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Evaluation of newer insecticides against gram pod borer and its impact on population of natural enemies in summer green gram

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Abstract
Green gram is grown in the tropical climates, insect pest plays an important role in the economic production of the crop. The gram pod borer is one of the important and destructive pest of green gram. Thus, seven insecticides *viz*., indoxacarb 14.5 SC 0.012%, chlorantraniliprole 18.5 SC 0.0055%, emamectin benzoate 5 SG 0.0025%, flubendiamide 20 WG 0.012%, diafenthiuron 50 WP 0.060, imidacloprid 17.8 SL 0.0055%, flonicamid 50 WG 0.015% were evaluated against gram pod borer larval population at N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat during summer season of 2021 and 2022. Among them chlorantraniliprole 18.5 SC, flubendiamide 20 WG and emamectin benzoate 5 SG were most effective against gram pod borer larval population in green gram. All the evaluated insecticide cause more or less negative impact on population of natural enemies. However, emamectin benzoate 5 SG 0.0025% and diafenthiuron 50 WP 0.0600% were found comparatively less harmful to the natural enemies *viz*., coccinellids and green lacewing.

Keywords: Insecticides, gram pod borer, coccinellids, green lacewing, green gram

Introduction
Pulses has a capacity to restore or improve soil fertility by microbial fixation of atmospheric nitrogen which further enhances their importance and utility. Pulses account for around 20 per cent of the area under food grains and contribute around 7 to 10 percent of the total food grains production of country (Mohanty and Satyasai, 2015) [3]. The major pulse crops that have been under cultivation in India are chickpea, pigeon pea, mungbean, urdbean, horsegram, cowpea and the minor pulses such as drybean, mothbean, lathyrus, lentil and pea (Mahalakshmi *et al*., 2012) [2].

Green gram (*Vigna radiata* L. Wilczek) is a major pulse crop belongs to the family Leguminaceae (sub-family: Papilionaceae) and native to Indo-Burma region of Southeast Asia. Green gram is an important source of easily digestible high quality protein for vegetarians and sick people. Grains of green gram contain (amount in 100 g) protein (20.9 g), fat (1.3 g), dietary fiber (15.4), carbohydrate (49.6 g) and energy (325 kcal), it is also rich in minerals like iron (4.4 mg), magnesium (139 mg), calcium (132 mg), phosphorus (350 mg), potassium (1180 mg), zinc (1.62 mg), copper (1.16 mg) (Anon., 2019) and vitamins like ascorbic acid, thiamine, riboflavin, niacin, panothemic acid, vitamin A as well as amino acids such as arginine, histidine, lysine and tryptophan.

In India, it has many common name like mung, mungo, mungbean, golden gram, chicksaw pea, oregano pea and it is a third most important pulse crop after chickpea and pigeon pea. India is the largest producer and consumer of green gram in world. The average productivity of green gram in India has rather remained static due to several reasons. There are various constraints for low production in green gram *viz*., lack of suitable seed production techniques, cultural practices, inefficient harvest and postharvest operations, improper storage management practices etc. Out of these, insect pests play a major role in low production in the country.

Since, green gram is grown in the tropical climates, insect pest plays an important role in the economic production of the crop. Among the insect pests, about 64 species of different insect pests have been reported which devastating green gram in the field from seedling to maturity stage which cause serious yield losses (Lal, 1985) [1]. The pod borers is the most destructive and major pest as it causes yield loss of 30 to 40 per cent (Umbarkar & Parsana, 2014) [7]. It cause damage to leaves as well as economic plant parts such as flower buds, flowers and pods.

To avoid the yield losses caused by these pests and increase the production and productivity of green gram in India, all our efforts are needed to tackle these pests. Thus, newer insecticides are evaluated against pod borers of green gram and its impact on population of natural enemies.

Materials and Methods

In order to evaluate various insecticides against major pests of green gram, an experiment was carried out at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat during summer season of 2021 and 2022. All recommended agronomical practices were followed to raise green gram. The experiment was set up using the variety Gujarat Mungbean – 6 (GM-6) a Randomized Block Design (RBD) with 8 treatments duplicated three times using a suggested package of practices excluding plant protection in a plot size of (3.15 x 1.5 m) at a spacing of (45 x 10 cm). With eight treatments, including control, the response of major pests to several insecticides was studied. T1: Indoxacarb 14.5 SC (0.0120%), T2: Chlorantraniliprole 18.5 SC (0.0055%), T3: Emamectin benzoate 5 SG (0.0025%), T4: Flubendiamide 20 WG (0.0120%), T5: Diafenthiuron 50 WP (0.0600%), T6: Imidacloprid 17.8 SL (0.0055%), T7: Flonicamid 50 WG (0.0150%) and Untreated Control.

The first spray of respective insecticides were sprayed after appearance of sufficient pest loads, the second spray was applied after 10 days of first spray. All the insecticides were applied as a foliar spray using a knapsack sprayer fitted with a hollow cone nozzle. The observations were recorded one day prior to first spray and subsequently at 3, 5, 7 and 10 days after each spray.

The observations of larval population of gram pod borer were counted from randomly selected 5 plants in each plot. The population of natural enemies *viz*., coccinellids (grub and adult) and green lacewing (egg and larva) were recorded from randomly selected 5 plants in each plots to know the impact of insecticides on population of natural enemies.

The data on larval population of gram pod borer and natural enemies were subjected to Analysis of Variance (ANOVA). Before analysis, the number data on larval population of gram pod borer were subjected to square root transformation ($\sqrt{X + 0.5}$). The treatment means were compared using Duncan's New Multiple Range Test (Steel & Torrie, 1980) [6]. The data were analysed periodically, pooled over periods and spray, pooled over periods, sprays and years to judge the consistency as well as overall efficacy of treatments.

Results and Discussion

The results obtained are presented hereunder and discussed with the research done at elsewhere.

Gram pod borer

The data of gram pod borer larval population on pooled over periods, pooled over sprays during both years and pooled over years are presented in Table 1.

Pooled over periods

The data on larval population of gram pod borer after first spray (summer, 2021) revealed that the significantly lower (2.09 larvae/ plant) larval population was recorded in plots treated with chlorantraniliprole 18.5 SC, which was at par with emamectin benzoate 5 SG (2.09 larvae/ plant). Indoxacarb 14.5 SC and flubendiamide 20 WG were equally effective but significantly superior than rest of the treatments. Imidacloprid 17.8 SL, diafenthiuron 50 WP and flonicamid 50 WG registered significantly higher larval population and were at par with control.

More or less similar trend of effectiveness was noted after second spray (summer, 2021) wherein chlorantraniliprole 18.5 SC (0.82 larva/ plant) and emamectin benzoate 5 SG (0.89 larva/ plant) recorded significantly lower larval population and both were at par. The treatments flubendiamide 20 WG and indoxacarb 14.5 SC were at par similarly, imidacloprid 17.8 SL, diafenthiuron 50 WP and flonicamid 50 WG were also at par but found significantly superior than control.

The data of pooled over periods after first spray (summer, 2022) indicated that chlorantraniliprole 18.5 SC (1.46 larvae/ plant) and emamectin benzoate 5 SG (1.57 larvae/ plant) were at par with each other and significantly effective than rest of the treatments. Flubendiamide 20 WG and indoxacarb 14.5 SC recorded 2.60 and 2.67 larvae per plant and were not significantly different from each other. While, the rest of the three treatments were at par with control and recorded significantly higher larval population.

After second spray (summer, 2022), chlorantraniliprole 18.5 SC (0.82 larvae/ plant) and emamectin benzoate 5 SG (0.87 larvae/ plant) as well as flubendiamide 20 WG (1.66 larvae/ plant) and indoxacarb 14.5 SC (1.78 larvae/ plant) were at par with each other. Imidacloprid 17.8 SL was at par with diafenthiuron 50 WP and flonicamid 50 WG. The later two treatments were at par with control.

Pooled over sprays

The data pooled over sprays during summer, 2021 indicated that all the treatments recorded significantly lower larval population when compare with control except flonicamid 50 WG which was at par with control during summer, 2021, 2022 and in pooled analysis. Among the treatments, the significantly lower (1.06 larvae/ plant) larval population of gram pod borer was noted in treatment chlorantraniliprole 18.5 SC, which was remained at par with emamectin benzoate 5 SG (1.14 larvae/ plant). The next set of effective treatments were flubendiamide 20 WG and indoxacarb 14.5 SC with recording population of 2.03 and 2.12 larvae/ plant, respectively and both were at par. Imidacloprid 17.8 SL was at par with diafenthiuron 50 WP.

The data on pooled over sprays during summer, 2022 showed that significantly lower (1.14 larvae/ plant) larval population of when crop was treated with chlorantraniliprole 18.5 SC, which was at par with emamectin benzoate 5 SG (1.19 larvae/ plant). Treatments of flubendiamide 20 WG and indoxacarb 14.5 SC recorded larval population of 2.09 and 2.19 larvae per plant, respectively and both were at par. Though, the treatments imidacloprid 17.8 SL (3.50 larvae/ plant) and diafenthiuron 50 WP (3.62 larvae/ plant) showed significantly lower larval population than the control.

Pooled over years

The data of pooled over two years (Table 1, Fig. 1) on larval population of gram pod borer revealed that chlorantraniliprole 18.5 SC was found superior by recording lower larval population (1.11 larvae/ plant) which was at par with emamectin benzoate 5 SG with larval population of 1.16 larvae per plant and found most effective. The next effective treatments were flubendiamide 20 WG (2.06 larvae/ plant) and indoxacarb 14.5 SC (2.16 larvae/ plant) which was at par and found mediocre. The treatments imidacloprid 17.8 SL (3.46 larvae/ plant), diafenthiuron 50 WP (3.66 larvae/ plant) registered significantly lower larval population and found superior over control and found less effective. The order of effectiveness of various treatments against gram pod borer was chlorantraniliprole 18.5 SC > emamectin benzoate 5 SG > flubendiamide 20 WG > indoxacarb 14.5 SC > Imidacloprid 17.8 SL > diafenthiuron 50 WP > flonicamid 50 WG > control.

Earlier, Sravangoud and Kumar (2022) [5] reported that chlorantraniliprole 18.5 SC gave maximum mean larval reduction followed by emamectin benzoate 5 SG in green gram. Thus, the results of the present findings are more or less in accordance with earlier findings in green gram or other crops.

Table 1: Efficacy of different insecticides against gram pod borer, *H. armigera* infesting green gram (Pooled over periods, sprays and years)

Tr. no.	Treatments	Dose (g or ml/ 10 l)	No. of larva(e)/ plant						
			2021			2022			Pooled over years
			First spray	Second spray	Pooled over sprays	First spray	Second spray	Pooled over sprays	
T_1	Indoxacarb 14.5% SC	8	1.73^{b} (2.49)	1.51^{b} (1.78)	1.62^{b} (2.12)	1.78^{b} (2.67)	1.51^{b} (1.78)	1.64^{b} (2.19)	1.63^{b} (2.16)
T_2	Chlorantraniliprole 18.5% SC	3	1.35^{a} (1.32)	1.15^{a} (0.82)	1.25^{a} (1.06)	1.40^{a} (1.46)	1.15^{a} (0.82)	1.28^{a} (1.14)	1.27^{a} (1.11)
T_3	Emamectin benzoate 5% SG	5	1.37^{a} (1.38)	1.18^{a} (0.89)	1.28^{a} (1.14)	1.44^{a} (1.57)	1.17^{a} (0.87)	1.30^{a} (1.19)	1.29^{a} (1.16)
T_4	Flubendiamide 20% WG	6	1.69^{b} (2.36)	1.49^{b} (1.72)	1.59^{b} (2.03)	1.76^{b} (2.60)	1.47^{b} (1.66)	1.61b (2.09)	1.60^{b} (2.06)
T_5	Diafenthiuron 50% WP	12	2.13^{c} (4.04)	1.95^{c} (3.30)	2.04^{cd} (3.66)	2.07^{c} (3.78)	1.97^{cd} (3.38)	2.03^{c} (3.62)	2.04^{cd} (3.66)
T_6	Imidacloprid 17.8% SL	3	2.08^{c} (3.83)	1.88^{c} (3.03)	1.98^{c} (3.42)	2.09^{c} (3.87)	1.92^{c} (3.19)	2.00^{c} (3.50)	1.99^{c} (3.46)
T_7	Flonicamid 50% WG	3	2.18^{c} (4.25)	1.98^{cd} (3.42)	2.08^{de} (3.83)	2.17^{c} (4.21)	2.01^{cd} (3.54)	2.09^{cd} (3.87)	2.09^{de} (3.87)
T_8	Untreated control	-	2.23^{c} (4.47)	2.10^{d} (3.91)	2.17^{e} (4.21)	2.22^{c} (4.43)	2.10^{d} (3.91)	2.16^{d} (4.17)	2.15^{e} (4.12)
S. Em ±	Treatment (T)		0.05	0.04	0.03	0.05	0.05	0.03	0.02
	Period (P)		0.03	0.03	0.02	0.04	0.03	0.02	0.02
	Spray (S)		-	-	0.02	-	-	0.02	0.01
	Year (Y)		-	-	-	-	-	-	0.01
C. D. at 5 %	T		0.11	0.11	0.09	0.12	0.11	0.10	0.07
	P		0.08	0.08	0.07	0.08	0.08	0.07	0.05
	S		-	-	0.05	-	-	0.05	0.03
	Y		-	-	-	-	-	-	NS
C. V. %			9.09	9.68	8.72	9.37	9.70	9.47	9.39

Note: 1. Figures in parenthesis are retransformed values; those outside are $\sqrt{x+0.5}$ transformed values
2. Treatment mean with the letter(s) in common are not significant at 5% level of significance

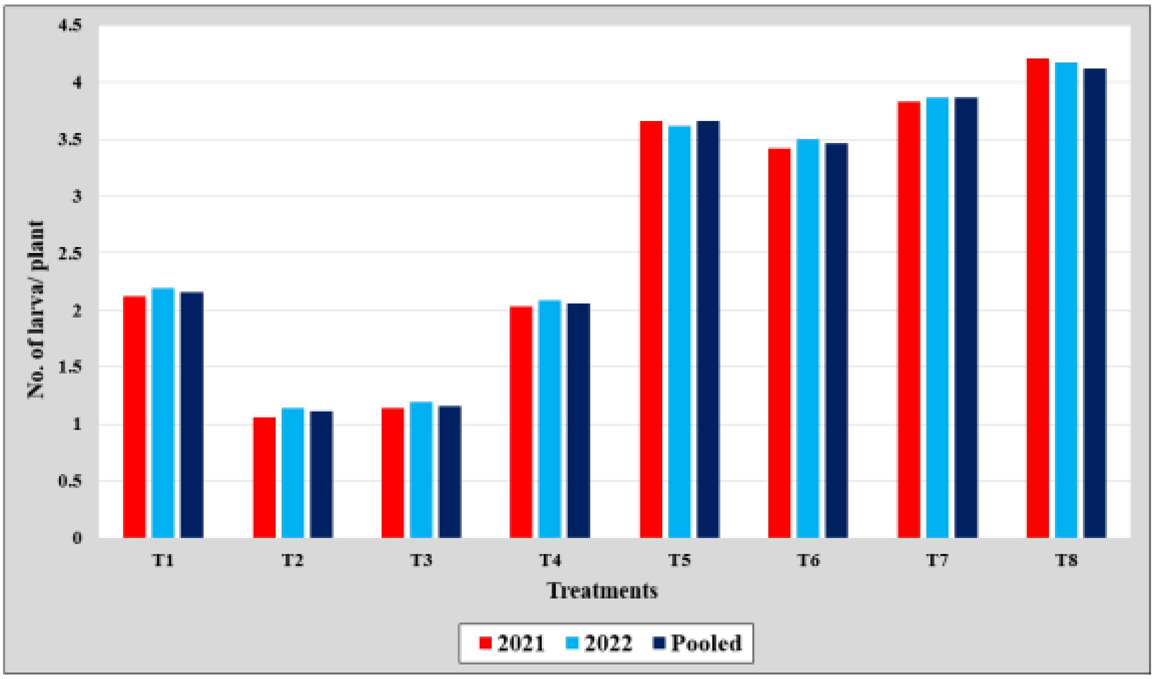

Fig 1: Efficacy of different insecticides against gram pod borer, *H. armigera* infesting green gram (Pooled over years)

Natural enemies

The different insecticides were also evaluated for their impact on population of natural enemies *viz*., coccinellids (grub + adult) and green lacewing (egg + larva).

Coccinellids (grub and adult)

The data of coccinellids (grub and adult) population on pooled over periods, pooled over sprays during both years and pooled over years are presented in Table 2.

Pooled over periods

The data on pooled over periods (summer, 2021) regarding population of coccinellids revealed that the significantly higher population was noted in control (0.52/ plant) but it was at par with emamectin benzoate 5 SG (0.42/ plant) after first spray during summer, 2021. Flubendiamide 20 WG was at par with all insecticide treatments.

After second spray (summer, 2021), significantly higher population was noted in control (0.42/ plant) but it was at par with flonicamid 50 WG (0.33/ plant). Diafenthiuron 50 WP and emamectin benzoate 5 SG were at par with all insecticide treatments.

The data on pooled over periods after first spray (summer, 2022) revealed that emamectin benzoate 5 SG recorded significantly higher population (0.24/ plant) of coccinellids as compared to imidacloprid 17.8 SL and indoxacarb 14.5 SC. However, the significantly highest (0.40/ plant) population was recorded in control. Diafenthiuron 50 WP was at par with all the insecticides.

After second spray (summer, 2022), the significantly highest (0.60/ plant) population was recorded in control. Among the insecticides, diafenthiuron 50 WP recorded significantly higher population than indoxacarb 14.5 SC, flubendiamide 20 WG, chlorantraniliprole 18.5 SC and imidacloprid 17.8 SL. Emamectin benzoate 5 SG was at par with all the insecticides.

Pooled over sprays

The data on coccinellids population during summer, 2021 (Table 2) revealed that significantly highest population was recorded in control (0.46/ plant). However, emamectin benzoate 5 SG and flonicamid 50 WG noted significantly higher population than imidacloprid 17.8 SL. The rest of the treatments were at par with each other.

The data on pooled over sprays (summer, 2022) revealed that diafenthiuron 50 WP recorded significantly higher population as compared to chlorantraniliprole 18.5 SC, imidacloprid 17.8 SL and indoxacarb 14.5 SC. Flonicamid 50 WG was at par with all the insecticide treatments. However, the significantly highest population was recorded in control (0.50/ plant).

Table 2: Impact of different insecticides on population of coccinellids in green gram (Pooled over periods, sprays and years)

Tr. no.	Treatments	Dose (g or ml/ 10 l)	No. of coccinellids (Grub and adult)/ plant						
			2021			2022			Pooled over years
			First spray	Second spray	Pooled over sprays	First spray	Second spray	Pooled over sprays	
T_1	Indoxacarb 14.5% SC	8	0.94^{bc} (0.38)	0.87^{bc} (0.26)	0.90^{bc} (0.31)	0.78^{c} (0.11)	0.83^{cd} (0.19)	0.80^{d} (0.14)	0.85^{cd} (0.22)
T_2	Chlorantraniliprole 18.5% SC	3	0.91^{bc} (0.33)	0.84^{c} (0.21)	0.88^{bc} (0.27)	0.81^{bc} (0.16)	0.80^{d} (0.16)	0.81^{cd} (0.16)	0.84^{d} (0.21)
T_3	Emamectin benzoate 5% SG	5	0.96^{ab} (0.42)	0.88^{bc} (0.27)	0.92^{b} (0.35)	0.86^{b} (0.24)	0.85^{bcd} (0.22)	0.86^{bc} (0.24)	0.89^{b} (0.29)
T_4	Flubendiamide 20% WG	6	0.94^{bc} (0.38)	0.87^{bc} (0.26)	0.90^{bc} (0.31)	0.83^{bc} (0.19)	0.82^{cd} (0.17)	0.83^{bcd} (0.19)	0.86^{bcd} (0.24)
T_5	Diafenthiuron 50% WP	12	0.90^{c} (0.31)	0.88^{bc} (0.27)	0.89^{bc} (0.29)	0.84^{bc} (0.21)	0.90^{b} (0.31)	0.87^{b} (0.26)	0.88^{bc} (0.27)
T_6	Imidacloprid 17.8% SL	3	0.89^{c} (0.29)	0.82^{c} (0.17)	0.85^{c} (0.22)	0.79^{c} (0.12)	0.80^{d} (0.14)	0.80^{d} (0.14)	0.83^{d} (0.19)
T_7	Flonicamid 50% WG	3	0.93^{bc} (0.36)	0.91^{ab} (0.33)	0.92^{b} (0.35)	0.82^{bc} (0.17)	0.86^{bc} (0.24)	0.84^{bcd} (0.21)	0.88^{bc} (0.27)
T_8	Untreated control	-	1.01^{a} (0.52)	0.96^{a} (0.42)	0.98^{a} (0.46)	0.95^{a} (0.40)	1.05^{a} (0.60)	1.00^{a} (0.50)	0.99^{a} (0.48)
S. Em ±	Treatment (T)		0.03	0.02	0.02	0.02	0.03	0.02	0.01
	Period (P)		0.02	0.02	0.01	0.02	0.02	0.01	0.01
	Spray (S)		-	-	0.01	-	-	0.01	0.03
	Year (Y)		-	-	-	-	-	-	0.06
C. D. at 5 %	T		0.06	0.06	0.05	0.06	0.06	0.05	0.03
	P		0.05	0.04	NS	0.04	NS	NS	NS
	S		-	-	0.03	-	-	NS	NS
	Y		-	-	-	-	-	-	0.02
C. V. %			9.95	9.48	9.80	10.08	10.09	10.03	9.91

Note: 1. Figures in parenthesis are retransformed values; those outside are $\sqrt{x + 0.5}$ transformed values
2. Treatment mean with the letter(s) in common are not significant at 5% level of significance

Pooled over years

The data on pooled over years regarding coccinellids population indicated that the significantly highest population was recorded in control (0.48/ plant). Flubendiamide 20 WG was at par with all the insecticide treatments. The chronological order of various insecticides based on population of coccinellids (grub and adult) per plant was; control (0.48) > emamectin benzoate 5 SG (0.29) > diafenthiuron 50 WP (0.27) ≥ flonicamid 50 WG (0.27) > flubendiamide 20 WG (0.24) > indoxacarb 14.5 SC (0.22) >

chlorantraniliprole 18.5 SC (0.22) > imidacloprid 17.8 SL (0.19).

Green lacewing (egg and larva)
The data of green lacewing (egg and larva) population on pooled over periods, pooled over sprays during both years and pooled over years are presented in Table 3.

Pooled over periods
The data on pooled over periods after first spray (summer, 2021) revealed that the significantly higher (0.46/ plant) population of green lacewing was noted in control than rest of the treatments expect diafenthiuron 50 WP, chlorantraniliprole 18.5 SC and flonicamid 50 WG. Whereas, the remained treatment was at par with each other.
After second spray (summer, 2021), the significantly higher population (0.26/ plant) of green lacewing was registered in control as compared to indoxacarb 14.5 SC, flubendiamide 20 WG, chlorantraniliprole 18.5 SC and imidacloprid 17.8 SL. was at par with all the insecticide treatments.
The data after first spray (summer, 2022) revealed that the significantly higher (0.40/ plant) population of green lacewing was noted in control as compared to flubendiamide 20 WG, emamectin benzoate 5 SG, indoxacarb 14.5 SC and imidacloprid 17.8 SL. Diafenthiuron 50 WP recorded significantly higher population than emamectin benzoate 5 SG, indoxacarb 14.5 SC and imidacloprid 17.8 SL.
After second spray (summer, 2022), the significantly higher population (0.29/ plant) of green lacewing was registered in control than rest of the treatments except flubendiamide 20 WG with which it was at par. This treatment also recorded significantly higher population than chlorantraniliprole 18.5 SC, emamectin benzoate 5 SG and imidacloprid 17.8 SL.

Pooled over sprays
The data on green lacewing population during summer, 2021 (Table 3) revealed that significantly higher population was recorded in control (0.36/ plant) than rest of the treatment except flonicamid 50 WG and diafenthiuron 50 WP with which it was at par. The remained treatments were at par with each other.
During summer 2022, significantly higher green lacewing population was recorded in control (0.35/ plant) than rest of the treatment except diafenthiuron 50 WP with which it was at par. Flonicamid 50 WG and chlorantraniliprole 18.5 SC were at par with all the insecticide treatments.

Table 3: Impact of different insecticides on population of green lacewing in green gram (Pooled over periods, sprays and years)

Tr. no.	Treatments	Dose (g or ml/ 10 l)	No. of green lacewing (egg and larva)/ plant						
			2021			2022			Pooled over years
			First spray	Second spray	Pooled over sprays	First spray	Second spray	Pooled over sprays	
T_1	Indoxacarb 14.5% SC	8	0.87^{c} (0.26)	0.80^{b} (0.14)	0.84^{cd} (0.21)	0.83^{d} (0.19)	0.79^{bcd} (0.12)	0.81^{cd} (0.16)	0.82^{de} (0.17)
T_2	Chlorantraniliprole 18.5% SC	3	0.93^{abc} (0.36)	0.79^{b} (0.12)	0.86^{bcd} (0.24)	0.90^{abc} (0.31)	0.78^{cd} (0.11)	0.84^{bcd} (0.21)	0.85^{cd} (0.22)
T_3	Emamectin benzoate 5% SG	5	0.89^{bc} (0.29)	0.82^{ab} (0.17)	0.86^{bcd} (0.24)	0.86^{cd} (0.24)	0.78^{cd} (0.11)	0.82^{cd} (0.17)	0.84^{cde} (0.21)
T_4	Flubendiamide 20% WG	6	0.87^{c} (0.26)	0.79^{b} (0.12)	0.83^{d} (0.19)	0.87^{bcd} (0.26)	0.84^{ab} (0.21)	0.86^{bc} (0.24)	0.84^{cde} (0.21)
T_5	Diafenthiuron 50% WP	12	0.94^{ab} (0.38)	0.86^{a} (0.24)	0.90^{ab} (0.31)	0.93^{ab} (0.36)	0.83^{bc} (0.19)	0.88^{ab} (0.27)	0.89^{b} (0.29)
T_6	Imidacloprid 17.8% SL	3	0.89^{bc} (0.29)	0.77^{b} (0.09)	0.83^{d} (0.19)	0.83^{d} (0.19)	0.75^{d} (0.06)	0.79^{d} (0.12)	0.81^{e} (0.16)
T_7	Flonicamid 50% WG	3	0.93^{abc} (0.36)	0.86^{a} (0.24)	0.89^{abc} (0.29)	0.89^{abcd} (0.29)	0.79^{bcd} (0.12)	0.84^{bcd} (0.21)	0.87^{bc} (0.26)
T_8	Untreated control	-	0.98^{a} (0.46)	0.87^{a} (0.26)	0.93^{a} (0.36)	0.95^{a} (0.40)	0.89^{a} (0.29)	0.92^{a} (0.35)	0.93^{a} (0.36)
S. Em ±	Treatment (T)		0.03	0.02	0.02	0.03	0.02	0.02	0.01
	Period (P)		0.02	0.02	0.01	0.02	0.02	0.01	0.01
	Spray (S)		-	-	0.01	-	-	0.01	0.01
	Year (Y)		-	-	-	-	-	-	0.01
C. D. at 5 %	T		0.06	0.05	0.05	0.06	0.05	0.05	0.03
	P		0.04	0.04	0.04	0.04	0.04	0.03	0.02
	S		-	-	0.02	-	-	0.02	0.01
	Y		-	-	-	-	-	-	NS
C. V. %			9.93	9.72	10.03	9.80	9.52	9.73	9.88

Note: 1. Figures in parenthesis are retransformed values; those outside are $\sqrt{x + 0.5}$ transformed values
2. Treatment mean with the letter(s) in common are not significant at 5% level of significance

Pooled over years
The data on pooled over years regarding green lacewing population indicated that the significantly highest population was recorded in control (0.36/ plant) than rest of the treatments. Diafenthiuron 50 WP recorded significantly higher population than rest of the treatments but was at par with flonicamid 50 WG. The chronological order of various insecticides based on population of green lacewing per plant was; control (0.36) > diafenthiuron 50 WP (0.29) > flonicamid 50 WG (0.26) > chlorantraniliprole 18.5 SC (0.22) > emamectin benzoate 5 SG (0.21) > flubendiamide 20 WG (0.21) > indoxacarb 14.5 SC (0.17) > imidacloprid 17.8 SL (0.16).
While shifting the literatures, scanty information is available on impact of insecticides on natural enemies in green gram. However in other crops, Pawar and Bharpoda (2013) [4]

reported that comparatively lesser toxicity of flonicamid against coccinellids in safflower. Yadav *et al*. (2015) [8] in black gram at Pantnagar, Uttarakhand reported that indoxacarb 14.5% SC was observed relatively higher toxic to the coccinellid beetles. The variations in impact of insecticides on natural enemies might be due to different doses, climatic conditions of the location or variations in crop.

Conclusion

From the present investigation it can be concluded that the gram pod borer of green gram could be effectively managed by spray application of chlorantraniliprole 18.5 SC 0.0055%, flubendiamide 20 WG 0.012% and emamectin benzoate 5 SG 0.0025%. All the evaluated insecticide cause more or less negative impact on population of natural enemies. However, emamectin benzoate 5 SG 0.0025% and diafenthiuron 50 WP 0.0600% are found comparatively less harmful to the natural enemies *viz*., coccinellids and green lacewing.

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References

1. Lal SS. A review of insect pests of mungbean and their control in India. Tropical Pests Management. 1985;31(3):105-114.
2. Mahalakshmi MS, Rao CV, Rao KY. Efficacy of certain newer insecticides against legume pod borer, *Maruca vitrata* in urdbean, Indian Journal of Plant Protection. 2012;40(2):115-117.
3. Mohanty S, Satyasai KJ. Feeling the pulse, Indian pulses sector. NABARD Rural pulses, Issue 10, July – August, 2015.
4. Pawar SR, Bharpoda TM. Efficacy of botanicals and synthetic insecticides against aphid, *Uroleucon compositae* Theobald infesting safflower. Pesticide Research Journal. 2013;25(1):29-35.
5. Sravangoud M, Kumar A. Efficacy and economics of selected insecticides and biopesticides against spotted pod borer [*Maruca vitrata* (Geyer)] on green gram [*Vigna radiata* (L.) Wilczek]. The Pharma Innovation Journal. 2022;11(7):475-479.
6. Steel RGD, Torrie JH. Principle and procedures of statistics. Second Edition, Megraw Hill Book Company, New York, USA; c1980.
7. Umbarkar PS, Parsana GJ. Field efficacy of different insecticides against spotted pod borer, *Maruca vitrata* (Geyer) infesting green gram. Journal of Industrial Pollution Control. 2014;30(2):227-230.
8. Yadav SK, Patel S, Agnihotri M, Bisht RS. Efficacy of bio-pesticides and insecticides against sucking pest in green gram. Annals Plant Protection Science. 2015;23(2):223-226.