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Bio-efficacy of bio-pesticides against tobacco caterpillar (*Spodoptera litura*. Fab) on cabbage

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Abstract
The present investigation was carried out during *rabi* season of 2019-2020 at Experimental farm in SHUATS, Prayagraj. The experiment was laid out in randomized block design with seven treatments *viz*., *Beauveria bassiana* (1.5kg/ha), *Bacillus thuringiensis* (1.5kg/ha), NSKE (25kg/ha), Neem oil (15lit/ha), Spinosad (96ml/ha), Indoxacarb (73ml/ha) and Contol (Water). The observations on larval population *Spodoptera litura* 3, 5, and 7 days after treatment at each spraying (1st and 2nd spray) were recorded for computing the percent larval reduction. The yield data of cabbage heads influenced by each treatment were also recorded. Among all the treatments in both sprays Spinosad 45 EC was most efficacious in reducing the larval population (56.20% and 78.03%) of *Spodoptera litura*. The treatment with *Bacillus thuringiensis* (54.17% and 74.58%) also performed well against the pest. Similarly, *Beauveria bassiana* (51.83% and 72.20%), Indoxacarb (53.20% and 71.67%), NSKE (42.70% and 65.62%) and Neem oil (49.29% and 66.83%). Spinosad recorded the highest yield (285.40 q/ha), followed by NSKE which recorded (234.40 q/ha), *Bacillus thuringiensis* (222.70 q/ha) and Indoxacarb (222.20 q/ha) respectively.

Keywords: Cabbage, bio-pesticides, botanicals, *Spodoptera litura*

Introduction
In India, Cruciferous vegetables are grown and have an important place among *rabi* crops. Cabbage, *Brassica oleracea var. capitate* (Linn.), has appreciable nutritional and economic value and is a popular vegetable that in grown in all states of India. In plains it is grown as a winter crop. The production and yield of cabbage is greatly hampered by many insect pests. Cabbage is also known to be infested by several insect pest *viz*., tobacco caterpillar, (*Spodoptera litura* Fab.), cabbage butterfly (*Pieris brassicae*), diamond back moth (*Plutella xylostella* Linnaeus) and cabbage aphid (*Brevicoryne brassicae* L.). Out of these, cabbage butterfly, diamond back moth and tobacco caterpillar are the most destructive pest causing severe yield loss to cabbage every year [8, 9]. Among these, *Spodoptera litura* (F) (Lepidoptera: Noctuidae), is a major pest of cabbage. The pest cause damage to an extent of 80-100 percent in the nurseries under favourable conditions [2] and 10-25 percent to the field crop [10]. Several chemical insecticides belonging to various groups are recommended for the management of Tobacco caterpillar *Spodoptera litura* (Fab.) on cabbage crop. Indiscriminate use of several pesticides create problem in the natural ecosystem, environmental pollution, pest resistance and health hazards *etc.* Due to this, only microbial insecticides and botanical are used in order to avoid indiscriminate use of pesticides and importance of microbial insecticides in integrated pest management on sustainable basis. Hence the present study was undertaken for assessment of the efficacy of bio-pesticides for managing tobacco caterpillar (*Spodoptera litura*. Fab) on cabbage and to study the yield of cabbage.

Materials and Methods
The field experiment was conducted at the experimental farm of Department of Entomology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during *rabi* season of 2019-2020 to evaluate the Efficacy of bio-pesticides against tobacco caterpillar (*Spodoptera litura*) on Cabbage. The seeds of cabbage variety, 'Golden Acre' were sown in well prepared nursery beds. The seedlings were transplanted in the experimental field after four weeks. The cabbage seedlings were transplanted with a row to row and plant to plant space of 30 cm and 45 cm, respectively. The trail was laid out in a Randomized Block Design with Seven treatments with *Beauveria bassiana* (1.5 kg/ha), *Bacillus thuringiensis* (1.5 kg/ha),

Spinosad (96 ml/ha), NSKE (25 kg/ha), Neem oil (15 lit/ha), and Indoxacarb (73ml/ha) and control. The insecticides were sprayed when the level incidence reached economics threshold level. Spray preparations were applied using knapsack sprayer. The spray mixture of each treatment was prepared by mixing the required quantity of the insecticides formulations in water to make it equivalent. Each treatment was applied three times at 15 days interval. Pre-treatment population of *Spodoptera litura* (Fab.) was recorded 24 hours before the spray. Post treatment population of *S. litura* was recorded on 3, 7 and 10 days after each spray. Healthy cabbage heads were harvested when they reached appropriate marketable size and their weight from each treatment was expressed as marketable yield in quintal per hectare and subjected to analysis of variance.

Results and Discussion

The results (Table: 1) after 1st spray revealed that all the treatments were superior to control in managing the population of *Spodoptera litura*. The maximum percentage reduction was observed in Spinosad 45 SC @ 96ml/ha (56.20%) and it was significantly superior to rest of treatments. It was followed by *Bacillus thuringiensis* @ 1.5kg/ha (54.17%) and Indoxacarb @ 73ml/ha (53.20%). Following, the best treatments the percent reduction were also recorded in *Beauveria bassiana* @ 1.5kg/ha (51.83%), Neem oil @ 5% (49.29%) and NSKE @ 5% (42.70%). The lowest percent reduction was recorded in control (29.07%).

The data after 2nd spray revealed that the maximum percentage reduction was observed in Spinosad 45 SC (78.30%) and it was significantly superior to rest of treatments. It was followed by *Bacillus thuringiensis* @ 1.5kg/ha (74.58%) and *Beauveria bassiana* @ 1.5kg/ha (72.20%). Following, the best treatments the percent reduction were also recorded in Indoxacarb @ 73ml/ha (71.67%), Neem oil @ 5% (66.83%) and NSKE @ 96ml/ha (65.62%). Out of all these treatments control was recorded lowest population reduction.

The yield was also recorded and it revealed that Spinosad 45 SC @ 96ml/ha recorded (285.43 q/ha) yield which was highest. The Second highest yield was recorded in NSKE @ 50ml/ha (234.43 q/ha) followed by *Bacillus thuringiensis* @ 1.5kg/ha (222.73 q/ha) Indoxacarb @ 73ml/ha (222.24 q/ha) and Neem oil @ 5% (212.87 q/ha). The low yield was recorded from the plots sprayed with *Beauveria bassiana* @ 1.5kg/ha (190.12 q/ha) and Control (Water) (145.87 q/ha).

From the above findings it is evicted that all the treatments were effective in reducing the pest population of *Spodoptera litura*. After each spray Spinosad was most effective treatment for reduction pest population of *Spodoptera litura*. Followed by *Bacillus thuringiensis* and Indoxacarb. The effectiveness of spinosad over *Spodoptera litura* has also been reported by [6] she observed that hundred per cent control was observed at seven and fifteen days after application of spinosad. [3, 7] also reported that spinosad was most effective against *S. litura* in cauliflower. [5, 11] also reported the superiority of spinosad in controlling *Spodoptera litura* on different crops [1]. Observed maximum percent reduction was in *Bacillus thuringiensis* and observed significant yield of cabbage heads [12]. He found indoxacarb is most effective treatments [3]. Recorded significantly higher yield in Spinosad [4]. Also reported better yield of cabbage heads the treatment of Spinosad.

Table 1: Efficacy of Bio-Pesticides against Tobacco caterpillar (*Spodoptera litura*) on Cabbage during *rabi* in 2019-2020.

Treatments		Percent reduction over control (%)								Yield q/ha
		After 1st spray				After 2nd Spray				
		3 DAS	5DAS	7DAS	Mean	3DAS	5DAS	7DAS	Mean	
T_1	*Beauveria bassiana* @ 1.5 kg/ha	40.25	50.73	64.51	51.83	53.81	76.70	86.09	72.20	190.12
T_2	*Bacillus thuringiensis* @ 1.5 kg/ha	40.16	55.25	67.09	54.17	55.46	80.23	88.05	74.58	222.23
T_3	NSKE @ 25 kg/ha	35.14	45.25	47.72	42.70	51.22	71.61	74.04	65.62	234.43
T_4	Neem oil @ 15 lit/ha	39.71	49.67	58.48	49.29	48.06	70.76	81.67	66.83	212.87
T_5	Spinosad @ 96 ml/ha	41.61	57.95	69.05	56.20	58.23	84.19	92.48	78.30	285.43
T_6	Indoxacarb @ 73ml/ha	41.24	54.22	64.15	53.20	50.55	78.63	85.83	71.67	222.74
T_7	Control	22.11	30.10	35.02	29.07	00.00	00.00	00.00	00.00	145.87
F-test		S	S	S	S	S	S	S	S	S
C.D at 0.5%		21.16	21.73	22.09	09.01	15.11	09.46	07.17	12.29	03.81
S.E. (m) ±		06.86	07.05	07.17	02.92	04.90	03.07	02.32	03.99	01.23

Conclusion

The study concluded that, the use of bio-pesticides has been the most common method for controlling pest problems in agriculture. This does not create different problems like contamination of ecosystem, including soil, water pollution and occurrence of pesticide residue in food, pest resurgence, effect on non-target pest, etc. biopesticide of short residual activity, the formulation of Spinosad and *Bacillus thuringiensis*, can be suitability incorporated in field condition against *Spodoptera litura* as effective tool.

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