Comparative Efficacy and Economics of Biopesticides with EmamectinBenzoate against Diamondback Moth, *Plutellaxylostella*(L.) in Cabbage, *Brassica oleraceavar. Capitata* (L.)

ABSTRACT

A field trial was conducted during *rabi* season 2023-2024 at Central Research Farm (CRF), Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, Uttar Pradesh. The experiment was laid out in Randomised Block Design (RBD) with eight treatments each replicated thrice using a variety Green Soccer (546). The treatments *viz.,*Emamectin benzoate 5% SG, *Bacillus thuringiensis* 5.0% WP, Spinosad 02.50 % SC, *Verticillium lecanii* 5.0% SC, Neem seed kernel extract 5%, *Beauveria basssiana* 1x 10^8CFU/ml, Azadirechtin 00.03 % WSP and along with an untreated control against *plutellaxylostella* in cabbage.The data on larval population of Diamond back moth over control on first and second spray overall mean revealed that all treatments were significantly superior over control.Amomg all the treatments minimum larval population was recorded in in T_3 Spinosad 02.50 %SC (1.045) followed by T_1 Emamectin benzoate5%SG (1.212),T_2*Bacillus thuringiensis* 5.0% WP (1.345),T_6 *Beauveria bassiana* 1x 10^8 CFU/ml (1.512),T_4 *Verticillium lecanii*5.0 % SC (1.667),T_5 Neem seed kernel extract 5 % (1.934),T_7Azadirechtin 00.03 % WSP (2.133).While, the highest yield (298q/ha) was obtained from the treatment T_3spinosad 02.50%SC as well as B:C ratio (1:5.76) was obtained high from this treatment. It followed by T_1 Emamectin benzoate 5%SG (276q/ha) (1:5.53),*T_2 Bacillus thuringiensis* 5.0% WP (269q/ha)(1:5.42),T_6 *Beauveria bassiana*1x 10^8CFU/ml (259q/ha) (1:5.24), T_4 *Verticillium lecanii*5.0% SC(249q/ha)(1:5.04), T_5 Neem seed kernel extract 5% (233q/ha)(1:4.65), T_7Azadirechtin 00.03 % WSP(215q/ha)(1:4.42) and the lowest yield and B:C ratio is recorded in T_0 Control (186q/ha) (1:4.05).

Keywords: Biopesticides; Emamectin benzoate 5% SG; Plutellaxylostella; Spinosad 2.5%SC.

1. INTRODUCTION

Cabbage, (*Brassica oleracea* var *capitata* L.) an herbaceous plant of Family *Brassicaceae*, is a widely cultivated vegetable throughout the world as a longstanding dietary supplement. It has numerous health benefits that have increased its popularity all over the world.(Maity *et al*.,2018).

Brassica oleracea used like food and in herbal medicine. Cabbage juice can reduce constipation and has also been used as a laxative, as an antidote to mushroom poisoning, or a treatment for hangovers and headaches. In fact, cabbage has historically been used to stop sunstroke, or to relieve fevers. The leaves were also used to soothe swollen feet and to treat childhood croup. *Brassica* vegetables have also anti-inflammatory activity and have been used to different irritations of the human body(Alexandra *et al.,* 2020).

Regular consumption of dark green leafy vegetables is highly recommended because of their potential in reducing chronic diseases. (Miller-Ceberet*et al.,*2009)and glucosinolates in cabbage reduced risk of cancer induction and development. (Kang *et al.,*2006).

Cabbage cultivation is good at mainly on sandy to heavy soils rich in organic matter. Early crops desire light soil while late crops flourish better on heavier soils because of holding the moisture. On heavy soils, plants grow more slowly and the keeping quality is improved. A P^H range of 6.0-6.5 is considered as optimum for growing cabbage. Plants growing in saline soils are prone to diseases. In India, cabbage is grown in large areas having a cool and moist climate. The temperature range of 15^o-21^o C is considered as optimum for growth and head formation of the crop. The intensity of flowering depends upon the age of the plants and the period for which they are exposed to low temperatures (National Horticulture Board, 2018).

In 2020, world production of cabbages was 71 million tones, led by China with 48% of the world total (table). Other substantial producers were India, Russia, and South Korea.UN food and Agriculture Organization, Corporate Statistical Database (FAOSTAT). 2022. India is the largest producer of cabbage after China. India accounts for 8755000 tons of productivity in an area of 388000/ha. In India, Uttar Pradesh accounts for production of 5.7 million tones in an area of 0.72 million ha. (Kommojji and Tayde,2022).

The major insect pests, which cause maximum yield losses in cabbage are diamond back moth (*Plutellaxylostella* L), cabbage butterfly, (*Pieris brassicae* L), cabbage aphid (*Brevicorynebrassicae* L.), cabbage semilooper (*Trichoplusiani*), leaf webber (*Crocidolomiabinotalis*), cabbage head borer, (*Hellulaundalis* Fab.). Diamondback moth is the most destructive pest in cabbage growing areas and the yield loss were reported up to 52% in India (Krishnamoorthy, 2004).

However, the set back to optimum cabbage production is the attack of insect pests, the most important of which is the diamond back moth (DBM), *Plutellaxylostella* which has become a single limiting factor in the production of quality heads. It is one of the most destructive insect pests of cruciferous vegetables, currently accounting for US$2.7 billion worth of annual worldwide crop losses. Management of this pest depends largely on imposing heavy quantities of synthetic chemical pesticides all over the world.The DBM has developed resistance to all major classes of insecticides(Maity *et al*., 2018).

1. To evaluate the efficacy of biopesticides with Emamectin benzoate on the larvalpopulation ofdiamondback moth *Plutellaxylostella*(L.) in cabbage.
2. To calculate the cost benefit ratio (C:B) of the treatments.

2. MATERIALS AND METHODS

The experiment was conducted during *rabi* season in 2023-2024 at Central Research Farm (CRF), at Sam Higginbottom University of Agriculture,Technology and Sciences(SHUATS), Prayagraj, Uttar Pradesh (U.P) in a Randomized Block Design with eight treatments replicated three times using variety Green soccer-546 in a plot size of (2m x 1m) maintaining 0.3m borders as a bund with total gross area 105.6m^2 along with a recommended package of practices excluding plant protection.The site was uniform, cultivable with typical sandy loam soil having good drainage.

The treatments used in this experiment were Emamectin benzoate 5%SC, *Bacillus thuringiensis* 5.0% WP, Spinosad 02.50% SC, *Verticillumlecanii*5.0%SC, *Beauveria bassiana* 1x10^8CFU/ml, Neem seed kernel extract 5%, Azadirechtin 00.03% WSP(300 ppm) along with untreated control.against diamond back moth As the ETL 2-3 larvae per plant were crossed and application of the two rounds of insecticidal treatments were applied at 15 days interval(Devi and Tayde.,2017).

The insect population was counted from randomly selected plants in every plot and population per 5 plants was noted.After that mean of three replications was calculated for each treatment and the same was done with the untreated plot . The population of Plutellaxylostella was recorded before 1 day spraying and on 3^{rd} day ,7^{th} day and 14^{th} day after insecticidal application.Healthy cabbage heads

were harvested and their weight from each treatment was expressed as marketable yield in quintal per hectare. Ultimately, the cost benefit ratio was calculated on the basis of prevailing market price of yield, insecticides and spraying cost.

$$\text{Larval population} = \frac{\text{Number of Larvae}}{\text{Total number of } selected\ plants}$$ Mane *et al*. (2021)

Economics:

$$\text{Cost Bene it ratio} = \frac{\text{Gross Returns (t/ha)}}{\text{Total Cost of cultivation(t/ha)}}$$

Nikitha *et al.* (2021)

3. RESULTS AND DISCUSSION

The data on the larval population of diamondback moth *P. xylostella*in cabbage 3rd,7th and 14th day after first spray revealed that all the chemical treatments, were significantly superior over control. Among all the treatments lowest larval population was recorded in T_3 Spinosad 02.50 %SC (1.445) was recorded in Reddy *et al*.(2018), T_1 Emamectin benzoate 5%SG (1.556),T_2 *Bacillus thuringiensis* 5.0% WP (1.689), T_6 *Beauveria bassiana* 1x 10^8 CFU/ml (1.867), T_4 *Verticillium lecanii* 5.0 % SC (2.022), T_5 Neem seed kernel extract 5 % (2.289), T_7Azadirecthin 00.03% WSP(2.444) and T_0 control(3.511).

The data on the larval population of diamondback moth *P. xylostella*in cabbage 3rd,7th and 14th day after second spray revealed that all the chemical treatments, were significantly superior over control. Among all the treatments lowest larval population was recorded in in T_3 Spinosad 02.50 %SC (0.645), T_1 Emamectin benzoate 5%SG (0.867),T_2 *Bacillus thuringiensis* 5.0% WP (1.000), T_6 *Beauveria bassiana*1x 10^8 CFU/ml(1.156), T_4*Verticillium lecanii*5.0% SC(1.311), T_5 Neem seed kernel extract 5 % (1.578), T_7Azadirechtin 00.03 % WSP(1.822) and T_0 control(3.889).

The data revealed on population of *P. xylostella*over control on Overall mean revealed that all the treatments were significantly superior over control (3.700). Among all the treatments minimum larval population was recorded in in T_3 Spinosad 02.50 %SC (1.045)similarlyrcorded in Venugopal *et al*.(2017) T_1 Emamectin benzoate5%SG (1.212)similarly recorded in Harika *et al*.(2019), T_2 *Bacillus thuringiensis* 5.0% WP (1.345) ,T_6 *Beauveria bassiana* 1x 10^8 CFU/ml (1.512) ,T_4 *Verticillium lecanii*5.0 % SC (1.667), T_5 Neem seed kernel extract 5 % (1.934), T_7Azadirechtin 00.03 % WSP (2.133)similarly recorded in Puja *et al.* (2010).

All the insecticides were found very effective and significantly superior over control. The minimum larval population and the highest yield was recorded in T_3 Spinosad 02.50%SC (298q/ha) was recorded in Lal *et al.* (2021) T_1 Emamectin benzoate5%SG (276q/ha) Patel *et al*.(2020), T_2 *Bacillus thuringiensis* 5.0% WP (269q/ha),T_6 *Beauveria bassiana*1x 10^8CFU/ml (259q/ha) was similarly recorded in Khan and Tayde, (2022), T_4 *Verticillium lecanii* 5.0% SC (248q/ha), T_5 Neem seed kernel extract 5% (233q/ha) similarly recorded in Kumar and Kumar,(2020), T_7Azadirecthtin 00.03% WSP (215q/ha) and the lowest yield is recorded in T_0 Control (186q/ha).

When cost benefit ratio worked out, interesting result was achieved, among the treatment studied, the best and most economical treatment is in T_3 Spinosad 02.50%SC (1:5.76) similarly recorded in Yadav *et al*.(2017), followed byT_1 Emamectin benzoate 5%SG (1:5.53) was recorded in Kumar and Devappa, (2006),T_2 *Bacillus thuringiensis* 5.0% WP (1:5.42) T_6 *Beauveria bassiana* 1x 10^8CFU/ml (1:5.24), T_4 *Verticillium lecanii* 5.0% SC (1:5.04) recorded in G Laxman *et al.* (2019), T_5 Neem seed kernel extract 5 % (1:4.65), T_7Azadirechtin 00.03 % WSP (1:4.42) and T_0 Control (1:4.05).

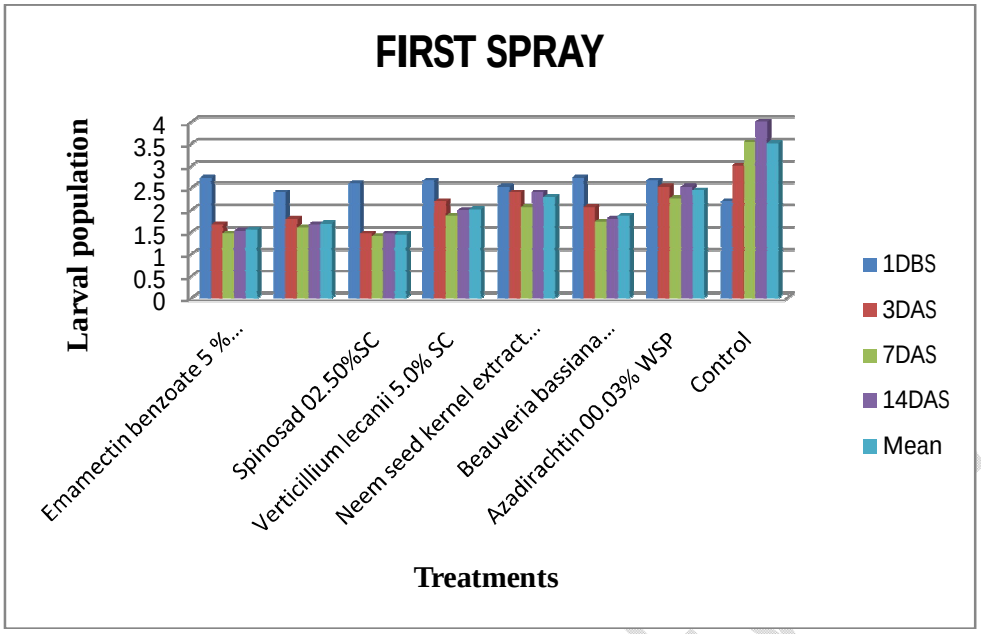

Fig. 1.Assessment of insecticides against diamondback moth,*Plutellaxylostella*in cabbage (1st spray)

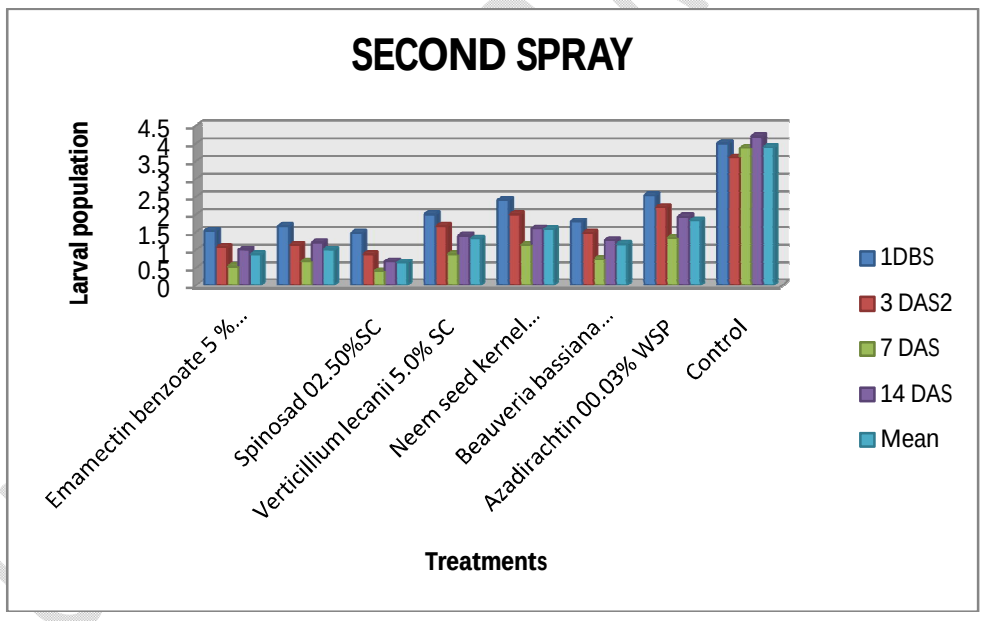

Fig. 2. Assessment of insecticides against diamondback moth,*Plutellaxylostella*(L.) in cabbage (2nd Spray)

Table1. Efficacy of biopesticides with Emamectin benzoate on the larval population of *P.xylostella* in cabbage, Yield and Cost Benefit ratio

	Treatments	Larval population of diamond back moth per five cabbage heads									Overall Mean	Yield (q/ha)	C:B Ratio
		1st Spray					2nd Spray						
		1DBS	3 DAS	7 DAS	14 DAS	Mean	3 DAS	7 DAS	14 DAS	Mean			
T1	Emamectin benzoate5%SG	2.733	1.667	1.467	1.533	1.556	1.067	0.533	1.0	0.867	1.212	276	1:5.53
T2	*Bacillus thuringiensis*5.0% WP	2.4	1.8	1.6	1.667	1.689	1.133	0.667	1.2	1.000	1.345	269	1:5.42
T3	Spinosad 02.50 % SC	2.6	1.467	1.4	1.467	1.445	0.867	0.4	0.667	0.645	1.045	298	1:5.76
T4	*Verticillium lecanii*5.0% SC	2.667	2.2	1.867	2.0	2.022	1.667	0.867	1.4	1.311	1.667	248	1:5.04
T5	Neem seed kernel extract 5 %	2.533	2.4	2.067	2.4	2.289	2.0	1.133	1.6	1.578	1.934	233	1:4.65
T6	*Beauveria bassiana*1x10^{8}CFU/ml	2.733	2.067	1.733	1.8	1.867	1.467	0.733	1.267	1.156	1.512	259	1:5.24
T7	Azadirachtin 00.03% WSP	2.667	2.533	2.267	2.533	2.444	2.2	1.333	1.933	1.822	2.133	215	1:4.42
T8	Control	2.2	3.0	3.533	4.0	3.511	3.6	3.867	4.2	3.889	3.700	186	1:4.05
	F-test	NS	S	S	S	S	S	S	S	S	S		
	S. Ed. (±)	0.269	0.106	0.054	0.118	0.173	0.102	0.081	0.057	0.167	0.222		
	C.D.(P= 0.05)	-	0.231	0.121	0.185	0.372	0.221	0.177	0.121	0.358	0.645	-	-

4. CONCLUSION

From the analysis of present study finding, it was concluded that among all treatment Spinosad 02.50%SC recorded best and proved best effective for Diamondback moth,(*Plutellaxylostella*) and Emamectin benzoate,5% SG proved the 2nd effective followed by *Bacillus thuringiensis* 5.0% WP , *Beauveria bassiana*1x 10^8CFU/ml , *Verticillium lecanii* 5.0% SC in managing (*Plutellaxylostella*) in cabbage (*Brassica oleracea*) on mean larval population. Therefore, the botanicals *i.e* Neem seed kernel extract 5% andAzadirechtin 00.03 % WSP may be useful in devising proper integrated pest management strategy against on Diamond Back Moth *(Plutellaxylostella*).

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