The Pharma Innovation Journal 2023; SP-12(7): 1577-1581

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(7): 1577-1581

www.thepharmajournal.com
Received: 25-04-2023
Accepted: 27-05-2023

Swati Sharma
Department of Entomology, IGKV, Raipur, Chhattisgarh, India

Neelkamal Patel
Department of Entomology, IGKV, Raipur, Chhattisgarh, India

Ashish Kumar Sharma
Department of Entomology, IGKV, Raipur, Chhattisgarh, India

Corresponding Author:
Swati Sharma
Department of Entomology, IGKV, Raipur, Chhattisgarh, India

Comparative efficacy of different insecticides alone and in combination with neem oil against diamondback moth, *Plutella xylostella* (Linn.) on cabbage

Swati Sharma, Neelkamal Patel and Ashish Kumar Sharma

Abstract
In a discipline study conducted at BTCCARS, Bilaspur (C.G.), various pesticides were assessed alone and in combination with neem oil against diamondback moth *(Plutella xylostella*) infestation on cabbage during 2022-23. The pesticides evaluated were spinosad 2.5% SC + neem oil, spinosad 2.5% SC, indoxacarb 14.5% SC + neem oil, indoxacarb 14.5% SC, flubendamide 39.35% SC + neem oil, flubendamide 39.35% SC, emamectin benzoate 5% SG + neem oil, and emamectin benzoate 5% SG. Comparative effects of these treatments were examined to identify effective strategies for diamondback moth control.

Keywords: Efficacy, *Plutella xylostella*, insecticides, *Azadiracta indica*

Introduction
Vegetables hold a pivotal role in achieving dietary balance, offering not just energy but also crucial protective nutrients like minerals and vitamins. Their nutrient density, short growth cycle, high productivity, economic viability, and ability to create employment make them indispensable for food and nutrition security. In India, vegetables thrive under diverse agroclimatic conditions, and among them, cruciferous varieties like cabbage and cauliflower shine for their nutritional and economic value to both producers and consumers. Cabbage (Brassica oleracea var. capitata Linn.) is a prominent leafy vegetable cultivated commercially across India, originating from the Mediterranean region. Its edible, enlarged terminal buds, known as heads, make cabbage a highly sought-after dietary staple globally.

India's vegetable production ranks second globally, with cabbage occupying a significant portion across approximately 4.03 lakh hectares. The country's impressive annual cabbage production of 93.69 lakh metric tonnes in 2019-20 faces formidable challenges due to various pests. The diamondback moth (*Plutella xylostella*), cabbage butterfly (*Pieris brassica*), cabbage aphid (*Brevicoryne brassica*), leaf webber (*Crocidolomia binotalis*), cabbage cutworm (*Spodoptera litura*), painted bug (*Bagrada cruciferarum*), head-eating caterpillar (*Helicoverpa armigera*), and mustard sawfly (*Athalic aproxima*) pose serious threats to cabbage crops. Among these pests, the diamondback moth stands out as a cosmopolitan pest, widely distributed worldwide and being a significant concern for cabbage growers. Addressing the destructive impact of the diamondback moth remains a vital aspect of safeguarding India's flourishing cabbage production.

In India, the diamondback moth (*Plutella xylostella*) inflicts severe damage on cruciferous vegetables, with potential yield losses reaching a staggering 90% (Verkerk and Wright, 1996) [8]. First reported in 1914, this cosmopolitan pest now prevails throughout the country, causing a 50-80% annual decrease in marketable yield, and under severe infestations, losses could exceed 80% (Devjani *et al*., 1999; Chelliah and Srinivasan, 1986) [4, 3]. The diamondback moth's migratory nature poses a significant challenge, particularly in areas with frequent insecticide usage, where it quickly develops resistance to many new chemicals (Kalra *et al*., 1997) [6]. In India, controlling the diamondback moth (P. *xylostella*) with traditional synthetic pesticides poses significant challenges due to high costs and insecticidal risks. The pest's rapid development and reproductive potential further complicate management. To tackle this issue, researchers conducted an experiment evaluating the bio-effectiveness of newly produced insecticides, either alone or in combination with botanicals. The goal is to identify effective and sustainable strategies for managing this destructive pest, ensuring the protection of cabbage crops, and promoting environmentally friendly pest management practices.

Methods and Materials

In the heart of India's vibrant tropical zone lies Bilaspur, where the Rabi season of 2022-2023 witnessed an innovative experiment at the esteemed Barrister Thakur Chhedilal University of Agriculture and Research Station. As a sub-university of the renowned Indira Gandhi Krishi Vishwavidyalaya, Raipur, Bilaspur thrived at the geographical coordinates of 21°47' and 23°8' north latitude, and 81°14' and 83°15' east longitude, elevating 263 meters above sea level. Embracing the essence of the dry subtropical zone, the experiment adopted a randomized block design with ten treatments, unveiling the secrets of the fertile lands with fervor and precision.

Table 1: Details of insecticidal treatments

S.N.	Treatments	Dose	Concentration
1.	Neem Oil (Azadirachtin 10000ppm)	3 ml./l.	0.03%
2.	Spinosad 2.5% SC	1.2 ml./l.	0.12%
3.	Spinosad 2.5% SC +Neem Oil	0.6 ml/l.+3 ml./l.	0.06+0.03%
4.	Indoxacarb 14.5 % SC	0.5 ml /l	0.05%
5.	Indoxacarb 14.5 % SC + Neem Oil	0.25 ml /l+3 ml./l.	0.025+0.03%
6.	Flubendamide 39.35 % SC	0.1 ml /l	0.01%
7.	Flubendamide 39.35 % SC + Neem Oil	0.05 ml /l+3 ml./l.	0.005+0.03%
8.	Emamectin benzoate 5% SG	0.36 ml /l	0.036%
9.	Emamectin benzoate 5 % SG + Neem Oil	0.18 ml./l+3 ml./l	0.018+0.03%
10.	Control (plain water)		

In pursuit of assessing insecticide effectiveness against the diamondback moth, the experiment captured photographs of five randomly chosen plants per plot before and at 3, 7, and 14 days after application. The square root transformation was applied to the pre- and post-treatment data, and statistical analyses followed a randomized block design using the Gomez and Gomez (1984) formula. The results were meticulously interpreted, shedding light on the relative bioefficacy of the various insecticides, aiding in the battle against this destructive pest.

Results and Discussions

In the Rabbi period of 2022-2023, field trials were conducted to evaluate the bio efficacy of various insecticides on diamondback moth populations at different time intervals. Two insecticide sprays were applied during the season. Larval populations were assessed on 5 randomly chosen plants per plot, one day before insecticide application as pre-treatment observation, and 3, 7, and 14 days after application as post-treatment observation.

Table 2: Comparative efficacy of different insecticides alone and in combination with neem oil against diamondback moth, *Plutella xylostella* (Linn.) on cabbage during *rabi*, 2022-23after first spray.

S. no.	Treatments	Dose	*Mean larval population of *P. xylostella* per plant: Pretreatment population	Posttreatment population: 3rd DAS	7th DAS	14th DAS	Overall mean	Percent reduction over control	Percent reduction over pre-treatment
T_1	Neem oil	3 ml./l.	7.56 (2.96)	6.25 (2.70)	6.96 (2.82)	8.23 (3.04)	7.15 (2.85)	21.34	5.42
T_2	Spinosad 2.5% SC	1.2 ml./l.	8.12 (3.03)	1.80 (1.67)	2.20 (1.79)	2.89 (1.97)	2.29 (1.81)	74.81	71.80
T_3	Spinosad 2.5% SC+Neem oil	0.6 ml/l.+3 ml./l.	7.89 (2.96)	1.50 (1.58)	1.89 (1.70)	2.50 (1.87)	1.97 (1.72)	78.33	75.03
T_4	Indoxacarb14.5%SC	0.5 ml /l	8.56 (3.01)	4.45 (2.34)	4.95 (2.44)	6.80 (2.79)	5.41 (2.52)	40.48	36.80
T_5	Indoxacarb 14.5% SC+Neem oil	0.25 ml/l+3 ml./l.	8.45 (3.03)	4.23 (2.29)	4.76 (2.40)	6.20 (2.68)	5.06 (2.46)	44.33	40.12
T_6	Flubendamide 39.35% SC	0.1 ml/l	8.98 (3.03)	2.50 (1.87)	3.02 (2.00)	4.53 (2.35)	3.35 (2.08)	63.15	62.69
T_7	Flubendamide 39.35% SC +Neem oil	0.05 ml/l+3 ml./l.	7.85 (2.98)	2.20 (1.79)	2.79 (1.94)	4.20 (2.30)	3.08 (2.01)	66.12	60.76
T_8	Emamectin Benzoate 5% SG	0.36 gm /l	8.26 (3.04)	3.60 (2.15)	4.0 (2.23)	5.80 (2.60)	4.46 (2.33)	50.94	46.00
T_9	Emamectin benzoate 5% SG+Neem oil	0.18 gm./l+3 ml./l	7.56 (2.96)	3.20 (2.05)	3.80 (2.19)	5.30 (2.52)	4.12 (2.25)	54.68	45.50
T_{10}	Control		7.58 (2.96)	8.20 (3.04)	8.80 (3.13)	10.23 (3.36)	9.09 (3.17)	-	-
S.Em.±		-	0.038	0.036	0.052	0.06	0.041		
CDat5%		-	NS	NS	0.157	0.181	0.123		

*Mean of three replications, Figures in parentheses are square root transformed values, DAS=days after spraying

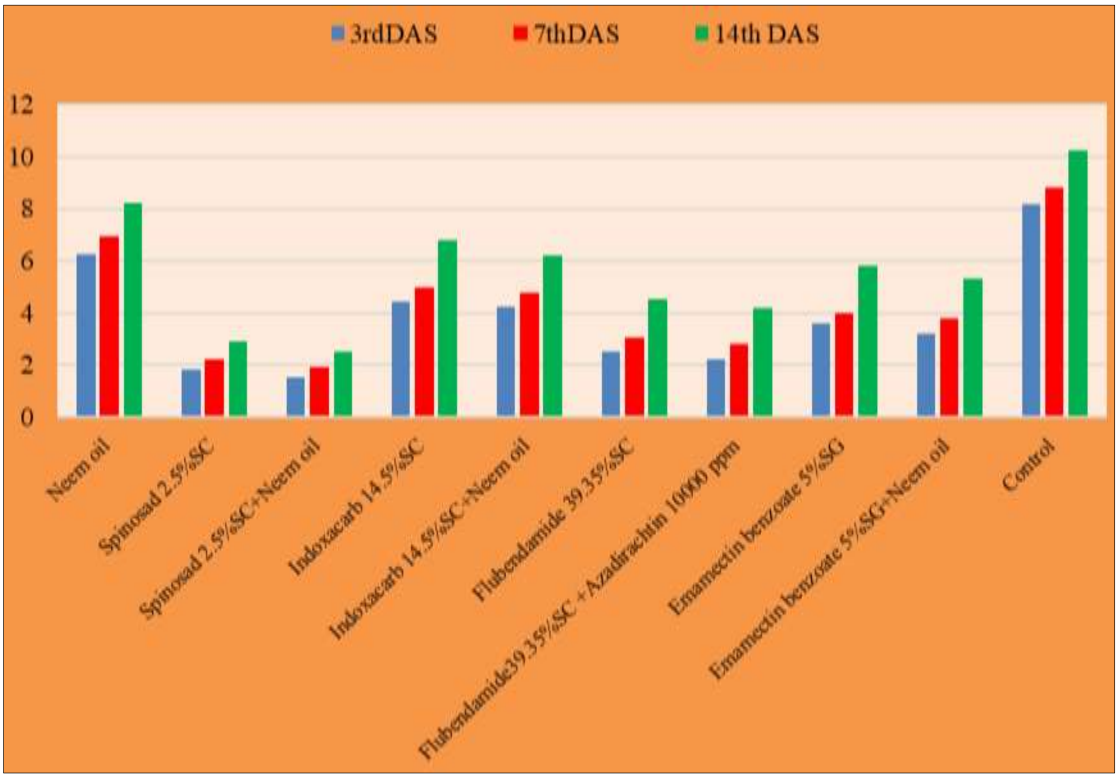

Fig 1: Relative efficacy of different insecticide against DBM after first spray2022-23.

Pre-Treatment Observation

Diamondback moth larval numbers in pretreatment showed minimal variation, ranging from 7.56 to 7.58 larvae/plant across different treatments, including the control. The non-significant differences suggest a uniform distribution of pest populations.

Post-treatment observation

During the study, table 2 shows the larval populations of the diamondback moth were observed 3, 7, and 14 days after insecticide spraying. Notably, three days after application, all treatments displayed significant reduction in diamondback moth larvae compared to the untreated control. Treatment T_3, comprising spinosad 2.5% SC and neem oil, exhibited the lowest larval populations (1.50 larvae/plant), on par with T_2 containing spinosad 2.5% SC (1.80 larvae/plant). T_7 with flubendamide 39.35% SC and neem oil had the next lowest population (2.20 larvae/plant), while T_6 with flubendamide 39.35% SC displayed 4.23 larvae per plant.

Following the seven-day mark, larval populations varied across treatments, ranging from 1.89 to 8.80 larvae per plant. The smallest population was observed at T_3 (spinosad 2.5% SC + neem oil), comparable to T_2 (spinosad 2.5% SC) with an average of 1.80 larvae per plant. Other treatments, like T_7 (flubendamide 39.35% SC + neem oil), T_6 (flubendamide 39.35% SC), T_9 (Emamectin benzoate 5% SG + neem oil), T8 (Emamectin benzoate 5% SG), and T_5 (indoxacarb 14.5% SC + neem oil), displayed larval populations ranging from 2.79 to 30.2 larvae per plant. T_1 (neem oil) had the highest larval population with an average of 6.25 larvae per plant, followed by T_4 (indoxacarb 14.5% SC) with 4.45 larvae per plant, and 8.20 larvae per plant in the untreated control.

During the observation period, Treatment 1 (neem oil) exhibited the highest larval population with 6.96 larvae per plant, closely followed by Treatment 4 (indoxacarb 14.5% SC) with 4.95 larvae per plant. The untreated control had a significant count of 8.80 larvae per plant. After two weeks, varying larval populations ranging from 2.50 to 10.23 larvae per plant were recorded across treatments. Treatment 3 (Spinosad 2.5% SC + neem oil) emerged as the most effective remedy with 2.50 larvae per plant. Treatment 2 (spinosad 2.5% SC) displayed comparable efficacy at 2.89 larvae per plant. Other treatments, including T_7 (flubendamide 39.35% SC + neem oil) with 4.20 larvae/plant, T_6 (flubendamide 39.35% SC) with 4.53 larvae/plant, T_9 (Emamectin benzoate 5% SG + neem oil) with 5.30 larvae/plant, T_8 (Emamectin benzoate 5% SG) with 5.80 larvae/plant, and T_5 (indoxacarb 14.5% SC + neem oil) with 6.20 larvae/plant, also exhibited notable larval populations. Notably, the highest larval populations were observed in Treatment 1 when neem oil was combined with indoxacarb 14.5% SC, recording 8.23 larvae per plant. Treatment 4 displayed 6.80 larvae per plant compared to 10.23 larvae per plant in the untreated control.

Over all mean population of *Plutella xylostella*

The first spraying revealed varying effectiveness among treatments in managing diamondback moth populations. The lowest mean larval population was observed in spinosad 2.5% SC + neem oil treatment (1.97 larvae/plant), followed by spinosad 2.5% SC (2.29 larvae/plant), flubendamide 39.35% SC + neem oil (3.08 larvae/plant), flubendamide 39.35% SC (3.35 larvae/plant), Emamectin benzoate 5% SG + neem oil (4.12 larvae/plant), Emamectin benzoate 5% SG (4.46 larvae/plant), and Indoxacarb 14.5% SC + neem oil (5.06 larvae/plant). Neem oil displayed the highest mean larval population (7.15 larvae/plant), followed by indoxacarb 14.5% SC (5.41 larvae/plant). The untreated control recorded a mean larval population of 9.09 larvae/plant.

Percent Reduction Over Control

The efficacy of different insecticide treatments against diamondback moth larval infestation was evaluated. The order of efficacy was based on the percentage reduction compared to the control at the first spray. The treatment with the highest percentage reduction over the control was Spinosad 2.5% SC + Neem oil (78.33%). This was followed by spinosad 2.5% SC (74.81%), flubendamide 39.35% SC + neem oil (66.12%), flubendamide 39.35% SC (63.15%), emamectin benzoate 5% SG + neem oil (54.68%), Emamectin benzoate 5% SG (50.94%), Indoxacarb 14.5% SC + Neem oil (44.33%), Indoxacarb 14.5% SC (40.48%), and Neem oil (21.34%). These data are shown in Table 2.

Percent reduction over pre-treatment

The insecticide treatments' effectiveness was ranked based on the percentage reduction of first spray compared to the pretreatment for diamondback moth larval infestation. Neem oil (75.03%) combined with spinosad 2.5% SC (T_2) demonstrated the highest reduction, followed by spinosad 2.5% SC alone (71.80%) and flubendamide 39.35% SC + neem oil (T_7) with 60.76% reduction. Emamectin benzoate 5% SG + neem oil (T_9) showed a reduction of 45.50%, while indoxacarb 14.5% SC + neem oil (T_5) and indoxacarb 14.5% SC (T_4) had 40.12% and 36.80% reductions, respectively. Flubendamide 39.35% SC (T_6) exhibited 62.69% reduction, and emamectin benzoate 5% SG (T_8) with neem oil recorded 5.42% reduction. (Table 2) presents these data, guiding the selection of effective insecticide treatments to combat diamondback moth infestations.

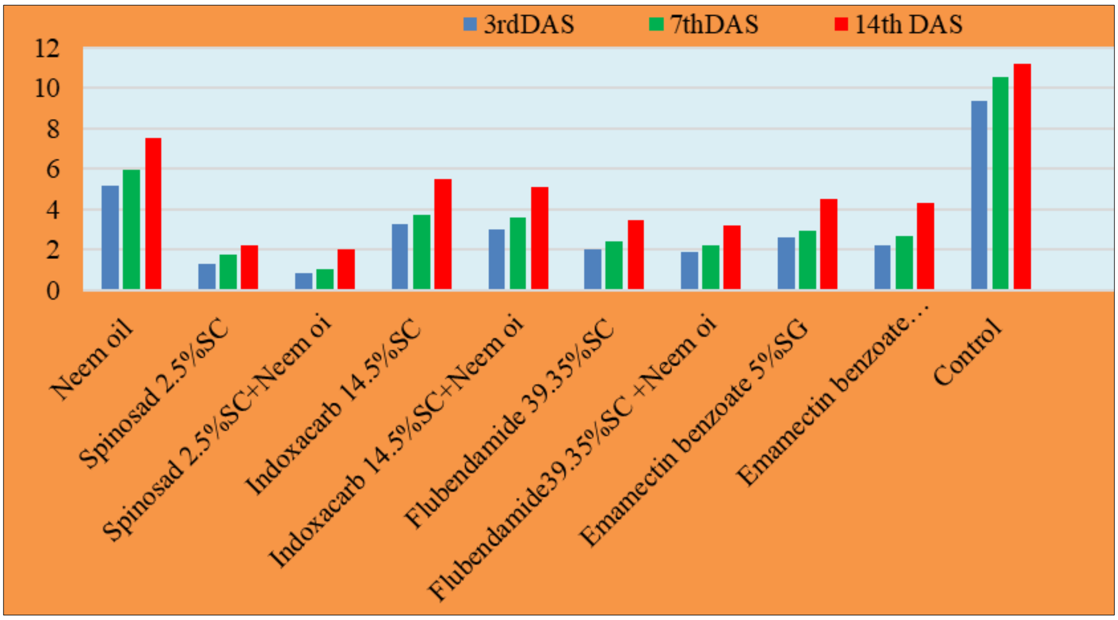

Fig 2: Relative efficacy of different insecticide against DBM after second spray 2022-23

Table 3: Comparative efficacy of different insecticides alone and in combination with neem oil against diamondback moth, *Plutella xylostella* (Linn.) on cabbage during *rabi season* 2022-23 after second spray.

*Meanlarval Population of *P. Xylostella* perplant								Percent reduction over control	Percent reduction over pretreatment
				Posttreatment population					
S. no.	Treatments	Dose	Pretreatment population	3rdDAS	7thDAS	14thDAS	Over all mean		
T_1	Neem oil	3 ml./l.	9.23 (3.20)	5.20 (2.49)	5.94 (2.63)	7.52 (2.92)	6.21 (2.68)	40.29	32.72
T_2	Spinosad 2.5% SC	1.2 ml./l.	9.20 (3.20)	1.30 (1.51)	1.80 (1.67)	2.20 (1.79)	1.77 (1.66)	82.98	80.76
T_3	Spinosad 2.5% SC+ Neem oil	0.6 ml/l.+3 ml./l.	9.10 (3.19)	.85 (1.36)	1.02 (1.41)	2.02 (1.75)	1.30 (1.51)	87.50	85.71
T_4	Indoxacarb14.5% SC	0.5 ml /l	8.25 (3.12)	3.25 (2.06)	3.75 (2.18)	5.50 (2.55)	4.17 (2.26)	59.90	49.45
T_5	Indoxacarb 14.5% SC+ Neem oil	0.25 ml /l+3 ml./l.	8.36 (3.13)	3.02 (2.02)	3.60 (2.14)	5.10 (2.47)	3.93 (2.21)	62.21	52.99
T_6	Flubendamide 39.35% SC	0.1 ml /l	9.45 (3.19)	2.03 (1.76)	2.45 (1.86)	3.50 (2.12)	2.68 (1.91)	74.23	71.64
T_7	Flubendamide 39.35% SC +Neem oil	0.05 ml /l+3 ml./l.	9.58 (3.21)	1.87 (1.70)	2.20 (1.80)	3.20 (2.05)	2.44 (1.85)	76.54	74.53
T_8	Emamectin Benzoate 5% SG	0.36 gm /l	9.45 (3.19)	2.60 (1.90)	2.96 (1.99)	4.50 (2.35)	3.36 (2.08)	67.69	64.44
T_9	Emamectin benzoate 5% SG+ Neem oil	0.18 gm./l+3 ml./l	9.32 (3.21)	2.20 (1.79)	2.70 (1.920	4.30 (2.30)	3.07 (2.01)	70.48	67.06
T_{10}	Control		8.78 (3.15)	9.36 (3.22)	10.58 (1.92)	11.20 (3.49)	10.40 (3.37)	-	-
S.Em.±			0.057	0.033	0.053	0.050	0.047		
CDat 5%			NS	NS	0.157	0.150	0.140		

*Mean of three replications, Figures in parentheses are square root transformed values, DAS=days after spraying

Pretreatment Observation

In the pre- treatment observation, the larval population ranged from 8.25 to 9.58 larva/plant among different treatments and it was found statistically non-significant.

Post Treatment Observation

After three days of spraying, the cabbage plants displayed varying larval populations, ranging from 0.85 to 9.36 larvae per plant, depending on the treatment. Spinosad 2.5% SC + neem oil treatment (T_2) exhibited the lowest larval population (0.85 larvae/plant), comparable to Spinosad 2.5% SC treatment (T_3) with 1.30 larvae/plant. Other treatments like Emamectin benzoate 5% SG + neem oil (T_9) with 2.20 larvae/plant, Emamectin benzoate 5% SG (T_8) with 2.60 larvae/plant, Flubendamide 39.35% SC + neem oil (T_7) with 2.03 larvae/plant, and Indoxacarb 14.5% SC + neem oil (T_5) with 3.02 larvae/plant showed relatively low larval populations. In contrast, T_1 neem oil had the largest larval population (5.20 larvae/plant), followed by T_4 indoxacarb 14.5% SC with 3.25 larvae/plant, while the untreated control had 9.36 larvae/plant. After seven days, significant reduction in diamondback moth larvae was observed at T_3 (Spinosad 2.5% SC + neem oil) with 1.02 larvae/plant, similar to T_2 (Spinosad 2.5% SC) with 1.80 larvae/plant. T_6 (Flubendamide 39.35% SC) recorded 2.45 larvae/plant, followed by T_7 (Flubendamide 39.35% SC + neem oil) with 2.20 larvae/plant. T_5 (Indoxacarb 14.5% SC + neem oil) had 3.60 larvae/plant, while T_8 (*Emamectin benzoate* 5% SG) and T_9 (Emamectin benzoate 5% SG + neem oil) exhibited 2.70 larvae/plant.

The highest larval populations were observed at T_1, one day after spraying, with H. neem oil treatment having 5.94 larvae/plant, followed by T_4 with H. indoxacarb 14.5% SC having 3.75 larvae/plant, outperforming the untreated control with 10.58 larvae/plant. Similarly, after 14 days of the second spraying, larval densities ranged from 2.02 to 11.20 per plant. T_3 (spinosad 2.5% SC + neem oil) with 2.02 larvae/plant and T_2 (spinosad 2.5% SC) with 2.20 larvae/plant were determined to be the most successful treatments. T_7 (flubendamide 39.35% SC + neem oil) with 3.20 larvae/plant, T_6 (flubendamide 39.35% SC) with 3.50 larvae/plant, T9 (emamectin benzoate 5% SG + neem oil) with 3.80 larvae/plant, and T_5 (indoxacarb 14.5% SC + neem oil) with 5.10 larvae/plant were the subsequent treatments. T_1 with H. neem oil had the highest larval occurrence with 7.52 larvae/plant, followed by T_4 with H. indoxacarb 14.5% SC (5.50 larvae/plant), outperforming the untreated control (11.20 larvae/plant).

Over all mean populations of *Plutella xylostella* (Linn.)

During the second spray, the average larval population revealed that T_3 (Spinosad 2.5% SC + Neem oil) had the fewest larvae (1.30/plant), showing lower efficacy compared to other pesticide treatments. T_7 (Flubendamide 39.35% SC + Neem oil) had 2.44 larvae/plant, T_2 (Spinosad 2.5% SC) had 1.77 larvae/plant, T_5 (Indoxacarb 14.5% SC + Neem oil) had 3.93 larvae/plant, T_9 (Emamectin benzoate 5% SG + Neem oil) and T_6 (Flubendamide 39.35% SC) both had 2.68 larvae/plant. T1 had the highest larval population (6.21/plant), followed by T4 with indoxacarb 14.5% SC (4.17/plant), while the untreated control had 10.40 larvae/plant.

Percent Reduction Over Control

Table 3 ranks the effectiveness of pesticides in preventing and reducing diamondback moth larval infestation after the second spray. H. spinosad 2.5% SC + neem oil demonstrated the highest efficacy with a rate of 85.71%, followed by H. spinosad 2.5% SC at 80.76%. Flubendamide 39.35% SC + neem oil (74.53%) and Flubendamide 39.35% SC (71.64%) were also effective in reducing larval infestation. Emamectin benzoate 5% SG + neem oil (T_9) and H. neem oil (T_1) exhibited significant reductions as well.

Conclusion

In light of *Plutella xylostella's* resistance to novel pesticides, the use of a synergistic combination of neem oil and new pesticides holds promise to enhance efficacy in controlling this destructive insect. This approach not only provides effective control for cruciferous crops but also offers economic benefits and minimizes the risk of resistance development.

References

1. Anonymous. Statistics: Area and production statistics national Horticulture Board; c2021. www.http://nhb.gov.in/ database2021.
2. Begna F, Damtew T. Evaluation of four botanical insecticides against diamondback moth, *Plutella xylostella* L. (Lapidoptera: Plutellidae) on head cabbage in the central rift valley of Ethiopia. Sky journal of Agriculture Research. 2015;4(5): 97-105.
3. Chelliah S, Srinivasan K. In: Diamondback moth management. (Talekar, N.S and Griggs, T.D., eds.): Proceedings of the First International Workshop, 1985, AVRDC, Taiwan; c1986. p. 63-76.
4. Devjani P, Singh TK. field density and biology of diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) on cauliflower in Manipur. J. Adv. Zool. (Fide: A.A.U. CAB abstracts-1990-20\O, ovidsp. tx. ovid. com). 1999;20(I):53-55.
5. Fletcher TB. Some South Indian Insects. Superintd. Govt. Press, Madras. Acad. Sci., USA. 1914;88:5119-5123.
6. Kalra VK, Sharma SS, Chauhan R, Bhanot JP. Shift in the level of resistance together with relative toxicity of some commonly used and important insecticides to diamondback moth, *Plutella xylostella* L. in Haryana. J Entomol. 1997;21:351-354.
7. Meena KA. Bio-efficacy of some newer insecticides against insect pests of cabbage. Journal of Entomology and Zoology Studies. 2018;6(5):1102-1106.
8. Verkerk RH, Wright DJ. Multitrophic interactions and management of the diamondback moth: a review bulletin of Entomological Research. 1996;86(3):205-2016.