

## Original Research Article

**“Efficacy of certain insecticides and biopesticides against Diamondback moth  
*Plutella xylostella* (Linnaeus) on cabbage, *Brassica oleracea* (Linnaeus)”**

### **ABSTRACT**

A field experiment was conducted in the *Rabi* season of 2021 at Central research farm (CRF), Prayagraj, Uttar Pradesh, India. The experiment was laid in Randomised Block Design (RBD) with eight treatments each replicated thrice using a Golden acer. The treatments were Spinosad 45SC, Flubendiamide 20% WG, *Bacillus thuringiensis* 0.5% WP, Indoxacarb 14.5SC, Neem

oil, *Beauveria bassiana* 1% WP ( $1 \times 10^8$  CFU/gm), Azadirachtin 0.03% EC and untreated Control. The data on the mean larval population of the first spray and second spray, overall mean revealed that all the treatments except untreated control are effective and at par. Among all the treatments, the least larval population of Diamondback moth was recorded in Spinosad 45SC (0.800) followed by Flubendiamide 20% WG (0.934), Indoxacarb 14.5SC (1.223), and Neemoil (1.667), Azadirachtin 0.03% EC (1.811) which was followed by *Bacillus thuringiensis* 0.5% WP (2.156), *Beauveria bassiana* 1% WP (2.211) was the least effective among all treatments. While the highest yield 302 q/ha was obtained from the treatment Spinosad 45SC. It was followed by Flubendiamide 20% WG (270 q/ha) and Indoxacarb 14.5SC (256 q/ha). When the cost-benefit ratio was worked out, an interesting result was achieved. Among the treatments studied, the best and most economic treatment was Flubendiamide 20% WG (1:6.12) followed by Spinosad 45SC (1:5.89), Indoxacarb 14.5SC (1:5.16), Neemoil (1:5.00), Azadirachtin 0.03% EC (1:4.89), *Bacillus thuringiensis* 0.5% WP (1:4.75), *Beauveria bassiana* 1% WP (1:4.43) as compared to control plot (1:2.96).

**KEYWORDS:** Botanicals, Biopesticides, Cabbage, Efficacy, Spinosad, *Plutella xylostella*.

## INTRODUCTION

“Cabbage is the second most important cole crop, which originated in Europe and in the Mediterranean region after cauliflower. Cabbage is one of the most popular winter vegetables grown in India. The botanical name of cabbage is *Brassica oleracea var capitata* L., Family Crucifera, and Chromosome number:  $2n=18$ . The English name cabbage comes from the French *caboché*, meaning head referring to its round form. Cabbage has widespread use in traditional medicine, in the alleviation of symptoms associated with Gastrointestinal Disorders (gastritis, peptic and duodenal ulcers, irritable bowel syndrome) as well as in the treatment of Minor cuts and wounds and Mastitis” (Rokayya *et al.*, 2013).

“Cabbage has an anti-cancer property, it protects against bowel cancer due to the presence of indole-3-carbinol. It is known to possess medicinal properties and its enlarged terminal buds is a rich source of Ca, P, Na, K, S, Vitamin A, Vitamin C, and Dietary fiber. 100 gm of cabbage contains 25g of calories, 0 gm of Fat, 18mg of Sodium, Cholesterol 0 mg, 170 gm of Potassium, 6g of Carbohydrate, 1.3 gm of Protein, Vitamin A 1%, Vitamin C 60%, Calcium 4%, Iron 2%, Vitamin B6 5%, mg 3%”. (source: USDA nutrient database).

In India, West Bengal accounts highest production of cabbage in the world which is 2288.50 tonnes, which has the share of 25.32 percent 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).

“*Plutella xylostella* was first recorded in 1746 and probably from European origin. About 128 countries or regions reported infestation by this insect pest in 1972. The level of infestation varies from place to place for example the infestation is serious in South and Southern Asian countries and moderate in other Asian region than the Mediterranean region. *Plutella xylostella* L. is a foreign pest” (Harcourt, 1963).

In India, diamondback moth (DBM) was first recorded in 1914 (Fletcher, 1914) on cruciferous vegetables. “This species distributed Haryana, Uttar Pradesh, Orissa, Bihar, West Bengal, Assam, Karnataka, Maharashtra, Madhya Pradesh and Tamil Nadu. DBM has national importance on cabbage as it causes 50-80% annual loss in the marketable yield”. (Devjani and Singh, 1999). “Frequent use of chemical insecticides at higher doses results in plundering of natural enemies” (Haseeb *et al.*, 2004) and “development of insecticide resistance in *Plutella xylostella* against a range of insecticide in different parts of India” (Talekar *et al.*, 1990).

## **MATERIALS AND METHODS**

The experiment was conducted during *rab* season 2021 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 Golden variety in a plot size of 2m×2m at a spacing of 45×30cm with a recommended package of practices excluding plant protection. The soil of the experimental site was well drained and medium-high. The Research field is located on the right side of Rewa Road at 25° 22' 15.888" North Latitude and 81° 51' 31.4712" East longitude and is about 98 m above mean sea level. The climate at Prayagraj is typical subtropical which prevails in the eastern part of Uttar Pradesh. The extremes of both summer and winter are experienced here. The maximum temperature was recorded during summer up to 47°C and the minimum temperature was recorded during winter up to 1.5°C. All necessary facilities for the cultivation of crops were available at the research farm.

The population of the caterpillar was recorded (4-5 larvae on each plant) and 5 plants were randomly selected and tagged from each plot. The population of *Plutella xylostella* was recorded before 1-day spraying and on the 3<sup>rd</sup> day, 7<sup>th</sup> day, and 14<sup>th</sup> day after insecticidal application.

The healthy marketable yield obtained from different treatments was collected separately and weighed. The cost of insecticides used in this experiment was recorded during the season of 2020-2021. The cost of botanicals used was obtained from a nearby market. The total cost of plant protection consisted of the cost of treatments, sprayer rent, and labor charges for the spray. There were two sprays throughout the research period and the overall plant protection expenses were calculated. Total income was realized by multiplying the total yield per hectare by the prevailing market price, while the net benefit is obtained by subtracting the total cost of plant protection from total income. The benefit over the control for each sprayed treatment was obtained by subtracting the income of the control treatment from that of each sprayed treatment.

### **Preparation of Insecticidal solution:**

The desired concentration of insecticidal spray solution for each treatment was freshly prepared each and every time at the site of experiment, just before the start of spraying operations. The quantity of spray materials required for crop was gradually increased as the crop advanced in age. The spray solution of desired concentration was prepared by adopting the following formula:

$$(C \times A) V = \% \text{ a.i.}$$

Where,

V= Volume of a formulated pesticide

required.C=Concentration required.

A=Volume of total solution to be prepared.

% a.i.= Given Percentage strength of a formulated pesticide

$$\text{Total no. of larvae} \times 100$$

**Larval Population count**= .....

*5 randomly selected plants*

*Net returns*

**B:CRatio**= .....

*Total cost incurred*

**Where, B:CRatio=Benefit Cost Ratio**

## RESULTS AND DISCUSSION

All the insecticidal treatments were significantly superior to the untreated control in reducing the infestation of Diamondback moth on cabbage. The number of the larval population recorded one day prior to the first spray was in the mean range of 5.200 to 4.533 (Table. 1) one day after spray a low mean larval population of 2.533 and 2.733 was recorded in spinosad 45SC and flubendiamide 20% WG respectively that differed significantly with other treatments plots but statistically at par with each other.

All the treatments significantly differed from the untreated control after the first spray and a reduction in the larval population of *Plutella xylostella* was observed in all the insecticidal treatments. First, spray overall mean the least larval population was observed in spinosad 45SC (0.66) followed by flubendiamide 20% WG (0.800), whereas the highest larval population was recorded in *Bacillus thuringiensis* 0.5% WP (1.933) as shown in Table 1.

Similarly, after the second spray the overall means, the least larval population was observed in spinosad 45SC (0.933) followed by flubendiamide 20% WG (1.067), The highest larval population was observed in *Beauveria bassiana* 1% WP (2.422) as shown in Table 1.

“The data on the mean larval population of the first spray and second spray, overall mean

revealed that all the treatments except untreated control are effective and at par. Among all the treatments least larval population of Diamondback moth was recorded in Spinosad 45SC (0.8). Similar findings were made by **Rahingul and Sasya (2016), and Stanikzi and Thakur (2016)**. Flubendiamide 20% WG (0.934) is found to be the next best treatment which is in line with the findings of **Sharma et al., (2017), Harika et al., (2019), and Maity et al., (2018)** reported that Flubendiamide 20% WG (0.934) was found most effective in reducing the larval population of Diamondback moth as well as increasing the yield.

Indoxacarb 14.5SC (1.223) is found to be the next best treatment which is in line with the findings of **Yadav et al., (2017)**. Neem oil (1.667) is found to be the next effective treatment which is in line with the findings of **Feyissa and Tebkaw (2015), and Devi and Tayde (2017)**. Azadirachtin 0.03% EC (1.811) is found to be the next effective treatment which is in line with the findings of **Bhagat et al., (2019)**. The result of *Bacillus thuringiensis* 0.5% WP (2.156) is in support of **Oke et al., (2010)**. *Beauveria bassiana* 1% WP (2.211) is found to be least effective but comparatively superior over the control, these findings are supported by **Ghosh et al., (2007) and Vandenberg et al., (2013)**.

**Table1:Efficacyofinsecticidesandbiopesticidesagainst Diamondback moth,*Plutellaxylostella*oncabbage**

S.No.	Treatments	Thelarvalpopulationof <i>Plutellaxylostella</i>									Yield q/ha	B:C
		Firstspray				Secondspray				Overall mean		
		3DAS	7DAS	14DAS	Mean	3DAS	7DAS	14DAS	Mean			
T <sub>1</sub>	Spinosad45SC	2.533 <sup>f</sup>	1.867 <sup>e</sup>	1.733 <sup>e</sup>	0.667 <sup>b</sup>	1.200 <sup>e</sup>	0.933 <sup>f</sup>	0.667 <sup>e</sup>	0.933 <sup>b</sup>	0.8 <sup>b</sup>	302	1:5.89
T <sub>2</sub>	Flubendiamide20% WG	2.733 <sup>ef</sup>	2.133 <sup>e</sup>	1.800 <sup>e</sup>	0.8 <sup>b</sup>	1.333 <sup>e</sup>	1.067 <sup>ef</sup>	0.800 <sup>e</sup>	1.067 <sup>b</sup>	0.933 <sup>b</sup>	270	1:6.12
T <sub>3</sub>	<i>Bacillusthuringiensis</i> 0.5% WP	4.200 <sup>bc</sup>	3.933 <sup>b</sup>	3.333 <sup>b</sup>	1.933 <sup>b</sup>	2.733 <sup>b</sup>	2.467 <sup>b</sup>	1.933 <sup>b</sup>	2.378 <sup>b</sup>	2.155 <sup>b</sup>	203	1:4.75
T <sub>4</sub>	Indoxacarb14.5SC	3.00 <sup>e</sup>	2.733 <sup>d</sup>	2.267 <sup>d</sup>	1.067 <sup>b</sup>	1.733 <sup>d</sup>	1.333 <sup>e</sup>	1.067 <sup>d</sup>	1.378 <sup>b</sup>	1.222 <sup>b</sup>	256	1:5.16
T <sub>5</sub>	Neemoil3%	3.600 <sup>d</sup>	3.200 <sup>c</sup>	2.800 <sup>c</sup>	1.467 <sup>b</sup>	2.267 <sup>c</sup>	1.867 <sup>d</sup>	1.467 <sup>c</sup>	1.867 <sup>b</sup>	1.667 <sup>b</sup>	223	1:5.00
T <sub>6</sub>	<i>Beauveriabassianna</i> 1% WP	4.533 <sup>b</sup>	4.133 <sup>b</sup>	3.600 <sup>b</sup>	2.00 <sup>b</sup>	2.933 <sup>b</sup>	2.333 <sup>bc</sup>	2.00 <sup>b</sup>	2.422 <sup>b</sup>	2.211 <sup>b</sup>	195	1:4.43
T <sub>7</sub>	Azadirachitin0.03%EC	3.933 <sup>bc</sup>	3.533 <sup>c</sup>	3.000 <sup>c</sup>	1.6 <sup>b</sup>	2.400 <sup>c</sup>	2.067 <sup>cd</sup>	1.600 <sup>c</sup>	2.022 <sup>b</sup>	1.811 <sup>b</sup>	206	1:4.89
T <sub>0</sub>	Control	8.067 <sup>a</sup>	11.067 <sup>a</sup>	14.067 <sup>a</sup>	13.46 <sup>a</sup>	8.600 <sup>a</sup>	11.067 <sup>a</sup>	13.467 <sup>a</sup>	11.045 <sup>a</sup>	12.256 <sup>a</sup>	118	1:2.96
	F-test	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	-	-
	S.Ed (±)	<b>0.21</b>	<b>0.18</b>	<b>0.15</b>	<b>0.99</b>	<b>0.15</b>	<b>0.13</b>	<b>0.12</b>	<b>0.81</b>		-	-
	C.D.(P =0.5)	<b>0.450</b>	<b>0.382</b>	<b>0.320</b>	<b>2.129</b>	<b>0.332</b>	<b>0.269</b>	<b>0.249</b>	<b>1.737</b>	<b>1.650</b>	-	-

All the treatments were superior over control. The highest increased yield over control was recorded in Spinosad 45SC (184q/ha) followed by Flubendiamide 20% WG (152q/ha), Indoxacarb 14.5SC (138q/ha), Neem oil (105q/ha), Azadirachtin 0.03% EC (88q/ha), *Bacillus thuringiensis* 0.5% WP (85q/ha) and *Beauveria bassiana* 1% WP (77q/ha). When the cost-benefit ratio was worked out, an interesting result was achieved. Among the treatments studied, the best and most economical treatment was Flubendiamide 20% WG (1:6.12) followed by Spinosad 45SC (1:5.89), Indoxacarb 14.5SC (1:5.16), Neem oil (1:5.00), Azadirachtin 0.03% EC (1:4.89), *Bacillus thuringiensis* 0.5% WP (1:4.75), *Beauveria bassiana* 1% WP (1:4.43) and, as compared to control plot (1:2.96).

### **Conclusion:**

From the critical analysis of the present findings, it can be concluded that Spinosad 45% SC is more effective in controlling the larval population of the Diamondback moth followed by Flubendiamide 20% WG, Indoxacarb 14.5 SC, Neem oil, and Azadirachtin 0.03% EC in managing *Plutella xylostella*. Among the treatments studied, Flubendiamide 20% WG gave the highest cost-benefit ratio (1:6.12) and marketing yield (152q/ha) followed by Spinosad 45SC, Indoxacarb 14.5 SC, Neem oil, and Azadirachtin 0.03% EC, *Bacillus thuringiensis* 0.5% WP and *Beauveria bassiana* 1% WP respectively as such more trials are required in future to validate the findings which can be useful for the farmers in a feasible manner for sustainable production of cabbage. Therefore Botanicals and Biopesticides may be useful in devising a proper integrated pest management strategy against the Diamondback moth.

## REFERENCES

- Bhagat, P., Kerketta, A., and Yadu, Y.K. (2019).** Evaluation of botanicals against diamondback moth, *Plutellaxylostella* (Linn.) on cabbage (*Brassica oleracea* var. capitata L.) crop, 7(6):484-488.
- Devi, H.D and Tayde, A.R. (2017)** Comparative Efficacy of Bio-Agents and Botanicals on the Management of Diamondback Moth (*Plutellaxylostella* Linn.) on Cabbage under Allahabad Agro climatic Conditions; *International Journal of Current Microbiology and Applied Sciences*, 6(7):711-716.
- Feyissa, B. and Tebkaw, D. (2015)** Evaluation of four botanical insecticides against Diamondback moth, *Plutellaxylostella* L. (Lepidoptera: Plutellidae) on head cabbage in the Central rift valley of Ethiopia. *Sky J Agric Res.*, 4 (5): 97-105.
- Ghosh, S. K., Chaudhary, M, and Kumar, P. (2007)** Myco-jail a novel formulation of *Beauveria bassiana* for managing diamondback moth (*Plutellaxylostella*) in subtropical and tropical crucifer production systems. *The 6th International Workshop on Management of the Diamondback Moth and Other Crucifer Insect Pests*.
- Harcourt, D.G. (1963)** Major mortality factors in the population dynamics of the diamondback moth. *Mem Entomol Soc Can.*, 95 (32):55-56.
- Harika, G., Dhurua, S, Suresh, M, and Sreesandhya, N. (2019)** Evaluation of Certain Insecticides against Diamondback Moth (DBM) *Plutellaxylostella* on Cauliflower. *International Journal of Bio-resource and Stress Management*, 10(1):070-076.
- Haseeb, M., Liu, T.X. and Jones, W.A. (2004)** Effects of selected insecticides on *Cotesia plutellae* (Hymenoptera: Braconidae), a larval parasitoid of *Plutellaxylostella* (Lepidoptera: Plutellidae). *Biocontrol*, 49: 33-46.
- Maity, L., Padhi, G., and Samanta, A. (2018)** Population dynamics and management of diamondback moth *Plutellaxylostella* (L.) in cabbage ecosystem of West Bengal. *International Journal of Chemical Studies*, 6(1): 381-385.
- Oke, O.A., Charles, N. C., Ismael, C. and Lesperance, D. (2010)** Efficacy of botanical and biological method to control the diamondback moth (*Plutellaxylostella* L.) in cabbage (*Brassica oleracea* var. capitata L.) under open field conditions at Anse Boileau, Seychelles, *Journal of Agricultural Extension and Rural Development*, 2 (7): 141-143.
- Rahimgul, S. and Sasya, Th. (2016)** Efficacy of chemical insecticides and botanicals in the management of diamondback moth (*Plutellaxylostella*) in cabbage (*Brassica oleracea*

var.capitataL.).*InternationalJournalofMultidisciplinaryResearchandDevelopment*,  
3(6):101-104.

**Rokayya, S., Li, C.J., Zhao, Y., Li, Y. and Sun, C.H. (2013).** Cabbage (*Brassicaoleracea*L.var.capitata)PhytochemicalwithAntioxidantandAnti-inflammatorypotential.*AsianPacific Journal of Cancer Prevention*, 14(11): 6657-6662.

**Sharma, P., Kumawat, K.C., Khinchi, H.C., Kumar . V and Prasad,B.(2017)** Bioefficacyofdifferentinsecticidesagainstdiamondbackmoth;*InternationalJournalofChemicalstudies*, 5(3): 891-83.

**Stanikzi, R and Thakur, S. (2016)** Efficacy of chemical insecticides and botanicals in themanagementofdiamondbackmoth(*Plutellaxylostella*)incabbage(*Brassicaoleracea*var.*capitata*L.)*InternationalJournalofMultidisciplinaryResearchandDevelopment*3(6); 101-104.

**Vandenberg, J. D., Shelton, A. M., Wilsey, W. T., and Ramos, M. (2013).** Assessment of*Beauveriabassiana*SpraysforControlofDiamondbackMoth(Lepidoptera:Plutellidae)on Crucifers*Journal of EconomicEntomology*, 5(4): 122-125.

**Venugopal,U.,Kumar,A.,Satish,KandRamya,V.(2017)**,Efficacyofcertaininsecticidesagainst diamondback moth (*Plutellaxylostella*L.) on cabbage (*Brassica oleracea* Var.CapitataL, / agriculture update, *TECHSER*(6)/1612-161

**Yadav, R., Lyall, H., Choudhary, J.K. and Singh, D. (2017)** Efficacy of selected botanicalsand biopesticides against diamondback moth, *Plutellaxylostella*(Linn) on cabbage;*Internationaljournal ofAdvanced BiologicalResearch*,7 (1): 195-200

**Yadav, S.K., Raju, S.V.S., Yadav, M.K., Srivastava, A.K. and Dwivedi, P.K. (2017)** BioefficacyofnewinsecticidalmolesagainsttheDiamondbackmoth(*Plutellaxylostella*)oncauliflower *Journal ofExperimentalZoologyIndia*, 20(1):465-469.