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Comparative efficacy of certain chemicals with biopesticides against diamondback moth, *Plutella xylostella* (L.) in cabbage, *Brassica oleracea* (L.)

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Abstract
The present investigation entitled "Comparative efficacy of certain chemicals with biopesticides against diamondback moth, *Plutella xylostella* on *Rabi* season cabbage in Prayagraj (U.P.)" cultivar i.e. Golden acre was conducted during December to February at Central Research Farm, SHUATS, Naini, Prayagraj. A Field trial was conducted during *Rabi* season 2019-2020. To determine the efficacy of some bio-agent (*Beauveria bassiana*) botanicals (Neem oil, NSKE 5%) and chemicals (Spinosad 45 SC, Fipronil 5 SC, Nisco sixer plus, Novaluron 10EC) along with an untreated control against *Plutella xylostella* in Cabbage. Each insecticide was sprayed twice at 15 days intervals. The larval count per plant was taken days before and 3, 7 and 14 days after each spray. All the insecticides tested significantly reduced the pest population compared to control. The highest percent population reduction of diamondback moth larvae against control was observed in Spinosad 45 SC (53.84%). The mean crop yield ranged between 25.82 t/ha to 74.53 t/ha in the insecticidal treatment, the highest being Spinosad 45 SC (74.53 t/ha) followed by Fipronil 5 SC (68.18 t/ha). The cost benefit ratio varied from 1:1.0 to 1:3.27 in different insecticidal treatments, the highest in Spinosad 45 SC (1:3.27) followed by Fipronil 5 SC (1:297).

Keywords: *Beauveria bassiana*, efficacy, cost-benefit ratio, *Plutella xylostella*

Introduction
Among all vegetables, crucifers particularly cabbage and cauliflower are most important because of their economical and nutritional values from consumer and producer points of view. Cabbage (*Brassica oleracea* Var. *capitata* L.) is a cold loving plant and is supposed to have originated in The Mediterranean region. Cabbage ranks the fourth vegetable grown in India with 0.245 million ha area and 5.87 MT production. India ranks second in cabbage production next only to China with 99.5 tonnes production. This crop is grown in China, India, Poland, Rumania, U.S.A., Canada etc. In India West Bengal ranks first with 2.17 MT production (Anonymous, 2012) [1]. It is grown mainly in West Bengal, Orrisa, Bihar, Assam, Karnataka, Maharashtra, Gujrat and Tamil Nadu. In India cabbage is cultivated on 3.31 lakh hectares of land producing 72.81 lakh metric tonnes, having average productivity of 22.9 metric tonnes per hectare during the year 2012-13. Cabbage is rich in calcium, iron, carotene, thiamin and vitamin B. It is cultivated for its edible head. Cooked cabbage contains a good amount of Vitamin-B and a fair amount of proteins as compared to leafy vegetables. It is also used in curry and sambar preparations. Economic significance and remunerative nature of the cole crops in a short span have compelled the growers to adopt it under intensive cultivation. (Source)

Insect-pests are the major limiting factors in the production of these vegetables. Cabbage has been reported to be attacked by a number of insect pests. More than 27 species of insect-pests are reported on cabbage in India (Bhatia and Verma 1993) [2] of which 11 belonged to order Lepidoptera, 5 to Orthoptera, 3 each to Heteroptera and Coleoptera, 2 each to Homoptera and Hymenoptera and 1 to Diptera. Among these, fourteen pests have so far been recorded infesting cabbage crop in Maharashtra (Palande *et al.* 2004) [12]. The population of *C. binotalis*, *H. undalis*, *P. xylostella* and *S. litura* on cabbage varied from 3.8 to 44.0, 1.0 to 6.2, 0.6 to 1.6 and 0.6 to 3.2, 1.0 to 5.0, 1.0 to 1.6, 1.6 to 20.4 and 0.2 to 1.0 larvae/quadrate during rainy and winter seasons 2006–07, respectively (Patait *et al.*, 2008) [13]. Cabbage is the most preferred host plant of all pests followed by cauliflower and knolkhol (Sachan and Gangwar, 1990) [16]. The diamondback moth is cosmopolitan in distribution In India, it was first recorded on cruciferous vegetables in 1914 and now it is distributed throughout the country found

diamondback moth as the most devasting 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. Dollars (Talekar and Shelton, 1993) [19]. Estimated about 52 percent losses in marketable yield due to diamondback moth. The losses could be more than 80 percent under severe infestation of diamondback moth on cabbage (Sachan and Srinivasan, 1972) [17].

Materials and Methods

The field trial was laid out at the Central Research Field in randomized block design with eight treatments including an untreated control, each with three replications. The "Golden acre" variety of cabbage was used and a healthy crop was raised by following all the recommended agronomical practices. The plot size was 2m x 2m and the spacing between rows and plants was maintained at 45 and 30 cm, respectively. In the experiment eight different treatments consisting application of T1 *Beauveria bassiana* (5gm/lit), T2 Novaluron 10 EC (1ml/lit), T3 NSKE 5% (5ml/lit), T4 Niscosixer plus (2ml/lit), T5Spinosad 45 SC (0.5ml/lit), T6 Neem oil (2ml/lit), T7 Fipronil 5 SC (2ml/lit), and untreated control.Sprays were initiated on reaching 3-5 larvae per plant (i.e after the population reaching ETL) and plant damage by the diamondback moth. Spraying repeated two times with 15 days intervals during the crop season as when the damage exceeded 10-20 percent. Spraying was done with the help of a knapsack sprayer. Observations on larvae and plant damage by the diamondback moth were recorded daily on 5 randomly selected plants per plot from these data was taken and expressed in percentage. The total yield of the marketable cabbage obtained from different treatments was calculated and converted by considering the additional cost (cost of insecticides and operational charges) and benefit (compared to untreated control) in the respective treatments.

Results

The data on the first spray insect population count on mean (3, 7 and 14) day after spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments highest percent reduction was recorded in T5 Spinosad 45 SC (53.43%) which was statistically par with T7 Fipronil 5 SC (31.29%) followed by T4 Nisco sixer plus (27.85%) and T2 Novaluron 10 EC (24.77%) was statistically par with T6 Neem oil (21.62%) and T1 *Beauveria bassiana* (16.47%) the treatments par with T3 NSKE 5% (14.29%) was found to be least effective among all the treatments and is significantly superior over the control.

The data on the second spray insect population count on mean (3, 7 and 14) day after spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments highest percent reduction was recorded in T5 Spinosad 45 SC (53.84%) which was statistically par with T7 Fipronil 5 SC (31.77%) followed by T4 Niscosixer plus (28.19%) and T2 Novaluron 10 EC (24.82%) was statistically par with T6 Neem oil (22.37%) and T1 *Beauveria bassiana* (17.14%) the treatments par with T3 NSKE 5% (14.63%) was found to be least effective among all the treatments and is significantly superior over the control.

Discussion

In the present research work highest percent reduction was recorded in Spinosad 45 SC treated plot (53.43%) similar findings were also reported by Mitch *et al*., (2014) [6] reported that the spinosad 45 SC treated plot shown lowest percent population of cabbage (49.15%) while the infestation in control plot was (86.12%). Fipronil 5 SC treated plot showed (32.29%) percent population of diamondback moth similar findings were also reported by Rajiv *et al*., (2017) [15] Mean percent population of Niscosixer plus treated plot is (27.85%) which is reported by Nieto *et al*., (2006) [1] reported (44.17%) that the population in control plot was (21.41%). Insect population on of Novaluron10EC treated plot is (24.77%) which is also found similar to (73.75) reported by Mohan *et al*., (2003) while the population in the control plot was 31.23%. Similarly, Patra *et al*., (2015) reported (87.15%) population in Novaluron 10 EC treated plot while the population in control plot is (11.33%). The Mean insect population of Neem oil treated plot is (21.62%) similar findings were reported by Nieto *et al*., (2006) [1] (36.1%) insect population in neem oil plot while the population in control plot was (11.21%). *Beauveria bassiana* treated plots shown (16.47%) population similar findings were reported by Mitch *et al*., (2017) reported (32.24%) population in the treated plot while the population in control plot is (31.23%), (14.29%) percent population was found in NSKE5% treated plot. Similar findings were also Patait *et al*. (2008) [13] reported (44.0%) population in NSKE 5% treated plot while the infestation in control plot is (32.01%).

The best and most economical treatment in T5-Spinosad 45 SC (1:3.27) which was statistically par with T7-Fipronil 5 SC (1:2.97) followed by T4-Niscosixer plus (1:2.61) and T2-Novaluron 10 EC (1:2.26) was statistically par with T6-Neem oil (1:2.12) and T1-Beauveria bassiana (1:1.65) the treatments statistically par with T3-NSKE 5% (1:1.34) was least effective among all the treatments. Control plot T0 (1:1.0) infestation.

Conclusion

From the findings present investigation holds a good promise in the daimondbak moth on cabbage management and it showed that Spinosad 45% SC is most effective out of seven treatments. It also gave the highest cost benefit ratio and marketable yield. Fipronil, Niscosixer plus, Novaluron, Neem oil and *Beauveria bassiana* also effective control on cabbage. NSKE 5% is the least effective among the treatments. These plant products also helps in reducing pollution in the environment. Hence it can be suitably incorporated as treatments in the IPM programme.

Table 1: Comparative efficacy of certain chemicals with biopesicides against diamondback moth, *Plutella xylostella* (L.) in cabbage, *Brassica oleracea* (L.) (1st spray)

Treatments		Percent population of DBM larvae After spray				
		1 DBS	3rd Day	7th Day	14th Day	Mean
T_1	*Beauveria bassiana*	8.33	12.77	15.99	20.66	16.47
T_2	Novaluron 10 EC	7.33	19.34	22.76	32.21	24.77
T_3	NSKE 5%	5.66	11.55	14.12	17.21	14.29
T_4	Niscosixer plus	8.33	17.67	25.32	40.56	27.85
T_5	Spinosad 45 SC	7.33	42.77	53.55	63.99	53.43
T_6	Neem oil	8.00	16.21	21.76	26.88	21.62
T_7	Fipronil 5 SC	8.66	23.66	30.23	39.99	31.29
T_0	Untreated	7.66	9.06	8.80	8.73	8.86
Overall Mean		7.66	17.99	24.06	31.27	24.82
F- test		NS	S	S	S	S
S. Ed. (±)		2.66	1.45	1.83	2.50	3.29
C. D. (P = 0.05)		-	3.15	3.97	5.42	7.13

Table 2: Comparative efficacy of certain chemicals with biopesicides against diamondback moth, *Plutella xylostella* (L.) in cabbage, *Brassica oleracea* (L.) (2nd spray)

Treatments		Percent population of DBM larvae After spray			
		3rd Day	7th Day	14th Day	Mean
T_1	*Beauveria bassinet*	13.107	16.773	21.55	17.143
	Novaluron 10 EC	19.470	23.340	31.66	24.823
	NSKE 5%	11.887	14.453	17.55	14.630
	Niscosixer plus	17.900	25.660	41.01	28.190
	Spinosad 45 SC	43.103	53.773	64.66	53.845
	Neem oil	16.550	22.010	28.55	22.370
	Fipronil 5 SC	23.993	30.567	40.77	31.777
	Untreated	8.600	8.400	8.93	8.644
		19.33	24.37	31.83	25.17
F- test		S	S	S	S
S. Ed. (±)		1.35	2.19	2.46	3.23
C. D. (P = 0.05)		2.92	4.75	5.33	7.01

Table 3: Economics of cultivation

Treatment	Yield of t/ha	Cost of yield (₹)	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Total cost (₹)	B:C ratio
NSKE 5%	30.18	2200 ₹/t	66396	47498	2000	49498	1:1.34
Neem oil	48.15	2200 ₹/t	105930	47498	2400	49898	1:2.12
Beauveria bassiana	37.53	2200 ₹/t	82566	47498	2300	49798	1:1.65
Novaluron 10EC	52.72	2200 ₹/t	115984	47498	3650	51148	1:2.26
Fipronil 5 SC	68.18	2200₹/t	149996	47498	2900	50398	1:2.97
Spinosad 45 SC	74.53	2200 ₹/t	163966	44798	2600	50098	1:3.27
Niscosixer plus	60.40	2200 ₹/t	132880	44798	3400	50898	1:2.61
Untreated	25.82	2200 ₹/t	56804	44798	------	44798	1:1.0

Cost of yield per tonnes (₹). 2200

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