International Journal of Plant & Soil Science

34(22): 1071-1076, 2022; Article no.IJPSS.91005
ISSN: 2320-7035

Efficacy of Certain Insecticides and Biopesticides against Dimondback Moth *Plutella xylostella* (Linnaeus) on Cabbage, *Brassica oleracea* (Linnaeus)

Mummareddy Vaishnavi [a*¥] and Anoorag R. Tayde [a#]

[a] *Department of Entomology Faculty of Agriculture Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj – 211007, Uttar Pradesh, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2022/v34i2231471

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/91005

Original Research Article

Received 16 June 2022
Accepted 24 August 2022
Published 27 August 2022

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 ($1X10^8$ 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 14.5 SC (1.223), and Neem oil (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 economical

[¥] *M.Sc. Scholar.*
[#] *Assistant Professor;*
**Corresponding author: E-mail: mummureddy12vaish@gmail.com;*

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) as compared to control plot (1:2.96).

Keywords: Botanicals; biopesticides; cabbage; efficacy; spinosad; Plutella xylostella.

1. 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 caboche, 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" [1].

"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 regions than the Mediterranean region. *Plutella xylostella* L. is a foreign pest" [2].

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 dose results in plundering of natural enemies" [3] and "development of insecticide resistance in *Plutella xyllostella* against a range of insecticide in different parts of India" (Talekar et al., 1990).

2. MATERIALS AND METHODS

The experiment was conducted during *rabi* 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 theresearch 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 3rd day,7th day, and 14th 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 theprevailing 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 obtainedby subtracting the income of the control treatment from that of each sprayed treatment.

2.1 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:

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

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

Larval Population count = ($Total\ no.of\ larvae$ × 100) / 5 $randomly\ selected\ plants$

B:C Ratio = $Net\ returns$ / $Total\ cost\ incurred$

Where, B:C Ratio = Benefit Cost Ratio

3. 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 respective 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 means the least larval population was observed in spinosad 45SC (0.66) followed by flubendiamide20%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 bassianna* 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 Rahimgul and Sasya [4], and Stanikzi and Thakur [5]. Flubendiamide 20% WG (0.934) is found to be the next best treatment which is in line with the findings of Sharma et al., [6], Harika et al., [7] and Maity et al., [8] 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 14.5 SC (1.223) is found to be the next best treatment which is in line with the findings of Yadav et al., [9]. Neem oil (1.667) is found to be the next effective treatment which is in line with the findings of Feyissa and Tebkaw [10], and Devi and Tayde [11]. 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., [12]. The result of *Bacillus thuringiensis* 0.5% WP (2.156) is in support of Oke et al., [13]. *Beauveriabassiana* 1% WP (2.211) is found to be least effective but comparatively superior over the control, these findings are supported by Ghosh et al., [14] and Vandenberg et al., [15].

Table 1. Efficacy of insecticides and biopesticides against Diamondback moth, *Plutella xylostella* on cabbage

S.No.	Treatments	The larval population of *Plutella xylostella*									Yieldq/ha	B: C
		First spray				Second spray				Overall mean		
		3 DAS	7 DAS	14 DAS	Mean	3 DAS	7 DAS	14 DAS	Mean			
T_1	Spinosad 45SC	2.533^{f}	1.867^{e}	1.733^{e}	0.667^{b}	1.200^{e}	0.933^{f}	0.667^{e}	0.933^{b}	0.8^{b}	302	1:5.89
T_2	Flubendiamide 20% WG	2.733^{ef}	2.133^{e}	1.800^{e}	0.8^{b}	1.333^{e}	1.067^{ef}	0.800^{e}	1.067^{b}	0.933^{b}	270	1:6.12
T_3	*Bacillus thuringiensis* 0.5% WP	4.200^{bc}	3.933^{b}	3.333^{b}	1.933^{b}	2.733^{b}	2.467^{b}	1.933^{b}	2.378^{b}	2.155^{b}	203	1:4.75
T_4	Indoxacarb 14.5 SC	3.00^{e}	2.733^{d}	2.267^{d}	1.067^{b}	1.733^{d}	1.333^{e}	1.067^{d}	1.378^{b}	1.222^{b}	256	1:5.16
T_5	Neem oil 3%	3.600^{d}	3.200^{c}	2.800^{c}	1.467^{b}	2.267^{c}	1.867^{d}	1.467^{c}	1.867^{b}	1.667^{b}	223	1:5.00
T_6	*Beauveria bassianna* 1% WP	4.533^{b}	4.133^{b}	3.600^{b}	2.00^{b}	2.933^{b}	2.333^{bc}	2.00^{b}	2.422^{b}	2.211^{b}	195	1:4.43
T_7	Azadirachitin 0.03% EC	3.933^{bc}	3.533^{c}	3.000^{c}	1.6^{b}	2.400^{c}	2.067^{cd}	1.600^{c}	2.022^{b}	1.811^{b}	206	1:4.89
T_0	Control	8.067^{a}	11.067^{a}	14.067^{a}	13.46^{a}	8.600^{a}	11.067^{a}	13.467^{a}	11.045^{a}	12.256^{a}	118	1:2.96
	F-test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	S	-	-
	S. Ed (±)	**0.21**	**0.18**	**0.15**	**0.99**	**0.15**	**0.13**	**0.12**	**0.81**		-	-
	C.D. (P = 0.5)	**0.450**	**0.382**	**0.320**	**2.129**	**0.332**	**0.269**	**0.249**	**1.737**	**1.650**	-	-

All the treatments were superior over control. The highest increased yield over control was recorded in Spinosad 45SC (184 q/ha) followed by Flubendiamide 20% WG (152 q/ha), Indoxacarb 14.5SC (138 q/ha), Neem oil (105 q/ha), Azadirachtin 0.03%EC (88 q/ha), *Bacillus thuringiensis* 0.5% WP (85q/ha) and *Beauveria bassiana* 1% WP (77 q/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).

4. 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 (152 q/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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Rokayya S, Li CJ, Zhao Y, Li Y, Sun CH. Cabbage (*Brassica oleracea* L. var. capitata) Phytochemical with Antioxidant and Anti-inflammatory potential. Asian Pacific Journal of Cancer Prevention. 2013;14(11):6657-6662.
2. Harcourt DG. Major mortality factors in the population dynamics of the diamondback moth. Mem Entomol Soc Can. 1963;95(32):55-56.
3. Haseeb M, Liu TX, Jones WA. Effects of selected insecticides on *Cotesia plutellae* (Hymenoptera: Braconidae), a larval parasitoid of *Plutella xylostella* (Lepidoptera: Plutellidae). Biocontrol. 2004;49:33-46.
4. Rahimgul S, Sasya Th. Efficacy of chemical insecticides and botanicals inthe management of diamondback moth (*Plutella xylostella*) in cabbage (*Brassica oleracea* var. capitata L.). International Journal of Multidisciplinary Research and Development. 2016;3(6):101-104.
5. Stanikzi R, Thakur S. Efficacy of chemical insecticides and botanicals in the management of diamondback moth (*Plutella xylostella*) in cabbage (*Brassica oleracea* var. capitata L.) International Journal of Multidisciplinary Research and Development. 2016;3(6):101-104.
6. Sharma P, Kumawat KC, Khinchi HC, Kumar V, Prasad B. Bioefficacy of different insecticides against diamondback moth; International Journal of Chemicalstudies. 2017;5(3):891-83.
7. Harika G, Dhurua S, Suresh M, Sreesandhya N. Evaluation of Certain Insecticides against Diamondback Moth (DBM) *Plutella xylostella* on Cauliflower. International Journal of Bio-resource and Stress Management. 2019;10(1):070-076.
8. Maity L, Padhi G, Samanta A. Population dynamics and management of diamondback moth *Plutella xylostella* (L.) in cabbage ecosystem of West Bengal. International Journal of Chemical Studies. 2018;6(1):381-385.
9. Yadav SK, Raju SVS, Yadav MK, Srivastava AK, Dwivedi PK. Bio- efficacy of new insecticidal molecules against the Diamondback moth (*Plutella xylostella*) on cauliflower Journal of Experimental Zoology India. 2017;20(1):465-469.
   Yadav R, Lyall H, Choudhary JK, Singh D. Efficacy of selected botanicals and biopesticides against diamondback moth, *Plutella xylostella* (Linn) on cabbage; International Journal of Advanced Biological Research. 2017;7(1):195-200.
10. Feyissa B, Tebkaw D. Evaluation of four botanical insecticides against Diamondback moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae) on head cabbage inthe Central rift valley of Ethiopia. Sky J Agric Res. 2015;4(5):97-105.

11. Devi HD, Tayde AR. Comparative Efficacy of Bio-Agents and Botanicals on the Management of Diamondback Moth (*Plutella xylostella* Linn.) on Cabbage under Allahabad Agro climatic Conditions; International Journal of Current Microbiology and Applied Sciences. 2017;6(7):711-716.
12. Bhagat P, Kerketta A, Yadu YK. Evaluation of botanicals against diamondback moth, *Plutella xylostella* (Linn.) on cabbage (*Brassica oleracea* var. capitata L.) Crop. 2019;7(6):484-488.
13. Oke OA, Charles NC, Ismael C, Lesperance D. Efficacy of botanical and biological method to control the diamondback moth (*Plutella xylostella* L.) in cabbage (*Brassica oleracea* var capitata L.) under open field conditions at Anse Boileau, Seychelles, Journal of Agricultural Extension and Rural Development. 2010; 2(7):141-143.
14. Ghosh SK, Chaudhary M, Kumar P. Myco-jail a novel formulation of *Beauveria bassiana* for managing diamondback moth (*Plutella xylostella*) in subtropical and tropical crucifer production systems. The 6th International Workshop on Management of the Diamondback Moth and Other Crucifer Insect Pests; 2007.
15. Vandenberg JD, Shelton AM, Wilsey WT, Ramos M. Assessment of *Beauveria bassiana* Sprays for Control of Diamondback Moth (Lepidoptera: Plutellidae) on Crucifers Journal of Economic Entomology. 2013;5(4):122-125.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/91005