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Ecofriendly management of Diamondback Moth, *Plutella xylostella* (Linn.) on Cabbage and Cauliflower in district Gurugram, Haryana

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ABSTRACT

A field based investigation was carried out for ecofriendly management of the insect pest *Plutella xylostella* (L.) on cabbage and cauliflower at identified 'hot spot'- Khanpur village of Pataudi block in Gurugram district, Haryana. Among treatments, newer insecticides of microbial origin, Spinosad 45% SC and Emamectin benzoate 5% S.G showed highest reduction in larval population of *P. xylostella* on both the crops with lowest number of larval count over control. Performance of biopetsicide, *Beauveria bassiana* is also noteworthy while in neem based formulations, neem oil showed remarkable reduction as compared to Neem Seed Kernel Extract (NSKE) resulted 65.79%, 58.82% and 67.84%,63.85% on cabbage and cauliflower respectively. All the treatments were observed significantly over control.

Key words*: Plutella xylostella (L.), Spinosad, Emamectin benzoateand Beauveria bassiana*

Introduction

The cole crops, cauliflower (*Brassica oleracea var.botrytis*) and cabbage (*Brassica oleracea var. capitata*) are the most popular and widely grown vegetables all over in the world. Being short duration crops can be grown in succession throughout the year (Khonje, 2013) and contribute significantly to the national and regional income of rural youth (Ekesi *et al*., 2009). In order to improve the quality and quantity, it is essential that production of these vegetables should be increased considerably (Singh, *et al.*, 2018) which is known to hampered by major pest, diamond back moth, *Plutella xylostella* L. (*Plutellidae*: *Lepidoptera*) in more than 100 countries across the globe affects cruciferous plants especially *Brassica oleracea* crops such as cauliflower, cabbage, broccoli, brussels sprouts, turnip, this pest known for serious yield losses to crucifers (Grzywacz *et al.*, 2010). In India, the estimated annual crop losses due to this pest is up to 16 million USD (Mojan *et al*., 2003).

Out of ignorance the farmers are generally using synthetic insecticides for controlling *P. xylostella* (Kibata, 1996). This pest has developed resistance against all major groups of pesticides including *Bacillus thuringiensis* bacterial based biopesticides (Tabashnik *et al*., 1990; Zhou *et al*., 2011). In India, Krishnamoorthy in (2004) reported that 52% yield loss on cauliflower due to *P. xylostella.*

The farmers are compelled to use chemical insecticides in order to cultivate lucratively while traditional and cultural practices alone cannot give satisfactory control over the pest menace. Indiscriminate use of chemical insecticides at higher doses results in development of insecticidal resistance in *P. xylostella* against a range of insecticides in different parts of India (Talekar *et al*., 1990 and Vastrad *et al*., 2003). This has necessitated the use of alternative eco-friendly insecticides to manage the major pest by using the safe molecules and bio-pesticides viz., Neem Seed Kernel Extract (NSKE) 5%, Neem oil 300 ppm, *Beauveria bassiana*, Emamectin benzoate 5% SG, Spinosad 45% SC etc. under field condition for their comparative efficacy against *P. xylostella*.

Materials and Methods

The field experiment was laid out during Rabi season 2018-2019 in a Randomized Block Design (RBD) with six treatments including untreated control, each replicated thrice with cabbage. *var Golden acre* and Cauliflower *var. Pusa samradhi* at Khanpur Village under Pataudi block of Gurugram district of Haryana, India. Each treatment scheduled comprised of two sprays, except treatment number six which was taken as untreated control. The present study was carried out to evaluate the bio efficacy of neem products viz.NSKE 5 % @ 5 ml/l, Neem oil 300 ppm @ 10 ml/l along with bio-insecticides such as *Beuveria bassiana* @ 1 g/l, Emamectin benzoate 5% SG @0.2 g/l, and Spinosad 45% SC @ 0.5 ml/l water.

Required number of plots having a size of 3.5×4.0 m were prepared to accommodate all the six treatments with three replications in which two main irrigation channels of 1.0 meter width between two length sides of experimental plots, two sub irrigation channels 1.0 meter were provided in between three replications and plots were separated by trench of 0.5 meter space to abide drifting of different insecticides during spraying was reduced separately.

All the treatments were sprayed with the help of Knapsack sprayer, the 1st spray was applied after 25 days of transplanting during the month of November 2018 and 2nd spray was repeated after 15 days of 1st spray. To calculate the larval population of Diamond back moth, *P. xylostella*, direct visual counting method was used (Lal, 1998). The mean number of larvae of the pest was recorded from randomly 10 selected plants, each plot and the same was expressed as number of larval population/10 plants during morning hours between 8 AM to 10 AM when the pest population are known to be less active. The observations on Diamond back moth (DBM) population were recorded at weekly interval to monitor the Economic Threshold Level (ETL) of the pest for timely application of bio insecticides. Pretreatments counts of the larvae of DBM were taken one day prior in all the plots at each time of the spray. Post treatment count of DBM larvae were taken after 5 days and 10 days of spraying. Similar observations were also recorded after 2nd application of spraying.

The observations of target pest infestation in cabbage and cauliflower crops and mortality percentage of larval population were recorded and analyzed.

The following formula used for the calculation of percentage reduction of pest population over control (Henderson and Tilton, 1955) referring it to be modification (Abbott, 1925).

$$\text{Percent efficacy} = \left(1 - \frac{Ta}{Ca} \times \frac{Cb}{Tb}\right) \times 100$$

Where,

Ta= Number of insects on treated plots after bio insecticidal spray

Tb= Number of insects in treated plots before bio insecticidal spray

Ca= Number of insects in untreated plots after bio insecticidal spray

Cb= Number of insects in untreated plots before bio insecticidal spray. The percent reduction figures were transformed into angular values (Bliss, 1937) and subjected to analysis of variance $\sqrt{x+0.5}$, (Gomez and Gomez, 1976).

Results

Population distribution of *P. xylostella* on cabbage and cauliflower in district Gurugram

The larval population *P. xylostella* on cabbage and cauliflower was maximum in Pataudi Block it was 12.14 and 14.16 respectively which was subsequently low in Sohna, Farukhnagar and Gurugram in both the cole crops (Table 1) which is represented in Fig. 1.

Effect of different treatments in reduction of larval population of *P. xylostella* on cabbage.

The target insect pest *P. xylostella* was controlled by the application of all 5 treatments however maxi-

Table 1. Larval population of *Plutella xylostella* (L.) on cauliflower and cabbage in district Gurugram, Haryana

Locations(Blocks)	Cauliflower Mean/10 Plants *P. xylostella*	Cabbage Mean/10 Plants *P. xylostella*
Farukhanagar	12.82	10.96
Patudi	14.16	12.14
Sohana	8.72	8.25
Gurugram	7.92	6.58

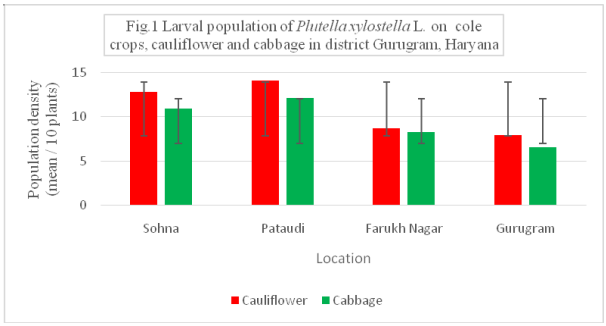

Fig. 1. Larval population of *Plutella xylostella* (L.) on cole crops, cauliflower and cabbage in district Gurugram, Haryana

mum management was recorded (77.33%) in Spinosad 45% SC treatment applied in cabbage crop followed by Emamectin benzoate 5% SG (72.66%). Among the neem formulations, neem oil 300 ppm applied (65.79%) found better than neem seed kernel extract 5% (58.82%) (Table 2). Fungal biopesticide, *Beuveria bassiana* was found to be in the middle order effectin the management pest population of *P.xylostella*, infesting cabbage (Table 2).

Effect of different treatments in reduction of larval population of *P.xylostella* on cauliflower

In case of cauliflower *P.xylostella*, infestation was little bit more hence the application of treatments were applied to that resulted higher management over the control but the trend found was almost similar such as Spinosad 45% SC resulted effective management of *P.xylostella*, (82.98%) followed by Emamectin benzoate 5% SG (79.52%). In case of *B. bassiana* it showed middle order effect as in case of cabbage also was observed. However neem oil 300ppm showed better control result than NSKE 5% (Table 3).

Discussion

A roving survey of district Gurugram was carried

Table 2. Efficacy of different treatments in reduction of larval population of*Plutella xylostella*(L.) infesting cabbage.

S. N.	Treatments	Dose	DBS	No. of *P. xylostella* (L.) larvae, Mean / 10 plants of cabbage									
				First Spray			Second Spray						
				5 DAS	Reduction over control (%)	10 DAS	Reduction over control (%)	5 DAS	Reduction over control (%)	10 DAS	Reduction over control (%)	Average larval count	Average Reduction over control (%)
1.	NSKE 5%	5 ml/ 1	8.98 (3.07)	3.74(2.05)	62.06	4.54(2.24)	58.30	5.34(2.42)	54.17	4.42(2.22)	60.78	4.51(2.24)	58.82
2.	Neem oil 300 ppm	10ml/1	7.02(2.74)	2.54(1.74)	67.04	2.88(1.84)	66.12	3.46(1.98)	62.02	2.82(1.82)	67.99	2.92(1.84)	65.79
3.	*Beauveria bassiana*	1g/1	6.08(2.56)	1.82(1.52)	72.73	2.38(1.70)	67.72	2.78(1.81)	64.76	2.12(1.61)	72.22	2.27(1.66)	69.35
4.	Emamectin benzoate 5% S.G.	0.2g/1	8.74(3.03)	2.24(1.65)	76.65	3.12(1.90)	70.56	3.54(2.00)	68.78	2.78(1.81)	74.65	2.92(1.85)	72.66
5.	Spinosad 45% S.C.	0.5 ml/1	10.36(3.39)	2.48(1.65)	78.20	2.98(1.86)	76.28	3.42(1.98)	74.55	2.56(1.75)	80.31	2.86(1.83)	77.33
6.	Untreated/ control	—	10.82(3.36)	11.88(3.52)	—	13.12(3.69)	—	14.04(3.82)	—	13.58(3.75)		13.15(3.69)	
	SE(m)±		0.141	0.078		0.212		0.148		0.169		0.159	
	CD (P=0.05)		0.450	0.249		0.676		0.472		0.541		0.507	

DBS= Days before spray, DAS= Days after spray, Figures in parentheses are transformed values.

Table 3. Efficacy of different treatments in reduction of larval population of *Plutella xylostella* (L.) infesting cauliflower.

S. N..	Treatments	Dose	DBS	No. of *P. xylostella* larvae, Mean / 10 plants of cauliflower									
				First Spray				Second Spray					
				5 DAS	Reduction over control (%)	10 DAS	Reduction over control (%)	5 DAS	Reduction over control (%)	10 DAS	Reduction over control (%)	Average larval count	Average Reduction over control (%)
1.	NSKE 5%	5 ml/ 1	8.76(3.04)	3.25(1.94)	65.70	3.95(2.11)	60.08	3.77(2.07)	64.61	3.60(2.02)	65.01	3.64(2.03)	63.85
2.	Neem oil 300 ppm	10 ml/1	12.08(3.55)	4.15(2.16)	68.23	4.76(2.29)	65.12	4.84(2.31)	67.05	4.12(2.15)	70.95	4.47(2.23)	67.84
3.	*Beauveria bassiana*	1g/1	9.35(3.14)	2.62(1.77)	74.09	3.02(1.88)	71.41	3.13(1.90)	72.47	2.79(1.81)	74.59	2.89(1.84)	73.14
4.	Emamectin benzoate 5% S.G.	0.2 g/1	10.02(3.24)	2.13(1.62)	80.34	2.42(1.71)	78.62	2.66(1.78)	78.17	2.24(1.65)	80.96	2.36(1.69)	79.52
5.	Spinosad 45% S.C.	0.5 ml/1	12.74(3.64)	2.19(1.64)	84.11	2.51(1.73)	82.56	2.93(1.85)	81.09	2.37(1.69)	84.16	2.50(1.72)	82.98
6.	Un treated/ control	—	12.96(3.67)	14.02(3.81)	—	14.64(3.89)	—	15.76(4.03)	—	15.22(3.96)		14.91(3.92)	
	SE(m)±		0.287	0.144		0.159		0.101		0.217		0.110	
	CD (P=0.05)		0.915	0.459		0.507		0.323		0.692		0.352	

DBS= Days before spray, DAS= Days after spray, Figures in parentheses transformed values.

out during Rabi season during 2018-2019-in four blocks, Sohana, Pataudi, Farukhnagar and Gurugram for assessing population distribution ofinsect pest, *P.xylostella* on cabbage and cauliflower. Out of these areas, Pataudi block was found to have more infestation of *P. xylostella* followed by Farukhnagar, Sohna and Gurugram blocks (Table 1 and Figure 1). Diamond Back Moth (DBM) is the single most destructive pest of cole crops and leafy vegetables. The entire infested plant may become riddled with holes under moderate to heavy populations. Larvae also feed in the developing heads of both the crops (Devi *et al.,* 1995).

Chemical pesticides, however, remain the prime approach for managing insect pests worldwide. As per the present scenario, its uses increasing in response to meet a demand of food production (Tilman *et al*., 2001). Out of ignorance, the growers are using chemical insecticides without level claim viz. Phorate, Diamethoate, Cypermethrin and Monocrotophos which are not recommended for combating insect pests of vegetables. The present investigation is an effort towards ecofriendly management of the insect pest *P. xylostella* a major pest of cole crops in India and aboard.

In the field based investigation, however maximum management of *P.xylostella* on cabbage was recorded in Spinosad 45% SC and second highest by Emamectin benzoate 5% SG. Among neem based formulations, neem oil 300 ppm found better than neem seed kernel extract 5% (Table 2). Result probably indicates the concentrated form of azadiractin with other metabolites were found more effective against larval population of *P. xylostella* under the field conditions while fungal biopesticide, *Beuveria bassiana* was found to be in the middle order effect in the management pest population of *P.xylostella*, infesting cabbage (Table 2).

The trend was same in case of cauliflower similar such as Spinosad 45% SC showed effective management of *P. xylostella* followed by Emamectin benzoate 5% SG and middle order effect in treatment of *B. bassiana*. However neem oil showed better control than neem seed kernel extract (Table 3). The reasons behind such results have been explained above. Singh *et al.* (2018) reported out of seven neem based bio-pesticides against *P.xylostella*, NSKE 5% was quite effective followed by Nimbicidin sprays. The cost benefit ratio was maximum in NSKE (1:15.16) in cabbage and (1:14.60) cauliflower (Table 3).

Thangavel *et al.* (2018) evaluated toxicity of

Emamectin benzoate 5% SG and Spinosad 45% SC was found most safe to egg parasitoid. Stanikzi *et al.*, (2016) reported that the maximum reduction of larval population of DBM on cabbage was recorded in Spinosad 45% SC, (49.40%) which was superior over control followed by Emamectin benzoate 5% SG (42.70%). Similarly highest yield was recorded in Spinosad 45% SC (187.60 q/ha). NSKE (39.10%) and neem oil (39.60 q/ha) were middle order effect against *P.xylostella*.

Mandal and Mandal, (2009) found that Cartap hydrochloride was most effective to control DBM followed by Spinosad and Imidachloprid. However, Satpathy *et al.* (2005) reported that Chlorphenapyr, a new insecticide showed promising results in controlling DBM on Cabbage and enhanced the yield.

Meena *et al.* (2011) tested six insecticides against DBM Cartap hydrochloride was found excellent treatment followed by Lambda cyhalothrin and Imidachloprid that enhanced yield of cole crops with high cost benefit ratio.

The present investigation revealed that Spinosad and Emamectin benzoate were found highly effective for safe and cost effective to growers which are advisable for growers in the management of *P. xylostella* at field level.

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