Original Research Article

Efficacy of certain insecticides and biopesticides against Dimondback moth *Plutellaxylostella*(Linnaeus) ~~on~~ that feed on cabbage, *Brassica oleracea*(Linnaeus)

ABSTRACT

In order to evaluate the **efficacy of certain insecticides and biopesticides against Dimondback moth *Plutellaxylostella*,** ~~A~~ a field experiment was conducted in *Rabi* season of 2021 at Central research farm (CRF), Prayagraj, Uttar Pradesh, India. The experiment was ~~laid~~ done using ~~in~~ Randomised Block Design (RBD) with eight different treatments each replicated thrice using a Golden acer???. The eight treatments tested were Spinosad 45SC, Flubendiamide 20% WG, *Bacillus thuringiensis* 0.5% WP, Indoxacarb 14.5SC, Neem oil, *Beauveriabassiana*1% WP ($1X10^8$ CFU/gm), Azadirachtin 0.03%EC ~~and~~ against untreated Control. The data on the mean larval population ~~of~~ after first ~~spray~~ and second sprays~~, overall mean~~ revealed that all the treatments except untreated control are effective and at par???. Among all the treatments, the least larval population of Diamondbackmoth 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???), and the least effective *Beauveriabassiana*1% WP (2.211) ~~was the least effective among all treatments~~. ~~While,~~ The highest yield OF WHAT? 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). WHAT about yields of the other five?

~~When cost benefit ratio was worked out, 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??), *Beauveriabassiana*1% WP (1:4.43??) as compared to control ~~plot~~ (1:2.96??).

KEY WORDS: Botanicals, Biopesticides, Cabbage, Diamondback ~~k~~moth, Efficacy,Spinosad, *Plutellaxylostella*.

Comment [MOU1]: Is this comparison valid when concentrations
Of each treatment are different?

INTRODUCTION

After cauliflower,cCabbage 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 varcapitata*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 wide spread use in traditional medicine, in alleviation of symptoms associated with Gastrointestinal Disorders (gastritis, peptic and duodenal ulcers, irritable bowel syndrome)as well as in 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 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 fibre. 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)**.

*Plutellaxylostella*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. *Plutellaxylostella*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 dose results in plundering of

natural enemies **(Haseeb *et al.*, 2004)** and development of insecticide resistance in *Plutellaxyllostella* against a range of insecticide in different parts of India **(Talekar*et al.*, 1990)**.

What is plundering of natural enemies, why should there be resistance when dose is high?

METERIALS 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 was up to 47°C and the minimum temperature ~~was~~ recorded during winterwas up to 1.5°C. All necessary facilities for cultivation of crop was available at research farm.

The population of caterpillar was recorded on 5 plants randomly selected and tagged ~~from~~ at each plot. The population of P~~p~~lutellaxylostella was recorded 1 day before ~~1 day~~ spraying and on 3 day ,7 day and 14 dayS after insecticidal~~ividal~~??application.

The healthy marketable yield obtained from different treatments was collected separately andweighed.Thecostofinsecticidesusedinthisexperimentwasrecordedduringseasonof2020-2021. The cost of botanicals used was obtained from nearby market. The total cost of plantprotection consisted of cost of treatments, sprayer rent and labo~~u~~r charges for the spray. Therewere two sprays throughout the research period and the overall plant protection expenses werecalculated.Totalincomewasrealizedbymultiplyingthetotalyieldperhectarebytheprevailing market price, while the net benefit is obtained by subtracting the total cost of plantprotectionfromtotalincome.Benefitoverthecontrolforeachsprayedtreatmentwasobtainedbys ubtractingthe income~~of~~ from thecontrol (no treatment)from thatof eachsprayed treatment.
Tabulate the cost data

RESULTS AND DISCUSSION

All the insecticidal treatments were significantly superior to the untreated control in reducing the infestation of Dimondback moth on cabbage. The number of larvael~~population~~ recorded one day prior to the first spray was in the mean range of 5.200 to 4.533(Table.1) However one day after spray, a lower 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 others.

All the treatments significantly differed from the untreated control after first spray and reduction in the larval population of *Plutellaxylostella*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) ,were as highest larval population was recorded in *Bacillus thuringiensis*0.5% WP(1.933) as shown in Table 1.

Similarly after 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 *Beauveriabassianna*1% WP(2.422) as shown in Table 1.

The data on the mean larval population of 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 Diamondbackmothwas recorded in Spinosad 45SC (0.8). Similar findings made by**Rahimgul and Sasya (2016), 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)** they reported that Flubendiamide 20% WG (0.934) was found most effective in reducing larval population of Diamondbackmothas 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.*, (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), 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) which is in support with**Oke*et al.*, (2010).***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.*, (2007) and Vandenberg *et al.*, (2013).**

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Comment [MOU2]: WRITE less confusing simple sentences

Table1:Efficacyofinsecticides and biopesticides against Dimondback moth, *Plutellaxylostella*on cabbage

S.No.	Treatments	Larval population of *Plutellaxylostella*										Yield q/ha	B: C
		First spray					Secondspray				Overallmean		
		1DBS	3DAS	7DAS	14DAS	Mean	3DAS	7DAS	14DAS	Mean			
T_1	Spinosad 45SC	5.200	2.533	1.867	1.733	0.667	1.200	0.933	0.667	0.933	0.8	302	1:5.89
T_2	Flubendiamide 20% WG	5.00	2.733	2.133	1.800	0.8	1.333	1.067	0.800	1.067	0.933	270	1:6.12
T_3	*Bacillus thuringiensis* 0.5% WP	4.800	4.200	3.933	3.333	1.933	2.733	2.467	1.933	2.378	2.155	203	1:4.75
T_4	Indoxacarb 14.5 SC	5.067	3.00	2.733	2.267	1.067	1.733	1.333	1.067	1.378	1.222	256	1:5.16
T_5	Neem oil 3%	5.067	3.600	3.200	2.800	1.467	2.267	1.867	1.467	1.867	1.667	223	1:5.00
T_6	*Beauveriabassianna*1% WP	4.533	4.533	4.133	3.600	2.00	2.933	2.333	2.00	2.422	2.211	195	1:4.43
T_7	Azadirachitin 0.03% EC	4.8	3.933	3.533	3.000	1.6	2.400	2.067	1.600	2.022	1.811	206	1:4.89
T_0	Control	4.933	8.067	11.067	14.067	13.467	8.600	11.067	13.467	11.045	12.256	118	1:2.96
	F-test	**NS**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	S	-	-
	S.Ed (±)	**0.25**	**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**	-	-

What are the abbreviations DBS, DAS WP?? S, C.D. , ECT. THE data is neither clear nor convincing. It is suggested that it be plotted

As graphs with mean and standard deviations

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 *Beauveriabassiana*1% WP (77q/ha). When cost benefit ratio was worked out, 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), *Beauveriabassiana*1% WP (1:4.43) and, as compared to control plot (1:2.96).

From the critical analysis of the present findings, it can be concluded that Spinosad 45SC is more effective in controlling larval population of Diamond backmoth followed by Flubendiamide 20% WG, Indoxacarb 14.5 SC, Neem oil and Azadirachtin 0.03%EC in managing *Plutellaxylostella*. 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 *Beauveriabassiana*1% WPrespectively 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 proper integrated pest management strategy against diamondback moth.

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