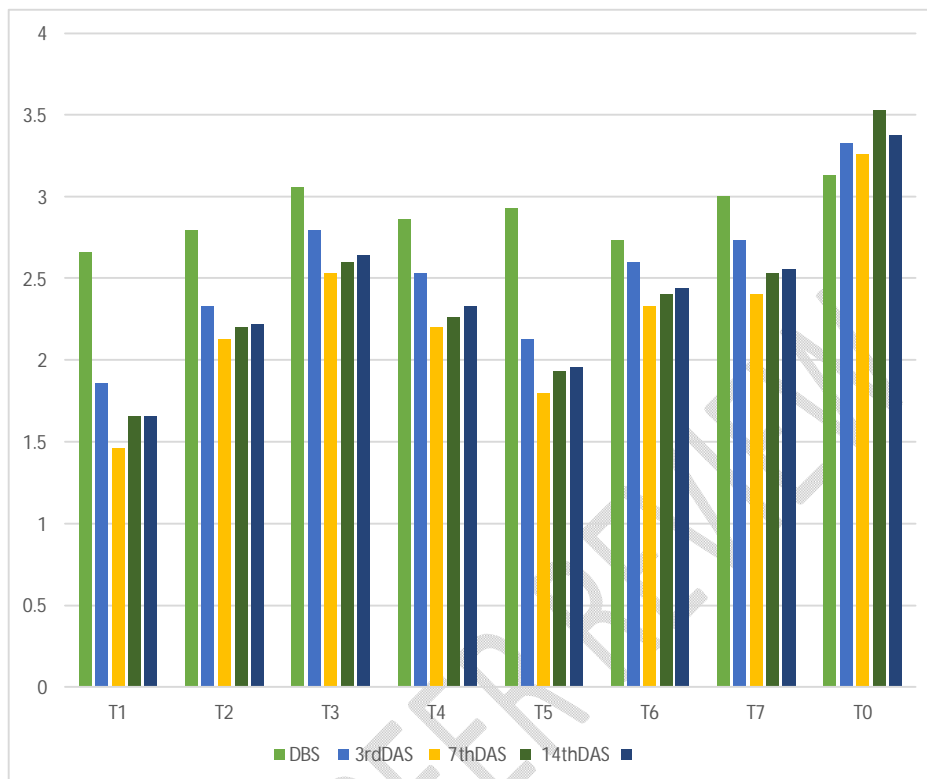
The data of overall mean analysis on larval population indicated that all the insecticidal treatments were significantly effective in reducing the larval population of gram pod borer (*Helicoverpa armigera*) as compared to control plots. The minimum larval population was recorded in Chlorantraniliprole (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) shows maximum larval population among all other treatments.

### 3.5 Third Days after Second Spray

The data on larval population of gram pod borer on 3<sup>rd</sup> day after 2<sup>nd</sup> 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.

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

Treatments	Larval Population/5 Plants				
	1DBS	3DAS	7DAS	14DAS	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
<b>F-test</b>	NS	S	S	S	S
<b>S. Ed. (±)</b>		0.13	0.13	0.12	0.06
<b>C. D. (P= 0.05)</b>		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 (1<sup>st</sup> Spray) (larval population)**

### 3.6 Seven Days after Second Spray

The data on larval population of gram pod borer on 7<sup>th</sup> day after 2<sup>nd</sup> 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) show maximum larval population among all treatments.

### 3.7 Fourteen Days after Second Spray

The data on larval population of gram pod borer on 14<sup>th</sup> day after 2<sup>nd</sup> 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

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

Treatments	Larva Population /5 Plants			
	3DAS	7DAS	14DAS	Mean
T1 Chlorantraniliprole 18.5%SC	1.26	0.8	1	1.02
T2 Indoxacarb 14.5SC	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
<b>F-test</b>	S	S	S	S
<b>S.Ed.(±)</b>	0.11	0.14	0.14	0.17
<b>C. D.(P= 0.05)</b>	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 <sup>st</sup> Spray	2 <sup>nd</sup> Spray	Mean
T1 Chlorantraniliprole 18.5%SC	1.66	1.02	1.34
T2 Indoxacarb 14.5SC	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
<b>F-test</b>	S	S	S

### 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 (2.14), 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 18.5SC, Indoxacarb 14.5 SC,

Azadiractin(Neemoil) 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.

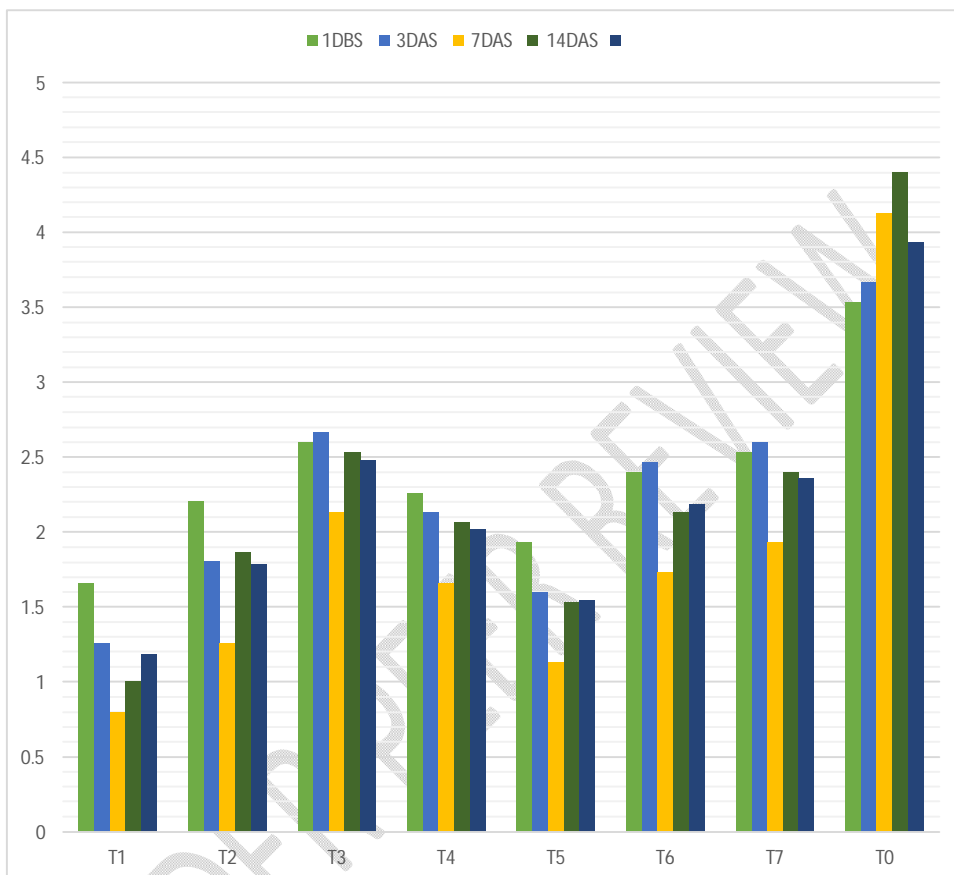
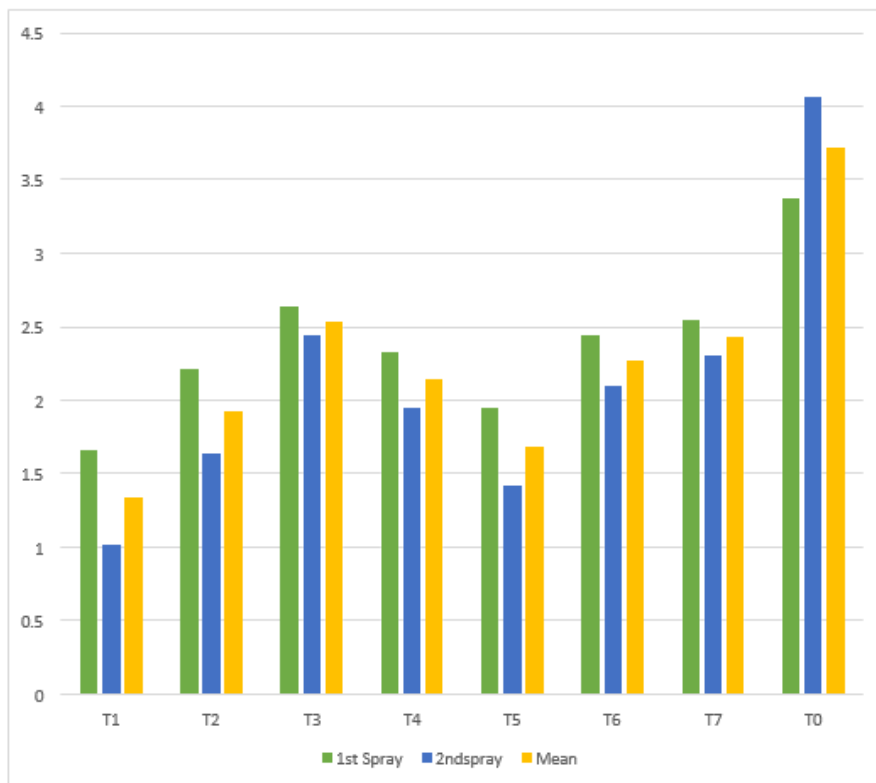


Fig.2. Graphical representation of 2<sup>nd</sup> spray (Larval population)

Table 4. Economics of cultivation

T.No	Treatment	Yield of q/ha	Cost of yield ₹/h	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Total cost (₹)	C:B ratio
T1	Chlorantraniliprole 18.5SC	24.08	6000	1,44,480	32,810	8280	41,090	1:3.51
T2	Indoxacarb 14.5SC	17.20	6000	1,03,200	32,810	4400	37,210	1:2.77
T3	Azadiractin 5%	12.60	6000	75,600	32,810	2900	35,710	1:2.11
T4	Imidacloprid 17.8%SL	17.10	6000	98,400	32,810	3200	36,010	1:2.73
T5	Spinosad 45 %SC	22.50	6000	1,23,000	32,810	14400	47,210	1:2.85
T6	Fipronil 5%SC	14.50	6000	87,000	32,810	3200	36,010	1:2.41
T7	<i>Bacillus thuringiensis</i> 4% WSP	13.70	6000	82,200	32,810	3200	36,010	1:2.28
T0	Control	10.50	6000	63,000	32,810	-----	32,810	1:1.92



**Fig.3.Graphicalrepresentationof(Overall larvalpopulation)**

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.

The data after overall mean analysis of 3<sup>rd</sup>, 7<sup>th</sup> and 14<sup>th</sup> days after 1<sup>st</sup> 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 significantly superior these findings are supported by Sharma and Tayde (2022) followed by Spinosad (1.95) similar findings also reported in Cowpea by Narayana et al., (2015). The next best treatment for managing the larval population was Indoxacarb (2.22) which was also supported by Narayana et al., (2015). The treatment Imidacloprid (2.33) found to be effective controlling gram pod borers similar findings were reported by Farooq et al., (2023). The treatment Fipronil (2.44) was also effective in controlling the larval population as supported by Satish et al., (2018). Bacillus thuringiensis (2.55) is the next best treatment in managing the larval population of pod borer which is reported by Satish et al., (2018) followed by Azadiractin (Neem oil) (2.64) which is less effective against gram pod borer similar results are recorded by Sharma and Tayde (2022).

Coming to 2<sup>nd</sup> spray overall mean analysis of 3<sup>rd</sup>, 7<sup>th</sup> and 14<sup>th</sup> 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 to these findings as supported by Sharma and Tayde (2022). Followed by Spinosad (1.42) similar findings are also reported in cowpea by Narayana et al., (2015). Indoxacarb (1.64) is the next best treatment for managing the population of gram pod borers similar findings were found in the Narayana et al., (2015). The treatment Imidacloprid (1.95) found to be effective in controlling the pod borer which is also reported by Farooq et al., (2023), the next best treatment Fipronil (2.10) which is in line findings of Satish et al., (2018). *Bacillus thuringiensis* (2.31) is the next effective treatment supported by Satish et al., (2018) followed by Neem oil (2.44) in controlling gram pod borers similar results are recorded by Sharma and Tayde (2020).

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 (2022), followed by Spinosad (22.50 q/ha) and (1:2.85) this result is supported by Barwa and Kumar (2022); followed by Indoxacarb (17.20) and (1:2.77) this findings is supported by Lavanya and Kumar (2022), 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 Narayana et al., (2015), followed by *Bacillus thuringiensis* (13.70) and (1:2.28) this result is supported by Mohanty and Tayde (2022), followed by Neem oil (12.60) and (1:2.11) similar findings are supported by Yerrabala et al., (2021).

## 5. CONCLUSION

From the analysis of the present findings it is evaluated that among all the treatments Chlorantraniliprole was found to be most effective against Gram pod borer followed by Spinosad. Indoxacarb resulted higher yield. While Imidacloprid, Fipronil ranked middle in order of their efficacy, then *Bacillus thuringiensis* and Neem oil found to be least effective in managing *Helicoverpa armigera* and it can be a part of Integrated pest management in order to avoid indiscriminate use of pesticide causing pollution in the environment and not much harmful to beneficial insects.

Among the treatments studied T1- Chlorantraniliprole gave the highest cost benefit ratio (1:3.51) and marketing yield (24.08 q/ha) followed by T5 Spinosad which gave the cost benefit ratio of (1:2.85) and marketing yield of (22.50 q/ha).

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