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# Comparative efficacy of selected chemicals and biopesticides against fall army worm [*Spodoptera frugiperda* (J. E. Smith)] on maize (*Zea mays* L.) at Prayagraj (U.P)

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**Abstract**
The experiment was conducted at the research plot of the Department of Agricultural Entomology at Central Research Field, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj during the *Kharif* season of 2021 "Comparative efficacy of selected chemicals and biopesticides against fall army worm [Spodoptera frugiperda (J. E. Smith)] on maize (*Zea mays* L.) at Prayagaj (U.P)" seven treatments were evaluated against, *Spodoptera frugiperda* i.e.,.T1Chlorantraniliprole 9.3% +Lamda-Cylothrin 4.6% ZC, T2 Chlorantraniliprole 18.5% SC, T3 *Beauveria Bassiana* 1.5% LF, T4Emamectin benzoate 5%SG, T5 Neem oil, T6 Spinetoram 11.7% SC, T7 Thiamethoxam 12.6%+ lambda cyhalothrin 9.5%, T0 Control, Were tested to the Evaluation against *Spodoptera frugiperda* and their influences on yield of Maize. Each insecticide was sprayed twice at 15 days interval. The leaves and cob infestation per plant was taken day before and 3, 7, and 14 days after each spray. All the insecticides tested significally reduced the pest infestation compared to control. The lowest larval reduction of fall army worm against control was observed in spinetoram 11.7%. The mean crop yield ranged between 23.41q/ha to 36.79q/ha, the highest being. T6 spinetoram 11.7% (36.79q/ha) followed by T2 Chlorantraniliprole 18.5% SC (36.34 q/ha). When cost benefit ratio worked out, interesting result was achieved, among the treatment studied, the best and most economical treatment T6 Spinetoram 11.7% SC (1:2.63) fallowed by the T2 Chlorantraniliprole 18.5%SC (1:2.61).

**Keywords:** Biopesticides, chemical insecticides, cost benefit ratio, *Spodoptera frugiperda*

## Introduction
Maize (*Zea mays* L.) is an important cereal food crop of the world with highest production and productivity as compared to rice and wheat. It is the most versatile crop which is being grown in more than 166 countries across the globe including tropical, sub tropical and temperate regions from sea level to 3000 m amsl. Maize is the third most important cereal after rice and wheat for human food by contributing almost 9% to India's food basket and 5% to World's dietary energy supply. Its production has increased more than 12 times from a mere 1.73 million tons 1950-51 to 21.73 million tons in 2010-11 (ASG, 2011) and presently it occupies 8.55 million hectare area with the mean yield of 2.54 tons/hectare. This achievement is remarkable despites ~75% maize area is under rainfed and low input condition, which oftenly faces vagaries of monsoon (Kumar *et al.*, 2012) [4]. Maize kernel is an edible and nutritive part of the plant. The composition of maize kernel is presented It also contains vitamin C, vitamin E, vitamin K, vitamin B1 (thiamine), vitamin B2 (niacin), vitamin B3 (riboflavin), vitamin B5 (pantothenic acid), vitamin B6 (pyridoxine), folic acid, selenium, N-p-coumaryl tryptamine, and N-ferrulyl tryptamine. Potassium is a major nutrient present which has a good significance because an average human diet is deficient in it (Kumar & Jhariya, 2013). There are many insect, pests and diseases of maize crop. It can cause damage to yield of maize. Insect infestation is one of them. Mathur, 1987 [6] observed that over 250 species are associated with maize in the field and storage conditions. Of these, 74 species have appeared recently and about a dozen are of potential economic importance Mathur, 1992. ln Bangladesh, Maize Plants are affected by different insect pests both at seedling stage, pre-flowering and corn formation. Among these, the cut worm (*Agrotisipsilon*), stem borer (*Sesamiainferens* and *Chilopartellus*), aphid (*Rhopalosiphummaidis*), Maize cob borer (*Helicoverpaarmigera*) and the maize corn earworm (*Helicoverpazea*), Among all the pests the fall army worm (*Spodoptera frugiperda*) cause greater damage.

## Materials and Methods

A field experiment was conducted during the *kharif* season of 2021 at the Crop Research farm, Department of Entomology, Naini Agriculture Institute, Sam Higginbottom university of Agriculture, Technology and sciences (SHUATS), Prayagraj, (U.P). which islocated at $25^0$24' 42" Nlatitude, $81^0$ 50' 56" E longitude and 98 m altitude above the mean sea level (MSL) on sandyloam soil, having moderately basic pH (7.2), organic carbon (0.35%), available N (108.0kg/ha),P (22.5kg/ha), K(280.0kg/ha), EC (0.14 $dSm^{-1}$), S (16.8.00 ppm), and Zn (0.51 ppm).

The experiment was laid down in randomized block design (RBD) with 3 replications and 8 treatments using variety GA-85 in a plot size of (2m × 2m) at a spacing of (45 × 30 cm). The infestation and population of fall army worm were recorded from five randomly selected plants from every plot. Two insecticidal sprays were applied at 15 days' interval starting from 45 days after sowing. The chemicals and essential biopesticides treatments include Chlorantraniliprole 9.3% + Lamda-Cylothrin 4.6% ZC, Chlorantraniliprole 18.5%SC, *Beauveria Bassiana* 1.5% LF, Emamectin benzoate 5%SG, Neem oil, Spinetoram 11.7% SC Thiamethoxam 12.6% + lambda cyhalothrin 9.5%ZC, along with untreated control. The spraying was done after the population level reachingltd ETL. The observations a was recorded one day before spray, 3rd, 7th, and 14th days after spraying. The assessment of the Larval population was done by calculating the number of Larval population and total number of healthy plants observed from five randomly selected plants per plot and expressed in percentage. The percent of Larval population was assessed at each plant by counting the total number of Larval population from each plot. The Larval was calculated by using the formulae;

## Results and Discussion

The results of the experiment entitled "Comparative efficacy of selected chemicals and biopesticides against fall army worm [Spodoptera frugiperda (J. E. Smith)]on maize (Zea mays L.) at Prayagaj (U.P)" to study cost benefit ratio during the *kharif* season of 2021.The data so obtained through observation on various aspects were subjected to statistical analysis wherever necessary and the complied mean data are tabulated in the following pages. Results obtained are presented aspect wise hereunder.It is evident from theoverall Larval population (first spray) 3, 7, &DAS mean (Table 1) (Fig 1) that T6 Spinetoram 11.7% SC (5.933), was found most effective insecticide treatment against fall army worm (Spodoptera frugiperda followed by T2 Chlorantraniliprole 18.5% SC (7.6), T1 Chlorantraniliprole 9.3% + Lambdacylothrin 4.6% ZC (7.21), T4 Emamectin benzoate 5% SG (8.889), T7 Thiamthoxam 12.6% + Lambdacylothrin 9.5% (9.422), T5 Neem oil (11.96).In this T3 *Beauveria Bassiana* 5% LF (12.11).is fouind to be highest larval popoulation than all treatments and is significally superior over the control T0 (18.96).

The data on the mean of leaves and cob infestation of second spray (3rd, 7th & 14th) mean (Table 2) (Fig 2) The lowest percent of larval population was observed in the T6 Spinetoram 11.7% SC (2.911), followed by T2 Chlorantraniliprole 18.5% SC (3.54), T1 Chlorantraniliprole 9.3% + Lambdacylothrin 4.6% ZC (4.016), T4 Emamectin benzoate 5% SG (5.600), T7 Thiamthoxam 12.6% + Lambdacylothrin 9.5% (5.467), T5 Neem oil (8.711).In this T3 Beauveria Bassiana 5% LF (10.311). is fouind to be highest larval popoulation than all treatments and is significally superior over the T0 control (21.485). The yields among the treatment were significant. The highest yield in (Table 3) (Fig 3) was recorded in T6 Spinetoram 11.7% SC (36.79q/ha) followedby T2 Chlorantraniliprole 18.5%SC (36.34q/ha),T1 Chlorantraniliprole 9.3% + Lamda-Cylothrin 4.6% ZC (35.12q/ha), T4 Emamectin benzoate 5%SG (31.51 q/ha), T7 Thiamethoxam 12.6% + lambda cyhalothrin 9.5% (31.42q/ha), T5 Neem oil (30 q/ha) T3 Beauveria Bassiana 1.5% LF 2%(29.56q/ha), and The treatments was least effective among all the treatments. Controlplot T0 (23.41q/ha) yield. When cost benefit ratio workedout in (Table 4) interesting result wasachieved, among thetreatment studied, the best and most economical treatment T6 Spinetoram 11.7% SC(1:2.63) followedby T2 Chlorantraniliprole (1:2.61), T1 Chlorantraniliprole 9.3% + Lamda-Cylothrin 4.6% ZC (1:2.30), T4 Emamectin benzoate 5%SG (1:2.29), T7 Thiamethoxam 12.6% + lambda cyhalothrin 9.5% (1:2.24), T5 Neem oil (1:2.20),T3Beauveria Bassiana 1.5% LF 2% (1:2.12), and T0 Control (1:1.86).

Among all the treatments Spinetoram 11.7% SC was found and it is most effective in managing the fall army worm on Maize.The values obtained in the first and second spray are 6.51 and 2.91 respectively. These results are supported by (Deshmukh *et al*., 2020) [2], The present investigation was conducted to evaluate the bio-efficacy of insecticides against Spodoptera frugiperda infesting maize Among the tested insecticides, Spinetoram11.7% SC was observed to be most effective in reducing the larval population, (Patidar *et al*., 2022) [10]

The field experiment spinosad 45SC @ 0.3 ml l-1, chlorantraniliprole 0.4G @ 10 kg ha-1 and chlorantraniliprole 9.3%+ lambda cyhalothrin 4.6% @ 0.5 ml l-1 were significantly superior (with 80.49, 77.02 and 74.67% reduction in larval incidence, respectively). The treatments with cyantraniliprole 19.8% + thiamethoxam 19.8%FS @ 6 ml kg-1, lambda cyhalothrin 5EC @ 2ml l-1 and fipronil 0.3G @ 12 kg ha-1 were the less effective ones. Emamectin benzoate 5SG gave maximum yield of 39,716 kg ha-1 with ICB ratio of 1:22.57. (Bai *et al*., 2021) [1]

Bio –efficacy of insecticides belonging to ten chemical group were assessed aginst the fall army wormy in maize the plot treated withspinetoram recorded highest grain (33.48q/ha) following by clorantraniliprole (31.12 q/ha) (kumar *et al*., 2021) [3]

The present field experiment were conducted to estimate "Bio-efficacy of different insecticides against fall armyworm, Spodoptera frugiperda (J.E. Smith) on Maize" The treatments of different insecticides *viz*., Spinetoram 11.7 SC @ 0.011 per cent, Lambda Cyhalothrin 5 EC @ 0.025 per cent, Chlorantraniliprole 9.3 + Lambda Cyhalothrin 4.6 ZC @ 0.008 + 0.002 per cent and Thiomethaxam 12.6 + Lambda cyhalothrin 9.5 ZC @ 0.003 + 0.002 per cent were evaluated against S. frugiperda (Meagher *et al.*, 2022) [9]

Maximum cost benefit ratio (1:2.63) was obtained in Spinetoram 11.7% SC which was supported by (Kumar *et al.*, 2021) [3] who reported that Spinetoram recorded the high yield. Chlorantraniliprole 18.5% SC 1:2.61 (Patidar *et al.*, 2022) [10] Chlorantraniliprole 9.3% + Lambdacylothrin 4.6% cost benefit ratio was 1:2.23 these findings are supported by. The cost benefit ratio of These results were to the findings reported by (Kumar *et al.*,2021) [3], and the next cost benefit

ratio obtained in the treatment Emamectin benzoate 5% SG 1:2.99 was supported by (Patidar *et al.*, 2022) [10] The results of the cost benefit ratio obtained in the treatment Thiamthoxam 12.6% + Lambdacylothrin 9.5% was 1:2.24 and similar to (Patidar *et al.*, 2022) [10] The cost benefit ratio of Neem oil (1:2.20) and *Beauveria Bassiana* 5% LF (1:2.08) which were supported

**Larval Population**

**Table 1:** "Comparative efficacy of selected chemicals and biopesticides against fall army worm [Spodoptera frugiperda(J. E. Smith)]on maize (Zea mays L.) at Prayagaj (U.P)"-(First spray)

| S. No | Treatments | Per cent Larval Population reduction of *Spodoptera frugiperda* / Five plants | | | | |
|---|---|---|---|---|---|---|
| | | 1DBS | 3DAS | 7DAS | 14DAS | Mean |
| T1 | Chlorantraniliprole 9.3% + Lamda-Cylothrin 4.6% ZC | 12.47 | 11 | 7.333 | 5.867 | 8.067 |
| T2 | Chlorantraniliprole 18.5%SC | 11.33 | 10.8 | 6.933 | 5.067 | 7.6 |
| T3 | *Beauveria Bassiana* 1.5% LF | 14 | 12.933 | 11.8 | 11.6 | 12.11 |
| T4 | Emamectin benzoate 5%SG | 11.53 | 11.533 | 8.467 | 6.667 | 8.889 |
| T5 | Neem oil | 14.8 | 13 | 11.67 | 11.2 | 11.96 |
| T6 | Spinetoram 11.7% SC | 11.47 | 9.533 | 4.667 | 3.6 | 5.933 |
| T7 | Thiamethoxam 12.6% + lambda cyhalothrin 9.5% | 14.2 | 12.8 | 9.467 | 6 | 9.422 |
| T0 | Control | 16.067 | 17.2 | 19.67 | 20 | 18.96 |
| | Ove all mean | 13.23 | 12.34 | 10.088 | 8.75 | 10.36 |
| | F-test | NS | S | S | S | S |
| | C.D.at 0.5% | ----- | 1.293 | 1.413 | 2.286 | 1.248 |
| | S.EdA(±) | 4.11 | 0.60 | 0.65 | 1.06 | 1.6 |

**Table 2:** "Comparative efficacy of selected chemicals and biopesticides against fall army worm [*Spodoptera frugiperda* (J. E. Smith)]on maize (Zea mays L.) at Prayagaj (U.P)"-(Second spray)

| S.N0 | Treatments | Per cent Larval Population reduction of *Spodoptera frugiperda* / Five plants | | | | |
|---|---|---|---|---|---|---|
| | | 1DBS | 3DAS | 7DAS | 14DAS | Mean |
| T1 | Chlorantraniliprole 9.3% + Lamda-Cylothrin 4.6% ZC | 5.867 | 5.73 | 3.133 | 2.133 | 4.016 |
| T2 | Chlorantraniliprole 18.5%SC | 5.067 | 3.25 | 3.133 | 1.933 | 3.54 |
| T3 | *Beauveria Bassiana* 1.5% LF | 11.6 | 11.133 | 9.933 | 9.867 | 10.311 |
| T4 | Emamectin benzoate 5%SG | 6.667 | 5.733 | 4.2 | 3.467 | 5.600 |
| T5 | Neem oil | 11.2 | 10.533 | 8.133 | 7.467 | 8.711 |
| T6 | Spinetoram 11.7% SC | 3.6 | 2.933 | 2.533 | 0.867 | 2.911 |
| T7 | Thiamethoxam 12.6% + lambda cyhalothrin 9.5% | 6 | 6.733 | 4.2 | 3.8 | 5.467 |
| T0 | Control | 20 | 20.27 | 21.47 | 24.2 | 21.485 |
| | Over all mean | 8.75 | 8.28 | 7.09 | 6.71 | 7.73 |
| | F-test | S | S | S | S | S |
| | C.D | 2.286 | 3.191 | 1.435 | 1.264 | 2.044 |
| | S.EdA(±) | 1.06 | 1.47 | 0.66 | 0.58 | 0.9425 |

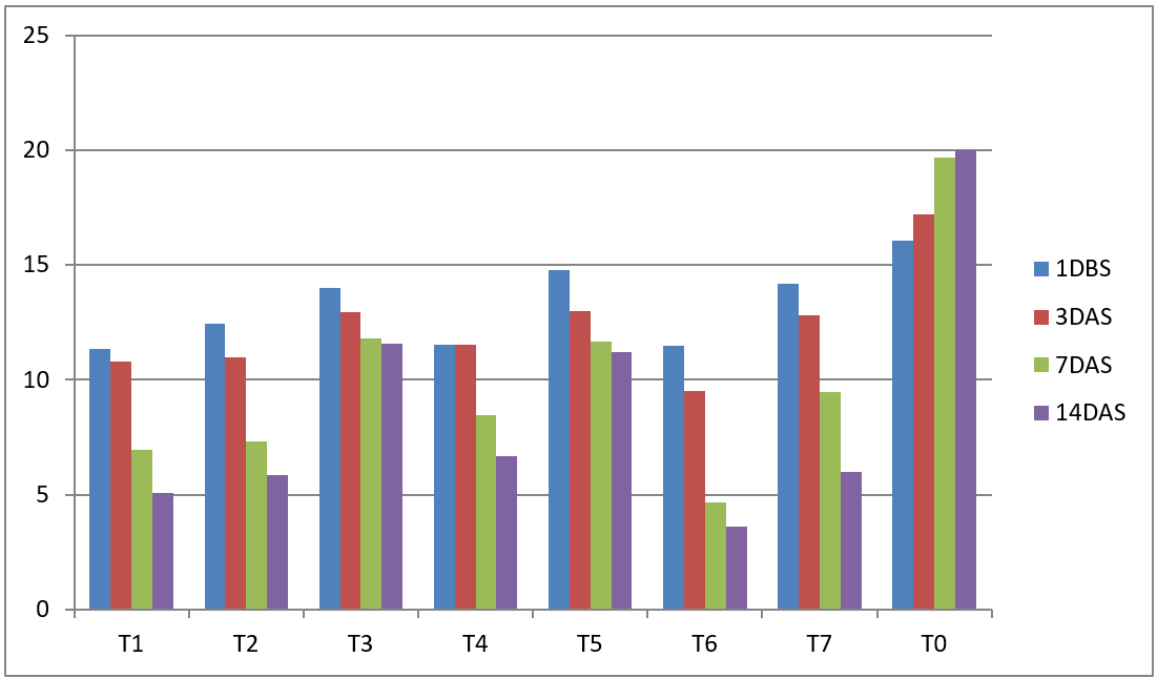


**Fig 1:** Comparative efficacy of selected chemicals and biopesticides against fall army worm [*Spodoptera frugiperda* (J. E. Smith)]on maize (*Zea mays* L.) at Prayagaj (U.P)- (First spray) (Larval population)

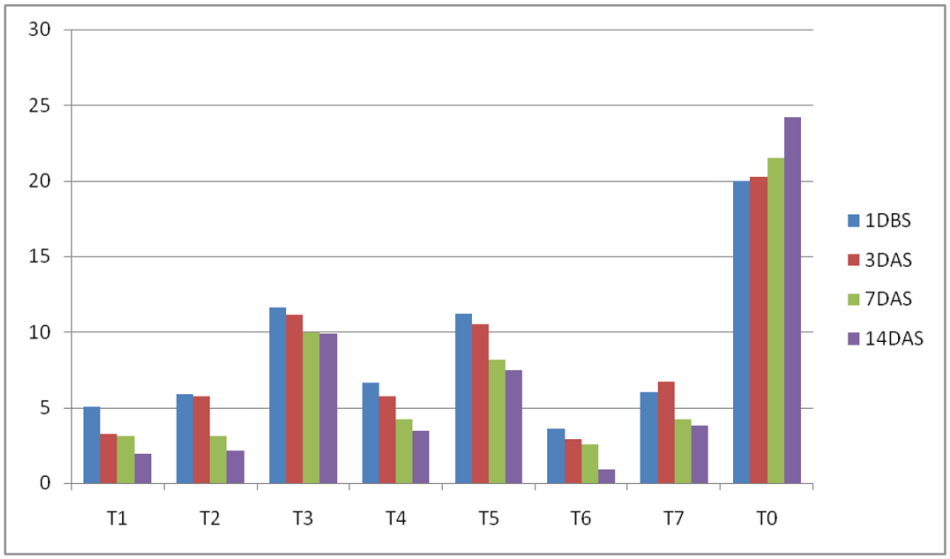


**Fig 2:** Comparative efficacy of selected chemicals and biopesticides against fall army worm [*Spodoptera frugiperda* (J. E. Smith)]on maize (Zea mays L.) at Prayagraj (U.P) (Second spray) (Larval population)

**Table 3:** "Comparative efficacy of selected chemicals and biopesticides against fall army worm [*Spodoptera frugiperda* (J. E. Smith)] on maize (*Zea mays* L.) at Prayagaj (U.P)" (Yield q/ha)

| S.no | Treatments | Yield q/ha |
|---|---|---|
| T1 | Chlorantraniliprole 9.3% + Lamda-Cylothrin 4.6% ZC | 35.12 |
| T2 | Chlorantraniliprole 18.5%SC | 36.34 |
| T3 | *Beauveria Bassiana* 1.5% LF | 29.56 |
| T4 | Emamectin benzoate 5%SG | 31.51 |
| T5 | Neem oil | 30 |
| T6 | Spinetoram 11.7% SC | 36.79 |
| T7 | Thiamethoxam 12.6% + lambda cyhalothrin 9.5% | 31.42 |
| T0 | Control | 23.41 |

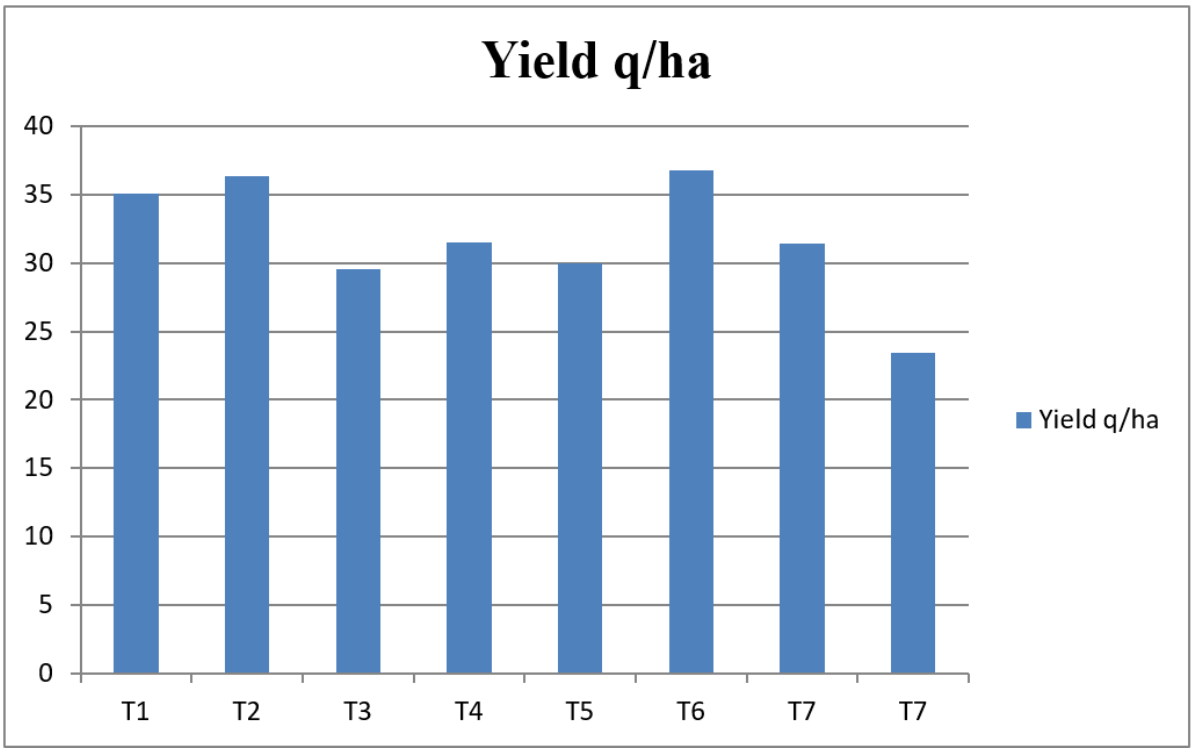


**Fig 3:** Graphical representation of yield on maize

**Table 4:** Benefit cost ration (BCR)

| S. No | Treatment | Yield of q/ha | Cost of yield (₹) | Total cost of yield(₹) | Common Cost (₹) | Treatment cost (₹) | Total cost(₹) | B:C ratio |
|---|---|---|---|---|---|---|---|---|
| T1 | Chlorantraniliprole 9.3% + Lamda-Cylothrin 4.6% ZC | 35.12 | 1870 | 65674.4 | 23422 | 5050 | 28472 | 1:2.30 |
| T2 | Chlorantraniliprole 18.5%SC | 36.34 | 1870 | 67955.8 | 23422 | 2500 | 25922 | 1:2.61 |
| T3 | *Beauveria Bassiana* 1.5% LF | 29.56 | 1870 | 55277.2 | 23422 | 2640 | 26062 | 1:2.12 |
| T4 | Emamectin benzoate5%SG | 31.51 | 1870 | 58923.7 | 23422 | 2200 | 25622 | 1:2.29 |
| T5 | Neem oil | 30 | 1870 | 56100 | 23422 | 2400 | 25822 | 1:2.20 |
| T6 | Spinetoram 11.7% SC | 36.79 | 1870 | 68797.3 | 23422 | 2800 | 26122 | 1:2.63 |
| T7 | Thiamethoxam 12.6% + lambda cyhalothrin 9.5% | 31.42 | 1870 | 58755.4 | 23422 | 2700 | 26122 | 1:2.24 |
| T0 | Control | 23.41 | 1870 | 43776.7 | 23422 | ----- | 23422 | 1:1.86 |

Cost of yield per quintal (₹) 1870

## Conclusion

On the basis of results of present investigation, it can be concluded that for management of fall armyworm, *Spodoptera frugiperda* the insecticide Spinetoram 11.75 SC shown most effective in controlling larval population by fall armyworm followed by Chlorantraniliprole 18.5%SC The highest yield was recorded in Spinetoram 11.7% SC (36.79 q/ha) and Spinetoram 11.7% SC (1:2.63) the both insecticides shown the best cost benefit ratio as compared to rest of the treatments. Since the findings are based on the field experiment done for one time it may be repeated for further confirmation and recommendation.

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