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Efficacy of newer insecticides against diamondback moth *Plutella xylostella* on cauliflower

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Abstract
Field experiments was conducted in *Rabi* season during 2017-18 at the farm of Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra) to study the efficacy of different insecticides against diamondback moth *Plutella xylostella and natural enemies in cauliflower*. the results revealed that the lowest population of diamondback moth was noticed in emamectin benzoate 5 % SG (2.87/plant), cyantraniliprole 10.26 % OD (2.97/plant), chlorantraniliprole 18.5 % SC (3.06/plant), flubendiamide 20 % WG (3.12/plant), fipronil 5 % SC (4.07/plant) and chlorfenapyr 10 % SC (4.10/plant). Which were at par with each other. The maximum reduction was observed in the plots treated with and emamectin benzoate 5 % SG (53.46 %), cyantraniliprole 10.26 % OD (52.11 %), flubendiamide 20 % WG (48.68 %). The highest curd yield were recorded in treatment emamectin benzoate 5 % SG (17.85 t/ha) which was followed by flubendiamide 20 % WG (17.20 t/ha).

Keywords: *cauliflower*, diamondback moth, efficacy, newer insecticide, *Plutella xylostella*

1. Introduction
Cauliflower is one of the most preferable, traditionally grown winter vegetable, requires cold and moist climate and is less hardy than cabbage. It is a rich source of nutrient including vitamin-A, vitamin-C, calcium, phosphorus, potassium, carbohydrates, protein, fat, fiber and iron. Cauliflower *Brassica oleracea* var. *botrytis* Linnaeus is a native of southern Europe and was introduced in India in 1822 from England (Chattergi 1986). The major cauliflower producing states are Bihar, Uttar Pradesh, Orissa, West Bengal, Assam, Haryana and Maharashtra. In Maharashtra, the area under cauliflower is 13,000 ha with total production of 259.69 thousand MT and average productivity of 20.49 MT/ha (Anonymous 2017) [1].

Diamondback moth is a most devastating pest of cole crops in the area of Punjab, Haryana, Himachal Pradesh, Uttar Pradesh, Bihar, Maharashtra, Tamil Nadu and Karnataka. It has a pest status of national importance. Annual expenditure on managing this pest was estimated to be 1 billion U.S. Dollar (Talekar and Shelton, 1993) [8]. Pest control in cauliflower by small-scale farmers is still heavily dependent on chemical insecticides. Improper and wide-spread use of chemical insecticides can cause under-ground and surface water pollution. Excessive use of insecticides also induces resistance development in target pests as well as killing beneficial organisms such as pollinators (especially bees) and natural enemies (insect parasitoids and predators) (Pedigo and Rice, 2006) [6]. The indiscriminate use of insecticides leads to resistance development in insects. In order to have effective control it was felt necessary to study relative efficacy of newer insecticides against diamondback moth.

2. Material and Methods
The experiment was laid out in a randomized block design (RBD) with 10 treatments replicated three times. The gross plot size was 3.6 m x 3.6 m and the spacing followed was 60 cm x 60 cm. The variety *INDAM-9803* (Indo-American Hybrid Pvt. Ltd.) was used. The observations of insect pests and natural enemies were recorded 1 day before spraying, 1, 3, 7, 15 and 21 days after spraying. The population was counted from randomly selected 5 plants from each of replication. The yield of curds was recorded from each plot in each replication separately. The formula used for the calculation of percentage reduction of pest population over control using following formula giving by Henderson and Tilton (1955) [4].

$$\text{Per cent efficacy} = 1 - \frac{Cb \times Ta}{Tb \times Ca} \times 100$$

Where;
Cb = Number on untreated control before treatment
Ta = Number on treated plot after treatment
Tb = Number on treated plot before treatment
Ca = Number on untreated check after treatment

The data obtained from the different treatments were computed to determine the mean values. The mean values after suitable transformation were subjected to statistical analysis to test significance as per Gomez and Gomez (1984) [3] for interpretation of the results using OPSTAT software.

3. Results and Discussion
The observations on larval count of diamondback moth on cauliflower one day before spraying (precount) and after sprayings are presented in Table No.1

3.1 Precount
The results revealed that there were no significant differences among all treatments indicating the even distribution of population in all treatments.

One day after spraying

The results revealed that the lowest population of DBM was noticed in emamectin benzoate 5 % SG (5.80/plant) which was at par with cyantraniliprole 10.26 % OD (5.83/plant), chlorantraniliprole 18.5 % SC (5.89/plant), flubendiamide 20 % WG (5.93/plant) and thiodicarb 75 % WP (6.33/plant). The highest population was noticed in plots treated with novaluron 10 % EC (7.13/plant), which was at par with diafenthiuron 50 % WP (7.00/plant). The maximum per cent reduction of DBM was observed in emamectin benzoate 5 % SG (22.11 %) treatment which was at par with cyantraniliprole 10.26 % OD (21.54 %), chlorantraniliprole 18.5 % SC (19.54) and flubendiamide 20 % WG (19.02%). The next better treatments were thiodicarb 75 % WP (15.25 %), fipronil 5 % SC (10.46 %), and chlorfenapyr 10 % SC (5.54 %).

Three days after spraying

The results revealed that the lowest population of DBM was noticed in emamectin benzoate 5 % SG (4.05/plant) which was at par with cyantraniliprole 10.26 % OD (4.15/plant), chlorantraniliprole 18.5 % SC (4.20/plant) and flubendiamide 20 % WG (4.30/plant).

The data on per cent reduction in DBM population revealed that larval population varied between 3.59 per cent to 41.57 per cent. The significantly lowest reduction was registered in novaluron 10 % EC (3.59 %). The highest reduction was observed in the plots sprayed with emamectin benzoate 5 % SG (41.57%), cyantraniliprole 10.26 % OD (40.79 %) and chlorantraniliprole 18.5 % SC (37.80 %) which was at par with each other. These were fallowed by flubendiamide 20 % WG (18.82 %), thiodicarb 75 % WP (18.17 %), fipronil 5 % SC (14.87 %) and chlorfenapyr 10 % SC (14.14 %).

Seven days after spraying

The results revealed that, the population of DBM larva and pupa ranged from 2.95 to 4.95/plant in different treatments. Emamectin benzoate 5 % SG (2.95/plant) was the most effective against DBM which was at par with cyantraniliprole 10.26 % OD (3.00/plant), chlorantraniliprole 18.5 % SC (3.20/plant), flubendiamide 20 % WG (3.27/plant) and fipronil 5 % SC (3.93/plant).

The data on per cent reduction in DBM population indicated that maximum reduction was achieved by spraying of emamectin benzoate 5 % SG (53.46 %) which was at par with cyantraniliprole 10.26 % OD (52.11 %), chlorantraniliprole 18.5 % SC (48.89 %) and flubendiamide 20 % WG (15.68 %). Minimum larval reduction were recorded from plots treated with novaluron 10 % EC (24.07 %), diafenthiuron 50 % WP (23.24 %) which was at par with each other. These were followed by chlorfenapyr 10 % SC (32.20 %), thiodicarb 75 % WP (32.29 %) and fipronil 5 % SC (33.06 %).

Fifteen days after spraying

The lowest population was noticed in emamectin benzoate 5 % SG (1.25/plant), which was at par with cyantraniliprole 10.26 % OD (1.40/plant), chlorantraniliprole 18.5 % SC (1.53/plant), flubendiamide 20 % WG (1.60/plant), fipronil 5 % SC (1.80/plant) and chlorfenapyr 10 % SC (2.01/plant). Highest larval population were observed in the plots treated with novaluron 10 % EC (2.35/plant), diafenthiuron 50 % WP (2.33/plant) and, thiodicarb 75 % WP (2.01/plant) which were at par with each other.

The data on per cent reduction in DBM population ranged between 41.25 per cent to 67.99 per cent. The highest reduction was observed in the plots sprayed with emamectin benzoate 5 % SG (67.99 %) However, it was at par with cyantraniliprole 10.26 % OD (63.44%), chlorantraniliprole 18.5 % SC (62.22 %), flubendiamide 20 % WG (59.46 %), fipronil 5 % SC (53.65 %) and chlorfenapyr 10 % SC (42.41 %). The significantly lowest reduction was registered in novaluron 10 % EC (41.25 %), diafenthiuron 50 % WP (41.53 %).

Twenty one days after spraying

The significantly lowest population were recorded from plots treated with emamectin benzoate 5 % SG (0.34/plant) which was at par with cyantraniliprole 10.26 % OD (0.50/plant), chlorantraniliprole 18.5 % SC (0.53/plant) and flubendiamide 20 % WG(0.55/plant). The untreated control (3.60/plant) recorded highest DBM population.

The maximum reduction were recorded in plots treated with Cyantraniliprole10.26%OD(90.25%)which is significantly sup erior among all other treatments. The next better treatments were emamectin benzoate 5 % SG (83.36 %), chlorantraniliprole 18.5 % SC (86.09 %), flubendiamide 20 % WG (84.40 %), fipronil 5 % SC (71.18 %), and thiodicarb 75 % WP (66.80 %). The lowest reduction was observed in novaluron 10 % EC (42.59 %). Purushotam *et al*.,2017 reported that the efficacy of different insecticides against DBM (*P. xylostella*), the investigations revealed that spinosad was found to be most effective reduced up to 94.33 percent population followed by emamectin benzoate (91.00%) and Flubendiamide (78.66%). The insecticides, viz., indoxocarb, fipronil and chlorantraniliprole were found moderately effective as they resulted in 70.66, 70.33 and 68.66 percent reduction, respectively

Mean

The results revealed that, the larval population ranged from 2.87 to 4.44/plant. All the insecticides provided effective control of DBM. The maximum larvae population were recorded in plots treated with novaluron 10 % EC (4.44/plant) and diafenthiuron 50 WP (4.40/plant) which were at par with each other. The next better treatments were chlorfenapyr 10 % SC (4.10/plant), thiodicarb 75 % WP (4.08/plant) and Fipronil5%SC (4.07/plant). Minimum Larval count was noticed in plots treated with emamectin benzoate 5 % SG (2.87/plant), cyantraniliprole 10.26 % OD (2.97/plant), chlora ntraniliprole 18.5 % SC (3.06/leaf) and flubendiamide 20 % WG (3.12/plant) which were at par with each other. However, the untreated control recorded significantly highest larval population (5.61/plant).

4. Yield

The highest curd yield were recorded in treatment emamectin benzoate 5 % SG (17.85 t/ha) which was followed by flubendiamide 20 % WG (17.20 t/ha), chlorantraniliprole 18.5 % SC (17.00 t/ha), cyantraniliprole 10.26 % OD (16.80 t/ha), novaluron 10 % EC (16.12 t/ha), chlorfenapyr 10 % SC (15.65 t/ha), thiodicarb 75 % WP (15.33 t/ha), Fipronil 5 %

Table 1: Efficacy of different insecticides against diamondback moth *Plutella xylostella* on cauliflower

Tr. No.	Treatment	Dose (g or ml/ha)	No. of larvae and pupae/plant						% Reduction					
			Precount	1DAS	3DAS	7DAS	15DAS	21DAS	Mean	1DAS	3DAS	7DAS	15DAS	21DAS	Mean
T1	Chlorantraniliprole 18.5 % SC	50 ml	7.86 (2.97)*	5.90 (2.62)	4.20 (2.28)	3.20 (2.04)	1.50 (1.58)	0.53 (1.23)	3.06 (2.02)	19.54 (26.19)#	37.80 (37.90)	47.09 (43.78)	62.22 (53.01)	86.09 (67.75)	46.68 (46.13)
T2	Fipronil 5% SC	1000 ml	7.88 (2.98)	6.80 (2.79)	5.85 (2.61)	3.93 (2.22)	1.80 (1.67)	1.00 (1.41)	4.07 (2.25)	10.46 (18.86)	14.87 (22.66)	35.18 (41.06)	53.65 (46.24)	71.18 (56.79)	33.05 (34.59)
T3	Thiodicarb 75% WP	1000 g	7.75 (2.96)	6.33 (2.71)	5.80 (2.60)	3.97 (2.23)	2.01 (1.74)	1.20 (1.48)	4.08 (2.26)	15.25 (22.96)	18.17 (25.13)	30.65 (44.25)	51.14 (45.08)	66.80 (53.64)	32.29 (34.01)
T4	Emamectin benzoate5% SG	150 g	7.48 (2.91)	5.80 (2.60)	4.05 (2.24)	2.95 (1.99)	1.25 (1.50)	0.34 (1.16)	2.87 (1.97)	22.11 (28.02)	41.57 (40.07)	49.43 (22.28)	67.99 (54.36)	86.36 (67.91)	53.46 (46.59)
T5	Novaluron 10% EC	750 ml	7.44 (2.91)	7.13 (2.83)	6.56 (2.74)	4.95 (2.44)	2.35 (1.83)	2.10 (1.74)	4.44 (2.33)	2.37 (8.85)	3.59 (10.91)	14.40 (32.42)	41.25 (36.95)	42.59 (36.26)	24.07 (28.29)
T6	Flubendiamide20 % WG	50 g	7.56 (2.93)	5.90 (2.63)	4.30 (2.30)	3.27 (2.07)	1.60 (1.61)	0.55 (1.25)	3.12 (2.03)	19.02 (25.73)	18.82 (25.61)	43.78 (39.15)	59.46 (49.76)	84.40 (66.18)	48.89 (43.95)
T7	Chlorfenapyr 10 % SC	750 ml	7.47 (2.91)	6.80 (2.80)	5.94 (2.63)	4.84 (2.42)	2.28 (1.81)	1.85 (1.69)	4.10 (2.26)	5.54 (13.60)	14.14 (22.07)	18.83 (31.81)	42.41 (39.98)	49.65 (43.22)	32.20 (34.09)
T8	Diafenthiuron 50 % WP	600 g	7.63 (2.94)	7.00 (2.81)	6.00 (2.64)	4.92 (2.43)	2.33 (1.82)	2.00 (1.72)	4.40 (2.32)	4.80 (12.61)	12.17 (20.40)	15.68 (42.97)	41.53 (39.78)	43.79 (39.91)	23.24 (27.69)
T9	Cyantraniliprole10.26 % OD	600 ml	7.71 (2.95)	5.83 (2.61)	4.15 (2.26)	3.00 (2.00)	1.40 (1.55)	0.50 (1.22)	2.97 (1.99)	21.54 (27.63)	40.79 (39.64)	48.74 (24.27)	63.44 (50.93)	90.25 (72.02)	52.11 (45.71)
T10	Control(Water spray)	---	7.72 (2.95)	7.44 (2.91)	7.06 (2.84)	5.94 (2.63)	4.03 (2.24)	3.60 (2.14)	5.61 (2.57)	–	–	–	–	–	–
	SE ±		0.04	0.04	0.07	0.08	0.08	0.08	0.10	0.90	1.62	2.71	3.15	2.47	1.64
	CD at 5%		N.S.	0.13	0.20	0.23	0.24	0.23	0.31	2.73	4.89	8.20	9.53	7.48	4.97
	CV		2.62	2.82	4.52	5.81	7.85	8.71	8.34	7.63	10.31	13.13	11.81	7.66	7.52

Table 2: Effect of different insecticides on curd yield of cauliflower

Tr. No.	Treatment	Curd yield (t/ha)
T_1	Chlorantraniliprole 18.5 % SC @ 50 ml/ha	17.00
T_2	Fipronil 5 % SC@ 1000 ml/ha	15.00
T_3	Thiodicarb 75 % WP@ 1000 g/ha	15.33
T_4	Emamectin benzoate 5 % SG @ 150 g/ha	17.85
T_5	Novaluron 10 % EC@ 750 ml/ha	16.12
T_6	Flubendiamide 20 % WG @ 50 g/ha	17.20
T_7	Chlorfenapyr 10 % SC@ 750 ml/ha	15.65
T_8	Diafenthiuron 50 % WP @ 600 g/ha	14.90
T_9	Cyantraniliprole 10.26 % OD @ 600 ml/ha	16.80
T_{10}	Control (Water spray)	10.82
	SE +	0.76
	CD at 5%	2.28
	CV	8.67

SC (15.00 t/ha), diafenthiuron 50 WP (14.90 t/ha),untreated control (10.82 t/ha). Rabari *et al.,* 2016 [7]. Revealed that the highest yield of cabbage was recorded in the treatment of spinosad 45 SC (339.26 q/ha) and it was at par with emamectin benzoate 5 SG (334.58 q/ha) and indoxacarb 14.5 SC (327.30 q/ha).

5. References

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