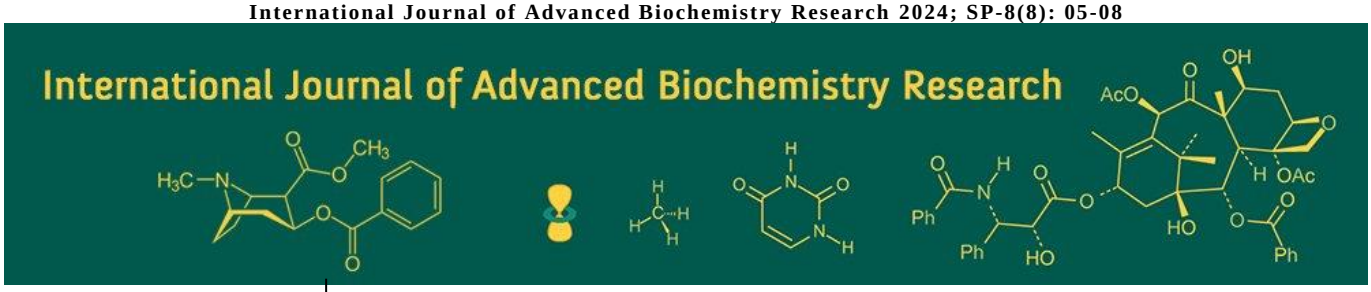

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Comparative efficacy of selected botanicals and chemical insecticide against pea pod borer *Etiella zinkenella* (Tr.) in pea at trance region of Yamuna, Prayagraj

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Abstract
The present investigation was conducted at the research plot at Central Research Field, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj during the *Rabi* season of 2024. The experiment was conducted in Randomized Block Design (RBD) by using eight treatments each replicated thrice *viz.*, Cypermethrin 25% EC @ 20ml/lit, Spinosad 45% SC @ 0.3 ml/lit, Deltamethrin 2.8% EC @ 1ml/lit, Neem oil 2% @ 2.5 gm/lit, *Beauveria bassiana* @2.5 gm/lit, Emamectin benzoate 5%SG @ 2ml/lit, Indoxacarb 18.5 SC @ 1.5 ml/lit and untreated control against *Etiella zinkenella* in pea crop. The mean of both firstand second spray revelled that Indoxacarb 18.5 @0.3 ml/lit recorded the lowest infestation of pod borer population i.e (1.79) which was significantly superior over control followed by (2.02), Spinosad 45% SC (2.23), Emamectin benzoate 5% SG (2.41), Cypermethrin 25% ECSC (2.61), Neem oil 0.03% EC (1.86) *Beauveria bassiana* (2.99) was least effective among all the treatments. The highest yield and cost benefit ratio was recorded in Indaxocarb 14.5% Sc (67.5) and(1:3.30), followed by Spinosad 45% SC (56.32) and (1:2.97), Emamectin benzoate 5%SG (49.3) and (1:2.45), Cypermethrin (48.4) and (1:2.57), Deltamethrin 2.8% EC (47.29) and (1:2.49), Neem oil 2% (44.5) and (1:2.28), *Beauveria Bassiana* (43.26) and (1:2.23) as compared to control (32.4) and (1:1.78).

Keywords: Botanicals, *Beauveria bassiana*, *Etiellla zinkenella*, Indaxocarb, *Pisum sativum* L., yield, C:B ratio

Introduction
Field Pea (*Pisum sativum* L.) is a very important leguminous vegetable crop. Mostly grown in all states of the country during *Rabi* season (Singh *et.al.,* 2002) [18] and because of its taste, nutritive value, fast growth and high yield this crop is patronized throughout the world. It is used as vegetable purpose as well as pulse (Singh and Dhooria 1971) [17]. The protein content in this crop is 19 to 27%. It has high caloric value and is a great source of ascorbic acid. The cooked 100 gm green pea contains, 74°/o moisture, 7°/o protein, 18 gm carbohydrates, 22mg calcium, 122 mg phosphorus and 2 mg, Iron with vitamin A (680 I.U), B1, B2, and vitamin C, 0.34, 0.16, and 26 mg, respectively. In addition to its food value it has proved to be an excellent source of fodder and the vines used in silage making in off season for feeding to livestock. The nitrogen fixing capacity of this crop restores soil fertility (Singh *et al.,* 2002) [18].

In India, during year 2023-24, area and production of pea is 549.0 thousand ha and 5680.00 thousand million tonnes respectively and productivity is 10.5 MT/ ha. Uttar Pradesh ranks first in area (175.01 ha) and production (1877.93 MT). In Madhya Pradesh pea is covering an area over 53.45 thousand ha with 534.0 thousand million tonnes production and 10.0 MT/ha productivity (Anon., 2021) [2]. Being a cool season crop, it is mostly cultivated in states of Uttar Pradesh, Bihar, Haryana, Punjab, Himachal Pradesh, Orissa and Karnataka. It ranks among the top 10 vegetable crops. In tropics and subtropics, its cultivation is restricted to cooler altitude and winter season. (Patidar, (2014) [14]

Pea pod borer, (*Etiella zinkenella*) is cosmopolitan and widely distributed in India. It is a serious pest of pea. The moths emerge in February and March. The eggs are laid both singly and in clusters on various parts of the plants. The newly emerged larval feed on foliage for

some time and later enter into the pods and feed on the green grains. The larval stages are completed in 10-27days and pupate in the soil. Life cycle completes in 45-56 days and passes through 5 generations in one year and often causes heavy loss on pea crop especially in dry season (Meena *et al.*, 2020) [11].

Pea pod borer, is a cosmopolitan pest of worldwide distribution. It attacks cultivated legumes including cowpea, garden pea (*Pisum sativum*), lima bean, mung bean, pigeon pea, common bean (*Phaseolus vulgaris*) and soyabean. Soyabean is the preferred host. Different biotypes of *E. zinckenella* exist throughout the world. For example, *E. zinckenella* is a serious pest of Phaseolus vulgaris in the USA, but does not attack soyabean there, despite the large area that is under cultivation. However, it is a threat to soyabean in most of South-East Asia, where it does not readily attack P. vulgaris. Damage to soyabean in South-East Asia is widespread. It damages about 10- 15% of pods in Taiwan. However, up to 80% of pods may be damaged in Indonesia. In Iloilo Province, the Philippines, where soyabean is a recently introduced crop, *E. zinckenella* damaged 57% of pods, even in insecticide-protected plots (Kumar *et al.* 2015) [9]. *E. zinckenella* causes about 40% yield loss in soyabean in the Province of Lorestan, and in adjacent areas in Iran (Roopa *et al.*, 2014) [15]. In India, it infested 11.4 and 50.9% of lentil and pea pods, respectively, resulting in respective yield losses of 10.6 and 23.9% (Ghulam, 2020) [6]. *E. zinckenella* caused 40% yield loss.

Materials and Methods

The experiment was conducted during Rabi season 2024 at Central Research Farm (CRF), SHUATS, Prayagraj, Uttar Pradesh, India, in a Randomized Block Design with eight treatments replicated three times using variety GS-10 in a plot size of 2 m × 1 m at a spacing of 30cm × 10cm with a recommended package of practices excluding plant protection. The soil of the experimental site was well drained and medium high. The treatments used in experiment were *viz*., Cypermethrin 25% EC 0.5 ml/lit, Spinosad 45% SC 0.3 ml/lit, Deltamethrin 208% @ 1ml/lit, Neem oil 5 ml/lit, *Beauveria bassiana* 2.5 ml/lit, Emamectin benzoate 5% SG 2 gm /lit, Indaxocarb 14.5% Sc 1ml/lit and treatment of untreated control were tested against to pea pod borer.

The insect population was counted from randomly selected plants in every plot and population per 5 plants was noted. After that mean of three replications was calculated for each treatment and the same was done with the untreated plot. The population of *Etiella zinkenella* was recorded before 1st day spraying and on 3rd day, 7th day and 14th day after insecticidal application. Healthy pods were harvested and their weight from each treatment was expressed as marketable yield in quintal per hectare. Ultimately, the cost benefit ratio was calculated on the basis of prevailing market price of yield, insecticides and spraying cost.

$$\text{Benefit- Cost Ratio} = \frac{\text{Gross return}}{\text{Total cost of cultivation}}$$ Singh *et al*., (2017) [19]

Table 1: Assessment of botanicals and chemical insecticides against pea pod borer *Etiella zinkenella* (Tr.) in Pea during rabi 2023-2024.

Sr. no	Treatments	DBS	Larval population (No.)								Yield (q/ha)	C: B ratio
			1st spray				2nd spray					
			3DAS	7DAS	14DAS	Mean	3DAS	7DAS	14DAS	Mean		
T_1	Cypermethrin 25 EC 0.5 ml/lit	5.0	3.26bcde	2.40bcd	3.00bc	2.88cde	2.73bc	1.53bc	1.73c	1.99bcd	48.40	1:2.57
T_2	Spinosad 45% SC 0.30 ml/lit	5.40	3.00de	1.93cd	2.66cd	2.53ef	2.26c	1.26cd	1.53cd	1.68de	56.32	1:2.97
T_3	Deltamethrin 2.8% EC 1 ml/lit	4.87	3.53bcd	2.66bcd	3.26bc	3.15bcd	2.96bc	1.66bc	1.93bc	2.18bcd	47.29	1:2.49
T_4	Neem oil @ 2% 5 ml/lit	4.40	3.80bc	2.80bc	3.60b	3.40bc	3.06bc	1.60bc	2.06bc	2.24bc	44.50	1:2.28
T_5	*Beauveria Bassiana* 2 × 108 Spores/gm 2.5 gm/lit	4.0	3.93b	2.93b	3.60b	3.50b	3.26b	1.86b	2.40b	2.50b	43.26	1:2.23
T_6	Emamectin benzoate 5% SG 2gm/lit	5.00	3.13cde	2.20bcd	2.73cd	2.68def	2.46bc	1.40c	1.60cd	1.82cde	49.30	1:2.45
T_7	Indaxocarb 14.5% Sc 1ml/lit	5.73	2.73e	1.86d	2.20d	2.26f	2.13c	0.93d	1.06cd	1.37e	67.50	1:3.30
T_8	Control	6.20	6.93a	7.13a	8.46a	7.50a	7.93a	8.33a	8.86a	8.04a	32.40	1:1.78
	F-test	NS	S	S	S	S	S	S	S	S		
	C.D. (P=0.05%)	_	0.93	0.93	0.81	0.51	0.93	0.40	0.65	0.53		
	S.Ed. (±)	_	5.31	5.31	6.75	3.54	6.939	5.31	6.753	3.54		

Results and Discussion

The results (Table -1) after 1st and 2nd spray revealed that all the treatments were significantly superior over the control. The data on the mean larval population of pea pod borer *Etiella zinkenella* in pea 3rd, 7th and 14th day after first spray revealed that all the treatments were significantly superior over control. Among all the treatments lowest larval population was recorded in T_7 Indaxocarb 14.5% SC (2.26) followed by T_2 Spinosad 45% SC (2.53), T_6 Emamectin benzoate 5%SG (2.68), T_1 Cypermethrin 25% EC2.87), T_3 Deltamethrin 2.8% (3.15), T_4 Neem oil 2% (3.40) and T_5 *Beauveria bassiana* (3.50) was found to be least effective than all the treatments and is significantly superior over the control (7.50).

The data on the mean larval population of pea pod borer *Etiella zinkenella* infesting pea 3rd, 7th and 14th day after second spray revealed that all the treatments were significantly superior over control. Among all the treatments lowest larval population was recorded in T_7 Indaxocarb 14.5% Sc (1.37) followed by T_2 Spinosad 45% (1.68), T_6 Emamectin benzoate 5%SG (1.82), T_1 Cypermethrin 25% EC (1.99), T_3 Deltamethrin (2.18), T_4 Neem oil 2% (2.24) and T_5 *Beauveria Bassiana* (2.50) and T_8 Control (8.04).

The highest yield (q/ha) and cost benefit ratio was recorded in Indaxocarb 14.5% Sc (67.5) and (1:3.30), followed by Spinosad 45% SC (56.32) and (1:2.97), Emamectin benzoate 5%SG (49.3) and (1:2.45), Cypermethrin (48.4) and (1:2.57), Deltamethrin 2.8% EC (47.29) and (1:2.49), Neem oil 2% (44.5) and (1:2.28), *Beauveria Bassiana* (43.26) and (1:2.23) as compared to control (32.4) and (1:1.78).

The data on the mean larval population in the first and second spray reveled that the minimum larval population were recorded in Indaxocarb 14.5% SC (2.26) and (1.37). The results are similar to be findings reported by Nitharwal *et al.*, (2017) [12], Yadav *et al.*, (2015) [25], Lakshmikanth and

Kumar (2018) [10]. Spinosad was found to be next best treatment. The results of Spinosad 45% SC (2.53) and (1.68) are supported by Ambule *et al.,* (2015) [1], Singh *et al.,* (2017) [19] and Ghulam *et al.,* (2020) [6].

Emamectin benzoate 5%SG (2.66) and (1.80) found to be the next best effective treatment. These results were similar finding of Pal *et al.,* (2018) [13]. Neem oil @ 2% (3.40) and (2.26) found to be next effective treatment and its results are supported by Dhaka *et al.,* (2018) [4] and Meena *et al.,* (2020) [11]. Deltamethrin 2.8% EC (3.10) and (2.13) and Cypermetrin 5% EC (2.86) and (1.96) are found to be effective treatments and the results were similar to findings reported by Gaje *et al.,* (2010) [5], Satish *et al.,* (2018) [16] and Meena *et al.,* (2020) [11]. *Beauveria bassiana* (3.53) and (2.46) found to be effective in reducing the larval population and the results were supported by Kesharwani *et al.,* (2011) [7].

Higher yield (67.5 q/ha) and higher cost benefit ratio was obtained from indaxocarb and lowest in control plot (32.4 q/ha). Similar findings were made by Pal *et al.,* (2018) [13], who recorded the highest cost benefit ratio. Nitharwal *et al.,* (2017) [12] and Banshtu *et al.,* (2020) [3] also reported that the Spinosad is the best and most economical treatment recorded (56.32 q/ha) and cost benefit ratio (1:2.97). Khademul *et al.,* (2020) [8] and Vaibhav *et al.,* (2018) [22] reported highest grain yield in Emamectin benzoate and cost effectiveness of Emamectin benzoate was also very high and very favourable with incremental benefit ratio. Shreelakshmi *et al.,* (2015) [20] reported that cost effectiveness of Neem oil was high withcost benefit ratio. Recorded yield (44.5 q/ha) and cost benefit ratio (1:2.28).

Conclusion

Field pea (*Pisum sativum* L.) is a valuable leguminous crop known for its high yield, nutritional benefits, and soil fertility enhancement. Despite its widespread cultivation across India's cooler regions, it faces significant challenges from the pea pod borer (*Etiella zinkenella*), a pest causing substantial yield losses. The recent study evaluated various pest control methods, including chemical and botanical treatments, during the 2023-24 Rabi season. Among these, Indaxocarb 14.5% SC emerged as the most effective, providing the highest yield and cost-benefit ratio. Spinosad and Emamectin benzoate also proved effective. Overall, timely and targeted pest management is crucial for optimizing pea production and profitability.

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