MANAGEMENT OF RICE CASEWORM (*Nymphula depunctalis*) IN RICE IN EASTERN REGION OF UTTAR PRADESH

ABSTRACT:

The present investigation entitled ~~Studies on the infestation and management of rice caseworm (*Nymphula depunctalis*) in rice~~ was carried out at Heera Puri research field, IANS, DDUGU, District Gorakhpur during *Kharif*, 2023. In the kharif season of 2023, there was a rice crop, the relative effectiveness of six insecticides viz. ~~Flubendiamide~~ flubendiamide 39.35% SC, NSKE, ~~Cartap~~ cartap hydrochloride 50% SP, ~~Spinosad~~ spinosad 45 SC, ~~Neem~~ neem oil, and ~~Emamectin~~ emamectin benzoate 5% SC with control was assessed in the field against the rice caseworm. Spinosad 45 SC 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~~ emamectin benzoate 5% SC, followed by ~~Flubendiamide~~ flubendiamide 39.35 % SC, ~~Cartap~~ cartap hydrochloride 50% SP, Neem oil, and NSKE. The significantly higher grain yield was obtained in Spinosad 45 SC treated plots which are followed by ~~Emamectin~~ emamectin benzoate 5% SC, ~~Flubendiamide~~ flubendiamide 39.35 % SC, ~~Cartap~~ cartap hydrochloride 50% SP, ~~Neem~~ neem oil and NSKE 5%. The economics of various treatments based on net profit and cost of plant protection revealed that~~,~~ the highest cost: benefit ratio was calculated in ~~Spinosad~~ spinosad 45 SC followed by ~~Emamectin~~ emamectin benzoate 5% SC, followed by ~~Cartap~~ cartap hydrochloride 50% SP, ~~Chlorantraniliprole~~ chlorantraniliprole 18.5% SC, NSKE, ~~Neem~~ neem oil, ~~Flubendiamide~~ flubendiamide 39.35 % SC.

KEYWORDS: Efficacy, Infestation, Nymphula depunctalis. Rice case worm,

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 (Anonymous, 2022). 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 of the states like West Bengal, Assam and Orissa two crops of rice 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 (Chaturvedi *et al.* 2024). ~~This has necessitated the use of intensive farming systems, with inputs like narrow genetic base varieties, high fertilizer dose applications, irrigation, multiple cropping etc. which favour abrupt pest development.~~ 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 (Reddy, 2013). 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) (Bentur, 2009). They feed on rice crop from nursery to the maturity stage and also in storage. Some of them reach the

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status of pests causing economic losses under farmer's field conditions. Among them, whorl maggot, caseworm, chaffer beetle, 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 (Jacob *et al.* 1978). 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. 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. 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. Feeding damage includes cutting off the leaf cases and may result in patches of severe defoliation, stunted growth and death of plants (Srivastava *et al.* 2012). Rice at seedling and tillering stages are the preferred hosts but do not occur after maximum tillering (Pathak, 1975).

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 pests 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 pests insects of rice for effective pest management. The pest ecology and prevailing weather conditions play an important role in managing the pest effectively and well in time. Keeping in view the severity and importance of these insect pests in Uttar Pradesh, the present investigations were undertaken.

2. MATERIAL AND METHODS

The present study was conducted at Heera Puri research field, IANS, DDUGU, 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' 46/ N and longitude 83^{0}*2'^{1} E. The research field is under Agro-climatic Zone IV north northNorth-eastern plain region. Gorakhpur has a humid subtropical dry winter climate. The region typically receives about 4.28 inches of precipitation mostly from middle June to September with occasional rain in winter The relative humidity of Gorakhpur is around 68% although it varies from 38% during summer to 84% during the monsoon. The soil of the experimental site is uniform with sandy loam and fairly 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, Sambha Samba Mansoori 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 flubendiamide 39.35 % SC, T2: NSKE, T3: Cartap cartap hydrochloride 50% SP, T4: Spinosad spinosad 45 SC, T5: Neem neem oil, T6: Emamectin emamectin benzoate 5 % SC, T7: Controlcontrol. Sprays were initiated on reaching after the population reached ETL and shoot and fruit damage by the borer and repeated with 15 days intervals 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. 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 flubendiamide39.35% SC, NSKE, Cartap cartap hydrochloride 50% SP, Spinosad spinosad45 SC, Neem neem oil, and Emamectin emamectin benzoate 5% SC was assessed in the field against the rice caseworm. To prevent caseworm infection in the crop, a total of two times pesticide insecticide applications were made. Crop damage was seen in the first and second sprays 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

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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~~ spinosad ~~45% SC~~ was found most effective with a minimum fruit infestation of 4.87 ~~per cent~~ % followed by emamectin benzoate which registered 4.92% ~~per cent~~ infestation, ~~Flubendiamide~~ flubendiamide ~~39.35 % SC~~ (5.06 per cent), ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (5.18% ~~per cent~~), ~~Neem~~ neem oil (5.48% ~~per cent~~), NSKE (5.56% ~~per cent~~) whereas the highest infestation was recorded in the control plot with 9.71% ~~per cent~~ 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~~ spinosad ~~45% SC~~ was found most effective with a minimum fruit infestation of 2.61 per cent followed by emamectin benzoate (2.84% ~~per cent~~) infestation, ~~Flubendiamide~~ flubendiamide ~~39.35 % SC~~ (2.95 ~~per cent~~%), ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (3.09% ~~per cent~~), ~~Neem~~ neem oil (4.71% ~~per cent~~), NSKE (4.95% ~~per cent~~) whereas the highest infestation was recorded in the control plot with 11.90% ~~per cent~~ 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~~ spinosad ~~45% SC~~ proved most effective followed by emamectin benzoate ~~5 % SC~~ and flubendiamide ~~39.35 % SC~~ resulting in 3.42, 3.56 and 3.73 ~~per cent~~% infestation, respectively. The treatments of ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (3.88 ~~per cent~~%), ~~Neem~~ neem oil (3.99 ~~per cent~~%) and NSKE (4.09 ~~per cent~~%) 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~~ spinosad ~~45% SC~~ was found most effective with a minimum infestation of 3.63 per cent followed by emamectin benzoate (3.77 ~~per cent~~%) infestation, ~~Flubendiamide~~ flubendiamide ~~39.35 % SC~~ (3.91 ~~per cent~~%), ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (4.05 ~~per cent~~%), ~~Neem~~ neem oil (4.73 ~~per cent~~%), NSKE (4.87 ~~per cent~~%) whereas the highest infestation was recorded in the control plot with 11.36 ~~per cent~~% 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 ~~per cent~~% followed by emamectin benzoate which registered 4.99 ~~per cent~~% infestation ~~Flubendiamide~~ flubendiamide ~~39.35 % SC~~ (5.09 ~~per cent~~%), ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (5.18 ~~per cent~~%), ~~Neem~~ neem oil (5.42 ~~per cent~~%), NSKE (5.49 ~~per cent~~%) whereas the highest infestation was recorded in the control plot with 13.62% ~~per cent~~ 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~~ spinosad ~~45% SC~~ was found most effective with a minimum infestation of 4.82 ~~per cent~~% followed by emamectin benzoate which registered 4.99 per cent infestation, ~~Flubendiamide~~ flubendiamide ~~39.35 % SC~~ (5.09 ~~per cent~~%), ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (5.18 ~~per cent~~%), ~~Neem~~ neem oil (5.42 ~~per cent~~%), NSKE (5.49 ~~per cent~~%) whereas the highest infestation was recorded in the control plot with 13.62 ~~per cent~~% 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~~ spinosad ~~45% SC~~ proved most effective followed by emamectin benzoate ~~5 % SC~~ and ~~Flubendiamide~~ flubendiamide ~~39.35 % SC~~ resulting in 3.91, 4.05 and 4.14 ~~per cent~~% infestation, respectively. The treatments of ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (4.19 ~~per cent),~~% ~~Neem~~ neem oil (4.36 ~~per cent~~%) and NSKE (4.45 ~~per cent~~%) 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~~ spinosad ~~45% SC~~ was found most effective with a minimum infestation of 4.27 per cent followed by emamectin benzoate (4.37 ~~per cent~~%) infestation, ~~Flubendiamide~~ flubendiamide ~~39.35 % SC~~ (4.51 ~~per cent~~%), ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (4.59 ~~per cent~~%), ~~Neem~~ neem oil (4.76 ~~per cent~~%), NSKE (4.83 ~~per cent~~%) whereas the highest infestation was recorded in the control plot with 14.04 per cent infestation. The overall mean of two sprays revealed that the most effective treatment was ~~Spinosad~~ spinosad ~~45% SC~~ recorded the lowest fruit infestation (3.95 ~~per cent~~%) followed by ~~Emamectin~~ emamectin benzoate ~~5% SC~~ (4.07 ~~per cent~~%), ~~Flubendiamide~~ flubendiamide ~~39.35 % SC~~ (4.21 ~~per cent),~~ %~~Cartap~~ cartap hydrochloride ~~50% SP~~ (4.32 ~~per cent~~%), ~~Neem~~ neem oil (4.75 ~~per cent~~%), NSKE (4.85 ~~per cent~~%) whereas the highest infestation was recorded in the control plot with 12.70 per cent infestation (Table 3). Thus, it is clear, from the results that ~~Spinosad~~ 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~~ emamectin benzoate ~~5% SC~~, followed by ~~Flubendiamide~~ flubendiamide~~39.35 % SC~~, ~~Cartap~~ cartap

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hydrochloride ~~50% SP~~, ~~Neem~~ neem oil, NSKE. The present findings are in accordance with the Srivastav *et al*., 2012 who reported spinosad as the best treatment.

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~~it~~ 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	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	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

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

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

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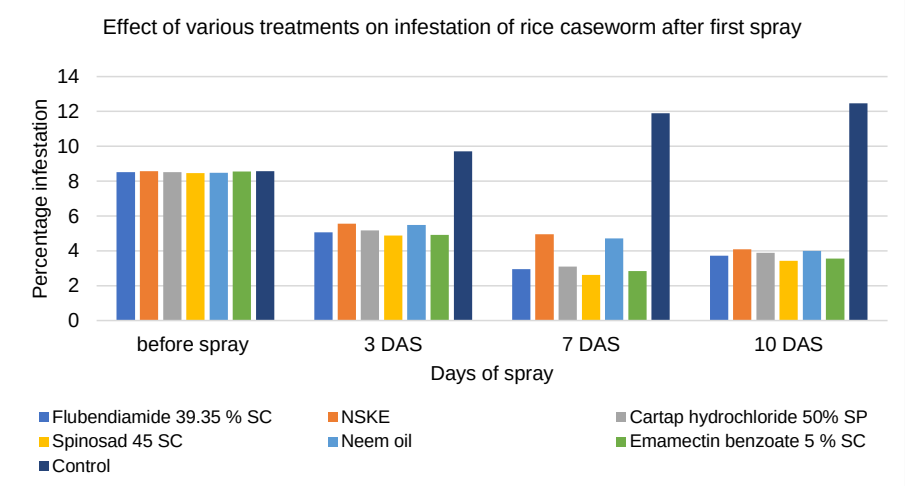

Sr. No.	Treatment	Dose g/ lit ha^{-1}	Percentage infestation of caseworm in rice		
			2nd Spray		
			3 DAS	7 DAS	10 DAS
1	Flubendiamide 39.35 % SC	250	5.09 (2.467)	4.14 (2.266)	4.29 (2.301)
2	NSKE	25	5.49 (2.548)	4.45 (2.335)	4.56 (2.359)
3	Cartap hydrochloride 50% SP	1000	5.18 (2.486)	4.19 (2.278)	4.39 (2.322)

4	Spinosad 45 SC	100	4.82 (2.412)	3.91 (2.216)	4.09 (2.257)
5	Neem oil	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

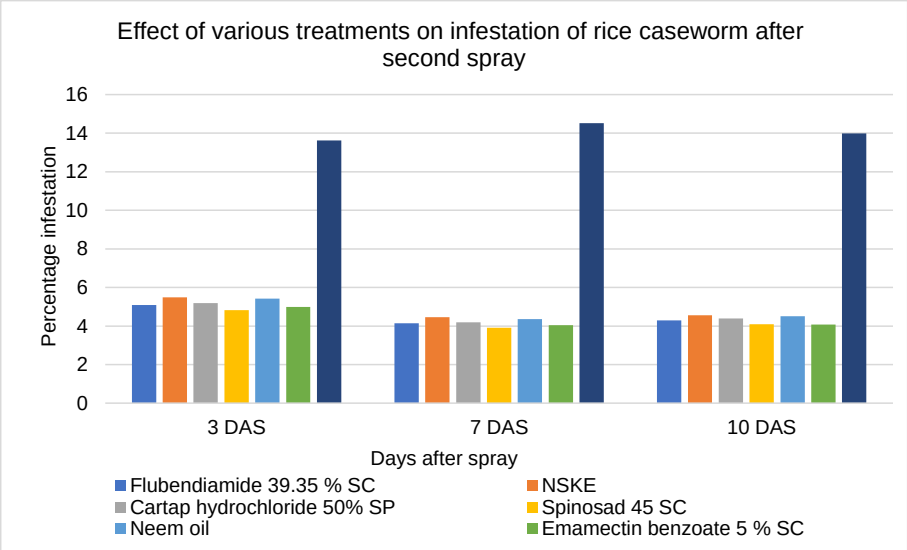

Figure 2 Effect of various treatments on infestation of rice caseworm after second spray.

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

No.	Treatment	Dose g/ lit 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	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	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

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 50.24 to 59.61 q per ha. in contrast to the untreated plot, which produced the lowest fruit yield of 45.31 q per ha. The significantly higher grain yield (59.61 q per ha) was obtained in Spinosad 45 SC treated plots which are followed by ~~Emamectin~~ emamectin benzoate ~~5% SC~~ (57.14 q per ha), ~~Flubendiamide~~ flubendiamide ~~39.35 % SC~~ (56.21 q per ha), ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (55.08 q per ha), ~~Neem~~ neem oil (51.26 q per ha) and NSKE 5 % (50.24 q per ha) (Table 4 & Figure 3). The significantly higher percentage increase in yield over control (31.56 %) was obtained in ~~Spinosad~~ spinosad ~~45 SC~~= treated plots which are followed by ~~Emamectin~~ emamectin benzoate ~~5% SC~~ (26.11 %), ~~Flubendiamide~~ flubendiamide ~~39.35 % SC~~ (24.06 %), ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (21.56 %), ~~Neem~~ neem oil (13.13 %) and NSKE 5 % (10.88 %) (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~~ spinosad ~~45 S C~~ - (11.77) followed by ~~Emamectin~~ emamectin benzoate ~~5% SC~~ (11.53), followed by ~~Cartap~~ cartap hydrochloride ~~50% SP~~ (7.09), Chlorantraniliprole 18.5% SC (8.34), NSKE (5.24), ~~Neem~~ neem oil (3.69), ~~Flubendiamide~~ flubendiamide 39.35 ~~% SC~~ (3.55). The highest B: C ratio of ~~Spinosad~~ spinosad ~~45 SC~~ may be due to its low price and dose concentration.

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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	56.21	24.06
2	NSKE	50.24	10.88
3	Cartap hydrochloride 50% SP	55.08	21.56
4	Spinosad 45 SC	59.61	31.56
5	Neem oil	51.26	13.13
6	Emamectin benzoate 5 % SC	57.14	26.11
7	Control	45.31	~~0.00~~ -

Table 5. Economics of different insecticides against rice caseworm.

No.	Treatment	Yield(q/ha)	Insecticide Cost	Total cost of Plant Protection	Gross Income	Net Income	Benefit over control	B:C
1	Flubendiamide 39.35 % SC	56.21	4110	5010	117478.9	112468.9	17771	3.55
2	NSKE	50.24	750	1650	105001.6	103351.6	8653.7	5.24
3	Cartap hydrochloride 50% SP	55.08	1625	2525	115117.2	112592.2	17894.3	7.09
4	Spinosad 45 SC	59.61	1440	2340	124584.9	122244.9	27547	11.77
5	Neem oil	51.26	1750	2650	107133.4	104483.4	9785.5	3.69
6	Emamectin benzoate 5 % SC	57.14	1073	1973	119422.6	117449.6	22751.7	11.53
7	Control	45.31	-	-	94697.9	94697.9	-	-

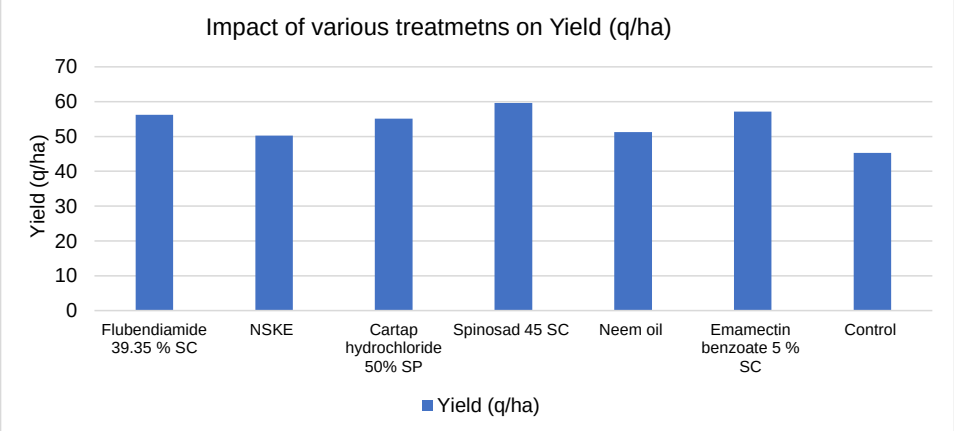

Figure 3. Impact of various treatments on Yield (q/ha)

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

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lowest infestation. The second-best treatment was Emamectin benzoate 5% SC, followed by Flubendiamide 39.35 % SC, Cartap hydrochloride 50% SP, Neem oil, NSKE. The significantly higher grain yield (59.61 q per ha) was obtained in Spinosad 45 SC treated plots which are followed by Emamectin benzoate 5% SC (57.14 q per ha), Flubendiamide 39.35 % SC (56.21 q per ha), Cartap hydrochloride 50% SP (55.08 q per ha), Neem oil (51.26 q per ha) and NSKE 5 % (50.24 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 (11.77) followed by Emamectin benzoate 5% SC (11.53), followed by Cartap hydrochloride 50% SP (7.09), Chlorantraniliprole 18.5% SC (8.34), NSKE (5.24) Neem oil (3.69), Flubendiamide 39.35 % SC (3.55).

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