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Assessing the Effectiveness of Various Chemicals against the Yellow Stem Borer in Rice

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted to assess the effectiveness of various insecticides at Heera Puri research field, IANS, DDUGU, District Gorakhpur during *Kharif*, 2023. Various treatments used during the period of the experiment were T1: Chlorantraniliprole 18.5 SC, T2: Emamectin benzoate 5% SC, T3: Cartap hydrochloride 50% SP, T4: Lambda-cyhalothrin 5% EC, T5: NSKE 5%, T6: *Beauveria bassiana*, T7: *Bacillus thuringienisis* T8: Control. Chlorantraniliprole 18.5 SC showed a significantly lower percentage of the dead heart followed by Emamectin benzoate 5 % SC, Lambda cyhalothrin 5% EC, Cartap hydrochloride 50% SP, NSKE, *Beauveria bassiana* and *Bacillus thuringienisis*. The highest percentage of dead hearts were found under untreated control. The

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significantly higher grain yield (42.45 q per ha) was obtained in Chlorantraniliprole 18.5 SC treated plots which are followed by Emamectin benzoate 5% SC (40.85 q per ha) and a higher percentage increase in yield over control was obtained (49.95 %) in Chlorantraniliprole 18.5 SC treated plots. The economics of various treatments based on net profit and cost of plant protection revealed that. the highest cost: benefit ratio Lambda cyhalothrin 5% EC (9.87) followed by Emamectin benzoate 5% SC (8.80) and Chlorantraniliprole 18.5% SC (7.70).The highest B: C ratio of Lambda-cyhalothrin 5 EC may be due to its low price and dose concentration.

Keywords: Rice; bio-efficacy; yellow stem borer; YSB; B:C ratio.

1. INTRODUCTION

Rice is the seed of the monocot plant *Oryza sativa* (Asian rice) or *Oryza glaberrima* (African rice) belongs to the family Graminae is originated from China. It is a staple food for more than two billion people. Around the world, rice is farmed in many different climates and with various agricultural approaches. In terms of global rice production and consumption, India ranks 2nd after China in terms of world rice production and consumption [1]. It is grown from east to west and from north to south throughout India. It is grown across a large geographic range and in a variety of cultural environments.

India's rice production has reached an all-time high, with a total production of 1357.55 lakh tonnes in the agricultural year 2022-23 and total rice cultivated is 47,832 (1000 Ha). It is higher by 62.84 Lakh tonnes than the previous year's Rice production of 1294.71 Lakh tonnes. In the agricultural year 2022-23. Uttar Pradesh emerged as a major rice-producing state in India. The state witnessed a significant rice production of 544.17 lakh tonnes, contributing substantially to the country's overall rice output. This impressive production was achieved through cultivation on a vast area of 6,421 thousand hectares, demonstrating the state's vast potential for rice cultivation [2]. The data highlights Uttar Pradesh's critical role in India's rice production and underscores the need for continued support and innovation in the agricultural sector to enhance productivity and sustainability. For higher growth of agriculture, quantitative assessment of the contribution of different factors of agricultural output growth is important for reorienting the programmes and prioritizing agricultural development. Various factors affect the growth of agricultural output. Major ones of these factors are area and yield [3].

A great source of nourishment is rice. Uncooked rice has 6–9% protein, 77–84 percent carbohydrates, and all eight of the B vitamins—thiamine, riboflavin, and niacin—in good amounts. necessary amino acids. Since transplanted rice has more favourable growing conditions for increased yield, rice is typically grown by transplanting in puddled soils. However, during the next ten years, rice production must rise by roughly 3% annually to feed the nation's growing population [4].

Insect pests constitute the major yield-limiting biotic stresses throughout rice-growing countries [5]. From seedling to maturity, rice crop is affected by no. of various insect pests which causes the severe quantitative and qualitative loss in yield [6]. Rice is attacked and harmed by more than 100 insect species [7,8,9]. Numerous them frequently only occasionally show up and do not result in financial loss. But a few species are quite essential and do cause a lot of damage. The primary economically significant pests in India are stem borers, gall midges (*Orseolia oryzae* Wood-Mason), brown planthoppers (*Nilaparvata lugens* Stal), leaf folders (*Cnaphalocrocis medinalis* Gunee), and green leafhoppers (*Nephotettix virescens* Dist.). These pests often cause production constraints in a range of rice-growing environments [10].

The following insect pests cause damage to rice crops: brown plant hopper (*Nilaparvata lugens* Stal), gall midge (*Orseolia oryzae* Wood Mason), leaf folder (*Cnaphalocrocis medinalis Guenee*), and stem borer (*Scirpophaga incertulas* Walker). Season by season and place to area, the magnitude of losses resulting from these insect pests' devastation varies dramatically. Variability in weather parameters and biotic mortality variables cause the intensity of pest damage to vary throughout different seasons, years, and agro-climatic zones. A better understanding of the dynamics of pest populations about meteorological conditions can aid in pest management [11]. The eggs, larvae, pupae, and adults are the four distinct stages of the Yellow Stem Borer's full metamorphosis. The larvae eat on the upper part of the leaves at first, then go to the stem to feed on nutrients [12,13]. Yellow

Stem Borer is seen during the vegetative phase and reproductive phase, which is called “dead heart” and “white head” or “white ear,” respectively [14]. The damage is seen in the young or vegetative state, in which the central leaf, i.e., the tillers, are damaged and turn brown, which is called "dead heart." During the reproductive stage, after the formation of the spikelet, the panicle turns white, and no grain filling occurs, which represents "whiteheads" or "white ears." In both phases, the central tiller and panicle can be easily pulled out by hand and show feeding near the base [15]. Dead hearts" during the tillering stage and "White ear heads" during the reproductive stage are caused by the larva [16].

Damage that occurs in the plant's early growth phase (50%) has a higher impact on crop production reduction than damage that occurs in later stages, like the reproductive (30%) or ripening (20%) phases of the plant [17]. An infestation of YSB drastically lowers rice output. According to a study conducted in India [18] Yellow stem borer infection resulted in a 42.7% yield reduction. Similarly, Yellow stem borer infestation was reported to produce a 46.4% yield loss in a study conducted in Bangladesh by Haq et al*.* [19]. Farmers and the rice business stand to lose a great deal financially as a result of these yield losses. In the fight against this unpleasant larva, farmers heavily rely on synthetic insecticide as their preferred weapon because of broad-spectrum action, inexpensive cost, and quick killing power. A study by Ali et al*.* [20] found a favourable association between rice productivity and the usage of pesticides, suggesting that applying insecticides had a beneficial effect on rice output. It was observed that research into the effectiveness of various pesticides against yellow stem borer is vital for the effective management of yellow stem borer. Furthermore, there isn't much research comparing various pesticides' effectiveness against yellow stem borer in Nepalese rice production systems. As a result, the study's primary goal was to evaluate how well different insecticides worked to prevent the Yellow Stem Borer. The study specifically assessed the effectiveness of seven different pesticides.

2. MATERIALS AND METHODS

The present study took place at Heera Puri research field, IANS, DDUGU, in District Gorakhpur during the *Kharif* season of 2023. The experiment farm is situated at an elevation of 75 meters above mean sea level with latitude 26*46’ N and longitude 83*2’E. The research field is under Agro-climatic Zone IV north northeastern plain region. Gorakhpur experiences a humid subtropical climate with dry winters. The region typically receives about 4.28 inches of precipitation, mostly from mid-June to September, with occasional winter rain. The relative humidity of Gorakhpur is around 68% although it varies from 38% during summer to 84% during the monsoon. The experimental site's soil is uniform, with sandy loam and good drainage. The *pH* value of the soil is 6.5 – 7.5. Soil is medium in organic carbon and nitrogen. The recommended rice variety *Swarna* was sown and transplanted in a plot size of 4m x 3m, with row-to-row and plant-to-plant spacing of 20cm and 20cm, respectively. In the experiment eight different treatments consisting of application of T1: Chlorantraniliprole 18.5 SC, T2: Emamectin benzoate 5% SC, T3: Cartap hydrochloride 50% SP, T4: Lambda-cyhalothrin 5% EC, T5: NSKE 5%, T6: *Beauveria bassiana*, T7: *Bacillus thuringienisis* T8: Control. Sprays were initiated upon reaching the Economic Threshold Level (ETL), and the borer damaged the rice plant. Sprays were repeated at 15-day intervals throughout the crop season. Two sprays of each insecticide were applied through a knapsack sprayer (battery-operated) insect population at ETL. For recording the observations, five hills were marked in each plot and observations on rice stem borer were recorded one day before and thereafter, three, seven and ten days after the treatment of application and data was presented in mean value. The grain yield per plot was also recorded. The economics of different insecticidal treatments was worked out based on the prevailing market price of insecticides and application cost. Further, the net profit and cost-benefit ratio were worked out.

3. RESULTS AND DISCUSSION

To present a conclusive result, we provide the findings of the current investigation along with a justified explanation of the relevant components. In the *kharif* season rice crop of 2023, the relative bioefficacy of insecticides Chlorantraniliprole 18.5 SC, Emamectin benzoate 5% SC, Cartap hydrochloride 50% SP, Lambda-cyhalothrin 5% EC, NSKE 5%, *Beauveria bassiana* and *Bacillus thuringienisis* was assessed in the field against the rice stem borer. To prevent stem borer infection in the crop, we applied pesticides twice.

Observation of head heart infestation of First spray: The observation of the pre-treatments of dead hearts before imposing treatments showed statistically non-significant differences among different treatments, which ranged from 3.04 to 3.14 % dead heart. The data presented in Table 1 and Fig. 1 revealed that three days after treatment, all the treatments were found significantly superior over the control (untreated) against rice caseworm in rice. The treatment Chlorantraniliprole 18.5 SC showed the significantly lower percent of dead heart (2.06 %) followed by Emamectin benzoate 5% SC (2.17 %), Lambda cyhalothrin 5 EC (2.23%), Cartap hydrochloride 50% SP (2.29%), NSKE (2.56 %), *Beauveria bassiana* (2.67%), *Bacillus thuringienisis* (2.73%). The highest percentage of dead hearts were found under untreated control as 4.47%. The observation of the dead heart recorded after seven days of treatment application showed that among all the treatments Chlorantraniliprole 18.5 SC showed a significantly lower percent of dead heart (1.76 %) followed by Emamectin benzoate 5% SC (1.81 %), Lambda cyhalothrin 5 EC (1.84%), Cartap hydrochloride 50% SP (1.89 %), NSKE (1.9 %), *Beauveria bassiana* (2.06%), *Bacillus thuringienisis* (2.11%). The highest percentage of dead hearts were found under untreated control as 4.72 %. The observation of the dead heart recorded after ten days of first spray treatment application showed that among all the treatments Chlorantraniliprole 18.5 SC showed a significantly lower per cent of dead heart (1.91%) followed by Emamectin benzoate 5% SC (1.97%), Lambda cyhalothrin 5 EC (2.08 %), Cartap hydrochloride 50% SP (2.14%), NSKE (2.28%), *Beauveria bassiana* (2.36%), *Bacillus thuringienisis* (2.42%). The highest percentage of dead hearts were found under untreated control as 5.07%.

Observation of dead heart infestation of the second spray: The observation of the dead heart recorded after three days of second spray treatment application presented in Table in 2 showed that among all the treatments Chlorantraniliprole 18.5 SC showed a significantly lower percent of dead heart (1.53 %) followed by Emamectin benzoate 5 % SC (1.59 %), Lambda cyhalothrin 5 EC (1.64 %), Cartap hydrochloride 50% SP (1.69 %), NSKE (1.81 %), *Beauveria bassiana* (1.86 %), *Bacillus thuringienisis* (1.93 %). The highest percentage of dead hearts were found under untreated control as 5.86%. The observation of the dead heart recorded after seven days of the second spray treatment application presented in Table in 2 showed that among all the treatments Chlorantraniliprole 18.5 SC showed a significantly lower percentage of dead heart (0.91%) followed by Emamectin benzoate 5 % SC (0.97%), Lambda cyhalothrin 5 EC (1.03%), Cartap hydrochloride 50% SP (1.09%), NSKE (1.23%), *Beauveria bassiana* (1.27%), *Bacillus thuringienisis* (1.34%). The highest percentage of dead heart were found under untreated control as 5.37 %. The observation of the dead heart recorded after ten days of second spray treatment application showed that among all the treatments Chlorantraniliprole 18.5 SC showed a significantly lower percentage of dead heart (1.31%) followed by Emamectin benzoate 5 % SC (1.37%), Lambda cyhalothrin 5 EC (1.43%), Cartap hydrochloride 50% SP (1.47%), NSKE (1.61%), *Beauveria bassiana* (1.67%), *Bacillus thuringienisis* (1.72%). The highest percentage of dead hearts were found under untreated control as 5.47%.

Mean of 1st spray of infested dead heart: The observation of the dead heart recorded after three, seven, ten days of first treatment applications mean data presented in Table 3 and Fig. 3 showed that among all the treatments Chlorantraniliprole 18.5 SC showed a significantly lower per cent of dead heart (1.91 %) followed by Emamectin benzoate 5 % SC (1.99 %), Lambda cyhalothrin 5 EC (2.05 %), Cartap hydrochloride 50% SP (2.11 %), NSKE (2.27 %), *Beauveria bassiana* (2.36 %), *Bacillus thuringienisis* (2.42 %). The highest per cent of dead heart were found under untreated control as 4.75 %.

Mean of 2nd spray of infested dead heart: The mean observation of the dead heart recorded after three, seven and ten days after treatment application presented in Table 3 and Fig. 3 showed that among all the treatments Chlorantraniliprole 18.5 SC showed a significantly lower per cent of dead heart (1.25 %) followed by Emamectin benzoate 5 % SC (1.31 %), Lambda cyhalothrin 5 EC (1.37 %), Cartap hydrochloride 50% SP (1.42 %), NSKE (1.55 %), *Beauveria bassiana* (1.60 %), *Bacillus thuringienisis* (1.66 %). The highest percentage of dead heart were found under untreated control as 5.57 %.

Overall Mean of both the sprays: The mean observation of the dead heart recorded in both the sprays presented in Table in 3 and Fig. 3 showed that among all the treatments Chlorantraniliprole 18.5 SC showed a significantly lower percentage of dead heart (1.58 %) followed by Emamectin benzoate 5 % SC (1.65 %), Lambda cyhalothrin 5 EC (1.71 %), Cartap hydrochloride 50% SP (1.76 %), NSKE (1.91 %), *Beauveria bassiana* (1.98 %), *Bacillus thuringienisis* (2.04 %). The highest percentage of dead hearts were found under untreated control as 5.16.

Table 1. Observation of yellow stem borer infestation percentage of the first spray

Treatment no.	Treatment	Dose ha^{-1}	Percentage infestation of stem borer in rice 1st Spray			
			Before spray	3DAS	7 DAS	10 DAS
1	Chlorantraniliprole 18.5 SC	150/ml	3.11 (2.028)	2.06 (1.749)	1.76 (1.661)	1.91 (1.707)
2	Emamectin benzoate 5 % SC	250/gm	3.07 (2.017)	2.17 (1.781)	1.81 (1.677)	1.97 (1.724)
3	Cartap hydrochloride 50% SP	600/gm	3.04 (2.011)	2.29 (1.814)	1.89 (1.700)	2.14 (1.772)
4	Lambda cyhalothrin 5 EC	500/ml	3.14 (2.036)	2.23 (1.798)	1.84 (1.686)	2.08 (1.756)
5	NSKE	25/lit	3.09 (2.022)	2.56 (1.888)	1.97 (1.723)	2.28 (1.812)
6	*Beauveria bassiana*	2.5/lit	3.12 (2.030)	2.67 (1.916)	2.06 (1.748)	2.36 (1.834)
7	*Bacillus thuringienisis*	5/lit	3.06 (2.016)	2.73 (1.932)	2.11 (1.764)	2.42 (1.849)
8	Control	-	3.13 (2.031)	4.47 (2.338)	4.72 (2.392)	5.07 (2.464)
Sem±			0.007	0.006	0.005	0.010
CD			N/A	0.018	0.015	0.030

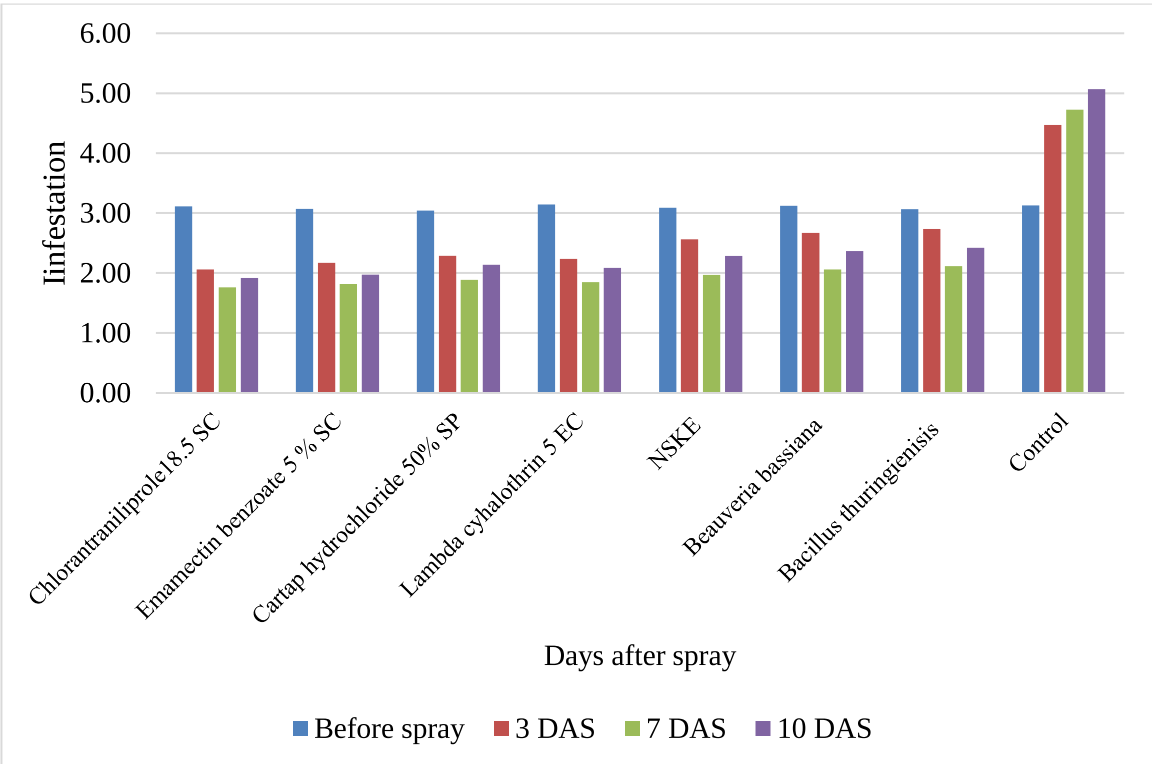

Fig. 1. Effect of various treatments on infestation of yellow stem borer after first spray

Table 2. Observation of yellow stem borer infestation percentage of the second spray

Treatment no.	Treatment	Dose ha-1	Percentage infestation of stem borer in rice		
				2nd Spray	
			3 DAS	7 DAS	10 DAS
1	Chlorantraniliprole 18.5 SC	150/ml	1.53 (1.519)	0.91 (1.381)	1.31 (1.521)
2	Emamectin benzoate 5 % SC	250/gm	1.59 (1.609)	0.97 (1.403)	1.37 (1.538)
3	Cartap hydrochloride 50% SP	600/gm	1.69 (1.639)	1.09 (1.445)	1.47 (1.572)
4	Lambda cyhalothrin 5 EC	500/ml	1.64 (1.625)	1.03 (1.425)	1.43 (1.559)
5	NSKE	25/lit	1.81 (1.676)	1.23 (1.494)	1.61 (1.616)
6	*Beauveria bassiana*	2.5/lit	1.86 (1.690)	1.27 (1.507)	1.67 (1.634)
7	*Bacillus thuringienisis*	5/lit	1.93 (1.712)	1.34 (1.529)	1.72 (1.649)
8	Control	-	5.86 (2.619)	5.37 (2.524)	5.47 (2.544)
Sem±			0.007	0.008	0.006
CD			0.022	0.024	0.019

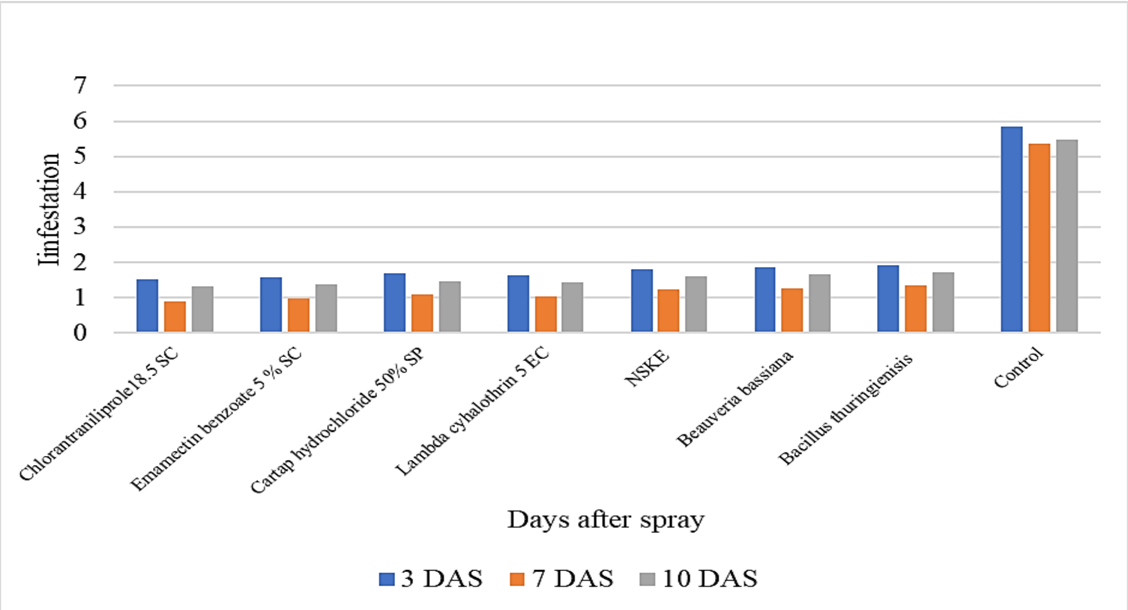

Fig. 2. Effect of various treatments on the infestation of yellow stem borer after second spray

Table 3. Effect of various treatments on infestation of yellow stem borer (mean observation)

Treatment no.	Treatment	Dose ha1	Mean of 1st spray (%)	Mean of 2nd spray (%)	The overall mean of two spray (%)
1	Chlorantraniliprole 18.5 SC	150/ml	1.91	1.25	1.58
2	Emamectin benzoate 5 % SC	250/gm	1.99	1.31	1.65
3	Cartap hydrochloride 50% SP	600/gm	2.11	1.42	1.765
4	Lambda cyhalothrin 5 EC	500/ml	2.05	1.37	1.71
5	NSKE	25/lit	2.27	1.55	1.91
6	*Beauveria bassiana*	2.5/lit	2.36	1.60	1.98
7	*Bacillus thuringienisis*	5/lit	2.42	1.66	2.04
8	Control	-	4.75	5.57	5.16

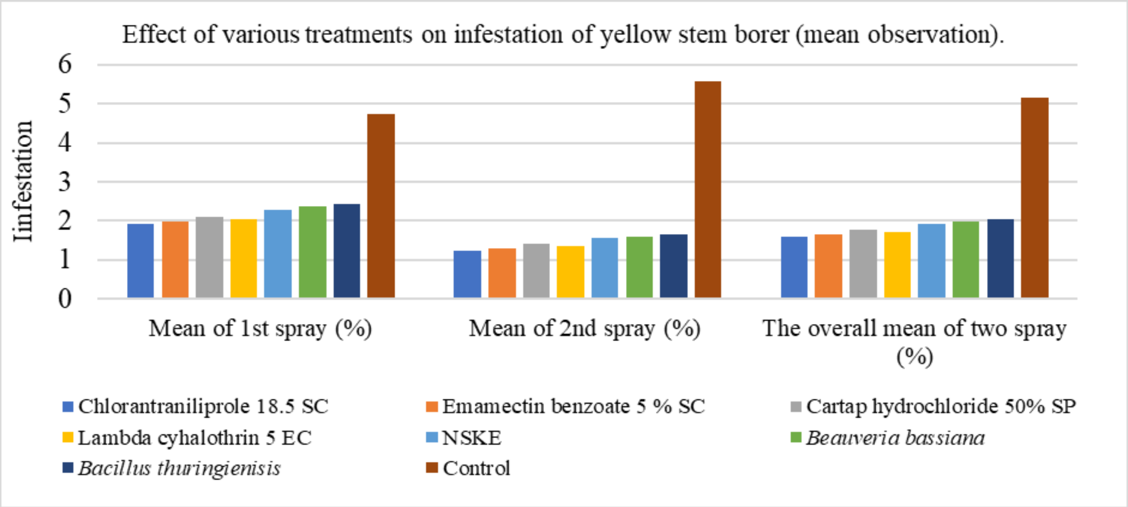

Fig. 3. Effect of various treatments on infestation of yellow stem borer (mean observation)

3.1 Discussion

The results of our study showed that the use of insecticides significantly reduced the level of injury and yield loss caused by yellow stem borer (YSB) in rice. Among the insecticides tested, chlorantraniliprole 18.5 SC was found to be the most effective in minimizing dead heart (DH%) symptoms, reducing them from 5.93% to 4.46%, and minimizing white heads from 7.56% to 2.5% in comparison to the control treatment. Upon closer examination, the observed effectiveness of chlorantraniliprole 18.5 SC in controlling the yellow stem borer infestation can be attributed to the insecticide formulation and active ingredients. Further, the mode of action and application effectiveness of chlorantraniliprole 18.5 SC may have also played a crucial role in its comparatively higher efficacy compared to other chemicals. Further research is needed to elucidate the specific factors that govern the efficacy of insecticides against the yellow ste0.m borer. The efficacy of chlorantraniliprole 18.5 SC in controlling YSB in rice is consistent with previous studies by Rahaman and Stout [21], Abhinandan and Gupta [22], Sountharya and Prasad [23], Sachan et al. [24], Kumbhar and Singh [25]. In particular, Sachan et al. [24] found that chlorantraniliprole 18.5 SC (150 ml/ha) and chlorantraniliprole 0.4 GR (10 kg/ha) were the most effective treatments in their field experiments. Similarly, Suri [26] and Sarao and Cheema [27] also reported that Chlorantraniliprole 18.5 SC was the most effective in minimizing YSB infestation.

Yield: The cumulative yield data revealed that the rice production gradually increased when crop was treated with different insecticides and marketable grain yield ranged from 35.26 to 42.45 q per ha. in contrast to the untreated plot, which produced the lowest fruit yield of 28.31 q per ha. The significantly higher grain yield (42.45 q per ha) was obtained in Chlorantraniliprole 18.5 SC treated plots which are followed by Emamectin benzoate 5% SC (40.85 q per ha), Lambda-cyhalothrin 5 EC (39.91 q per ha), Cartap hydrochloride 50% SP (39.01 q per ha), *Beauveria bassiana* (36.42 q per ha) and *Bacillus thuringienisis* (36.02 q per ha) and NSKE (35.26 q per ha) (Table 4 & Fig. 4).

Percentage increase in yield over untreated plot: The significantly higher percentage increase in yield over control (49.95 %) was obtained in Chlorantraniliprole 18.5 SC treated plots which are followed Emamectin benzoate 5% SC (44.30 %), Lambda cyhalothrin 5 EC (40.97 %), Cartap hydrochloride 50% SP (34.26 %), *Beauveria bassiana* (28.65 %) and *Bacillus thuringienisis* (27.23 %) and NSKE (24.55 %) (Table 4.).

Economics of different insecticides against caseworm damaging rice: The economics of various treatments based on net profit and cost of plant protection (Table 5) revealed that. the highest cost: benefit ratio Lambda-cyhalothrin 5 EC (9.87) followed by Emamectin benzoate 5% SC (8.80), followed by Chlorantraniliprole 18.5% SC (7.70), *Beauveria bassiana* (6.65), Cartap hydrochloride 50% SP (5.29), NSKE (5.18) *Bacillus thuringienisis* (5.01). The highest B: C ratio of Lambda-cyhalothrin 5 EC may be due to its low price and dose concentration.

Table 4. Influence of various insecticide treatments on rice yield and increase in yield (%) compared to control

Number	Treatment	Yield (q/ha)	Increase in yield (%) over control
T 1	Chlorantraniliprole18.5 SC	42.45	49.95
T 2	Emamectin benzoate 5 % SC	40.85	44.30
T 3	Cartap hydrochloride 50% SP	38.01	34.26
T 4	Lambda cyhalothrin 5 EC	39.91	40.97
T 5	NSKE	35.26	24.55
T 6	*Beauveria bassiana*	36.42	28.65
T 7	*Bacillus thuringienisis*	36.02	27.23
T8	Control	28.31	0.00

Table 5. Economics of different insecticides against yellow stem borer

S. No.	Treatment	Yield(q/ha)	Insecticide Cost (per hac)	Total cost of Plant Protection	Gross Income	Net Income	Benefit over control	B:C ratio
1	Chlorantraniliprole18.5 SC	42.45	1795	3395	88720.50	85325.50	26157.60	7.70
2	Emamectin benzoate 5 % SC	40.85	1073	2673	85376.50	82703.50	23535.60	8.80
3	Cartap hydrochloride 50% SP	38.01	1625	3225	79440.90	76215.90	17048.00	5.29
4	Lambda cyhalothrin 5 EC	39.91	630	2230	83411.90	81181.90	22014.00	9.87
5	NSKE	35.26	750	2350	73693.40	71343.40	12175.50	5.18
6	*Beauveria bassiana*	36.42	615	2215	76117.80	73902.80	14734.90	6.65
7	*Bacillus thuringienisis*	36.02	1080	2680	75281.80	72601.80	13433.90	5.01
8	Control	28.31	-	-	59167.90	59167.90	-	-

Labour cost - ₹300/labour, Requirement of labour- 2 labour/hac, No. of spray- 2 spray, Requirement of sprayer- 2 sprayer/hac, Rent of sprayer- ₹ 100/sprayer, Local mandi price of paddy- ₹2090/quintal

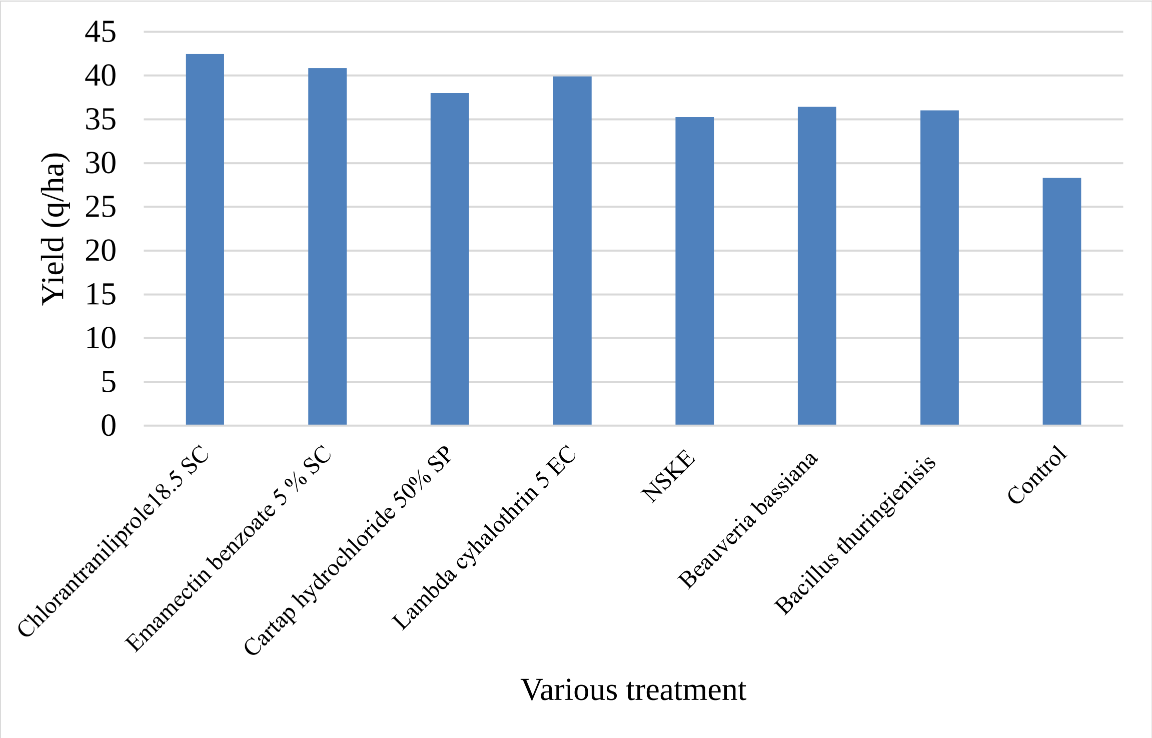

Fig. 4. Impact of various treatments on Yield (q/ha)

4. CONCLUSIONS

The effectiveness of various insecticides against the yellow stem borer was assessed. The mean observation of the dead heart recorded in both the sprays revealed that among all the treatments Chlorantraniliprole 18.5 SC showed a significantly lower percentage of dead heart (1.58 %) followed by Emamectin benzoate 5 % SC (1.65 %). The highest per cent of dead heart were found under untreated control as 5.16%. During the yield observation, it was observed that the significantly higher grain yield (42.45 q per ha) was obtained in Chlorantraniliprole 18.5 SC treated plots which are followed by Emamectin benzoate 5% SC (40.85 q per ha). The significantly higher percentage increase in yield over control (49.95 %) was obtained in Chlorantraniliprole 18.5 SC treated plots which are followed Emamectin benzoate 5% SC (44.30 %). The economics of various treatments based on net profit and cost of plant protection revealed that. the highest cost-benefit ratio Lambda cyhalothrin 5 EC (9.87) followed by Emamectin benzoate 5% SC (8.80).

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 manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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