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Evaluating the Efficacy of Selected Insecticides on Diamondback Moth (*Plutella xylostella*) Damaging Cabbage (*Brassica oleracea*)

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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

A field investigation was carried out in *Rabi* season of 2022-2023 at the Central Research Farm (CRF), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India to evaluate the efficacy of some selected pesticides on controlling diamondback moth that causes yield loss of cabbage. The experiment was laid in Randomized Block Design (RBD) with eight treatments each replicated thrice using a single variety Green Soccer. The treatments *viz.* NSKE 5% @50 ml/L, Spinosad 45% SC @0.35 ml/L, Emamectin Benzoate 5% SG

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@0.5 g/L, Neem oil 5% @50 ml/L, Dimethoate 30% EC @1 ml/L, Indoxacarb 14.5% SC @ 0.5 g/L, Cartap Hydrochloride 50% SP @0.5ml/L, and along with an untreated control was used against *Plutella xylostella* in Cabbage. The overall mean data on larval population of diamond back moth over control on first and second spray revealed that all treatments were significantly superior over control. Among all the treatments Spinosad 45% SC showed the lowest mean larval population (2.04%), (0.93%) followed by Emamectin benzoate 5% SG (2.22%) (1.06%), Indoxacarb 14.5% SC (2.66%) (1.37%), Cartap Hydrochloride 50% SP (3.20%) (1.86%), Dimethoate 30% EC (3.48%) (2.02 %), and NSKE 5% (4.08 %) (2.33 %), Neem oil 5% (3.82 %), (2.37 %) and highest population was recorded in control (8.13%), (7.73%). The highest yield and cost benefit ratio recorded in Spinosad 45% SC (296 q/ha) (1:5.7) followed by Emamectin benzoate 5% SG (264 q/ha) (1:6.2), Indoxacarb 14.5% SC (249 q/ha) (1:5.0), Cartap Hydrochloride 50% SP (215 q/ha) (1:4.8) followed by Dimethoate 30% EC (194 q/ha) (1:4.4), Neem oil 5% (178 q/ha), (1:3.9) and NSKE 5% (170 q/ha) (1:3.8) and control (102 q/ha) (1:2.5). The information obtained in this study has the potential application for controlling diamondback moth and will be useful to the farmers and researchers.

Keywords: Cabbage; efficacy; emamectin benzoate; indoxacarb; Plutella xylostella; spinosad.

1. INTRODUCTION

“Following cauliflower in importance, cabbage is the second most important crop that originated in Europe and the Mediterranean area. In India, cabbage is one of the most widely consumed winter veggies. *Brassica oleracea var capitata L*. is the Latin name for cabbage in vegetation.Following cauliflower in importance, cabbage is the second most important crop that originated in Europe and the Mediterranean area. In India, cabbage is one of the most widely consumed winter veggies. *Brassica oleracea var capitata L*. is the Latin name for cabbage in vegetation” [1].

The word "caboche," which in French refers to the vegetable's circular appearance, is where the English word "cabbage" originates. Wounds and sores were covered with cabbage leaves. It is claimed to be beneficial for those with diabetes and to aid with dyspepsia [2].

“Widespread usage of cabbage in traditional medicine includes treating minor cuts and wounds, mastitis, and symptoms related to gastrointestinal disorders (peptic and duodenal ulcers, gastritis, irritable bowel syndrome)” [3].

Bowel cancer is prevented by cabbage because it contains indole-3-carbinol, which has anti-cancer properties. According to Kumar and Kumar [4], this plant is recognised for its therapeutic qualities and has larger terminal buds that are a great source of calcium, phosphorus, sodium, potassium, sulphur, vitamin C, and dietary fibre. “In 100 grammes of cabbage, there are 25 grammes of calories, 0 grammes of fat, 18 mg of sodium, 0 mg of cholesterol, 170 grammes of potassium, 6 grammes of carbohydrates, 1.3 grammes of protein, 1% of vitamin A, 60% of vitamin C, 4% of calcium, 2% of iron, 5% of vitamin B6, and 3% of potassium” [5]

With a production share of 25.32 percent, West Bengal leads India in the production of cabbage globally with 2288.50 tonnes, followed by Orissa with 1058.78 tonnes, Madhya Pradesh with 686.91 tonnes, Bihar with 673.44 tonnes, and Uttar Pradesh with 302.97 tonnes [6].

“The insect-pests *viz*., diamond back moth (*Plutella xylostella* Linnaeus), cabbage butterfly (*Pierisbrassicae* Linnaeus), tobacco caterpillar (*Spodoptera litura* Fabricius), cabbage semilooper (*Trichoplusia ni* Hubner), aphid (*Brevicoryne brassicae* Linnaeus), painted bug (*Bagrada cruciferarum* Kirkaldy), cabbage leaf webber (*Crocidolomia binotalis* Zeller), cabbage head borer (*Hellula undalis* Fabricius), cabbage flea beetle (*Phyllotreta cruciferae* Goeze) and Bihar hairy caterpillar (*Spilosoma obliqua* Walk) are frequently found on cabbage during various seasons and result in significant losses” [7].

“There is a two- to four-day range for the egg period (incubation time). The larva went through four distinct stages of development. With a total larval period of 7 to 12 days, the first, second, third, and fourth instar larvae lived for 2 to 3 days, 2 days, 1 to 3 days, and 2 to 4 days, respectively. One to two days and three to five days, respectively, were spent in the pre-pupal and pupal stages. Under laboratory conditions, the adults' lifespan ranged from 3 to 7 days, while the overall duration varied between 13 and 22 days” [8]. Estimated that the diamond back moth caused losses in commercial output of

almost 52%. In the event of a significant diamondback moth infestation on cabbage, losses could exceed 80%. According to [4] cabbage semiloopers caused 70.63 percent of the damage, with yield losses of up to 64–78 percent. *H. undalis* is a pest that causes havoc with cauliflower and cabbage. It is available all over India and around the world. Usually, reports of it concern mustard, radish, cauliflower, cabbage, and turnips.

2. MATERIALS AND METHODS

The experiment was conducted during *Rabi* season 2022-23 at the Central Research Farm (CRF) of Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, Uttar Pradesh, India, in a Randomized Block Design with eight treatments replicated three times using a local variety in a plot size of (2m×1m) at a spacing of (45×30 cm) with a recommended package of practices excluding plant protection. The soil of the experimental site was well drained and medium high. The treatments used in this experiment were *viz.,* NSKE 5% (50 ml/lit), Spinosad 45% SC (0.35 ml/lit), Emamectin benzoate 5% SG (0.5 g/lit), Neem oil 5% (50 ml/lit), Dimethoate 30% EC (1 ml/lit), Indoxacarb 14.5% SC (0.5 g/lit), cartap hydrochloride 50% SP (0.5 ml/lit) and control. These treatments were applied in two sprays at a 15 days interval.

Five plants from each plot were randomly chosen and tagged to record the caterpillar population. Subsequently, the average of three replications was determined for every treatment, and the untreated plot underwent the same process. One day prior to spraying, as well as three, seven, and fourteen days following the application of insecticidal treatment, the *Plutella xylostella* population was measured**.**

2.1 Benefit Cost Ratio

Net returns were used to evaluate each treatment's cost-effectiveness. The entire cost of the therapy was subtracted from the gross returns to get the net return for each treatment. Plant protection fees and cultivation are included in the total cost of production.

Gross return = Marketable Yield x Market price
Net return = Gross return – Total cost

$$B{:}\,C\ Ratio\ = \frac{Gross\ return}{Total\ cost\ of\ cultivation} \quad [8]$$

3. RESULTS AND DISCUSSION

Following the first and second sprays, the results (Table 1) showed that every treatment outperformed the control by a significant margin. Data on the larval population of *Plutella xylostella*, the cabbage diamond back moth, after three, seven, and fourteen days following the initial spray showed that all treatments were significantly better than control. Out of all the treatments, the plot treated with Spinosad 45% SC (2.04) recorded least larval population as compared to the remaining treatments followed by Emamectin Benzoate 5% SG (2.22) and Indoxacarb 14.5% SC (2.66). Similarly, Cartap Hydrochloride 50% SP (3.20) recorded larval population followed by Dimethoate 30% EC (3.48), Neem oil 5% (3.82) and NSKE 5% (4.08).

Data on the larval population of *Plutella xylostella*, the cabbage diamond back moth, at three, seven, and fourteen days following the second spray showed that all treatments were significantly better than control.Out of all the treatments, the plot treated with Spinosad 45% SC (0.93) recorded least larval population as compared to the remaining treatments followed by Emamectin Benzoate 5% SG (1.06) and Indoxacarb 14.5% SC (1.37). Similarly, Cartap Hydrochloride 50% SP (1.37), recorded larval population of followed by Dimethoate 30% EC (2.02), NSKE 5% (2.33) and Neem oil 5% (2.37).

There was a notable difference in yields between the various treatments. Every treatment outperformed the control. It was the largest yield ever recorded in Spinosad 45% SC (296 q/ha) followed by Emamectin Benzoate 5% SG (264 q/ha), Indoxacarb 14.5% SC (249 q/ha), Cartap Hydrochloride 50% SP (215 q/ha), Dimethoate 30% EC (194 q/ha), Neem oil 5% (178 q/ha) and NSKE 5% (170 q/ha) as compared to control plot (102 q/ha). When cost benefit ratio was worked out, interesting result was achieved. Among the all treatments studied, the best and most economical treatment was Spinosad 45% SC (1:5.7) followed by Emamectin Benzoate 5% SG (1:6.2), Indoxacarb 14.5% SC (1:5.0), Cartap Hydrochloride 50% SP (1:4.8), Dimethoate 30% EC (1:4.4), Neem oil 5% (1:3.9), NSKE 5% (1:3.8) and, as compared to control plot (1:2.5).

All treatments, with the exception of the untreated control, are equally successful, according to data on the mean larval population of the first and second sprays. The lowest diamond back moth larval population across all

Table 1. Efficacy of selected chemicals and neem oil against Diamond back moth, *Plutella xylostella* on cabbage

S.No	Treatments	Doses	Larval population of *Plutella xylostella*										Yield	C:B ratio
			First spray					Second spray						
			1DBS	3 DAS	7 DAS	14 DAS	Mean	1DBS	3 DAS	7 DAS	14 DAS	Mean		
T_0	Control	____	4.93	8.00^{a}	8.26^{a}	8.13^{a}	8.13^{a}	8.13^{a}	7.53^{a}	7.93^{a}	7.73^{a}	7.73^{a}	102	1:2.5
T_1	NSKE 5%	50ml/L	5.20	4.53^{a}	3.60^{b}	4.13^{b}	4.08^{b}	4.13^{b}	2.66^{bc}	2.00^{b}	2.33^{bc}	2.33^{bc}	170	1:3.8
T_2	Spinosad 45% SC	0.35ml/L	5.00	2.53^{f}	1.73^{e}	1.86^{e}	2.04^{f}	1.86^{e}	1.20^{f}	0.66^{e}	0.93^{f}	0.93^{f}	296	1:5.7
T_3	Emamectin Benzoate 5% SG	0.5g/L	4.80	2.73^{ef}	1.80^{e}	2.13^{e}	2.22^{f}	2.13^{e}	1.33^{f}	0.80^{e}	1.06^{ef}	1.06^{ef}	264	1:6.2
T_4	Neem oil 5%	50ml/L	5.06	4.20^{bc}	3.33^{b}	3.93^{b}	3.82^{bc}	3.93^{b}	2.73^{b}	1.93^{b}	2.46^{b}	2.37^{b}	178	1:3.9
T_5	Dimethoate 30% EC	1ml/L	5.06	3.93^{cd}	3.00^{c}	3.53^{c}	3.48^{cd}	3.53^{c}	2.40^{cd}	1.60^{c}	2.06^{cd}	2.02^{cd}	194	1:4.4
T_6	Indoxacarb 14.5% SC	0.5g/L	4.53	3.00^{e}	2.26^{d}	2.73^{d}	2.66^{e}	2.73^{d}	1.73^{e}	1.06^{d}	1.33^{e}	1.37^{e}	249	1:5.0
T_7	Cartap Hydrochloride 50% SP	0.5ml/L	4.80	3.60^{d}	2.80^{c}	3.20^{c}	3.20^{d}	3.20^{c}	2.26^{d}	1.46^{c}	1.86^{d}	1.86^{d}	215	1:4.8
	F- test	-	NS	S	S	S	S	S	S	S	S	S		
	CD.at 0.05%		-	0.42	0.32	0.37	0.38	0.37	0.29	0.20	0.28	0.35		
	S. Ed. (±)		1.34	0.62	0.89	0.74	0.72	0.74	0.69	0.81	0.52	0.63		

DBS- Day Before Spraying, DAS- Day After Spraying, NS-Non-significant, S-Significant

treatments was found in Spinosad 45% SC (1.48). Similar findings made by Venugopal et al. [9] and Reddy et al. [10]. Emamectin Benzoate 5% SG (1.645) is found to be the next best treatment which is in line with the findings of Sujay et al. [11] and Sharma et al. [12] they reported that Emamectin Benzoate 5% SG (2.023) was found most effective in reducing larval population of diamond back moth as well as increasing the yield. Indoxacarb 14.5% SC (2.534) is found to be the next best treatment which is in line with the findings of Stanikzi and Thakur [13] and Sharma et al. [12]. Cartap Hydrochloride 50% SP (2.756) is found to be the next effective treatment which is in line with the findings of Lal et al. [14] and Bajpai et al. [15]. Dimethoate 30% EC (3.100) is found to be the next effective treatment which is in line with the findings of Thil et al. [16].

The yields among the different treatments were significant. All the treatments were superior over control. The highest yield was recorded in Spinosad 45% SC (296 q/ha) similar findings of Kumar and Kumar [4], Harika et al. [8], followed by Emamectin Benzoate 5% SG (264q/ha), These findings are supported by Stanikzi and Thakur [13], Kommoji and Tayde [17]. Indoxacarb 14.5% SC (249q/ha), similar findings of Gaddam et al. [18].

4. CONCLUSION

The current study's findings demonstrated that Spinosad 45 SC followed by Emamectin benzoate 5 SG, Indoxacarb 14.5 SC, Cartap hydrochloride 50 SP and Dimethoate 30 EC, are the most effective treatments against diamond back moth, *Plutella xylostella* of cabbage and generated the highest yield and the highest Cost-Benefit ratio. NSKE 5% and Neem oil 5% found to be the least effective in controlling the diamondback moth, *Plutella xylostella* in cabbage.

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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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