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Study on the population dynamics and management of *Diamondback moth* (*Plutella xylostella*) on cabbage

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Abstract
Studies on population dynamics and management of diamond backmoth, *Plutella xylostella* (Linnaeus) on cabbage revealed that the pest population of *Plutella xylostella* (Linnaeus) appeared from third week December which gradually increased and attained a peak of 8.90 larvae per plant during fourth week January. It indicated that the pest was more active during the month of January. Later on, the pest population declined gradually towards the maturity of the crop. Among the different weather parameters, maximum temperature exhibited highly significant positive correlation (0.839) with *P. xylostella.* Whereas, remaining all the weather parameters showed non-significant correlation. In the management the maximum damage, maximum yield and larval population over control was observed in Chlorantraniliprole 18.5 SC followed by Emamectin Benzoate 5 SG. Two sprays were found more effective in controlling *P. xylostella* than single spray.

Keywords: Bio-efficacy, DBM, ETL, population dynamics, weather parameters

Introduction
Cabbage is a high yielding and remunerative Rabi vegetable crop. India is the second largest producer of vegetables next to China in the world and India contribute 14% of the total word production of vegetable. In India, it is grown on the area of 10436 hactare and 187474million tonnes with the productivity of 15 ton/hac during 2021-22 (National Horticulture Board 2022). Major vegetable producing state are West Bengal, Uttar Pradesh, Maharashtra, Karnataka, Madhya Pradesh, Gujarat, etc. The vegetables serve carbohydrate, protein, fat, minerals, and vitamins in the human diets. Cabbage is rich source of fiber, iron, calcium, potassium, vitamin C, vitamin K and vitamin B6 and protein. This crop is attacked by 375 species of insect pests (Oatman *et al.* 1969) [2]. Among the insect pests of cabbage, *P. xylostella* is the most destructive pest of cruciferous plants throughout the world Talekar *et al.* (1993) [4]. In India, insect pest causes annual loss about US$ 36 billion. Such tools have been utilizing in Integrated Pest Management (IPM) programs to diminish crop losses with least affecting the quality of environment. The insect-pests infestation also affected the weight of cabbage head per plant with a mean loss 23.73 per-sent in respectively. The host range of *P. xylostella* is limited to Brassicaceae family, which contains glucosinolates and 2 sulfuras secondary plant compounds. DBM is rely on glucosinolates cue for host location, oviposition and herbivory. The neonate larvae feed on the lower surface of the leaf and exhibit irregular patches of damage, and the upper leaf epidermis is shows intact while young larvae feed on all plant parts. Young larvae feed on the leaf tissue inner side and upper leaf surface remains intact. This type of damage is called "windowing", In cases of severe infestation, entire leaves could be damage. The insect-pests attack during both vegetative and reproductive stage of the crops. The *P. xylostella* populations have evolved resistance to almost every insecticide class applied in the field Zhao *et al.* (2006) [13].

Material and Methods
The present investigation entitled was conducted at the Experimental farm College of Horticulture, Banda University of Agriculture and Technology, Banda during Rabi season of 2022-2023. The main aim of investigation to population dynamics and bio-efficacy of selective insecticides. In population dynamics the plot size is 10 X 10 m^2 and keeping the spacing of 45 cm x 30 cm. The five plants were selected randomly and tagged from each quadrate. The absolute larval population of *P. xylostella* was counted from seedling to maturity

stage of crop at weekly interval. The data thus obtained were correlated with various meteorological weather parameters to ascertain the effects of abiotic factors on population fluctuation of the pest on cabbage. For bio-efficacy selective insecticides such as Spinosad 45% SC, NSKE @ 5%, Fipronil 5 SC, Emamectin benzoate 5% SG, Indoxacarb14.5SC, Chlorantraniliprole 18.5 SC, Chloropyriphos 20 EC and compared with control. The area of each treatment was 5 x 4 m. Each treatment was replicated 3 times, with in 24 plots. Variety Green voyager Design Randomized Block Design (RBD). sowing date 06/10/2020 Date of Transplanting 10 & 11/11/20218 Spacing 50 x 50 cm with Plot size 5 x 4 m. The 35 days old cabbage seedlings were transplanted on 10th and 11th November, 2022. Insecticide was applied as per treatment in experimental field with recommended concentration by using knapsack sprayer. The total sprays volume was taken as 600 l/ha. The first insecticidal application was applied when DBM larval /plant population reached at ETL. The ETL of DBM in cabbage was reported 5 larvae/ plant. The second and third application was given on the basis of need at 15 days interval after the first application. The percent field efficacy of various treatments against DBM larvae were calculated by using the formula suggested by Henderson. The yield of marketable Cabbage head was recorded from each plot.

Result and Discussion

population dynamics Pest comes after 5th week of transplanting i.e. 3rd week of December with 0.65 larvae per plant, which gradually increased and attained a peak of 9.65 larvae per plant in 4th week of January (11th week after transplanting). The population of *P. xylostella* was ranged from 0.65 to 9.65 larvae per plant. Further, the pest population declined gradually with maturity of the crop and it reached upto 1.10 larvae per plant during 14th week after transplanting (2nd week of March) (Table 1). The correlation studies of *P. xylostella* with various weather parameters indicated that only maximum temperature exhibited highly significant positive correlation (r= 0.629**), whereas rainfall (r= 0.290^{NS}) is show positive non-significant whereas minimum temperature (r= -0.408^{NS}), and relative humidity (r= -0.120^{NS}) showed non-significant negative correlation with population of *P. xylostella* on cabbage. Roy *et al*. (2005) [14] reported the pest population showed non-significant negative correlation with morning relative humidity (r = -0.2717), mean relative humidity (r = -0.5467) and wind speed (r = - 0.1148). Raju *et al*. (1993) [3] reported that Positive correlation of the pest population with minimum temperature, maximum temperature and morning relative humidity. Gashawbeza *et al*. (2006) [7] reported P. *xylostella* has a major proportionate for loss of about 36.1 to 91.2% in cabbage. Hill and Foster, (2000) [15] reported the *P. xylostella* infest to the cabbage from the seedling to harvest stage and pretenses one of the main challenges to cabbage production many parts of the world.

Table 1: Population of *P. xylostella* on cabbage in relation with different weather parameters during Rabi 2022-23

Sr. no.	SMW	Week after transplanting	Mean larval population P. *xylostella*/ plant
1	49	2	0.00
2	50	3	0.00
3	51	4	0.65
4	52	5	2.85
5	1	6	3.55
6	2	7	4.96
7	3	8	6.55
8	4	9	9.65
9	5	10	8.88
10	6	11	7.82
11	7	12	7.45
12	8	13	5.86
13	9	14	3.54
14	10	15	1.10
Max T			0.839^{**}
Min T			-0.408^{NS}
RH			-0.120^{NS}
RF			0.290^{NS}

Insecticide application

First insecticidal spray

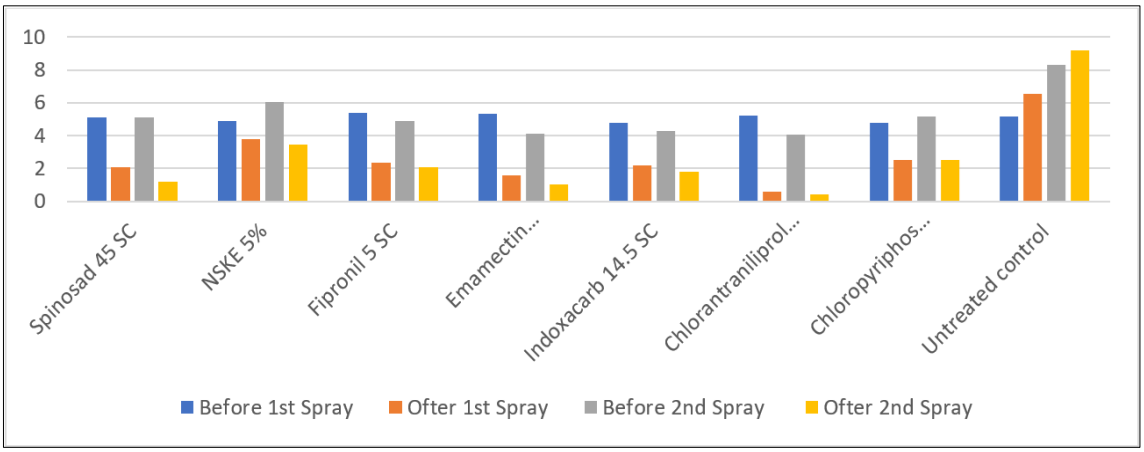
P. xylostella on cabbage before and after 1st insecticidal spray taken the data when insect population reach ETL so reduction of larval population by use of different novel insecticidal molecules. One day before of the first insecticidal spray, mean larval population of *P. xylostella* in various treatments including untreated control was recorded in the range of 5.30 to 4.80 per plant during Rabi 2022-23. After first insecticidal spray, the mean larval population was varied in the range 0.58 to 6.55 per plant. The minimum mean larval population 0.58 per plant was recorded in Chlorantraniliprole and 1.60 per plant in Emamectin benzoate treated plots followed by Spinosad (2.05 per plant), Indoxacarb (2.47 per plant), Fipronil (2.35 per plant), Chloropyriphos (2.50 per plant), NSKE (3.80 per plant), and maximum larval population 6.55 per plant was recorded in untreated plots. At 7th day after 1st spray, the mean larval population of all the treatments were statistically varied to each other. The Chlorantraniliprole and Emamectin benzoate were at par to each other and both these treatments were significantly superior over rest of the treatments. All the chemical treatments were significantly superior over the NSKE treatment.

After 15th day of first spray was applied the second spray. Before second insecticidal spray the data reveal taken from every treatment and every replication. The reduction of larval population by virtue of different novel insecticidal molecules against *P. xylostella* on cabbage before and after 2nd insecticidal spray (Table 2). One day before of the second insecticidal spray, mean larval population of *P. xylostella* in

various treatments including untreated control was recorded in the range of 4.04 to 6.06 per plant during Rabi 2022-23. The minimum mean larval population 4.04 per plant was recorded in Chlorantraniliprole and 4.10 per plant in Emamectin benzoate treated plots followed by Spinosad (5.13 per plant), Indoxacarb (4.30 per plant), Fipronil (4.86 per plant), Chloropyriphos (5.95 per plant), NSKE (6.06 per plant), and maximum larval population 8.30 per plant was recorded in untreated plots. At after 2nd spray the mean larval population was varied in the range 0.42 to 9.20 per plant. The minimum mean larval population 0.42 per plant was recorded in Chlorantraniliprole and 1.05 per plant in Emamectin benzoate treated plots followed by Spinosad (1.20 per plant), Indoxacarb (1.80 per plant), Fipronil (2.10 per plant), Chloropyriphos (2.50 per plant), NSKE (3.48 per plant), and maximum larval population 9.20 per plant was recorded in untreated plots (Table – 2). At after 2nd spray, the Chlorantraniliprole and Emamectin benzoate were at par to each other and both these treatments were significantly superior over rest of the treatments. All the chemical treatments were significantly superior over the NSKE treatment. All the treatments were significantly superior over control. Our findings are corroborating by Patra *et al.* (2013) [5, 11, 12]. Hannig *et al.* (2009) [9] reported the speed of action of Chlorantraniliprole against target pest species, based on time for feeding cessation and reduction in feeding damage, is significantly greater than that of most recently developed insecticides. Pandurang *et al.* (2015) [10] reported that Chlorantraniliprole was most effective in reducing the infestation of DBM followed by Spinosad and indoxacarb.

Table 2: Percent field bio-efficacy of various insecticidal treatments in larval population of *P. xylostella* on cabbage

Sr. no.	Treatments	Before 1st Spray	After 1st Spray	Before 2nd Spray	After 2nd Spray
1	Spinosad 45 SC	5.1	2.05	5.13	1.2
2	NSKE 5%	4.9	3.8	6.06	3.48
3	Fipronil 5 SC	5.4	2.35	4.86	2.1
4	Emamectin Benzoate 5 SG	5.3	1.6	4.1	1.05
5	Indoxacarb 14.5 SC	4.8	2.21	4.3	1.8
6	Chlorantraniliprole 18.5 SC	5.2	0.58	4.04	0.42
7	Chloropyriphos 20EC	4.8	2.5	5.15	2.5
8	Untreated control	5.15	6.55	8.3	9.2
	C. D.	N/A	0.247	0.247	0.257
	C. V.	11.52	7.707	7.707	8.295



Graph 1: Percent field bio-efficacy of various insecticidal treatments in reducing larval population of *P. xylostella* on cabbage during 2022-23.

Marketable yield

Two harvesting are done in the total cropping period of cabbage during 2022-23. Both the harvesting of cabbage heads, the highest marketable yield 350.50 q/ ha was recorded from Chlorantraniliprole treated plots followed by Emamectin benzoate (290.30 q/ ha), Spinosad (220.50 q/ ha), Indoxacarb (190.50 q/ ha), Fipronil (180.50 q/ ha), Chloropyriphos (165.50 q/ ha), NSKE (154.20 q/ ha) and minimum marketable yield 96.60 q/ ha was recorded in untreated plots (Table – 3). The marketable yield of Chlorantraniliprole and Emamectin benzoate were at par to each other treatments were significantly superior over rest of the treatments. Highest yield of cabbage recorded from the Chlorantraniliprole followed by Spinosad Sawant and Patil (2018) [16]. Maximum marketable cabbage head was recorded in cyantraniliprole followed by chlorantraniliprole, flubendiamide, novaluron, metaflumizone, diafenthiuron and fipronil Aiswarya *et al.* (2018) [6].

Table 3: Impact of various insecticidal treatments on yield during rabi season 2022-23.

Sr. no.	Treatments	Yield q/ha	% Yield increase over control
1	Spinosad 45 SC	220.5	228.26
2	NSKE 5%	154.2	159.63
3	Fipronil 5 SC	180.5	186.85
4	Emamectin Benzoate 5 SG	290.3	300.52
5	Indoxacarb 14.5 SC	190.4	197.11
6	Chlorantraniliprole 18.5 SC	350.5	362.84
7	Chloropyriphos 20 EC	165.5	171.33
8	Untreated control	96.6	-
	C.D.	4.053	-
	C.V.	1.114	-

Conclusions

The pest population of *Plutella xylostella* (Linnaeus) appeared from third week December which gradually increased and

attained a peak of 9.65 larvae per plant during fourth week January. It indicated that the pest was more active during the month of January. Later on, the pest population declined gradually towards the maturity of the crop. Among the different weather parameters, evening relative humidity exhibited highly significant negative correlation with *P. xylostella*. Whereas, remaining all the weather parameters showed non-significant correlation. The field bio-efficacy of Chlorantraniliprole 18.5 SC and Emamectin Benzoate 5 SG were statistically at par to each other treatments and were significantly superior over rest of the treatments. The highest marketable yield was recorded from Chlorantraniliprole treated plots followed by other treatments. The marketable yield of Chlorantraniliprole and Emamectin Benzoate were at par to each other and both these treatments were significantly superior over rest of the treatments.

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