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Efficacy of certain chemical and botanicals against diamondback moth (*Plutella xylostella*) on cabbage under field condition

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Abstract
The Central Research Farm (CRF) is where the current investigation was carried out, Department of Entomology, SHUATS, Prayagraj during *Rabi* season 2021-22. In the Randomised Block Design, there were eight treatments, including an untreated control, and each was replicated three times. Eight treatments *viz*, Cypermethrin 25% EC, Spinosad @ 45% SC, Neem oil @ 2%, Karanj oil @ 2%, Chlorantraniliprole 18.5% SC, Datura leaf extract @ 5%, Fipronil 5% SC, one untreated plot was taken. The observation on overall larval population of *P. xylostella* on cabbage. This demonstrates that each treatment was vastly superior to the control. Chlorantraniliprole 18.5% SC (01.42) found superior followed by Spinosad 45% SC (01.65), Cypermethrin 25% EC (02.02), Fipronil 5% SC (02.17), Neem oil @ 2% (02.36), Karanj oil @ 2% (02.60), Datura leaf extract @ 5% (02.81) as compared to control control (03.83). The results were quite interesting. This shows that each treatment was significantly better than the control. Chlorantraniliprole 18.5% SC (270.80 q/ha) (1:6.19), followed by Spinosad 45 SC (238.15 q/ha) (1:5.51), Cypermethrin 25% EC (220 q/ha) (1:5.46), Fipronil 5% SC (205 q/ha) (1:5.10), Neem oil @ 5% (170 q/ha) (1:4.0), Karanj oil @ 5% (165 q/ha) (1:4.0), Datura leaf extract @2% (135 q/ha) (1:3.40) vs the control (115 q/ha) (1:2.62).

Keywords: Chlorantraniliprole, cost-benefit ratio, Cypermethrin, *Plutella xylostella*, Spinosad

Introduction
Cruciferous vegetables play a significant role in India's Rabi crop production. *Brassica oleracea* var. capitata (Linn.), also known as cabbage, is a widely consumed vegetable that is grown in all of India's states and has significant nutritional and commercial significance. It is frequently used in salads, curries, and other dishes as well as fresh and boiling vegetables. It is well recognized to have therapeutic qualities, and its expanded terminal buds are a rich source of calcium, phosphorus, sodium, potassium, sculpture, Vitamin A, Vitamin C, and dietary fibre. 25 g of calories, 0 g of fat, 18 mg of sodium, 0 mg of cholesterol, 170 g of potassium, 6 g of carbohydrate, 1.3 g of protein, 1% of vitamin A, 60% of vitamin C, 4% of calcium, 2% of iron, 5% of vitamin B6, and 3% of magnesium are found in 100 g of cabbage. (Source: USDA nutrient database).

After China, India is the country that produces the most cabbage. India is producing about 8755000 tonnes in an area of 388000/ha with a productivity of 22,564 (kg/ha). In 5.7 million tonnes of cabbage are produced in Uttar Pradesh on an area of around 0.72 million acres. 33881515 tonnes of the world's cabbage production come from China. India (8,500,000 tonnes), Japan (2,300,000 tonnes), South Korea (2,118,930 tonnes), and Indonesia (1,487,531 tonnes) are the other Asian nations on the list. Russia (3,309,315), Ukraine (1,922,400), Poland (1,198,726), and Romania (990,154 tonnes) are the top four European producers of cabbage. 964,830 tonnes of the global production are produced in the US.

West Bengal produces the most cabbage in India, with a share of 2288.50 tonnes, followed by Orissa (1058.78 tonnes), Madhya Pradesh (686.91 tonnes), Bihar (673.44 tonnes), and Uttar Pradesh (302.97). Source: National Horticultural board (NHB 2017-2018).

The important insect species that attack cabbage include the diamondback moth (*Plutella xylostella* L), cabbage leaf webber (Crocodolomia binotalis Zeller), tobacco caterpillar (Spodoptera litura Fabricius), cabbage semi-looper (Thysanoplusia orichalcea Fabricius), and cabbage aphid (Brevicoryne brassicae W). The weight of cabbage heads per plant was similarly impacted by the insect-pest infestation, with a mean loss of 23.73 per sent in.

(Jat *et al.*, 2017) [9].

On cruciferous crops, the Diamond back moth (DBM) was first observed in India in 1914 (Fletcher, 1914). Currently, this species is found throughout India anywhere crucifers are produced. Due to the attack, Kumar *et al.* (1983) [12] found a 52% decrease in the marketable yield of cabbage. The P.xylostella diamondback moth is a member of the order Lepidoptera, family Plutellidae, class Insecta, phylum Arthropoda, and kingdom Animalia. Important crucifers such as mustard, Brassica campestris var toria, and Brassica campestris var sarson are all infested by DBM in India. (Chand and Choudhary 1977, Singh and Singh 1982) [3, 17].

Materials and Method

The experiment was carried out throughout the Rabi season of 2021–2022 at the Sam Higginbottom University of Agriculture, Technology and Sciences' Central Research Farm in Prayagraj, Uttar Pradesh. The investigation was conducted at a height of 98 metres above sea level, at 25.45° North latitude and 81.85° East longitude. The choice of the site was consistent, cultivable, and had typical sandy loam soil with good drainage. A seedling of the Golden Acre type of cabbage, which was one month old, was transplanted into a plot with dimensions of 2 m by 2 m and spacing of 60 cm by 60 cm. The experiment was conducted in Randomized Block Design (RBD) with eight treatments including an untreated control i.e., Cypermethrin 25% EC 0.3 ml/lit, Spinosad 45% SC 0.3 ml/lit, Neem oil@ 2% 20 ml/lit, Karanj oil@ 2% 20 ml/lit, Chlorantraniliprole 18.5% SC 0.3 ml/lit, Datura leaf extract @ 5% 50 ml/lit and Fipronil 5% SC 0.3 ml/lit. All the treatments were replicated thrice.

When the pest reached its minimum ETL level 2-3 larvae per plant were crossed, the first spray on 5th February 2022 and second spray on 20th February were given at an interval of 15 days with the help of hand compression sprayer imposing the treatments @ 500 l/ha. The spray fluid was thoroughly stirred before spraying. Spraying was done at morning hours and the point of runoff for thorough coverage.

The data on the pest population was recorded at one day before spraying as pre-treatments count and 3rd, 7th, 14th days after spraying as post-treatment counts. For assessing the larval population of diamondback moth, the total number of larvae and 5 randomly selected plant per plot were observed. The yield data in each treatment was recorded separately and subjected to statistical analysis to test the significance of mean yield variation in different treatments.

Table 1: Efficacy of chemical insecticide and botanicals on a larval population of diamond back moth (*Plutella xylostella)* on cabbage during *Rabi* season 2021

T. No.	Treatment	Larval population of *P. xylostella*									Overall mean	Yield (q/ha)	B:C Ratio
		1st Spray					2nd Spray						
		1 DBS	3 Das	7 Das	14 Das	Mean	3 DBS	7 Das	14 Das	Mean			
T_1	Cypermethrin 25% EC	03.13	02.40^{f}	02.06^{c}	02.26^{cd}	02.24^{e}	02.06^{c}	01.46^{de}	01.86^{d}	01.80^{e}	02.02^{de}	220.00	1:5.46
T_2	Spinosad 45% SC	03.20	02.00^{g}	01.66^{d}	01.86^{de}	01.84^{f}	01.66^{d}	01.26^{ef}	01.46^{e}	01.46^{f}	01.65^{ef}	238.15	1:5.51
T_3	Neem oil@ 2%	03.33	02.80^{d}	2.33^{c}	02.46^{bc}	02.53^{cd}	02.20^{bc}	02.00^{c}	02.40^{c}	02.20^{cd}	02.36^{bcd}	170.00	1:4.00
T_4	Karanj oil@ 2%	03.46	03.00^{c}	02.66^{b}	02.60^{bc}	02.75^{bc}	02.33^{bc}	02.40^{b}	02.60^{bc}	02.44^{bc}	02.60^{bc}	165.00	1:4.00
T_5	Chlorantraniliprole 18.5% SC	03.60	01.80^{h}	01.40^{d}	01.60^{e}	01.60^{f}	01.46^{d}	01.06^{f}	01.20^{e}	01.24^{f}	01.42^{f}	270.80	1:6.19
T_6	Datura leaf extract@ 5%	03.40	03.20^{b}	02.93^{b}	02.80^{b}	02.97^{b}	02.53^{b}	02.60^{b}	02.80^{b}	02.64^{b}	02.81^{b}	135.00	1:3.40
T_7	Fipronil 5% SC	03.20	02.66^{e}	02.06^{c}	02.33^{bcd}	02.35^{de}	02.20^{bc}	01.80^{cd}	02.00^{d}	02.00^{de}	02.17^{cde}	205.00	1:5.10
T_0	Control	03.13	03.33^{a}	03.53^{a}	03.73^{a}	03.53^{a}	03.86^{a}	04.13^{a}	04.40^{a}	04.13^{a}	03.83^{a}	115.00	1:2.62
	F-Test	NS	S	S	S	S	S	S	S	S	S		
	S.Ed (±)	04.87	02.32	08.04	12.15	06.25	08.85	09.75	09.13	07.98	10.23		
	C.D. (P=0.05)	-	0.10	0.320	0.52	0.27	0.35	0.35	0.37	0.31	0.57		

*DBS-Days before spray, *DAS-Days after spray, NS=No significant, *S-Significant, *B:C-Benefit Cost Ratio

Result and Discussion

One day before first spray the pre-treatment counts of larval population ranged from 3.13 to 3.60 (Table No.1) The data analysis for the overall mean of 1st spray larval population of *Plutella xylostella* overall mean revealed that all the treatments were superior over control. Among all the treatments Chlorantraniliprole @ 18.5% SC (1.60) and Spinosad @ 45% SC (1.84) recorded significantly lowest larval population and proved their superiority. The next best treatments were Cypermethrin @ 25% SE (2.24), Fipronil @ 5% SC (2.35), Neem oil (2.53), karanji oil (2.75) and Datura leaf extract (2.97) were found least effective by recording highest population of larva.

The data analysis for an overall mean of 2nd spray revealed that all the treatments were superior over control. Among all the treatments Chlorantraniliprole @ 18.5% (1.24) and Spinosad @ 45% SC (1.46) recorded significantly lowest larval population and proved their superiority. The next best treatments were Cypermethrin @ 25% SE (1.80), Fipronil @ 5% SC (2.20), Neem oil (2.20), karanj oil (2.44) and Datura leaf extract (2.64) were found least effective by recording highest population of larva.

The data analysis for overall mean of 1st 2nd spray revealed that all the treatments were superior over control Among all the treatments Chlorantraniliprole 18.5 SC (1.42) was found to be the most effective treatment among all followed by Spinosad 45 SC (1.65), Cypermethrin 25% EC (2.02), Fipronil 5% SC (2.17), Neem oil (2.36), Karanj oil (2.60) and Datura leaf extract (2.81) was least effective among all the treatments. Control plot T_0 (3.83).

Similar findings supported by Sharma *et al.* (2016) [16] Sawant *et al.* (2018) [15]. Chowdary *et al.* (2019) [4] reported that Chlorantraniliprole was found significantly to be most effective in reducing larval population. Mane *et al* (2021) [14] also reported that Spinosad 45% SC (0.3 ml/l) treated cabbage plot found most effective, Likewise, separate study conducted by Harika *et al.* (2019) [8] it was reported that spinosad 45 SC proved most effective. Giri *et al.* (2020) [7]. Also reported the lowest larval population and damages were recorded in Cypermethrin. From this study that Kumar *et al.* (2020) [12] reported that fipronil 5% SC effective against *P. xylostella*. Devi *et al.* (2017) [5] reported that Neem oil effective against larval population of *P. xylostella*. Sridhar *et al.* (2010) [18] reported that Karanj oil most effective against reducing *P.*

xylostella. Karimzadeh *et al.* (2020) [11] reported that Datura leaf extract found effective against *P. xylostella*.

Data presented in table -1 revealed that among the highest yield was obtained from Chlorantraniliprole 18.5 SC (270.80 q/ha), followed by Spinosad 45 SC (238.15 q/ha), Cypermethrin 25% EC (220 q/ha), Fipronil 5% SC (205 q/ha), Neem oil @ 2% (170 q/ha), Karanj oil @ 2% (165 q/ha) and Datura leaf extract@ 5% (135 q/ha) was least effective among all the treatments. Control plot (115 q/ha) yield. The highest cost-benefit ratio was noticed in Table 1 Chlorantraniliprole 18.5 SC (1:6.9), followed by Spinosad 45 SC (1:5.51), Cypermethrin 25% EC (1:5.46), Fipronil 5% SC (1:5.10), Neem oil @ 2% (1:4.0), Karanj oil @ 2% (1:4.0), Datura leaf extract @ 5% (1:3.40) and Control plot (1:2.6) ratio.

Our findings are similar with Sawant *et al.* (2018) [15] and Sharma *et al.* (2016) [16] reported highest yield (238.15q/ha) was recorded in Chlorantraniliprole 18.5 SC. Harika *et al.* (2019) [8] reported that the highest yield was recorded in Spinosad (228.80 q/ha). Kumar *et al.* (2020) [12] most significant in Spinosad 45 SC (1:3.27) followed by Fipronil 5 SC (1:297).

From the analysis of present finding, it was concluded that among all treatment Chlorantraniliprole 18.5 SC proved to be the most effective treatment and datura leaf extract was found to be the least effective among the treatments in managing *plutella xylostella* larval population

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