

Bioefficacy of certain insecticides in cabbage against lepidopteran pests

Ravi Singh, Sameer Kumar Singh*, Kamal Ravi Sharma, Umesh Chandra and Pradeep Kumar Dalal[#]

^{*}Department of Entomology, College of Agriculture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya 224 229, Uttar Pradesh, India.

[#]Department of Vegetable Science, College of Horticulture and Forestry, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya 224 229, Uttar Pradesh, India.

Email: drsameerent@nduat.org

ABSTRACT: Among the insecticides evaluated for bioefficacy against lepidopteran pests (diamond back moth, *Plutella xylostella*, leaf webber, *Crociodolomia binotalis* Zell and tobacco caterpillar, *Spodoptera litura* Fab), chlorantraniliprole 18.5 SC @10g a.i ha⁻¹ was most effective. Incidence of diamond back moth was 0.72±0.11 and 0.47±0.07 larvae plant⁻¹, respectively after first and second spray, leaf webber 0.62±0.10 and 0.54±0.08 larvae plant⁻¹ respectively, after first and second spray and tobacco caterpillar 0.91±0.07 and 0.65±0.08 larvae plant⁻¹, respectively, after first and second spray. Flubendiamide 20 WG @25g a.i ha⁻¹ was next best and novaluron 10 EC @75g a.i ha⁻¹ which was least effective. The maximum yield of 264.54 q ha⁻¹ was obtained from chlorantraniliprole. while the minimum yield of 215.60 q ha⁻¹ was recorded in novaluron. The highest cost-benefit ratio of 1:33.23 was recorded in chlorantraniliprole, while the lowest ratio of 1:6.69 in novaluron.

KEY WORDS: Diamond back moth, leaf webber, tobacco caterpillar, yield, incremental cost-benefit ratio, chlorantraniliprole

INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata*) is a short-duration, nutrient-rich vegetable crop capable of producing high-quality food per unit area and time, making it an important component of modern agriculture. In India, cabbage is cultivated over 397 thousand hectares, with an annual production of 9.21 million metric tons and an average productivity of 23.19 MT ha⁻¹. Major cabbage-growing states include West Bengal, Uttar Pradesh, Odisha, Bihar, Assam, Maharashtra, and Karnataka, with Uttar Pradesh alone contributing 348.94 thousand MT annually (Sharma *et al.*, 2022). Cabbage production

in India is severely constrained by insect pest infestations, with around 37 species reported. Among these, the diamondback moth (*Plutella xylostella* L.), cabbage leaf webber (*Crociodolomia binotalis* Zell.), tobacco caterpillar (*Spodoptera litura* Fab.), cabbage semilooper (*Trichoplusia ni* Hübner), cabbage butterfly (*Pieris brassicae* L.), flea beetles (*Phyllotreta cruciferae* Goeze), aphid (*Brevicoryne brassicae* Linn.), and mustard sawfly (*Athalia lugens proxima* Klug) are the most destructive. These pests can cause yield losses ranging from 80–100 per cent in nurseries to 10–25 per cent in field crops (Lal *et al.*, 2020). The tobacco caterpillar is an economically important

* Author for correspondence

polyphagous pest with a broad host range, attacking plants from nearly 120 families, including cultivated crops, weeds, vegetables, fruits, and ornamentals, and is distributed worldwide (Dodiya *et al.*, 2023). In India, the diamondback moth is a particularly serious pest of cabbage, causing annual marketable yield losses of 50–80 per cent (Kumar *et al.*, 2025). Similarly, the cabbage leaf webber inflicts severe damage, with yield losses reported between 37.2 and 81.8 per cent (Kumbar *et al.*, 2022). Bio-efficacy evaluations of insecticides are essential for identifying the most suitable options for pest control. Such studies help determine optimal application strategies, support resistance management, and facilitate the integration of chemical control with biological and cultural practices within an Integrated Pest Management (IPM) framework. Therefore, the present study was undertaken to evaluate the bio-efficacy of selected insecticides against major insect pests of cabbage under field conditions.

MATERIALS AND METHODS

The bio-efficacy of selected insecticides (Table 1) against lepidopteran borers was evaluated at the Students' Instructional Farm (SIF) using a Randomized Block Design (RBD) with eight treatments (Table 1) and three replications. Each plot measured 1.8×2.7 m, with a one metre field border. The spacing was maintained at 45 cm between rows and 45 cm between plants, with a 0.5 m gap between plots. Observations were recorded on the larval population of *Spodoptera litura*, *Crociodolomia binotalis* and *Plutella xylostella*, expressed as the number of larvae per plant. Pre-treatment counts were taken one day before spraying, followed by counts at 3, 7 and 10 days after each application. The mean pest population after each spray was computed from these observations.

The recommended volume of spray solution was applied to each plot (except untreated control plots). The required amount of formulation was calculated using the formula:

$$\frac{\text{Amount of formulation (kg or L ha}^{-1}\text{)} = \text{Dose recommended in a.i./ha (kg or g/ha)}}{\text{Concentration of toxicant in insecticidal formulation \%}} \times 100$$

Concentration of toxicant in insecticidal formulation %

Where:

a.i. = active ingredient

Dose recommended in a.i. ha⁻¹ = the amount of pure active ingredient needed per hectare

Concentration of toxicant (%) = percentage of active ingredient in the insecticidal formulation

The spray mixture for each treatment was prepared by mixing the required quantity of insecticide formulation in water to achieve a spray volume equivalent to 500 L ha⁻¹. For each treatment, the spray solution was prepared fresh before application and applied to the respective plots using a knapsack hand sprayer fitted with a cone-type nozzle. Spraying was carried out in the morning hours under suitable wind conditions to minimize spray drift to adjacent plots and reduce loss of spray fluid due to high wind velocity. All necessary protective measures were followed during application. After spraying, the sprayer was thoroughly cleaned and washed. In each treatment, head yield was recorded separately. The plot yields were converted to yield per hectare and subjected to statistical analysis to determine the significance of differences among treatments. The Incremental Cost–Benefit Ratio (ICBR) was calculated using the formula:

$$\text{ICBR} = \frac{\text{Additional return from treatment (Rs/ha)}}{\text{Additional total cost of treatment (Rs./ha.)}}$$

RESULTS AND DISCUSSION

Diamondback moth (*P. xylostella*): Among all treatments, chlorantraniliprole (18.5% SC) proved most effective, recording the lowest larval population (0.72 ± 0.11 and 0.47 ± 0.07 larvae plant⁻¹) and the highest per cent efficacy after the first and second sprays (75.77 and 85.01% respectively). This was followed by cyantraniliprole (10.26% OD) (0.97 ± 0.09 and 0.68 ± 0.04 larvae plant⁻¹ after the first and second sprays respectively and per cent efficacy after the first and second sprays as 67.41 and 78.28% respectively). These results are consistent with Sawant and Patil (2018), who reported maximum larval reduction of *P. xylostella* in chlorantraniliprole-treated plots (91.30% with 1.02 larvae plant⁻¹). Beena and Selvi (2022) similarly noted that diamide insecticides such as chlorantraniliprole, cyantraniliprole and

Table1. Bio-efficacy of certain insecticides against caterpillar pests in cabbage (mean larval population of plant⁻¹)

Treatments/ dose ha ⁻¹	DBM				Leaf webber				<i>Spodoptera littoralis</i>			
	1 spray		2 spray		1 spray		2 spray		1 spray		2 spray	
	Mean*	PROC	Mean*	PROC	Mean*	PROC	Mean*	PROC	Mean*	PROC	Mean*	PROC
Emamectin benzoate 5SG@10g	1.31±0.12 (1.33)	57.26	0.90±0.03 (1.18)	71.01	1.10±0.11 (1.26)	64.79	0.86±0.07 (1.16)	73.26	1.16±0.17 (1.28)	65.51	1.08±0.07 (1.31)	69.73
Indoxacarb 14.5SC@40g	1.53±0.16 (1.39)	52.25	1.26±0.06 (1.32)	59.69	1.58±0.08 (1.39)	54.31	1.01±0.16 (1.23)	68.56	1.42±0.13 (1.38)	57.71	1.39±0.06 (1.42)	60.83
Chlorantraniliprole 18.5 SC@10g	0.72±0.11 (1.10)	75.77	0.47±0.07 (0.98)	85.01	0.62±0.10 (1.06)	80.12	0.54±0.08 (1.02)	83.26	0.91±0.07 (1.18)	72.97	0.65±0.08 (1.13)	81.84
Flubendiamide 20WG@25g	1.28±0.04 (1.26)	63.58	0.79±0.08 (1.13)	74.61	0.83±0.15 (1.15)	73.38	0.72±0.03 (1.10)	77.71	1.00±0.08 (1.22)	70.15	0.84±0.07 (1.21)	76.44
Cyantraniliprole 10.26% OD@60g	0.97±0.09 (1.21)	67.41	0.68±0.04 (1.08)	78.28	1.05±0.12 (1.24)	66.60	0.78±0.10 (1.13)	75.81	1.08±0.17 (1.25)	67.83	0.99±0.08 (1.28)	72.22
Novaluron 10EC@75g	1.82±0.05 (1.49)	42.07	1.47±0.11 (1.40)	55.02	1.71±0.10 (1.48)	45.47	1.13±0.07 (1.27)	65.04	1.72±0.19 (1.49)	48.59	1.50±0.15 (1.47)	57.87
Spinosad 2.5SC@17.5g	1.47±0.15 (1.37)	54.18	1.03±0.10 (1.24)	66.84	1.27±0.02 (1.33)	59.50	0.89±0.09 (1.18)	72.29	1.28±0.14 (1.33)	61.69	1.26±0.10 (1.37)	64.73
Control	2.99±0.06 (1.87)	-	3.12±0.12 (1.90)	-	3.13±0.08 (1.90)	-	3.22±0.06 (1.93)	-	3.35±0.10 (1.96)	-	3.56±0.12 (2.04)	-
SEm±	(0.02)	-	(0.02)	-	(0.02)	-	(0.02)	-	(0.05)	-	(0.02)	-
CD at 5%	(0.07)	-	(0.06)	-	(0.08)	-	(0.07)	-	(0.14)	-	(0.06)	-

Figures in the parenthesis are "x + 0.5 transformed values, NS= Non- significant, DBS= A Day before spray, DAS= Days after spray, PROC= Percent reduction over control, *Mean of three replications

flubendiamide achieved over 95 per cent population reduction compared with the untreated control (Table 1).

Leaf webber (*C. binotalis*): The lowest mean larval population of *C. binotalis* was recorded in plots treated with chlorantraniliprole (18.5% SC) after the first and second sprays (0.62 ± 0.10 and 0.54 ± 0.08 larvae plant⁻¹; efficacy as 80.12 and 83.26%), followed by flubendiamide (20% WG) (0.83 ± 0.15 and 0.72 ± 0.03 larvae plant⁻¹; efficacy as 73.38 and 77.71%) after the first and second sprays, respectively. These findings align with Karuppaiah and Srivastava (2013) and Jemimah *et al.* (2021), both of whom highlighted the superior efficacy of chlorantraniliprole against leaf webber infestation (Table 1).

Tobacco caterpillar (*S. litura*): Chlorantraniliprole again recorded the lowest larval counts after the first and second sprays (0.91 ± 0.07 and 0.65 ± 0.08 larvae plant⁻¹; efficacy as 72.97 and 81.84%). Flubendiamide followed closely (1.00 ± 0.08 and 0.84 ± 0.07 larvae plant⁻¹; efficacy as 70.15 and 76.44%). Similar results were reported by Smriti *et al.* (2019), who found chlorantraniliprole highly toxic to third instar larvae of *S. litura*, and by Nayaka *et al.* (2019), who recorded the lowest larval population (0.38 and 0.29 larvae plant⁻¹) in treated plots (Table 1).

Effect of different insecticides on yield:

Cabbage yield varied between 215.60 and 264.54 q ha⁻¹ in treated plots. The highest yield was obtained with chlorantraniliprole (264.54 q ha⁻¹), which was significantly superior to all other treatments, followed by flubendiamide (259.13 q ha⁻¹) and cyantraniliprole (254.30 q ha⁻¹). The lowest yield among treatments was recorded for novaluron (215.60 q ha⁻¹), while the untreated control produced 201.59 q ha⁻¹. Sawant and Patil (2018) reported maximum yield (238.15 q ha⁻¹) with chlorantraniliprole, representing a 129.23 per cent increase over the control, followed by flubendiamide. Gill *et al.* (2010) also documented the highest yields from flubendiamide treated plots (Table 2).

Economics of management: The highest benefit–cost ratio (BCR) was achieved with chlorantraniliprole (1:33.23), followed by flubendiamide (1:27.62), emamectin benzoate 5 SG (1:23.77), indoxacarb 14.5 SC (1:9.97), cyantraniliprole (1:8.11), spinosad 2.5 SC (1:7.03), and novaluron (1:6.69). Sawant and Patil (2018) also found the highest incremental cost–benefit ratio for chlorantraniliprole (1:16.40), followed by flubendiamide (1:14.98) (Table 2).

Bioefficacy of insecticides evaluated against lepidopteran pests in cabbage, revealed that chlorantraniliprole 18.5 SC @10g a.i ha⁻¹ was most effective, followed by flubendiamide 20 WG @25g

Table 2. Economics (ha⁻¹) of certain insecticides used for management of lepidopteran borers in cabbage

Treatments/ dose ha ⁻¹	Cost of spray	Yield (q)	Yield over Control (q)	Total return	Net return	ICBR	Rank
T1- Emamectin benzoate 5 SG @10g	2088	231.31	29.72	51712.8	49624.8	23.77	III
T2-Indoxacarb 14.5 SC@40g	2900	219.88	18.29	31824.6	28924.6	9.97	IV
T3-Chlorantraniliprole 18.5 SC@10g	3200	264.54	62.95	109533	106333	33.23	I
T4- Flubendiamide 20 WG@25g	3498	259.13	57.54	100119.6	96621.6	27.62	II
T5-Cyantraniliprole 10.26% OD@60g	10068	254.3	52.71	91715.4	81647.4	8.11	V
T6- Novaluron 10 EC@75g	3170	215.6	14.01	24377.4	21207.4	6.69	VII
T7- Spinosad 2.5 SC@17.5g	5336	226.23	24.64	42873.6	37537.6	7.03	VI
T8- Control	-	201.59	-	-	-	-	

Cost of produce @Rs.1050/q during Rabi 2023-24; ICBR -Incremental cost benefit ratio

a.i ha⁻¹. These may useful in the Integrated Pest Management (IPM) strategies that combine chemical, biological, and cultural controls, promoting environmentally friendly and safe agricultural practices.

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