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Evaluation of newer insecticides against spotted pod borer and its pod damage in summer green gram

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Abstract
Green gram (*Vigna radiata* L. Wilczek) is a major pulse crop belongs to the family Leguminaceae (sub-family: Papilionaceae). The spotted pod borer (*Maruca vitrata* Fabricious) is one of the most important and destructive pest of green gram (*Vigna radiata* L. Wilczek). 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 spotted pod borer larval population at Navsari Agricultural University, Navsari, Gujarat during summer season of 2021 and 2022. Among evaluated insecticides, chlorantraniliprole 18.5 SC and flubendiamide 20 WG were most effective against larval population as well as pod damage caused by spotted pod borer in green gram.

Keywords: Insecticides, spotted pod borer, *Maruca vitrata*, pod damage, green gram

Introduction
Pulses occupy a unique position in the agricultural economy of India being the major source of protein to meet the dietary needs of the Indian people as it is a cheap and best source of proteins (Nene, 2006) [1]. It constitute an excellent supplement of proteins in vegetarian diet of human beings and play a significant role in correcting the wide spread malnutrition in the country. Moreover, pulses has a capacity to restore or improve soil fertility by microbial fixation of atmospheric nitrogen which further enhances their importance and utility. 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].
The general assembly of the United Nations has recognized pulses as an essential source of protein and a part of improving nutrition globally and declared 2016 as 'The International Year of Pulses' (Anon., 2016) [3] for heighten public awareness of the nutritional benefits of pulses as a part of sustainable food security and nutrition. 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) [4].
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. It is important short duration pulse crop that is under cultivation since prehistoric time in India. It can be grown in a wide range of environment but widely grown in the South and Southeast Asian countries including India, China, Pakistan, Bangladesh and Thailand.
Among the insect pests, different insect pests have been reported which devastating green gram in the field from seedling to maturity stage which cause serious yield losses. Among the pod borers, the spotted pod borer or legume pod borer is the most destructive and major pest as it causes yield loss of 30 to 40 per cent (Umbarkar & Parsana, 2014) [5]. 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 the pest 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 spotted pod borer of green gram.

Materials and Methods
In order to evaluate various insecticides against spotted pod borer 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. T_1: Indoxacarb 14.5 SC (0.0120%), T_2: Chlorantraniliprole 18.5 SC (0.0055%), T_3: Emamectin benzoate 5 SG (0.0025%), T_4: Flubendiamide 20 WG (0.0120%), T_5: Diafenthiuron 50 WP (0.0600%), T6: Imidacloprid 17.8 SL (0.0055%), T_7: 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 spotted pod borer were counted from randomly selected 5 plants in each plot. For recording observations on pod damage, 5 plants were selected randomly from each net plot area and healthy as well as damaged pods per plant were counted at harvest of crop.

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

Results and Discussion

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

1. Spotted pod borer

The data of larval population on pooled over periods, pooled over sprays and pooled over years are presented in Table 1 and Figure.

Pooled over periods

Summer, 2021

The data on pooled over periods after first spray indicated that all the insecticide treatments recorded significantly lower spotted pod borer larval population than control. Among the insecticides, significantly lower (0.26 larva/ plant) larval population of spotted pod borer in plots treated with chlorantraniliprole 18.5 SC, which was at par with flubendiamide 20 WG (0.31 larva/ plant). Treatments of indoxacarb 14.5 SC and emamectin benzoate 5 SG recorded 0.69 and 0.73 larvae per plant, respectively and were at par with each other but recorded significantly lower larval populations than remained treatments. The treatments of diafenthiuron 50 WP, flonicamid 50 WG and imidacloprid 17.8 SL did not significantly differ from each other.

The similar trend of efficacy was observed after second spray. Chlorantraniliprole 18.5 SC was at par with flubendiamide 20 WG and recorded minimum larval population. Treatments of indoxacarb 14.5 SC and emamectin benzoate 5 SG were at par with each other; diafenthiuron 50 WP, flonicamid 50 WG and imidacloprid 17.8 SL were at par with each other.

Summer, 2022

The data on pooled over periods after first spray showed that chlorantraniliprole 18.5 SC (0.29 larva/ plant) and flubendiamide 20 WG (0.35 larva/ plant) registered significantly lower larval population than rest of the treatments and at par with each other. Treatments of indoxacarb 14.5 SC and emamectin benzoate 5 SG; diafenthiuron 50 WP, flonicamid 50 WG and imidacloprid 17.8 SL were not significantly differ from each other. The significantly highest (1.78 larvae/ plant) larval population was observed in control.

More or less similar trend of treatments effectiveness was noted after second spray wherein significantly lowest (0.17 larva/ plant) larval population of pod borer was observed in treatment chlorantraniliprole 18.5 SC and remained at par with flubendiamide 20 WG (0.22 larva/ plant). Indoxacarb 14.5 SC (0.60 larva/ plant) and emamectin benzoate 5 SG (0.78 larva/ plant) found next best treatments against spotted pod borer. The significantly highest (1.90 larva/ plant) larval population was observed in control.

Pooled over sprays

The data on pooled over sprays during summer, 2021 indicated that lower larval (0.19 larva/ plant) population of spotted pod borer was recorded when crop was treated with chlorantraniliprole 18.5 SC but it was at par with flubendiamide 20 WG (0.22 larva/ plant). Indoxacarb 14.5 SC (0.60 larvae/plant) and emamectin benzoate 5 SG (0.62 larva/ plant) were not significantly differ but found superior to rest of the treatments. Imidacloprid 17.8 SL (1.16 larvae/ plant), diafenthiuron 50 WP (1.22 larvae/ plant) and flonicamid 50 WG (1.30 larvae/ plant) showed significantly higher larval population and were at par with each other but significantly lower than the control, but comparatively found less effective against spotted pod borer.

The data indicated that all the insecticide treatments found significantly superior over control in reducing larval population. The trend of efficacy was similar as during summer, 2021.

Pooled over years

The data of pooled over two years, revealed that the significantly lower larval population (0.21 larva/ plant) was recorded in chlorantraniliprole 18.5 SC and found superior against spotted pod borer, which was at par with flubendiamide 20 WG (0.26 larva/ plant). Whereas, indoxacarb 14.5 SC and emamectin benzoate 5 SG with larval population of 0.64 and 0.71 larva per plant, respectively found as next best treatments. Imidacloprid 17.8 SL (1.24 larvae/ plant), diafenthiuron 50 WP (1.30 larvae/ plant) and flonicamid 50 WG (1.38 larvae/ plant) were at par which registered higher larval population and found comparatively less effective. The order of effectiveness of various treatments against spotted pod borer was chlorantraniliprole 18.5 SC > flubendiamide 20 WG > indoxacarb 14.5 SC > emamectin benzoate 5 SG > imidacloprid 17.8 SL > diafenthiuron 50 WP > flonicamid 50 WG > control.

2. Pod damage

The data of pod damage caused by spotted pod borer during summer, 2021 and 2022 as well as pooled over years are presented in Table 2.

Data on pod damage due to spotted pod borer recorded at harvest during summer, 2021 revealed that all the treated plots showed significantly lower damaged pods than control except flonicamid 50 WG which was at par with control. Among the insecticides, significantly lower (4.17%) damaged pod were registered in plots treated with chlorantraniliprole 18.5 SC, which was at par with flubendiamide 20 WG (5.02%). The treatments indoxacarb 14.5 SC and emamectin benzoate 5 SG were next best treatments and were at par. Imidacloprid 17.8 SL, diafenthiuron 50 WP and flonicamid 50 WG were at par with each other.

More or less similar trend of efficacy was registered as during summer, 2022. Chlorantraniliprole 18.5 SC showed significantly lower (5.48%) pod damage than rest of the treatments but it was at par with flubendiamide 20 WG (5.80%). Indoxacarb 14.5 SC (8.16%) was at par with flubendiamide 20 WG and emamectin benzoate 5 SG. Imidacloprid 17.8 SL and diafenthiuron 50 WP was at par with flonicamid 50 WG. The significantly higher (19.12%) pod damage was observed in control but at par with flonicamid 50 WG.

Pooled over years

Two years pooled data on pod damage revealed that all the insecticides treatments recorded significantly lower pod damage than control. Chlorantraniliprole 18.5 SC (4.80%) and flubendiamide 20 WG (5.40%) noted significantly lower pod damage than rest of the treatments and found most effective. Indoxacarb 14.5 SC and emamectin benzoate 5 SG were at par and found mediocre. Treatments of imidacloprid 17.8 SL, diafenthiuron 50 WP and flonicamid 50 WG were at par with each other and found least effective. The order of effectiveness of different insecticides on pod damage due to spotted pod borer was found to be chlorantraniliprole 18.5 SC > flubendiamide 20 WG > indoxacarb 14.5 SC > emamectin benzoate 5 SG > Imidacloprid 17.8 SL > diafenthiuron 50 WP > flonicamid 50 WG > control.

Earlier, Mahalakshmi *et al.* (2013) [7] reported that the chlorantraniliprole 18.5 SC @ 20 g a.i./ha was superior in reducing larval population of spotted pod borer and pod damage in black gram at Guntur Andhra Pradesh. Pant *et al.* (2021) [8] noted that the chlorantraniliprole 18.5% SC and flubendamide 48% SC was most effective against spotted pod borer larva and the lowest pod damage was recorded in chlorantraniliprole (5.18%) followed by flubendamide (5.44%) in cowpea at Chitwan, Nepal. Bhuva (2022) [9] reported that chlorantraniliprole 0.0055 per cent and flubendiamide 0.0120 per cent were found to be most effective against larval population of spotted pod borer and its pod damage in green gram at Anand, Gujarat. Thus, the results of the present findings are more or less in accordance with earlier findings in green gram or other crops. However, according to Umbarkar and Parsana (2014) [5] indoxacarb 0.0075% was the most effective insecticide by recording higher reduction of larval population and minimum pod damage due to *M. vitrata* in green gram at Junagadh, Gujarat. Yadav and Singh (2016) [10] at Varanasi, Uttar Pradesh found that per cent pod damage due to pod borer in mung bean recorded lowest in indoxacarb 14.5 SC. Thus, the present findings are not in agreement with these reports. The variations in effectiveness of these insecticides might be due to different doses, climatic conditions of the location, pest species or variations in crop.

Table 1: Efficacy of different insecticides against spotted pod borer, *M. vitrata* 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	1.09^{b} (0.69)	1.00^{b} (0.50)	1.05^{b} (0.60)	1.12^{b} (0.75)	1.05^{b} (0.60)	1.09^{b} (0.69)	1.07^{b} (0.64)
T_2	Chlorantraniliprole 18.5% SC	3	0.87^{a} (0.26)	0.78^{a} (0.11)	0.83^{a} (0.19)	0.89^{a} (0.29)	0.82^{a} (0.17)	0.86^{a} (0.24)	0.84^{a} (0.21)
T_3	Emamectin benzoate 5% SG	5	1.11^{b} (0.73)	1.02^{b} (0.54)	1.06^{b} (0.62)	1.15^{b} (0.82)	1.13^{b} (0.78)	1.14^{b} (0.80)	1.10^{b} (0.71)
T_4	Flubendiamide 20% WG	6	0.90^{a} (0.31)	0.81^{a} (0.16)	0.85^{a} (0.22)	0.92^{a} (0.35)	0.85^{a} (0.22)	0.88^{a} (0.27)	0.87^{a} (0.26)
T_5	Diafenthiuron 50% WP	12	1.34^{c} (1.30)	1.27^{c} (1.11)	1.31^{c} (1.22)	1.39^{c} (1.43)	1.35^{c} (1.32)	1.37^{c} (1.38)	1.34^{c} (1.30)
T_6	Imidacloprid 17.8% SL	3	1.32^{c} (1.24)	1.25^{c} (1.06)	1.29^{c} (1.16)	1.37^{c} (1.38)	1.33^{c} (1.27)	1.35^{c} (1.32)	1.32^{c} (1.24)
T_7	Flonicamid 50% WG	3	1.37^{c} (1.38)	1.30^{c} (1.19)	1.34^{c} (1.30)	1.42^{cd} (1.52)	1.38^{c} (1.40)	1.40^{c} (1.46)	1.37^{c} (1.38)
T_8	Untreated control	-	1.49^{d} (1.72)	1.54^{d} (1.87)	1.51^{d} (1.78)	1.51^{d} (1.78)	1.55^{d} (1.90)	1.53^{d} (1.84)	1.52^{d} (1.81)
S.Em ±	Treatment (T)		0.03	0.03	0.02	0.03	0.03	0.02	0.02
	Period (P)		0.02	0.02	0.02	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		0.07	0.07	0.06	0.07	0.07	0.06	0.04
	P		NS	0.05	NS	0.05	NS	NS	NS
	S		-	-	0.03	-	-	0.03	0.02
	Y		-	-	-	-	-	-	0.02
C. V. %			9.49	9.12	9.65	8.62	9.09	8.98	9.31

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

Table 2: Efficacy of different insecticides on pod damage caused by spotted pod borer in green gram

Tr. no.	Treatments	Dose (g or ml/ 10 l)	Pod damage (%) at harvest		
			2021	2022	Pooled over years
T_1	Indoxacarb 14.5% SC	8	15.58^{bc} (7.21)	16.60^{bc} (8.16)	16.09^{b} (7.68)
T_2	Chlorantraniliprole 18.5% SC	3	11.78^{a} (4.17)	13.54^{a} (5.48)	12.66^{a} (4.80)
T_3	Emamectin benzoate 5% SG	5	16.79^{c} (8.34)	17.20^{c} (8.74)	16.99^{b} (8.54)
T_4	Flubendiamide 20% WG	6	12.95^{ab} (5.02)	13.93^{ab} (5.80)	13.44^{a} (5.40)
T_5	Diafenthiuron 50% WP	12	22.08^{d} (14.13)	22.91^{d} (15.15)	22.50^{c} (14.64)
T_6	Imidacloprid 17.8% SL	3	21.44^{d} (13.36)	22.76^{d} (14.97)	22.07^{c} (14.12)
T_7	Flonicamid 50% WG	3	22.40^{de} (14.52)	23.25^{de} (15.58)	22.83^{c} (15.05)
T_8	Untreated control	-	25.12^{e} (18.02)	25.93^{e} (19.12)	25.53^{d} (18.57)
S.Em ±	Treatment (T)		0.86	0.87	0.61
	Year (Y)		-	-	0.31
C. D. at 5%	(T)		2.60	2.64	1.47
	(Y)		-	-	0.73
C. V. %			8.01	7.72	7.89

Note: 1. Figures in parenthesis are retransformed values; those outside are arc sine transformed values
2. Treatment means with the letter(s) in common are not significant at 5% level of significance

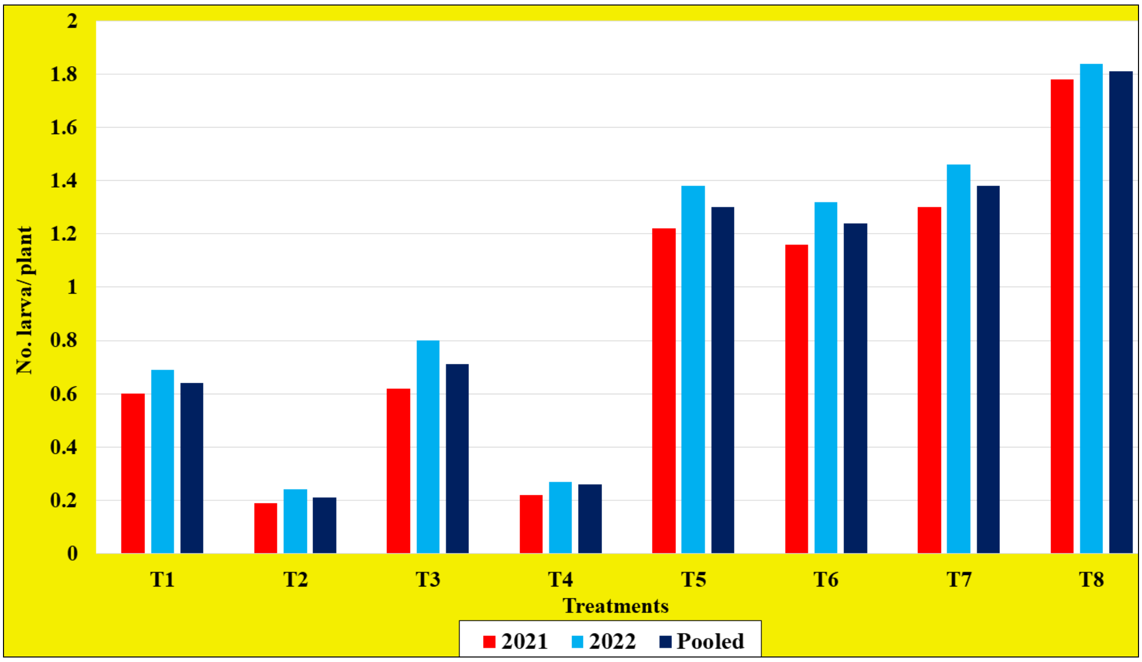

Fig 1: Efficacy of different insecticides against spotted pod borer, *M. vitrata* infesting green gram

Conclusion

From the present investigation it can be concluded that the larval population of spotted pod borer and its pod damage in green gram could be effectively managed by spray application of chlorantraniliprole 18.5 SC 0.0055% or flubendiamide 20 WG 0.012%.

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