Journal of Experimental Agriculture International

Volume 46, Issue 8, Page 866-874, 2024; Article no.JEAI.121209
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Management of Rice Caseworm (*Nymphula depunctalis*) in Rice in Eastern Region of Uttar Pradesh, India

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Authors' contributions

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

Article Information

DOI: https://doi.org/10.9734/jeai/2024/v46i82772

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/121209

Original Research Article

Received: 10/06/2024
Accepted: 12/08/2024
Published: 16/08/2024

ABSTRACT

The present investigationwas carried out at Heera Puri research field, Institute of Agriculture and Natural Sciences, Deen Dayal Upadhyaya Gorakhpur University, District Gorakhpur during *Kharif*, 2023. In the *kharif* season of 2023, there was a rice crop, the relative effectiveness of six insecticides viz. flubendiamide 39.35% SC, NSKE 5%, cartap hydrochloride 50% SP, spinosad 45 SC, neem oil 5%, and emamectin benzoate 5% SC with control was assessed in the field against the rice caseworm. Spinosad 45 SC (3.95 %) was found to be the most effective insecticide treatment among all pesticides for controlling the rice caseworm, as it has recorded the lowest infestation. The second-best treatment was emamectin benzoate 5% SC (4.07 %), followed by

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Cite as: *Patel, Gopi, Saroj Chauhan, Ritesh Kumar, and Pradumn Kumar Mourya. 2024. "Management of Rice Caseworm (Nymphula Depunctalis) in Rice in Eastern Region of Uttar Pradesh, India". Journal of Experimental Agriculture International 46 (8):866-74. https://doi.org/10.9734/jeai/2024/v46i82772.*

flubendiamide 39.35% SC (4.21%), cartap hydrochloride 50% SP (4.32%), Neem oil 5% (4.75%), and NSKE 5% (4.85%). The significantly higher grain yield was obtained in Spinosad 45 SC (55.94 q/ha) treated plots which are followed by emamectin benzoate 5% SC (54.19%), flubendiamide 39.35% SC (54.02 q/ha), cartap hydrochloride 50% SP (53.21 q/ha), neem oil 5% (52.36 q/ha) and NSKE 5% (51.27 q/ha). The economics of various treatments based on net profit and cost of plant protection revealed that the highest cost: benefit ratio Spinosad 45 SC (1:4.47) followed by Emamectin benzoate 5% SC (1:3.96), followed by Cartap hydrochloride 50% SP (1: 2.06), Neem oil 5% (1: 1.25), NSKE 5% (1: 1.23) and the lowest cost-benefit ratio was observed in Flubendiamide 39.35% SC (1: 0.88).

Keywords: Efficacy; infestation; Nymphula depunctalis; rice case worm; spinosad 45 SC.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the world's leading sources of food among cereals and an important staple food for almost half of the world's population. Worldwide, rice is grown over an area of 162.31 million hectares with a total production of 738.18 million tonnes. In India, the area of rice is about 42.96 million ha with a total production of 158.7 million tonnes [1]. It is the staple food for more than 65 per cent of the people of India. Major rice-growing states of India include West Bengal, Uttar Pradesh, Punjab, Orissa, Assam, Bihar, Tamil Nadu and Madhya Pradesh. In some states like West Bengal, Assam and Orissa three rice crops are raised in a year. In Uttar Pradesh total production of 15.27 million tonnes. The per cent share of production to all India is 11.72 [2]. The introduction of high-yielding varieties, adoption of new agronomic practices and monoculture over large areas along with the humid environment are favourable for the proliferation of insect pests which have increased the population of minor pests rendering them major pests and vice-versa [3]. In India, paddy is attacked by several insect pests viz., *Scirpophaga incertulas* (Walker), *Sesamia inferens* (Walker), *Chilo suppressalis* (Walker), *Nilaparvata lugens* (Stal.), *Sogatella furcifera* (Harvath), *Nephotettix virescens* (Distant), *Cnaphalocrocis medinalis* (Guenee), *Orseola oryzae* (Wood-Mason), *Dicladispa armigera* (Oliver), *Nymphula depunctalis* (Guenee), *Hydrillia Philippina* (Ferino), *Leptocorisa acuta* (Thunberg), *Hieroglyphus banian* (Fabricius) [4]. They feed on rice crop from nursery to the maturity stage. Some of them reach the status of pests causing economic losses under farmer's field conditions. Among them, whorl maggot, caseworm, gundi bug, rice hispa and black beetle are emerging as great concern to farmers.

The rice caseworm, *Nymphula depunctalis* (Gn.) occurs sporadically on rice in India and causes severe damage to young plants [5,6]. The caseworm, *N. depunctalis* is commonly found in lowlands with poor drainage and flooded fields. Because of poor stagnation in fields during floods, this pest can build up and cause severe loss in the early vegetative stage [7,8]. The leaf cases float to carry the larvae from one plant to another during the day and at night the larvae climb the plants to cut off leaves to make new cases, or feed on leaves on the water surface [9,10]. The entire crop may have to be resown and replanted in case of damaged leaves. The larvae enclose themselves within the tubular leaf case by cutting the leaf blade. Enclosed within the case, the larva attaches itself to the rice plant and feeds on the leaves [11,12]. Feeding damage includes cutting off the leaf cases and may result in patches of severe defoliation, stunted growth and death of plants [13-15]. Rice at seedling and tillering stages are the preferred hosts but do not occur after maximum tillering [16,17].

To overcome the losses and increase in yield, pesticide applications are very important. Newer groups of insecticides play a major role in insect pest management on rice, since they impart effective control against the target pest and have no longer residue persistence in plants/crops as well as in the soil. It is very important to study the bio-efficacy of insecticides against the insects of rice for effective pest management. Keeping in view the severity and importance of these insect pests in Uttar Pradesh, the present investigations were undertaken.

2. MATERIALS AND METHODS

The present study was conducted at Heera Puri research field, Institute of Agriculture and Natural Sciences, Deen Dayal Upadhyaya Gorakhpur University, District Gorakhpur during *Kharif*, 2023. The experiment farm is situated at an elevation of 75 meters above mean sea level

with latitude 26^0 46/ N and longitude $83^02/$ E. For conducting the investigation rice variety, Samba Mashuri (BPT 5204) was sown and transplanted in plot size of 3m x 4m, with row-to-row and plant-to-plant spacing of 20 cm and 20 cm, respectively. In the experiment seven different treatments consisting of application of T1: flubendiamide 39.35 % SC, T2: NSKE 5%, T3: cartap hydrochloride 50% SP, T4: spinosad 45 SC, T5: neem oil 5%, T6: emamectin benzoate 5% SC, T7: control. Sprays were initiated on reaching after the population at ETL level (2 fully damaged leaves per hill) and the spray was repeated with 15 days intervals after the last observation of first spray during the crop season. Spraying was done with the help of a knapsack sprayer. For recording the observations, five hills were marked in each plot and observations on rice caseworm incidence were recorded one day before and thereafter, three, seven and fifteen days of spray. The grain yield per plot was also recorded and converted in to q/ha basis. 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 effectiveness of six insecticides flubendiamide, NSKE, cartap hydrochloride, spinosad, neem oil, and emamectin benzoate was assessed in the field against the rice caseworm. To prevent caseworm infection in the crop, a total of two times insecticide applications were made. Crop damage was seen and after reaching the population at ETL the first spray were made and the observation was done at one day prior to treatment and three, seven, and ten-days following spraying. The pre-treatment observation showed that the percentage of rice caseworm infestation varied from 8.46 to 8.58 per plant. This indicated that there were no significant variations across the treatments, suggesting that the pest infestation on the crop under study was relatively similar. 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 spinosad was found most effective with a minimum fruit infestation of 4.87% followed by emamectin benzoate which registered 4.92% infestation, flubendiamide (5.06%), cartap hydrochloride (5.18%), neem oil (5.48%), NSKE (5.56%) whereas the highest infestation was recorded in the control plot with 9.71% infestation. The data presented in Table 1 and Fig. 1 revealed that seven days after treatment, all the treatments were found significantly superior over the control (untreated) against rice caseworm in rice. The treatment spinosad was found most effective with a minimum fruit infestation of 2.61% followed by emamectin benzoate (2.84%) infestation, flubendiamide (2.95 %), cartap hydrochloride (3.09%), neem oil (4.71%), NSKE (4.95%) whereas the highest infestation was recorded in the control plot with 11.90% infestation. The observation recorded ten days after the first spray indicated that all the insecticidal treatments were also found significantly superior over control (untreated). The treatment of spinosad proved most effective followed by emamectin benzoate and flubendiamide resulting in 3.42, 3.56 and 3.73 % infestation, respectively. The treatments of cartap hydrochloride (3.88%), neem oil (3.99%) and NSKE (4.09%) proved least effective in reducing the infestation of rice caseworm in rice (Table 1 and Fig. 1). The mean data represented in Table 3 showed that after the first spray, spinosad was found most effective with a minimum infestation of 3.63% followed by emamectin benzoate (3.77%) infestation, flubendiamide (3.91%), cartap hydrochloride (4.05%), neem oil (4.73%), NSKE (4.87 %) whereas the highest infestation was recorded in the control plot with 11.36 % infestation. The data presented in Table 2 and Fig. 2 revealed that three days after treatment, all the treatments were found significantly superior over the control (untreated) against rice caseworm. The treatment Spinosad 45% SC was found most effective with a minimum fruit infestation of 4.82 % followed by emamectin benzoate which registered 4.99 % infestation flubendiamide (5.09 %), cartap hydrochloride (5.18%), neem oil (5.42%), NSKE (5.49%) whereas the highest infestation was recorded in the control plot with 13.62% infestation. The data presented in Table 2 and Fig. 2 revealed that seven days after treatment, all the treatments were found significantly superior over the control (untreated) against rice caseworm. The treatment spinosad was found most effective with a minimum infestation of 4.82 % followed by emamectin benzoate which registered 4.99 % infestation, flubendiamide (5.09 %), cartap hydrochloride (5.18 %), neem oil (5.42 %), NSKE (5.49 %) whereas the highest infestation was

recorded in the control plot with 13.62% infestation. The observation recorded ten days after the second spray indicated that all the insecticidal treatments were found significantly superior over control (untreated). The treatment of spinosad proved most effective followed by emamectin benzoate and flubendiamide resulting in 3.91, 4.05 and 4.14% infestation, respectively. The treatments of cartap hydrochloride (4.19 % neem oil (4.36%) and NSKE (4.45%) proved least effective in reducing the infestation of rice caseworm (Table 2 and Fig. 2). The mean data represented in Table 3 showed that after the second spray, spinosad was found most effective with a minimum infestation of 4.27% followed by emamectin benzoate (4.37%) infestation, flubendiamide (4.51%), cartap hydrochloride (4.59%), neem oil (4.76%), NSKE (4.83%) whereas the highest infestation was recorded in the control plot with 14.04% infestation. The overall mean of two sprays revealed that the most effective treatment was spinosad recorded the lowest fruit infestation (3.95%) followed by emamectin benzoate (4.07%), flubendiamide (4.21% cartap hydrochloride (4.32%), neem oil (4.75%), NSKE (4.85%) whereas the highest infestation was recorded in the control plot with 12.70 % infestation (Table 3). Thus, it is clear, from the results that spinosad was found most effective insecticide treatment among all pesticides for controlling the rice caseworm, as it has recorded the lowest infestation. The second-best treatment was emamectin benzoate, followed by flubendiamide, cartap hydrochloride, neem oil, NSKE. The present findings are in accordance with the Srivastav et al., [14,15] who reported spinosad as the best treatment.

3.1 Yield

The cumulative yield data revealed that the fruit production gradually increased when rice caseworm was treated with different insecticides and marketable grain yield ranged from 49.51 to 55.94 q. per ha. in contrast to the untreated plot, which produced the lowest fruit yield of 49.51 q per ha. The significantly higher grain yield (55.94 q per ha) was obtained in Spinosad 45 SC treated plots which are followed by emamectin benzoate (54.19 q per ha), flubendiamide (54.02 q per ha), cartap hydrochloride (53.21 q per ha), neem oil (52.36 q per ha) and NSKE 5% (51.27 q per ha) (Table 4 & Fig. 3). The significantly higher percentage increase in yield over control (12.99%) was obtained in spinosad treated plots which are followed by emamectin benzoate (9.45%), flubendiamide - (9.11%), cartap hydrochloride (7.47%), neem oil 5% (5.76%)

Table 1. Field evaluation of various insecticides against caseworm in rice crop after first spray during Kharif season,2023

Sr. No.	Treatment	Dose g/ l ha^{-1}	Percentage infestation of caseworm in rice			
			1st Spray			
			Before spray	3 DAS	7 DAS	10 DAS
1	Flubendiamide 39.35 % SC	250	8.52 (3.085)	5.06 (2.462)	2.95 (1.987)	3.73 (2.175)
2	NSKE 5%	25	8.58 (3.095)	5.56 (2.562)	4.95 (2.439)	4.09 (2.257)
3	Cartap hydrochloride 50% SP	1000	8.52 (3.085)	5.18 (2.486)	3.09 (2.023)	3.88 (2.208)
4	Spinosad 45 SC	100	8.46 (3.075)	4.87 (2.423)	2.61 (1.901)	3.42 (2.102)
5	Neem oil 5%	25	8.48 (3.079)	5.48 (2.545)	4.71 (2.390)	3.99 (2.234)
6	Emamectin benzoate 5 % SC	250	8.55 (3.091)	4.92 (2.432)	2.84 (1.960)	3.56 (2.135)
7	Control	-	8.57 (3.093)	9.71 (3.273)	11.90 (3.592)	12.47 (3.670)
Sem			0.005	0.005	0.004	0.011
CD			NA	0.015	0.014	0.033

and NSKE 5% (3.55%) (Table 4). The economics of various treatments based on net profit and cost of plant protection (Table 4) revealed that the highest cost: benefit ratio spinosad (4.74) followed by emamectin benzoate (3.96), followed by cartap hydrochloride (2.06), neem oil (1.25), NSKE 5% (1.23), flubendiamide 39.35 (0.88). The highest B: C ratio of spinosad may be due to its low price and dose concentration.

Table 2. Field evaluation of various insecticides against caseworm in rice crop after second spray during *Kharif* season,2023

Sr. No.	Treatment	Dose g/ lha^{-1}	Percentage infestation of caseworm in rice		
			2nd Spray		
			3 DAS	7 DAS	10 DAS
1	Flubendiamide 39.35 % SC	250	5.09 (2.467)	4.14 (2.266)	4.29 (2.301)
2	NSKE 5%	25	5.49 (2.548)	4.45 (2.335)	4.56 (2.359)
3	Cartap hydrochloride 50% SP	1000	5.18 (2.486)	4.19 (2.278)	4.39 (2.322)
4	Spinosad 45 SC	100	4.82 (2.412)	3.91 (2.216)	4.09 (2.257)
5	Neem oil 5%	25	5.42 (2.533)	4.36 (2.315)	4.51 (2.347)
6	Emamectin benzoate 5 % SC	250	4.99 (2.447)	4.05 (2.248)	4.08 (2.253)
7	Control	-	13.62 (3.823)	14.51 (3.939)	13.98 (3.870)
Sem			0.009	0.007	0.0011
CD			0.030	0.023	0.034

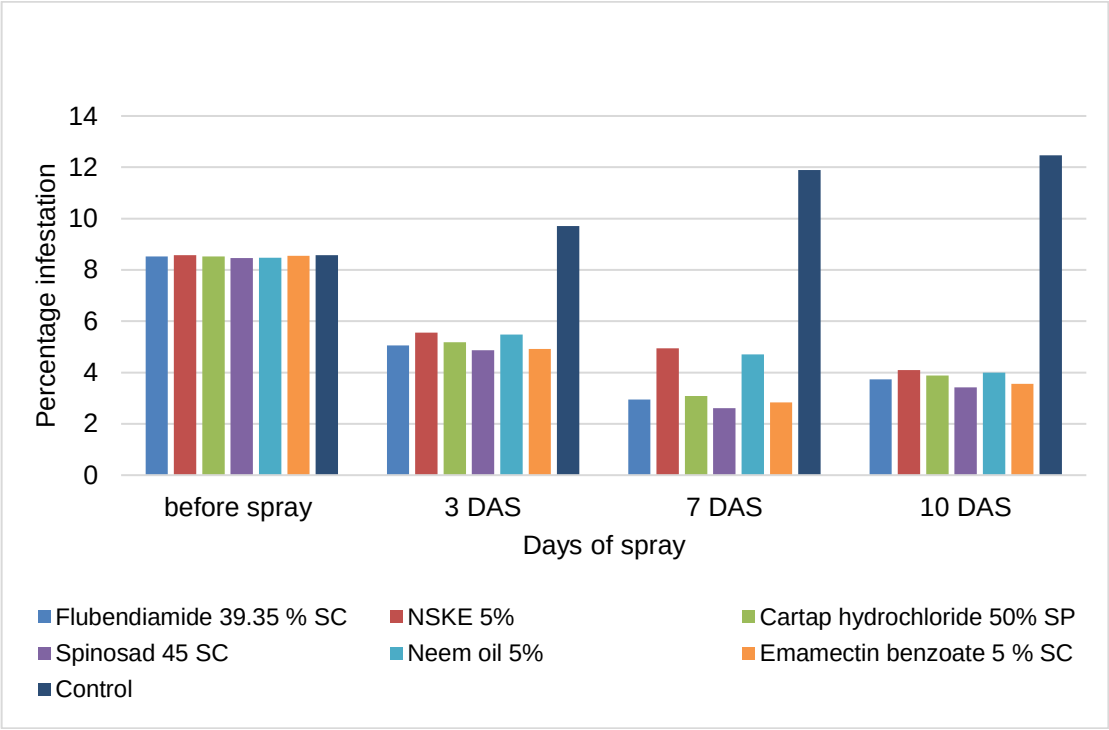

Fig. 1. Effect of various treatments on infestation of rice caseworm after the first spray

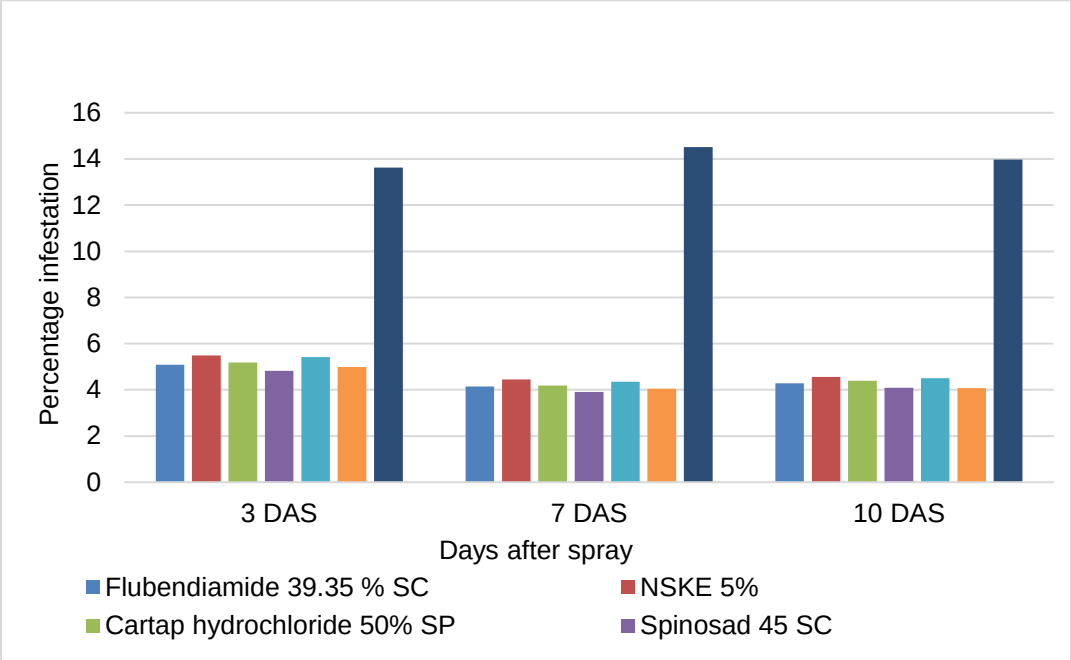

Fig. 2. Effect of various treatments on infestation of rice caseworm after second spray

Table 3. Mean percentage infestation of various insecticides against caseworm in rice crop after both sprays during Kharif season,2023

No.	Treatment	Dose g/ l ha^{-1}	Percentage infestation of caseworm in rice		
			The mean of first spray	Mean of the second spray	Overall mean
1	Flubendiamide 39.35% SC	250	3.91	4.51	4.21
2	NSKE 5%	25	4.87	4.83	4.85
3	Cartap hydrochloride 50% SP	1000	4.05	4.59	4.32
4	Spinosad 45 SC	100	3.63	4.27	3.95
5	Neem oil 5%	25	4.73	4.76	4.75
6	Emamectin benzoate 5 % SC	250	3.77	4.37	4.07
7	Control	-	11.36	14.04	12.70

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

S.N.	Treatments	Yield (q/ha)	Increase in yield (%) over control
1	Flubendiamide 39.35 % SC	54.02	9.11
2	NSKE 5%	51.27	3.55
3	Cartap hydrochloride 50% SP	53.21	7.47
4	Spinosad 45 SC	55.94	12.99
5	Neem oil 5%	52.36	5.76
6	Emamectin benzoate 5 % SC	54.19	9.45
7	Control	49.51	0.00

Table 5. Economics of different insecticides against rice caseworm

S.No.	Treatment	Yield (q/ha)	Insecticide Cost (per ha.)	Total cost of Plant Protection	Gross Income	Net Income	Benefit over control	B:C
1	Flubendiamide 39.35% SC	54.02	4110	5010	112901.8	107891.8	4415.9	0.88
2	NSKE 5%	51.27	750	1650	107154.3	105504.3	2028.4	1.23
3	Cartap hydrochloride 50% SP	53.21	1625	2525	111208.9	108683.9	5208	2.06
4	Spinosad 45 SC	55.94	1440	2340	116914.6	114574.6	11098.7	4.74
5	Neem oil 5%	52.36	1750	2650	109432.4	106782.4	3306.5	1.25
6	Emamectin benzoate 5 % SC	54.19	1073	1973	113257.1	111284.1	7808.2	3.96
7	Control	49.51			103475.9	103475.9		

(Total cost of plant protection= Insecticides cost + application charge of insecticides), Selling price of paddy- Rs. 2090/q.

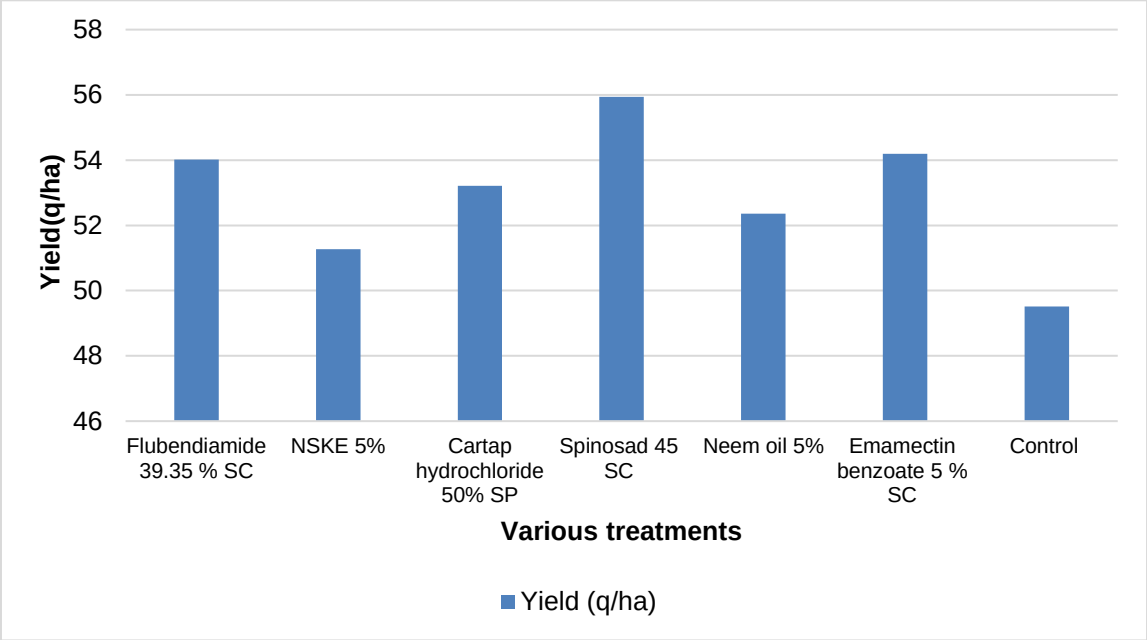

Fig. 3. Impact of various treatments on Yield (q/ha)

4. CONCLUSION

The present findings conclude that treatment such as Spinosad 45 SC was found most effective insecticide treatment among all pesticides for controlling the rice caseworm, as it has recorded the lowest infestation. The second-best treatment was Emamectin benzoate 5% SC, followed by Flubendiamide 39.35 % SC, Cartap hydrochloride 50% SP, Neem oil 5%, NSKE 5%. The significantly higher grain yield (55.94 q per ha) was obtained in Spinosad 45 SC treated plots which are followed by Emamectin benzoate 5% SC (54.19 q per ha), Flubendiamide 39.35 % SC (54.02 q per ha), Cartap hydrochloride 50% SP (53.21 q per ha), Neem oil (52.36 q per ha) and NSKE 5 % (51.27 q per ha). The economics of various treatments based on net profit and cost of plant protection revealed that the highest cost: benefit ratio Spinosad 45 SC (4.47) followed by Emamectin benzoate 5% SC (3.96), followed by Cartap hydrochloride 50% SP (2.06), Neem oil (1.25), NSKE (1.23), Flubendiamide 39.35 % SC (0.88).

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.

ACKNOWLEDGEMENTS

I am thankful to the director professors and whole staff of IANS for providing support and materials during the period of the investigations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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