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Bio-efficacy of novel insecticide molecules against pod borer, *Helicoverpa armigera* of Indian bean [*Lablab purpureus* (L.) sweet]

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Abstract
A field experiment was conducted at Agriculture Experimental Station, Navsari Agricultural University, Paria, Valsad during *rabi* 2018-19 and 2019-20. The relative efficacy of eleven insecticides, *viz*., bifenthrin 10 EC (0.01%), imidacloprid 17.8 SL (0.005%), buprofezin 25 SC (0.025%), indoxacarb 14.5 SC (0.00725%), flubendiamide 48 SC (0.015%), chlorantraniliprole 20 SC (0.006%), spinosad 45 SC (0.015%), flonicamid 50 WG (0.0075%), diafenthiuron 50 WP (0.03%), fipronil 5 SC (0.01%) and dinotefuran 20 SG (0.0025%) against pod borer, *Helicoverpa armigera* Hubner was evaluated. Among the evaluated insecticides, chlorantraniliprole (0.006%), spinosad (0.015%), indoxacarb (0.00725%) and flubendiamide (0.015%) were found more effective against *H. armigera*. The treatment buprofezin (0.025%) and dinotefuran (0.0025%) found less effective to control the pest. The order of effectiveness of various treatments against *H. armigera* was found to be chlorantraniliprole (0.006%) ≥ spinosad (0.015%) ≥ indoxacarb (0.00725%) ≥ flubendiamide (0.015%) > bifenthrin (0.01%) ≥ fipronil (0.01%) ≥ diafenthiuron (0.03%) > imidacloprid (0.005%) ≥ flonicamid (0.0075%) ≥ buprofezin (0.025%) ≥ dinotefuran (0.0025%) > control.

Keywords: Indian bean, *Helicoverpa armigera*, bifenthrin, imidacloprid, buprofezin, indoxacarb, flubendiamide, chlorantraniliprole, spinosad, flonicamid, diafenthiuron, fipronil and dinotefuran

1. Introduction
Indian bean [*Lablab pupureus* (L.) Sweet] is one of the most ancient pulse crops among cultivated pulses. It is native to India and is commonly grown in almost all states *viz*., Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu, Gujarat, etc. Besides India, it is also grown throughout the tropical regions of Asia, Africa and America. It is a perennial herbaceous plant that occupies an important place among the fruit and vegetable crops grown in the field as well as in kitchen gardens. It is a multipurpose crop grown for pulse, vegetables and forage. It is primarily grown for green pods, while dry seeds are used in various vegetable food preparations. It is also grown in home gardens as an annual crop or on fences as a perennial crop. Green seeds and green immature pods are especially used in the preparation of a very famous Gujarati dish named '*Undhiyu'* and in South Gujarat as '*Ubadiyu'*. In Gujarat, the Indian beans crop is mainly attacked by black aphid, *A. craccivora* Koch, leafhopper, *Empoasca kerri* Pruthi, thrips, *Megaleurothrips distalis* Karny and pod borer, *H. armigera* (Hubner) Hardwick.The pod borers are considered to be most important and they appeared regularly causing crop loss to the tune of 80 to 100 per cent in Lablab (Katagihallimath and Siddappaji, 1962) [5]. On an average 2.5 to 3.0 million tonnes of pulses are lost annually due to ravages of pest complex (Upadhyay and Mukerji, 1998) [10].

2. Materials and Methods
A field experiment was carried out at the Agriculture Experimental Station, Navsari Agricultural University, Paria, Valsad during *rabi* seasons of 2018-19 and 2019-20 for the evaluation of bio-efficacy of various insecticides against pod borer, *H. armigera* in Indian bean, *Katargam Papdi* (Local) variety was grown in a plot measuring 3.6 x 4.0 m^2 with a row to row and plant to plant distance of 45 and 20 cm, respectively, using Randomized Block Design with three replications and following all the recommended agronomic practices. Eleven different insecticides, *viz*., bifenthrin 10 EC (0.01%), imidacloprid 17.8 SL (0.005%), buprofezin 25 SC (0.025%), indoxacarb 14.5 SC (0.00725%), flubendiamide 48 SC (0.015%), chlorantraniliprole 20 SC (0.006%), spinosad 45 SC (0.015%), flonicamid 50 WG (0.0075%),

diafenthiuron 50 WP (0.03%), fipronil 5 SC (0.01%) and dinotefuran 20 SG (0.0025%) along with control were evaluated (Table 1). All the treatments were applied as foliar spray by using a knapsack sprayer fitted with a hollow cone nozzle. The first spray was applied 40 days after sowing and the second 20 days after the first spray. The population of pod borer was recorded a day before spray as well as one, three, five, seven, eleven and fifteen days after each spray. For the purpose, five plants were selected randomly and tagged from each net plot area of each treatment. Number of larvae from each selected plant and mean number of larvae per plant were worked out. The data on pod borer population was subjected to ANOVA after square root $\sqrt{X + 0.5}$ transformation.

Table 1: Details of insecticides used

Sr. No.	Insecticides	Formulation	Conc.(%)/Dosage
1.	Bifenthrin	10 EC	0.01%
2.	Imidacloprid	17.8 SL	0.005%
3.	Buprofezin	25 SC	0.025%
4.	Indoxacarb	14.5 SC	0.00725%
5.	Flubendiamide	48 SC	0.015%
6.	Chlorantraniliprole	20 SC	0.006%
7.	Spinosad	45 SC	0.015%
8.	Flonicamid	50 WG	0.0075%
9.	Diafenthiuron	50 WP	0.03%
10.	Fipronil	5 SC	0.01%
11.	Dinotefuran	20 SG	0.0025%
12.	Control (Water spray only)	-	-

3. Result and Discussion

During 2018-19, data on larval population recorded before and 1, 3, 5, 7, 11 and 15 days after spray (DAS) are presented in Table 2. Before the imposition of the first spray, all the treatments showed non-significant results for combating larval population suggesting an even distribution of pests in all the experimental plots. Overall, results of pooled over period and spray revealed a lower (0.29 larvae/plant) larval population when crop was treated with chlorantraniliprole (0.006%), which remained at par with spinosad (0.015%), indoxacarb (0.00725%) and flubendiamide (0.015%) in which larval population was 0.34, 0.38 and 0.39 larvae/plant, respectively. The next effective treatments were bifenthrin (0.01%), fipronil (0.01%) and diafenthiuron (0.03%).The treatment flonicamid (0.0075%) found less (0.96 larvae/plant) effective to control *H. armigera*, which was on par with buprofezin (0.025%) and dinotefuran (0.0025%) with larval population of 1.01 and 1.12 larvae/plant, respectively. The maximum (1.41 larvae/plant) larval population was observed in control.

A more or less similar trend was observed in the chemical management of *H. armigera* during 2019-20 are presented in Table 3. The population of pod borer showed non-significant results before the imposition of treatments indicated a homogeneous population of the *H. armigera* in all the experimental plots. Overall, results of pooled over the period and spray revealed a lower (0.30 larvae/plant) larval population when the crop was treated with chlorantraniliprole (0.006%), which remained at par with spinosad (0.015%), indoxacarb (0.00725%) and flubendiamide (0.015%) in which larval population was 0.38, 0.39 and 0.43 larvae/plant, respectively. The treatment buprofezin (0.025%) with 1.03 larvae/plant found less effective to control *H. armigera*, which was at par with dinotefuran (0.0025%) (1.22 larvae/plant). The maximum (1.62 larvae/plant) larval population was observed in control.

Two years of pooled data were presented in Table 4 revealed the lowest (0.29 larvae/plant) larval population was recorded in chlorantraniliprole (0.006%) after first spray and found significantly superior over all the treatments and at par with spinosad (0.015%), indoxacarb (0.00725%) and flubendiamide (0.015%) in which larval population was 0.36, 0.37 and 0.39 larvae/plant, respectively. The next best treatments were bifenthrin (0.01%), fipronil (0.01%) and diafenthiuron (0.03%) with larval population of 0.59, 0.69 and 0.75 larvae/plant and these treatments did not differ significantly from each other. More or less similar results were observed after second spray. The maximum (1.41 larvae/plant) larval population was observed in control. Significantly lowest (0.30 larvae/plant) population was recorded in chlorantraniliprole (0.006%) after second spray which was found significantly superior over all the treatments and at par with spinosad (0.015%), indoxacarb (0.00725%) and flubendiamide (0.015%) wherein larval population was 0.36, 0.41 and 0.43 larvae/plant, respectively. The next effective treatments were bifenthrin (0.01%), fipronil (0.01%) and diafenthiuron (0.03%) with 0.55, 0.61 and 0.63 larvae/plant, respectively.

Overall, results of pooled over period, spray and year revealed significantly lower (0.29 larvae/plant) in chlorantraniliprole (0.006%) and remained at par with spinosad (0.015%), indoxacarb (0.00725%) and flubendiamide (0.015%) in which larval population was 0.36, 0.39 and 0.41 larvae/plant, respectively. The treatment buprofezin (0.025%) found less (1.02 larvae/plant) effective to control *H. armigera*, which was at par with dinotefuran (0.0025%) with 1.17 larvae/plant. The maximum (1.51 larvae/plant) larval population was observed in control. The order of effectiveness of various treatments against *H. armigera* was found to be chlorantraniliprole (0.006%) ≥ spinosad (0.015%) ≥ indoxacarb (0.00725%) ≥ flubendiamide (0.015%) > bifenthrin (0.01%) ≥ fipronil (0.01%) ≥ diafenthiuron (0.03%) > imidacloprid (0.005%) ≥ flonicamid (0.0075%) ≥ buprofezin (0.025%) ≥ dinotefuran (0.0025%) > control.

The results of present investigation corroborates with the reports of Mallikarjuna *et al.* (2009) [6] who recorded the highest larva lreduction of pod borers with flubendiamide 480 SC and thiacloprid 48 SC followed by emamectin benzoate 5 SG and indoxacarb 14.5 SC in dolichos bean. Deshmukh *et al.* (2010) [2] reported that the spray application of flubendiamide (0.007%), indoxacarb (0.0075%), spinosad (0.009%) and emamectin benzoate (0.0015%) were found the most effective in reducing the *H. armigera* population and pod damage in chickpea. Chaudhari *et al.* (2015b)[1] recorded a minimum larval population of *H. armigera* in flubendiamide 48 SC 0.015 per cent followed by indoxacarb 14.5 SC 0.0725 per cent and chlorantraniliprole 20 SC 0.006 per cent with the least number of pod damage due to *H. armigera* in Indian beans at Anand, Gujarat. Shelke (2017) [9] showed that Emamectin benzoate 5 SG @ 0.002 per cent was found equally effective with Indoxacarb 14.5 SC @ 0.014 per cent in reducing the pod damage in dolichos bean at Dapoli, Maharashtra. Spinosad (0.01%) proved the most effective against pod borer complex in Indian beans followed by indoxacarb (0.01%) in Indian beans reported by Jat *et al.* (2017)[4] at Bikaner, Rajasthan. Neharkar *et al.* (2018)[7] showed that the flubendiamide 20 WDG @ 0.02 per cent emerged as the most superior one against pigeonpea pod borer complex recording minimum pod damage and at par with chlorantraniliprole 18.5 SC @ 0.01 per cent, spinosad 45 SC @ 0.027 per cent. indoxacarb 14.5 SC @ 0.015 per cent, emamectin benzoate 5 SG @ 0.002 per cent and Neem oil 2 per cent. Pal *et al*. (2018) [8] recorded that indoxacarb 14.5 SC found most superior against *H. armigera* of tomato. Devashrayee *et al*. (2022) [3] showed that the treatment of emamectin benzoate 5 SG at 0.002 per cent, indoxacarb 14.5 SC at 0.007 per cent and lambda cyhalothrin 5 SC at 0.005 per cent were found to be most effective against *H. armigera* and *M. vitrata* in Indian beans.

Table 2: Efficacy of different insecticides against pod borer, *H. armigera* infesting Indian bean (2018-19)

Treat. No.	No. of larvae/plant																							
	First spray								Second spray								Pooled							
	BS	1 DAS	3 DAS	5 DAS	7 DAS	11 DAS	15 DAS	Pooled	BS	1 DAS	3 DAS	5 DAS	7 DAS	11 DAS	15 DAS	Pooled	BS	1 DAS	3 DAS	5 DAS	7 DAS	11 DAS	15 DAS	Pooled
T_1	1.47	0.71	0.71	1.11	1.14	1.22	1.20	1.01	1.28	0.71	0.71	0.98	1.08	1.11	1.28	0.98	1.37	0.71	0.71	1.05	1.11	1.17	1.24	1.00
	(1.67)	(0.00)	(0.00)	(0.73)	(0.80)	(1.00)	(0.93)	(0.58)	(1.13)	(0.00)	(0.00)	(0.47)	(0.67)	(0.73)	(1.13)	(0.50)	(1.4)	(0.00)	(0.00)	(0.60)	(0.73)	(0.87)	(1.03)	(0.54)
T_2	1.54	1.54	1.28	1.14	1.05	1.11	1.22	1.22	1.22	1.22	1.20	1.08	1.11	1.22	1.14	1.16	1.38	1.38	1.24	1.11	1.08	1.17	1.18	1.19
	(1.87)	(1.87)	(1.13)	(0.80)	(0.60)	(0.73)	(1.00)	(1.02)	(1.00)	(1.00)	(0.93)	(0.67)	(0.73)	(1.00)	(0.80)	(0.86)	(1.43)	(1.43)	(1.03)	(0.73)	(0.67)	(0.87)	(0.90)	(0.94)
T_3	1.49	1.49	1.33	1.20	1.14	1.20	1.14	1.25	1.30	1.30	1.25	1.14	1.14	1.20	1.17	1.20	1.40	1.40	1.29	1.17	1.14	1.20	1.15	1.23
	(1.73)	(1.73)	(1.27)	(0.93)	(0.80)	(0.93)	(0.80)	(1.08)	(1.20)	(1.20)	(1.07)	(0.80)	(0.80)	(0.93)	(0.87)	(0.94)	(1.47)	(1.47)	(1.17)	(0.87)	(0.80)	(0.93)	(0.83)	(1.01)
T_4	1.45	1.43	0.71	0.71	0.71	0.91	0.95	0.90	1.20	1.28	0.71	0.71	0.71	0.91	1.17	0.91	1.32	1.35	0.71	0.71	0.71	0.91	1.06	0.91
	(1.60)	(1.53)	(0.00)	(0.00)	(0.00)	(0.33)	(0.40)	(0.38)	(0.93)	(1.13)	(0.00)	(0.00)	(0.00)	(0.33)	(0.87)	(0.39)	(1.27)	(1.33)	(0.00)	(0.00)	(0.00)	(0.33)	(0.63)	(0.38)
T_5	1.47	1.45	0.71	0.71	0.71	0.88	0.91	0.89	1.25	1.25	0.71	0.71	0.71	0.91	1.25	0.92	1.36	1.35	0.71	0.71	0.71	0.89	1.08	0.91
	(1.67)	(1.60)	(0.00)	(0.00)	(0.00)	(0.27)	(0.33)	(0.37)	(1.07)	(1.07)	(0.00)	(0.00)	(0.00)	(0.33)	(1.07)	(0.41)	(1.37)	(1.33)	(0.00)	(0.00)	(0.00)	(0.30)	(0.70)	(0.39)
T_6	1.52	1.35	0.71	0.71	0.71	0.80	0.88	0.86	1.28	1.25	0.71	0.71	0.71	0.84	0.98	0.87	1.40	1.30	0.71	0.71	0.71	0.82	0.93	0.86
	(1.80)	(1.33)	(0.00)	(0.00)	(0.00)	(0.13)	(0.27)	(0.29)	(1.13)	(1.07)	(0.00)	(0.00)	(0.00)	(0.20)	(0.47)	(0.29)	(1.47)	(1.20)	(0.00)	(0.00)	(0.00)	(0.17)	(0.37)	(0.29)
T_7	1.54	1.45	0.71	0.71	0.71	0.80	0.95	0.89	1.22	1.22	0.71	0.71	0.71	0.95	1.05	0.89	1.38	1.34	0.71	0.71	0.71	0.87	1.00	0.89
	(1.87)	(1.6)	(0.00)	(0.00)	(0.00)	(0.13)	(0.40)	(0.36)	(1.00)	(1.00)	(0.00)	(0.00)	(0.00)	(0.40)	(0.60)	(0.33)	(1.43)	(1.30)	(0.00)	(0.00)	(0.00)	(0.27)	(0.50)	(0.34)
T_8	1.47	1.47	1.28	1.20	1.08	1.14	1.22	1.23	1.33	1.33	1.25	1.05	1.08	1.20	1.14	1.17	1.40	1.40	1.26	1.12	1.08	1.17	1.18	1.20
	(1.67)	(1.67)	(1.13)	(0.93)	(0.67)	(0.80)	(1.00)	(1.03)	(1.27)	(1.27)	(1.07)	(0.60)	(0.67)	(0.93)	(0.80)	(0.89)	(1.47)	(1.47)	(1.10)	(0.77)	(0.67)	(0.87)	(0.90)	(0.96)
T_9	1.54	1.52	1.14	1.05	0.98	1.02	1.11	1.14	1.25	1.25	0.98	0.80	0.88	1.05	1.17	1.02	1.40	1.38	1.06	0.92	0.93	1.03	1.14	1.08
	(1.87)	(1.80)	(0.80)	(0.60)	(0.47)	(0.53)	(0.73)	(0.82)	(1.07)	(1.07)	(0.47)	(0.13)	(0.27)	(0.60)	(0.87)	(0.57)	(1.47)	(1.43)	(0.63)	(0.37)	(0.37)	(0.57)	(0.80)	(0.69)
T_{10}	1.52	1.52	1.14	1.02	0.98	0.95	1.02	1.10	1.28	1.28	0.95	0.84	0.84	1.02	1.14	1.01	1.40	1.40	1.04	0.93	0.91	0.98	1.08	1.06
	(1.80)	(1.80)	(0.80)	(0.53)	(0.47)	(0.40)	(0.53)	(0.76)	(1.13)	(1.13)	(0.40)	(0.20)	(0.20)	(0.53)	(0.80)	(0.54)	(1.47)	(1.47)	(0.60)	(0.37)	(0.33)	(0.47)	(0.67)	(0.65)
T_{11}	1.49	1.49	1.45	1.28	1.14	1.30	1.20	1.31	1.22	1.22	1.20	1.20	1.25	1.25	1.25	1.23	1.36	1.36	1.32	1.24	1.20	1.28	1.22	1.27
	(1.73)	(1.73)	(1.60)	(1.13)	(0.80)	(1.20)	(0.93)	(1.23)	(1.00)	(1.00)	(0.93)	(0.93)	(1.07)	(1.07)	(1.07)	(1.01)	(1.37)	(1.37)	(1.27)	(1.03)	(0.93)	(1.13)	(1.00)	(1.12)
T_{12}	1.49	1.52	1.52	1.45	1.45	1.47	1.45	1.48	1.25	1.25	1.28	1.28	1.25	1.28	1.33	1.28	1.37	1.38	1.40	1.36	1.35	1.37	1.39	1.38
	(1.73)	(1.80)	(1.80)	(1.60)	(1.60)	(1.67)	(1.60)	(1.68)	(1.07)	(1.07)	(1.13)	(1.13)	(1.07)	(1.13)	(1.27)	(1.13)	(1.40)	(1.43)	(1.47)	(1.37)	(1.33)	(1.40)	(1.43)	(1.41)
SEm.± T	0.09	0.08	0.06	0.05	0.06	0.06	0.07	0.03	0.07	0.07	0.05	0.05	0.06	0.06	0.07	0.03	0.06	0.06	0.04	0.04	0.05	0.06	0.06	0.02
S																	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
P								0.02								0.02								0.01
T x S																	0.07	0.07	0.05	0.04	0.04	0.04	0.05	0.03
T x P								0.06								0.06								0.04
S x P																								0.02
T x S x P																								0.06
CD at 5% T	NS	0.23	0.17	0.16	0.18	0.18	0.19	0.08	NS	0.22	0.16	0.16	0.17	0.19	NS	0.09	NS	0.17	0.12	0.13	0.15	0.17	0.17	0.07
S																	0.06	0.06	0.05	0.03	NS	NS	0.04	0.02
P								0.05								0.05								0.03
T x S																	NS	NS	NS	NS	NS	0.13	0.14	0.08
T x P								0.17								0.17								0.12
S x P																								0.05
T x S x P																								NS
CV %	10.01	9.47	9.43	9.27	10.71	9.76	10.28	9.80	10.28	10.61	9.65	9.87	10.56	10.45	10.69	12.46	10.96	10.91	10.21	11.12	12.81	13.22	12.87	13.31

Figures are $\sqrt{X + 0.5}$ transformed values and those in parentheses are original values. NS = Non-significant

Table 3: Efficacy of different insecticides against pod borer, *H. armigera* infesting Indian bean (2019-20)

Treat. No.	No. of larvae/plant																							
	First spray								Second spray								Pooled							
	BS	1 DAS	3 DAS	5 DAS	7 DAS	11 DAS	15 DAS	Pooled	BS	1 DAS	3 DAS	5 DAS	7 DAS	11 DAS	15 DAS	Pooled	BS	1 DAS	3 DAS	5 DAS	7 DAS	11 DAS	15 DAS	Pooled
T_1	1.40	0.71	0.71	1.02	1.20	1.20	1.33	1.03	1.35	0.71	0.71	1.05	1.14	1.17	1.35	1.02	1.38	0.71	0.71	1.03	1.17	1.18	1.34	1.02
	(1.47)	(0.00)	(0.00)	(0.53)	(0.93)	(0.93)	(1.27)	(0.61)	(1.33)	(0.00)	(0.00)	(0.60)	(0.80)	(0.87)	(1.33)	(0.60)	(1.40)	(0.00)	(0.00)	(0.57)	(0.87)	(0.90)	(1.30)	(0.61)
T_2	1.33	1.33	1.20	1.11	1.14	1.08	1.20	1.18	1.40	1.40	1.35	1.11	1.08	1.14	1.20	1.21	1.37	1.37	1.28	1.11	1.11	1.11	1.20	1.19
	(1.27)	(1.27)	(0.93)	(0.73)	(0.80)	(0.67)	(0.93)	(0.89)	(1.47)	(1.47)	(1.33)	(0.73)	(0.67)	(0.80)	(0.93)	(0.99)	(1.37)	(1.37)	(1.13)	(0.73)	(0.73)	(0.73)	(0.93)	(0.94)
T_3	1.38	1.38	1.25	1.20	1.17	1.22	1.22	1.24	1.33	1.33	1.30	1.20	1.08	1.20	1.28	1.23	1.35	1.35	1.28	1.20	1.12	1.21	1.25	1.24
	(1.40)	(1.40)	(1.07)	(0.93)	(0.87)	(1.00)	(1.00)	(1.04)	(1.27)	(1.27)	(1.20)	(0.93)	(0.67)	(0.93)	(1.13)	(1.02)	(1.33)	(1.33)	(1.13)	(0.93)	(0.77)	(0.97)	(1.07)	(1.03)
T_4	1.35	1.30	0.71	0.71	0.71	0.95	1.02	0.90	1.38	1.38	0.71	0.71	0.71	0.88	1.20	0.93	1.37	1.34	0.71	0.71	0.71	0.91	1.11	0.91
	(1.33)	(1.20)	(0.00)	(0.00)	(0.00)	(0.40)	(0.53)	(0.36)	(1.40)	(1.40)	(0.00)	(0.00)	(0.00)	(0.27)	(0.93)	(0.43)	(1.37)	(1.30)	(0.00)	(0.00)	(0.00)	(0.33)	(0.73)	(0.39)
T_5	1.43	1.43	0.71	0.71	0.71	0.91	1.05	0.92	1.40	1.38	0.71	0.71	0.71	0.88	1.22	0.93	1.41	1.40	0.71	0.71	0.71	0.89	1.14	0.93
	(1.53)	(1.53)	(0.00)	(0.00)	(0.00)	(0.33)	(0.60)	(0.41)	(1.47)	(1.40)	(0.00)	(0.00)	(0.00)	(0.27)	(1.00)	(0.44)	(1.50)	(1.47)	(0.00)	(0.00)	(0.00)	(0.30)	(0.80)	(0.43)
T_6	1.40	1.30	0.71	0.71	0.71	0.84	0.91	0.86	1.38	1.35	0.71	0.71	0.71	0.84	0.91	0.87	1.39	1.33	0.71	0.71	0.71	0.84	0.91	0.87
	(1.47)	(1.20)	(0.00)	(0.00)	(0.00)	(0.20)	(0.33)	(0.29)	(1.40)	(1.33)	(0.00)	(0.00)	(0.00)	(0.20)	(0.33)	(0.31)	(1.43)	(1.27)	(0.00)	(0.00)	(0.00)	(0.20)	(0.33)	(0.30)
T_7	1.43	1.35	0.71	0.71	0.71	0.88	1.05	0.90	1.35	1.35	0.71	0.71	0.71	0.91	1.08	0.91	1.39	1.35	0.71	0.71	0.71	0.89	1.06	0.91
	(1.53)	(1.33)	(0.00)	(0.00)	(0.00)	(0.27)	(0.60)	(0.37)	(1.33)	(1.33)	(0.00)	(0.00)	(0.00)	(0.33)	(0.67)	(0.39)	(1.43)	(1.33)	(0.00)	(0.00)	(0.00)	(0.30)	(0.63)	(0.38)
T_8	1.38	1.38	1.20	1.14	1.14	1.17	1.20	1.20	1.35	1.33	1.30	1.20	1.14	1.20	1.17	1.22	1.37	1.35	1.25	1.17	1.14	1.18	1.18	1.21
	(1.40)	(1.40)	(0.93)	(0.80)	(0.80)	(0.87)	(0.93)	(0.96)	(1.33)	(1.27)	(1.20)	(0.93)	(0.80)	(0.93)	(0.87)	(1.00)	(1.37)	(1.33)	(1.07)	(0.87)	(0.80)	(0.90)	(0.90)	(0.98)
T_9	1.35	1.35	1.08	0.91	0.98	1.05	1.08	1.08	1.30	1.30	1.17	1.02	0.95	1.08	1.02	1.09	1.33	1.33	1.12	0.96	0.97	1.06	1.05	1.08
	(1.33)	(1.33)	(0.67)	(0.33)	(0.47)	(0.60)	(0.67)	(0.68)	(1.20)	(1.20)	(0.87)	(0.53)	(0.40)	(0.67)	(0.53)	(0.70)	(1.27)	(1.27)	(0.77)	(0.43)	(0.43)	(0.63)	(0.60)	(0.69)
T_{10}	1.35	1.33	1.02	0.88	0.95	1.02	1.11	1.05	1.35	1.35	1.20	0.91	0.88	1.02	1.05	1.07	1.35	1.34	1.11	0.89	0.91	1.02	1.08	1.06
	(1.33)	(1.27)	(0.53)	(0.27)	(0.40)	(0.53)	(0.73)	(0.62)	(1.33)	(1.33)	(0.93)	(0.33)	(0.27)	(0.53)	(0.60)	(0.67)	(1.33)	(1.30)	(0.73)	(0.30)	(0.33)	(0.53)	(0.67)	(0.64)
T_{11}	1.33	1.35	1.35	1.30	1.25	1.30	1.35	1.32	1.38	1.38	1.35	1.28	1.22	1.25	1.33	1.30	1.35	1.37	1.35	1.29	1.24	1.28	1.34	1.31
	(1.27)	(1.33)	(1.33)	(1.20)	(1.07)	(1.20)	(1.33)	(1.24)	(1.40)	(1.40)	(1.33)	(1.13)	(1.00)	(1.07)	(1.27)	(1.20)	(1.33)	(1.37)	(1.33)	(1.17)	(1.03)	(1.13)	(1.30)	(1.22)
T_{12}	1.38	1.43	1.45	1.43	1.40	1.45	1.47	1.44	1.35	1.35	1.45	1.49	1.49	1.54	1.52	1.47	1.37	1.39	1.45	1.46	1.45	1.49	1.49	1.46
	(1.4)	(1.53)	(1.60)	(1.53)	(1.47)	(1.60)	(1.67)	(1.57)	(1.33)	(1.33)	(1.60)	(1.73)	(1.73)	(1.87)	(1.80)	(1.68)	(1.37)	(1.43)	(1.60)	(1.63)	(1.60)	(1.73)	(1.73)	(1.62)
SEm.±T	0.09	0.08	0.05	0.06	0.06	0.08	0.06	0.05	0.08	0.07	0.05	0.06	0.05	0.07	0.06	0.03	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.03
S																	0.03	0.02	0.01	0.02	0.01	0.02	0.02	0.01
P								0.02								0.02								0.01
T x S																	0.09	0.08	0.05	0.05	0.04	0.07	0.06	0.04
T x P								0.06								0.06								0.04
S x P																								0.02
T x S x P																								0.06
CD at 5% T	NS	0.23	0.16	0.18	0.19	0.23	0.18	0.13	NS	0.21	0.13	0.19	0.16	0.19	0.19	0.10	NS	0.15	0.11	0.15	0.14	0.16	0.14	0.08
S																	NS	NS	0.04	NS	NS	NS	NS	NS
P								0.05								0.05								0.03
T x S																	NS	NS	NS	NS	NS	NS	NS	NS
T x P								0.16								0.16								0.11
S x P																								0.05
T x S x P																								NS
CV %	11.13	10.54	9.46	10.94	11.09	12.76	9.15	17.54	10.04	9.68	7.51	10.94	9.44	10.42	9.18	9.08	9.64	9.72	8.94	12.48	12.18	12.20	9.65	15.23

Figures are $\sqrt{X + 0.5}$ transformed values and those in parentheses are original values. NS = Non-significant

Table 4: Efficacy of different insecticides against pod borer, *H. armigera* infesting Indian bean (Pooled: 2018-19 & 2019-20)

Treat. No.	No. of larvae/plant																							
	First spray								Second spray								Pooled							
	BS	1 DAS	3 DAS	5 DAS	7 DAS	11 DAS	15 DAS	Pooled	BS	1 DAS	3 DAS	5 DAS	7 DAS	11 DAS	15 DAS	Pooled	BS	1 DAS	3 DAS	5 DAS	7 DAS	11 DAS	15 DAS	Pooled
T_1	1.44	0.71	0.71	1.06	1.17	1.21	1.26	1.02	1.32	0.71	0.71	1.02	1.11	1.14	1.32	1.00	1.38	0.71	0.71	1.04	1.14	1.18	1.29	1.01
	(1.57)	(0.00)	(0.00)	(0.63)	(0.87)	(0.97)	(1.10)	(0.59)	(1.23)	(0.00)	(0.00)	(0.53)	(0.73)	(0.80)	(1.23)	(0.55)	(1.4)	(0.00)	(0.00)	(0.58)	(0.80)	(0.88)	(1.17)	(0.57)
T_2	1.44	1.44	1.24	1.13	1.10	1.10	1.21	1.20	1.32	1.32	1.28	1.10	1.10	1.18	1.17	1.19	1.38	1.38	1.26	1.11	1.10	1.14	1.19	1.20
	(1.57)	(1.57)	(1.03)	(0.77)	(0.70)	(0.70)	(0.97)	(0.96)	(1.23)	(1.23)	(1.13)	(0.70)	(0.70)	(0.90)	(0.87)	(0.92)	(1.40)	(1.40)	(1.08)	(0.73)	(0.70)	(0.80)	(0.92)	(0.94)
T_3	1.44	1.44	1.29	1.20	1.15	1.21	1.18	1.25	1.32	1.32	1.28	1.17	1.11	1.20	1.22	1.22	1.38	1.38	1.28	1.18	1.13	1.20	1.20	1.23
	(1.57)	(1.57)	(1.17)	(0.93)	(0.83)	(0.97)	(0.90)	(1.06)	(1.23)	(1.23)	(1.13)	(0.87)	(0.73)	(0.93)	(1.00)	(0.98)	(1.40)	(1.40)	(1.15)	(0.90)	(0.78)	(0.95)	(0.95)	(1.02)
T_4	1.40	1.37	0.71	0.71	0.71	0.93	0.98	0.90	1.29	1.33	0.71	0.71	0.71	0.89	1.18	0.92	1.35	1.35	0.71	0.71	0.71	0.91	1.08	0.91
	(1.47)	(1.37)	(0.00)	(0.00)	(0.00)	(0.37)	(0.47)	(0.37)	(1.17)	(1.27)	(0.00)	(0.00)	(0.00)	(0.30)	(0.90)	(0.41)	(1.32)	(1.32)	(0.00)	(0.00)	(0.00)	(0.33)	(0.68)	(0.39)
T_5	1.45	1.44	0.71	0.71	0.71	0.89	0.98	0.91	1.33	1.32	0.71	0.71	0.71	0.89	1.24	0.93	1.39	1.38	0.71	0.71	0.71	0.89	1.11	0.92
	(1.60)	(1.57)	(0.00)	(0.00)	(0.00)	(0.30)	(0.47)	(0.39)	(1.27)	(1.23)	(0.00)	(0.00)	(0.00)	(0.30)	(1.03)	(0.43)	(1.43)	(1.40)	(0.00)	(0.00)	(0.00)	(0.30)	(0.75)	(0.41)
T_6	1.46	1.33	0.71	0.71	0.71	0.82	0.89	0.86	1.33	1.30	0.71	0.71	0.71	0.84	0.95	0.87	1.39	1.32	0.71	0.71	0.71	0.83	0.92	0.86
	(1.63)	(1.27)	(0.00)	(0.00)	(0.00)	(0.17)	(0.30)	(0.29)	(1.27)	(1.20)	(0.00)	(0.00)	(0.00)	(0.20)	(0.40)	(0.30)	(1.45)	(1.23)	(0.00)	(0.00)	(0.00)	(0.18)	(0.35)	(0.29)
T_7	1.48	1.40	0.71	0.71	0.71	0.84	1.00	0.89	1.29	1.29	0.71	0.71	0.71	0.93	1.06	0.90	1.39	1.35	0.71	0.71	0.71	0.88	1.03	0.90
	(1.70)	(1.47)	(0.00)	(0.00)	(0.00)	(0.20)	(0.50)	(0.36)	(1.17)	(1.17)	(0.00)	(0.00)	(0.00)	(0.37)	(0.63)	(0.36)	(1.43)	(1.32)	(0.00)	(0.00)	(0.00)	(0.28)	(0.57)	(0.36)
T_8	1.43	1.43	1.24	1.17	1.11	1.15	1.21	1.22	1.34	1.33	1.28	1.13	1.11	1.20	1.15	1.20	1.38	1.38	1.26	1.15	1.11	1.18	1.18	1.21
	(1.53)	(1.53)	(1.03)	(0.87)	(0.73)	(0.83)	(0.97)	(0.99)	(1.30)	(1.27)	(1.13)	(0.77)	(0.73)	(0.93)	(0.83)	(0.94)	(1.42)	(1.40)	(1.08)	(0.82)	(0.73)	(0.88)	(0.90)	(0.97)
T_9	1.45	1.44	1.11	0.98	0.98	1.03	1.10	1.11	1.28	1.28	1.08	0.91	0.91	1.06	1.10	1.06	1.36	1.36	1.10	0.95	0.95	1.05	1.10	1.08
	(1.6)	(1.57)	(0.73)	(0.47)	(0.47)	(0.57)	(0.70)	(0.75)	(1.13)	(1.13)	(0.67)	(0.33)	(0.33)	(0.63)	(0.70)	(0.63)	(1.37)	(1.35)	(0.70)	(0.40)	(0.40)	(0.60)	(0.70)	(0.69)
T_{10}	1.44	1.43	1.08	0.95	0.97	0.98	1.06	1.08	1.32	1.32	1.08	0.88	0.86	1.02	1.10	1.04	1.38	1.37	1.08	0.91	0.91	1.00	1.08	1.06

	(1.57)	(1.53)	(0.67)	(0.40)	(0.43)	(0.47)	(0.63)	(0.69)	(1.23)	(1.23)	(0.67)	(0.27)	(0.23)	(0.53)	(0.70)	(0.61)	(1.40)	(1.38)	(0.67)	(0.33)	(0.33)	(0.50)	(0.67)	(0.65)
T_{11}	1.41	1.43	1.40	1.29	1.20	1.30	1.28	1.32	1.30	1.30	1.28	1.24	1.24	1.25	1.29	1.27	1.36	1.36	1.34	1.26	1.22	1.28	1.28	1.29
	(1.50)	(1.53)	(1.47)	(1.17)	(0.93)	(1.20)	(1.13)	(1.24)	(1.20)	(1.20)	(1.13)	(1.03)	(1.03)	(1.07)	(1.17)	(1.11)	(1.35)	(1.37)	(1.30)	(1.10)	(0.98)	(1.13)	(1.15)	(1.17)
T_{12}	1.44	1.47	1.48	1.44	1.43	1.46	1.46	1.46	1.30	1.30	1.37	1.39	1.38	1.41	1.43	1.38	1.37	1.39	1.42	1.41	1.40	1.44	1.44	1.42
	(1.57)	(1.67)	(1.70)	(1.57)	(1.53)	(1.63)	(1.63)	(1.62)	(1.20)	(1.20)	(1.37)	(1.43)	(1.40)	(1.50)	(1.53)	(1.41)	(1.38)	(1.43)	(1.53)	(1.50)	(1.47)	(1.57)	(1.58)	(1.51)
SEm ±T	0.06	0.06	0.04	0.04	0.04	0.05	0.04	0.03	0.05	0.05	0.04	0.04	0.04	0.05	0.05	0.02	0.04	0.04	0.03	0.03	0.03	0.04	0.03	0.02
Y x T	0.09	0.08	0.06	0.06	0.06	0.07	0.06	0.04	0.08	0.07	0.05	0.06	0.06	0.07	0.07	0.03	0.06	0.06	0.04	0.04	0.04	0.06	0.05	0.02
T x S x P																								0.04
Y x T x S x P																								0.06
CD at 5% T	NS	0.16	0.11	0.12	0.13	0.14	0.13	0.08	NS	0.15	0.10	0.12	0.11	0.13	0.14	0.06	NS	0.11	0.09	0.08	0.08	0.11	0.10	0.05
Y x T	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.14	NS
T x S x P																								NS
Y x T x S x P																								NS
CV%	10.55	9.98	9.45	10.11	10.91	11.39	9.70	14.61	10.16	10.13	8.56	10.47	10.00	10.43	9.95	12.48	10.83	10.53	10.22	10.17	9.46	12.75	10.06	13.29

Figures are $\sqrt{X + 0.5}$ transformed values and those in parentheses are original values. NS = Non-significant

4. Conclusion

The present investigation revealed lowest pod borer population was found with the insecticide treatments of chlorantraniliprole (0.006%), spinosad (0.015%), indoxacarb (0.00725%) and flubendiamide (0.015%). The order of effectiveness of various treatments were found to be chlorantraniliprole (0.006%) ≥ spinosad (0.015%) ≥ indoxacarb (0.00725%) ≥ flubendiamide (0.015%) > bifenthrin (0.01%) ≥ fipronil (0.01%) ≥ diafenthiuron (0.03%) > imidacloprid (0.005%) ≥ flonicamid (0.0075%) ≥ buprofezin (0.025%) ≥ dinotefuran (0.0025%) > control.

5. References

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