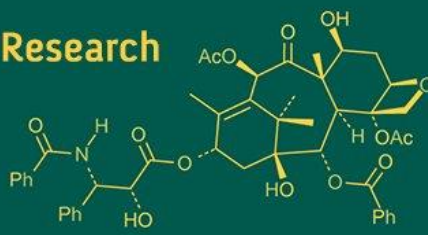


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Evaluation of botanicals and biopesticides against diamondback moth, *Plutella xylostella* (L.) infesting cabbage under western Uttar Pradesh conditions

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Abstract

A field experiment was conducted during Rabi 2025-26 at the Crop Research Centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut, Uttar Pradesh, to evaluate the bio-efficacy of botanicals and biopesticides against the diamondback moth, *Plutella xylostella* (L.) on cabbage. The experiment was laid out in a Randomized Block Design with seven treatments and three replications. Two foliar sprays were applied and larval populations were recorded before spraying and at 3, 7 and 14 days after each application. Among the treatments, Spinosad 45 SC was the most effective, recording the lowest mean larval population (2.44 and 1.50 larvae per five plants) with the highest reduction over control (72.88% and 85.00%) after the first and second sprays, respectively. *Bacillus thuringiensis* var. *kurstaki* ranked second, followed by *Metarhizium anisopliae*, while neem-based treatments and Agniastra were comparatively less effective. The study indicates that Spinosad 45 SC, followed by *Bacillus thuringiensis*, can be effectively incorporated into Integrated Pest Management (IPM) programmes for sustainable management of diamondback moth in cabbage under Western Uttar Pradesh conditions.

Keywords: Cabbage, *Plutella xylostella*, spinosad, *Bacillus thuringiensis*, biopesticides, botanicals, IPM

Introduction

Cabbage (*Brassica oleracea* L. var. *capitata*) is one of the most widely cultivated and economically important vegetable crops worldwide. It is an important leafy vegetable grown extensively in Africa, including Ethiopia, where it serves as both a staple food and a valuable source of income for farmers. Despite its importance, cabbage productivity in Ethiopia, particularly in the Amhara Regional State, remains considerably lower than the global average. Ethiopia produces approximately 6 t ha⁻¹ of cabbage, compared with an average yield of 16 t ha⁻¹ in East Africa and 28.8 t ha⁻¹ worldwide (CSA, 2021; Habtamu & Mnuyelet, 2022) [1, 2]. Several biotic and abiotic factors limit cabbage production, among which aphids are one of the most destructive insect pests. In addition to causing direct damage through sap feeding, aphids transmit nearly 50% of insect-borne plant viruses, resulting in substantial reductions in crop yield, quality and nutritional value (Gebreyohans, 2021; Opfer & McGrath, 2013) [3, 4]. Severe aphid infestations have been reported to cause yield losses ranging from 36.1% to 91.2% and in extreme cases, complete crop failure (Lidet *et al.*, 2008) [5]. In the Amhara Region of Ethiopia, cabbage aphids are considered a major production constraint, with reported yield reductions of 50-80% (Kassahun, 2018; Abdelmuhsin *et al.*, 2022; Fiodorova *et al.*, 2022; Zakinyan *et al.*, 2023; Negreiros *et al.*, 2024) [6-10]. Although synthetic insecticides remain the primary method for managing cabbage aphids and improving crop productivity (Iqbal *et al.*, 2011) [11], their indiscriminate use has resulted in insecticide resistance, pesticide residues, adverse effects on beneficial organisms and human health, environmental contamination and increased production costs (Shiberu & Mulugeta, 2016) [12]. Consequently, environmentally safe alternatives have gained increasing attention. Botanical pesticides, derived from plant materials, possess insecticidal and repellent properties while posing minimal risk to non-target organisms and the environment (Zahid *et al.*, 2016; Mahmood *et al.*, 2022) [13, 14]. Therefore, the present

study was undertaken to evaluate the field efficacy of botanical aqueous extracts for the management of cabbage aphids under field conditions.

Material and Methods

Experimental site

The present investigation entitled “Studies on Eco-friendly Management of Diamondback Moth (*Plutella xylostella* L.) in Cabbage” was conducted during Rabi 2025-26 at the Crop Research Centre (CRC), Sardar Vallabhbhai Patel University of Agriculture and Technology (SVPUAT), Modipuram, Meerut, Uttar Pradesh, India. The experimental farm is located at 28°57'-29°02' N latitude and 77°40'-77°45' E longitude, with an altitude of 237 m above mean sea level, representing the agro-climatic conditions of the Upper Gangetic Plains of Western Uttar Pradesh.

Experimental crop and design

The cabbage variety 'Golden Acre' was transplanted following the recommended agronomic practices. The experiment was laid out in a Randomized Block Design (RBD) with seven treatments, including an untreated control and three replications. Each experimental plot measured 3.0 × 4.0 m, maintaining a spacing of 60 × 50 cm between rows and plants.

Treatments and application

The treatments comprised Spinosad 45 SC (160 ml ha⁻¹), Agniastra (10 L ha⁻¹), *Bacillus thuringiensis* var. *kurstaki* (2 kg ha⁻¹), *Metarhizium anisopliae* (2 kg ha⁻¹), NSKE 5% (1.5 kg ha⁻¹), Nimbecidine 0.03% (2 L ha⁻¹) and an untreated control. Two foliar sprays were applied at a 15-day interval after the pest population reached the Economic Threshold Level (ETL) of 2 larvae per five plants using a knapsack sprayer.

Recording of observations

Observations on diamondback moth (*P. xylostella*) larval population were recorded from five randomly selected plants in each plot. Pre-treatment observations were recorded one day before spraying, while post-treatment observations were taken on the 3rd, 7th and 14th day after each spray. The efficacy of treatments was assessed based on the mean larval population per plant.

Statistical analysis

The experimental data were subjected to Analysis of Variance (ANOVA) after square-root transformation [$\sqrt{(x + 0.5)}$] of larval count data. Treatment means were compared at the 5% level of significance and the Incremental Cost-Benefit Ratio (ICBR) was calculated to assess the economic viability of different treatments.

Result

The efficacy of different botanicals and bio-pesticides against *Plutella xylostella* was evaluated during Rabi 2025-26. The pre-treatment larval population did not differ significantly among the treatments, indicating uniform pest

distribution before application. Following the first spray, all treatments significantly reduced the larval population compared with the untreated control. Among the treatments, Spinosad 45 SC proved to be the most effective, recording the lowest mean larval population (2.44 larvae per five plants) with 72.88% Mean Reduction Over Control (MROC). This was followed by *Bacillus thuringiensis* var. *kurstaki* (3.67 larvae per five plants; 59.22% MROC) and *Metarhizium anisopliae* (4.00 larvae per five plants; 55.55% MROC). Nimbecidine 0.03% and NSKE 5% provided moderate control, whereas Agniastra was comparatively less effective among the treated plots. The untreated control recorded the highest larval population (9.00 larvae per five plants).

A similar trend was observed after the second spray. Spinosad 45 SC again recorded the highest efficacy, with the lowest mean larval population (1.50 larvae per five plants) and 85.00% MROC, followed by *Bacillus thuringiensis* var. *kurstaki* (2.50 larvae per five plants; 75.00% MROC) and *Metarhizium anisopliae* (3.00 larvae per five plants; 70.00% MROC). Nimbecidine 0.03% and NSKE 5% showed moderate suppression of the pest population, while Agniastra was the least effective among the treated plots. The untreated control maintained the highest larval population (10.00 larvae per five plants).

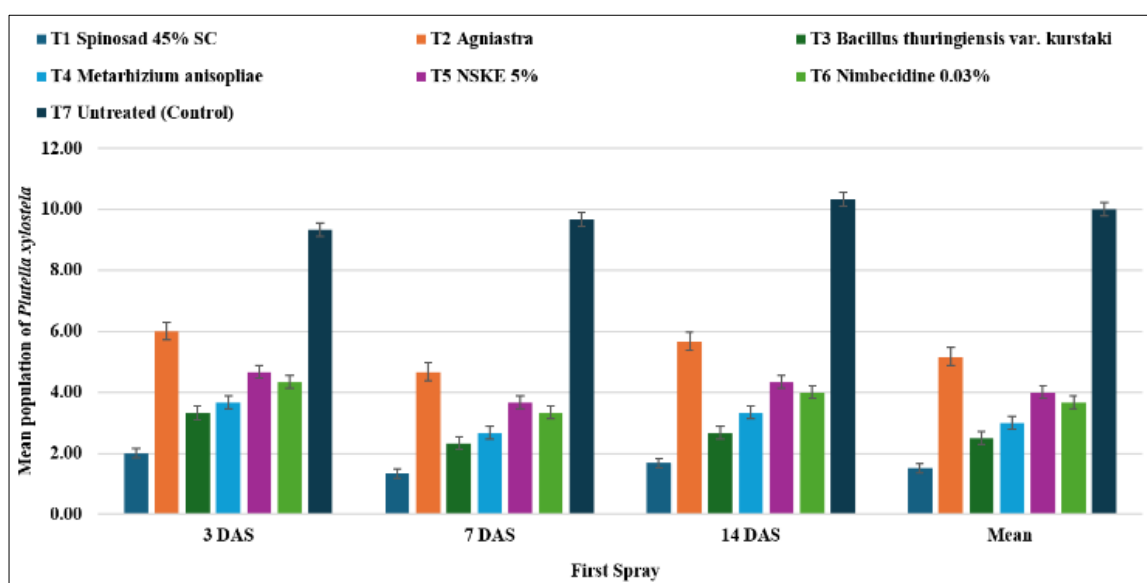
The present findings agree with those of Choudhary *et al.* (2025) ^[21], Sharma *et al.* (2024) ^[22], Prakashrao and Kumar (2022) ^[23] Kommoji *et al.* (2022) ^[24], Kumar *et al.* (2022) ^[20], who also reported efficacy of different insecticide and biopesticide in cabbage ecosystems under different agro-climatic regions of India.

Discussion

The present study revealed that all the evaluated botanicals and biopesticides significantly reduced the larval population of the diamondback moth (*Plutella xylostella*) compared with the untreated control. Among the treatments, Spinosad 45 SC was the most effective, followed by *Bacillus thuringiensis* var. *kurstaki* and *Metarhizium anisopliae*, whereas Nimbecidine 0.03% and NSKE 5% showed moderate efficacy and Agniastra was comparatively less effective. The superior performance of Spinosad observed in the present investigation is in close agreement with the findings of Ranjbari *et al.* (2011) ^[25], Stanikzi *et al.* (2016) ^[26], Dotasara *et al.* (2017) ^[27], Gaddam *et al.* (2021) ^[28], Prakashrao and Kumar (2022) ^[23], Sharma *et al.* (2022) ^[29] and Choudhary *et al.* (2025) ^[21], who also reported Spinosad as one of the most effective treatments against *P. xylostella*. Similarly, the effectiveness of *Bacillus thuringiensis* corroborates the reports of Vanlaldiki *et al.* (2013) ^[30], Singh *et al.* (2015) ^[31], Kumar *et al.* (2022) ^[20] and Sharma *et al.* (2024) ^[22], while the moderate efficacy of *Metarhizium anisopliae* agrees with the findings of Shehzad *et al.* (2021) ^[18] and Sapkota *et al.* (2022) ^[17]. The moderate performance of neem-based treatments is also consistent with the observations of Liang *et al.* (2002) ^[15] and Sitotaw *et al.* (2009) ^[16].

Table 1: Bio-efficacy of botanicals and bio-pesticides against diamondback moth, *Plutella xylostella* (Linn.) after 1st spray during Rabi, 2025-26

S. No.	Treatments	Dose (g/ml per ha)	No. of diamondback moth per five plants					
			1 st Spray					
			1 DAS	3 DAS	7 DAS	14 DAS	Mean	MRC%
T1	Spinosad 45% SC	160 ml/ha	7.33 (2.88)	3.00 (1.98)	2.00 (1.73)	2.33 (1.82)	2.44	72.88
T2	Agniastra	10 Lit/ha	7.67 (2.94)	6.66 (2.76)	5.66 (2.58)	6.33 (2.70)	6.22	30.88
T3	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	2 Kg /ha	7.00 (2.82)	4.00 (2.23)	3.33 (2.07)	3.66 (2.15)	3.67	59.22
T4	<i>Metarhizium anisopliae</i>	2 Kg/ha	7.67 (2.94)	4.33 (2.30)	3.66 (2.15)	4.00 (2.23)	4.00	55.55
T5	NSKE 5%	1.5 Kg	6.33 (2.70)	5.33 (2.51)	4.66 (2.37)	5.00 (2.44)	5.00	44.44
T6	Nimbecidine 0.03%	2 Lit/ha	7.33 (2.88)	5.00 (2.44)	4.33 (2.30)	4.66 (2.37)	4.67	48.11
T7	Untreated (Control)	-	8.33 (3.05)	8.66 (3.10)	9.00 (3.16)	9.33 (3.21)	9.00	-
CD at 5%			N/A	0.237	0.206	0.244	-	-
SE (m) (±)			0.074	0.076	0.066	0.078	-	-

**Fig 1:** Bio-efficacy of botanicals and bio-pesticides against diamondback moth, *Plutella xylostella* (Linn.) 1st spray during Rabi, 2025-26**Table 2:** Bio-efficacy of botanicals and bio-pesticides against diamondback moth, *Plutella xylostella* (Linn.) after 2nd spray during Rabi, 2025-26

S. No.	Treatments	Dose (g/ml per ha)	No. of diamondback moth per five plants				
			2 nd Spray				
			3 DAS	7 DAS	14 DAS	Mean	MRC %
T1	Spinosad 45% SC	160 ml/ha	2.00 (1.73)	1.33 (1.52)	1.66 (1.62)	1.50	85
T2	Agniastra	10 Lit/ha	6.00 (2.64)	4.66 (2.37)	5.66 (2.58)	5.17	48.3
T3	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	2 Kg /ha	3.33 (2.07)	2.33 (1.82)	2.66 (1.91)	2.50	75
T4	<i>Metarhizium anisopliae</i>	2 Kg/ha	3.66 (2.15)	2.66 (1.91)	3.33 (2.07)	3.00	70
T5	NSKE 5%	1.5 Kg	4.66 (2.37)	3.66 (2.15)	4.33 (2.30)	4.00	60
T6	Nimbecidine 0.03%	2 Lit/ha	4.33 (2.30)	3.33 (2.07)	4.00 (2.23)	3.67	63.3
T7	Untreated (Control)	-	9.33 (3.21)	9.66 (3.26)	10.33 (3.36)	10.00	-
CD at 5%			0.22	0.27	0.24	-	-
SE (m) (±)			0.07	0.08	0.07	-	-

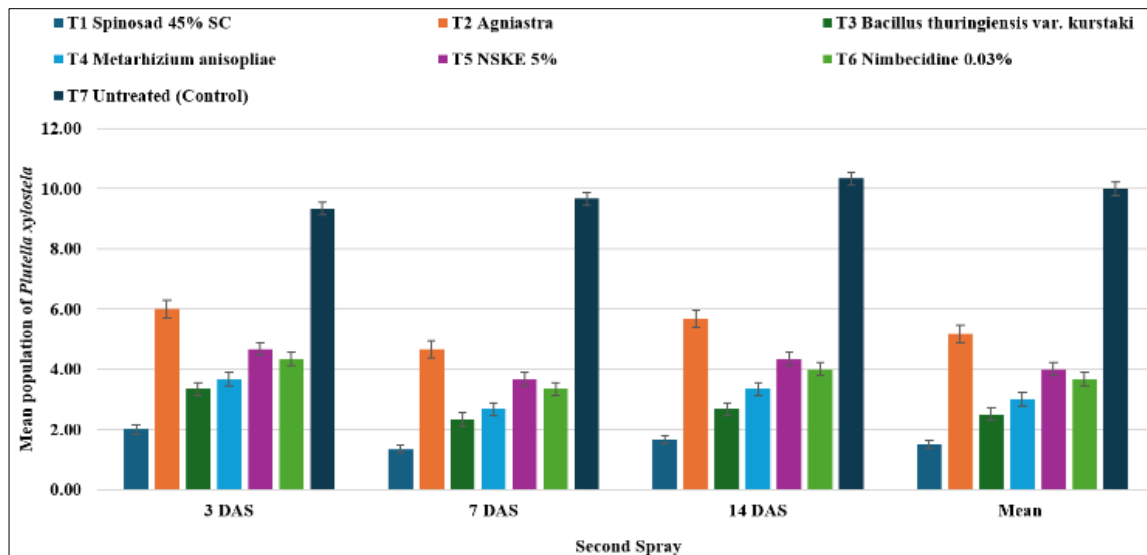


Fig 2: Bio-efficacy of botanicals and bio-pesticides against diamondback moth, *Plutella xylostella* (Linn.) during 2nd spray during Rabi, 2025-26

Conclusion

The present study demonstrated that all the tested botanicals and biopesticides significantly reduced the larval population of the diamondback moth, *Plutella xylostella*, compared with the untreated control. Among the evaluated treatments, Spinosad 45 SC proved to be the most effective, recording the lowest larval population and the highest reduction over control after both sprays. *Bacillus thuringiensis* var. *kurstaki* and *Metarhizium anisopliae* were the next most effective treatments, whereas neem-based products and Agniastra provided moderate suppression of the pest. The findings indicate that Spinosad 45 SC, followed by *Bacillus thuringiensis* var. *kurstaki*, can be effectively incorporated into integrated pest management (IPM) programmes for sustainable and eco-friendly management of diamondback moth in cabbage under the agro-climatic conditions of Western Uttar Pradesh.

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