E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(1): 15-20
Received: 17-10-2023
Accepted: 20-11-2023

Piyush H Patel
Ph.D. Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India

JJ Patel
Associate Professor and Head, Department of Entomology, College of Agriculture, Bharuch, Navsari Agricultural University, Navsari, Gujarat, India

Denisha R Patel
M.Sc. Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

Corresponding Author:
Piyush H Patel
Ph.D. Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India

Bio-efficacy and economics of newer insecticides against major sucking pests as well as yield of summer green gram

Piyush H Patel, JJ Patel and Denisha R Patel

DOI: https://doi.org/10.33545/2618060X.2024.v7.i1Sa.212

Abstract
Green gram (*Vigna radiata* L. Wilczek) is a major pulse crop belongs to the family Leguminaceae and native to Indo-Burma region of Southeast Asia. It is attacked by various pests among them sucking pests are important pest of green gram. Thus, seven insecticides were evaluated against major sucking pests of green gram. Among them, flonicamid 50 WG and imidacloprid 17.8 SL against Aphid (*A. craccivora*); imidacloprid 17.8 SL and flonicamid 50 WG against jassid, *E.* (*kerri*) and diafenthiuron 50 WP against whitefly (*B. tabaci*) found most effective. Chlorantraniliprole 18.5 SC gives higher grain yield (1114 kg/ha) and haulm yield (1540 kg/ha) followed by flubendiamide 20 WG and emamectin benzoate 5 SG. The maximum per cent increase in grain and haulm yield over control was recorded in chlorantraniliprole 18.5 SC (53.30, 43.31%, respectively). No avoidable losses in grain and haulm yield was occurred in chlorantraniliprole 18.5 SC followed by flubendiamide 20 WG (3.59 and 2.61%, respectively). The highest ICBR obtained in the treatment of imidacloprid 17.8 SL (1:5.19).

Keywords: Bio-efficacy, insecticides, aphid, jassid, whitefly, ICBR, avoidable loss

Introduction
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 is an important source of easily digestible high quality protein for vegetarians and sick people. It is recommended for conjunctivitis, diabetes, dysentery, summer heat, heatstroke, dehydration, edema and food poisoning (Shahrajabian *et al*., 2019) [5]. 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.

Since, green gram is grown in the tropical climates, insect pest plays an important role in the economic production of the crop (Swaminathan *et al*., 2012) [9]. 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) [2]. Of these, the sap feeders *viz*., aphid (*Aphis craccivora* Koch), jassid (*Empoasca kerri* Pruthi), whitefly (*Bemisia tabaci*) were important pests that causing economic damage to the crop. 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 major sucking pests of green gram.

Materials and Methods
In order to evaluate various insecticides against major sucking 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 sucking pests *viz*., aphid, jassid and whitefly were recorded from three compound leaves (top, middle and lower portion) of each randomly selected 5 plants in each plot. The data on larval population of all sucking pests and yield of green gram were subjected to Analysis of Variance (ANOVA). Before analysis, the number data on population of sucking pests 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) [7]. 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. For green gram yield, the crop was harvested when pods were fully matured. Plants were threshed after drying and grains were cleaned. Grain and haulm yield were recorded from each net plot area. Yield from each net plot was converted from kg/plot to kg/ha.

From recorded grain yield data, per cent increase in yield over control and avoidable loss were calculated for each treatment using following formula (Paul, 1976) [4].

$$\text{Increase in yield over control (\%)} = \frac{\text{Yield in treatment} - \text{Yield in control}}{\text{Yield in control}} \times 100$$

$$\text{Avoidable loss (\%)} = \frac{\text{Highest yield in treated plot} - \text{Yield in treated plot}}{\text{Highest yield in treated plot}}$$

The Incremental Cost Benefit Ratio (ICBR) for different treatments was worked out to test their cost effectiveness. For this purpose, the total cost of insecticidal treatment per hectare was calculated for each treatment based on the prevailing market price of insecticides, quantity of insecticide required to spray one hectare area and cost of labour for application of insecticide. The net profit (₹/ha) for each treatment was computed by deducting the cost of insecticidal treatment from the value of gross realization over control. The ICBR *i.e*., gain in rupee per rupee cost of insecticidal treatment was calculated by dividing gross realization over control with total cost of treatment.

Result and Discussion

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

1. Aphid

The data of aphid population on pooled over periods after each sprays and pooled over sprays during both the years as well as pooled over years are presented in Table 1.

Pooled over sprays

The pooled data over sprays presented in Table 1 (summer, 2021) indicated that all the treatments recorded significantly lower aphid population during 2021, 2022 and in pooled analysis. The significantly lower (0.87 aphid/ 3 leaves) aphid population was recorded when crop was treated with flonicamid 50 WG, which was found superior than all other treatments and remained at par with imidacloprid 17.8 SL (0.99 aphid/ 3 leaves). The next best effective treatment was diafenthiuron 50 WP (1.69 aphids/ 3 leaves) which was significantly effective than rest of the treatments. Flubendiamide 20 WG, chlorantraniliprole 18.5 SC and emamectin benzoate 5 SG were at par with each other.

The pooled over sprays data (summer, 2022) clearly indicated that significantly lower (1.09 aphids/ 3 leaves) population was recorded in flonicamid 50 WG and was at par with imidacloprid 17.8 SL (1.16 aphids/ 3 leaves) followed by diafenthiuron 50 WP (2.03 aphids/ 3 leaves). The treatments emamectin benzoate 5 SG, chlorantraniliprole 18.5 SC, flubendiamide 20 WG and indoxacarb 14.5 SC recorded significantly higher aphid population and were at par with each other.

Pooled over years

The data on pooled over years on aphid population revealed that flonicamid 50 WG (0.99 aphid/ 3 leaves) and imidacloprid 17.8 SL (1.09 aphids/ 3 leaves) were at par with each other but recorded significantly lower aphid population the rest of the treatments followed by diafenthiuron 50 WP (1.87 aphids/ 3 leaves). These three treatments found most effective. Chlorantraniliprole 18.5 SC and flubendiamide 20 WG were at par with each other and found mediocre. The remaining two emamectin benzoate 5 SG and indoxacarb 14.5 SC recorded higher aphid population and found least effective. The order of effectiveness of various treatments against aphids was flonicamid 50 WG > imidacloprid 17.8 SL > diafenthiuron 50 WP > chlorantraniliprole 18.5 SC > flubendiamide 20 WG > emamectin benzoate 5 SG > indoxacarb 14.5 SC > control.

2. Jassid

The data of jassid population on pooled over periods after each sprays and pooled over sprays during both the years as well as pooled over years are presented in Table 2.

Pooled over sprays

The data on pooled over sprays during 2021, indicated that all the treaments were significantly superior than control. Among the insecticides, significantly lower was recorded in imidacloprid 17.8 SL and flonicamid 50 WG (1.35 and 1.52 / 3 leaves, respectively) and both were at par with each other which was followed by diafenthiuron 50 WP (2.46 jassids/ 3 leaves). The treatments of emamectin benzoate 5 SG, chlorantraniliprole 18.5 SC and indoxacarb 14.5 SC were at par with each other. Flubendiamide 20 WG recorded significantly higher jassid population but was at par with chlorantraniliprole 18.5 SC and indoxacarb 14.5 SC.

Pooled over sprays data (summer, 2022) indicated that significantly higher (4.79 jassids/ 3 leaves) jassid population was recorded in control plot. Imidacloprid 17.8 SL and remained at par with flonicamid 50 WG recorded significantly lower (1.27 and 1.35 jassids/ 3 leaves, respectively) population and remained at par with each other. While, diafenthiuron 50 WP (2.26 jassids/ 3 leaves) was significantly effective than remained treatments. Emamectin benzoate 5 SG, chlorantraniliprole 18.5 SC and indoxacarb 14.5 SC were at par with each other. Flubendiamide 20 WG was at par with later two treatments chlorantraniliprole 18.5 SC and indoxacarb 14.5 SC.

Pooled over years

The pooled data over sprays and years on jassid population revealed that all the treaments were significantly superior than control. The significantly lower (1.30 jassids/ 3 leaves) jassid population was recorded in imidacloprid 17.8 SL but it was at par with flonicamid 50 WG (1.43 jassids/ 3 leaves), followed by diafenthiuron 50 WP (2.36 jassids/ 3 leaves). Flubendiamide 20 WG recorded significantly higher jassid population but was at par with chlorantraniliprole 18.5 SC and indoxacarb 14.5 SC and found least effective. The order of effectiveness of various treatments against jassids was imidacloprid 17.8 SL > flonicamid 50 WG > diafenthiuron 50 WP > emamectin benzoate 5 SG > chlorantraniliprole 18.5 SC > indoxacarb 14.5 SC > flubendiamide 20 WG > control.

3. Whitefly

The data of whitefly population on pooled over periods after each sprays and pooled over sprays during both the years as well as pooled over years are presented in Table 3.

Pooled over sprays

The data of pooled over sprays during summer, 2021 on whitefly population revealed that all the treatments recorded significantly lower whitefly population as compared to control except flubendiamide 20 WG with which it was at par. Significantly the lowest (1.35 whiteflies/ 3 leaves) population was recorded when crop was treated with diafenthiuron 50 WP. While, imidacloprid 17.8 SL (2.39 whiteflies/ 3 leaves) and flonicamid 50 WG (2.60 whiteflies/ 3 leaves) were at par with each other. Flubendiamide 20 WG was at par with chlorantraniliprole 18.5 SC and indoxacarb 14.5% SC.

Among the treatments, during summer, 2022 diafenthiuron 50 WP was found significantly superior and recorded minimum (1.43 whitefly/ 3 leaves) whitefly population followed by imidacloprid 17.8 SL (2.46 whiteflies/ 3 leaves) and flonicamid 50 WG (2.56 whiteflies/ 3 leaves) and both were at par during summer, 2022. Treatments of emamectin benzoate 5 SG, chlorantraniliprole 18.5 SC, indoxacarb 14.5% SC and flubendiamide 20 WG were at par with each other but recorded significantly lower whitefly population.

Pooled over years

The data on pooled over years showed that all the treatments recorded significantly lower whitefly population as compared to control except flubendiamide 20 WG with which it was at par. Diafenthiuron 50 WP treated plots recorded minimum (1.40 whitefly/ 3 leaves) population and found superior against whitefly. Treatment of imidacloprid 17.8 SL and flonicamid 50 WG were at par with each other and found mediocre in their efficacy. Treatments of emamectin benzoate 5 SG, chlorantraniliprole 18.5 SC and indoxacarb 14.5% SC were at par and found less effective.

While shifting the literatures, Sujatha and Bharpoda (2016b) [8] in green gram at Anand, Gujarat reported that imidacloprid 70 WG followed by diafenthiuron 50 WP and flonicamid 50 WG were found most effective against aphids, jassids and whiteflies. Meena *et al.* (2020a) [2] in green gram at Alwar, Rajasthan stated that for managing *E. kerri* imidacloprid 17.8 SL was the most effective. Shakya *et al.* (2020) [6] revealed that diafenthiuron 50 WP @ 312.5 g a.i./ha was found the most effective against whitefly in mung bean at Ayodhya, Uttar Pradesh. Contrary to the present results, Choudhary *et al.* (2022) [1] found that diafenthiuron 50 WP and chlorantraniliprole 18.5 SC were most effective against aphid and leafhopper population infesting indian beans at Jobner, Rajasthan. The variations in effectiveness of these insecticides might be due to different doses, climatic conditions of the location, pest species or variations in crop.

4. Yield

Two years pooled data presented in Table 4 revealed that all the insecticide treatments recorded significantly higher grain and haulm yield when compared with control. Chlorantraniliprole 18.5 SC recorded significantly higher grain yield (1114 kg/ha) than rest of the treatments which was at par with flubendiamide 20 WG (1074 kg/ha) and emamectin benzoate 5 SG (1045 kg/ha). Indoxacarb 14.5 SC recorded significantly lower (869 kg/ha) grain yield and it was at par with remained treatments. The descending order of the grain yield recorded in evaluated treatments was; chlorantraniliprole 18.5 SC > flubendiamide 20 WG > emamectin benzoate 5 SG > imidacloprid 17.8 SL > diafenthiuron 50 WP > flonicamid 50 WG > indoxacarb 14.5 SC > control.

Chlorantraniliprole 18.5 SC recorded significantly higher haulm yield (1540 kg/ha) and it was at par with rest of the treatments except indoxacarb 14.5 SC (1339 kg/ha). The lowest haulm yield of 1075 kg/ha recorded in untreated control plot.

Increase in yield over control (%)

The per cent increase in grain and haulm yield over control in green gram was maximum in chlorantraniliprole 18.5 SC (53.30, 43.31%, respectively) followed by flubendiamide 20 WG (47.80, 39.57%, respectively) and emamectin benzoate 5 SG (43.92, 36.16%, respectively). While it was minimum in indoxacarb 14.5 SC (19.69, 24.61%, respectively).

Avoidable loss (%)

Pooled over two years data on per cent avoidable loss revealed that no avoidable losses in grain and haulm yield was occurred in chlorantraniliprole 18.5 SC which was followed by flubendiamide 20 WG (3.59 and 2.61%, respectively) and emamectin benzoate 5 SG (6.12 and 4.99%, respectively). While it was maximum in control (34.77 and 30.22%, respectively).

5. Economics

The data on economics of different insecticides in green gram (Table 5) reveled that maximum total (grain + haulm) realization over control (₹ 30028/ ha) was obtained in chlorantraniliprole 18.5 SC followed by flubendiamide 20 WG (₹ 26958/ ha) and emamectin benzoate 5 SG (₹ 24762/ ha). The minimum realization over control (₹ 11461/ ha) was exhibited by the treatment of indoxacarb 14.5 SC.

As far as ICBR concerned, the highest ICBR (1:5.19) obtained in the treatment of imidacloprid 17.8 SL whereas it was minimum in indoxacarb 14.5 SC (1:2.13).

Table 1: Efficacy of different insecticides against aphid, *A. craccivora* infesting green gram (Pooled over periods, sprays and years)

Tr. no.	Treatments	Dose (g or ml/ 10 l)	No. of aphid/ 3 leaves/ 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	1.93^{cd} (3.22)	1.94^{cd} (3.26)	1.94^{d} (3.26)	1.98^{cd} (3.42)	1.99^{cd} (3.46)	1.99^{c} (3.46)	1.96^{d} (3.34)
T$_2$	Chlorantraniliprole 18.5% SC	3	1.80^{cd} (2.74)	1.85^{c} (2.92)	1.82^{c} (2.81)	1.97^{cd} (3.38)	1.90^{c} (3.11)	1.93^{c} (3.22)	1.87^{c} (3.00)
T$_3$	Emamectin benzoate 5% SG	5	1.89^{cd} (3.07)	1.87^{c} (3.00)	1.88^{cd} (3.03)	1.93^{c} (3.22)	1.89^{c} (3.07)	1.92^{c} (3.19)	1.91^{cd} (3.15)
T$_4$	Flubendiamide 20% WG	6	1.78^{cd} (2.67)	1.82^{c} (2.81)	1.80^{c} (2.74)	1.96^{cd} (3.34)	1.94^{c} (3.26)	1.95^{c} (3.30)	1.88^{c} (3.03)
T$_5$	Diafenthiuron 50% WP	12	1.54^{b} (1.87)	1.42^{b} (1.52)	1.48^{b} (1.69)	1.67^{b} (2.29)	1.50^{b} (1.75)	1.59^{b} (2.03)	1.54^{b} (1.87)
T$_6$	Imidacloprid 17.8% SL	3	1.31^{a} (1.22)	1.13^{a} (0.78)	1.22^{a} (0.99)	1.39^{a} (1.43)	1.19^{a} (0.92)	1.29^{a} (1.16)	1.26^{a} (1.09)
T$_7$	Flonicamid 50% WG	3	1.29^{a} (1.16)	1.06^{a} (0.62)	1.17^{a} (0.87)	1.36^{a} (1.35)	1.16^{a} (0.85)	1.26^{a} (1.09)	1.22^{a} (0.99)
T$_8$	Untreated control	-	2.04^{d} (3.66)	2.07^{d} (3.78)	2.05^{e} (3.70)	2.09^{d} (3.87)	2.14^{d} (4.08)	2.11^{d} (3.95)	2.08^{e} (3.83)
S. Em ±		Treatment (T)	0.05	0.05	0.03	0.04	0.05	0.03	0.02
		Period (P)	0.03	0.03	0.02	0.03	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	0.11	0.11	0.09	0.06
		P	0.08	0.08	NS	0.08	0.08	NS	NS
		S	-	-	NS	-	-	0.05	0.03
		Y	-	-	-	-	-	-	0.03
C. V. %			9.57	9.81	9.63	8.77	9.77	9.26	9.44

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 against jassid, E. kerri infesting green gram (Pooled over periods, sprays and years)

Tr. no.	Treatments	Dose (g or ml/ 10 l)	No. of jassid/ 3 leaves/ 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	2.13^{cd} (4.04)	2.32^{d} (4.88)	2.22^{cd} (4.43)	2.04^{c} (3.66)	2.16^{c} (4.17)	2.10^{cd} (3.91)	2.16^{cd} (4.17)
T$_2$	Chlorantraniliprole 18.5% SC	3	2.05^{c} (3.70)	2.22^{cd} (4.43)	2.13^{cd} (4.04)	2.03^{c} (3.62)	2.13^{c} (4.04)	2.08^{cd} (3.83)	2.11^{cd} (3.95)
T$_3$	Emamectin benzoate 5% SG	5	2.07^{c} (3.78)	2.14^{c} (4.08)	2.11^{c} (3.95)	1.98^{c} (3.42)	2.09^{c} (3.87)	2.04^{c} (3.66)	2.07^{c} (3.78)
T$_4$	Flubendiamide 20% WG	6	2.19^{cd} (4.30)	2.30^{cd} (4.79)	2.24^{d} (4.52)	2.11^{cd} (3.95)	2.19^{c} (4.30)	2.15^{d} (4.12)	2.20^{d} (4.34)
T$_5$	Diafenthiuron 50% WP	12	1.79^{b} (2.70)	1.65^{b} (2.22)	1.72^{b} (2.46)	1.73^{b} (2.49)	1.59^{b} (2.03)	1.66^{b} (2.26)	1.69^{b} (2.36)
T$_6$	Imidacloprid 17.8% SL	3	1.49^{a} (1.72)	1.23^{a} (1.01)	1.36^{a} (1.35)	1.45^{a} (1.60)	1.21^{a} (0.96)	1.33^{a} (1.27)	1.34^{a} (1.30)
T$_7$	Flonicamid 50% WG	3	1.54^{a} (1.87)	1.29^{a} (1.16)	1.42^{a} (1.52)	1.48^{a} (1.69)	1.24^{a} (1.04)	1.36^{a} (1.35)	1.39^{a} (1.43)
T$_8$	Untreated control	-	2.27^{d} (4.65)	2.50^{e} (5.75)	2.39^{e} (5.21)	2.23^{d} (4.47)	2.37^{d} (5.12)	2.30^{e} (4.79)	2.34^{e} (4.98)
S. Em ±		Treatment (T)	0.05	0.05	0.04	0.05	0.05	0.03	0.03
		Period (P)	0.03	0.04	0.03	0.03	0.04	0.02	0.02
		Spray (S)	-	-	0.02	-	-	0.02	0.01
		Year (Y)	-	-	-	-	-	-	0.01
C. D. at 5%		T	0.12	0.13	0.10	0.12	0.12	0.01	0.07
		P	0.08	NS	NS	0.08	0.09	NS	NS
		S	-	-	NS	-	-	NS	NS
		Y	-	-	-	-	-	-	0.04
C. V. %			8.95	9.75	9.34	9.07	9.48	9.25	9.30

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 3: Efficacy of different insecticides against whitefly, *B. tabaci* infesting green gram (Pooled over periods, sprays and years)

Tr. no.	Treatments	Dose (g or ml/ 10 l)	No. of whitefly/ 3 leaves/ 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	2.36^{cd} (5.07)	2.48^{cd} (5.65)	2.42^{cd} (5.36)	2.26^{cd} (4.61)	2.28^{c} (4.70)	2.27^{c} (4.65)	2.35^{c} (5.02)
T$_2$	Chlorantraniliprole 18.5% SC	3	2.32^{cd} (4.88)	2.44^{cd} (5.45)	2.38^{cd} (5.16)	2.22^{cd} (4.43)	2.25^{c} (4.56)	2.24^{c} (4.52)	2.31^{c} (4.84)
T$_3$	Emamectin benzoate 5% SG	5	2.30^{c} (4.79)	2.37^{c} (5.12)	2.34^{c} (4.98)	2.19^{c} (4.30)	2.21^{c} (4.38)	2.20^{c} (4.34)	2.27^{c} (4.65)
T$_4$	Flubendiamide 20% WG	6	2.43^{cd} (5.40)	2.50^{cd} (5.75)	2.47^{de} (5.60)	2.25^{cd} (4.56)	2.35^{c} (5.02)	2.30^{c} (4.79)	2.38^{cd} (5.16)
T$_5$	Diafenthiuron 50% WP	12	1.56^{a} (1.93)	1.16^{a} (0.85)	1.36^{a} (1.35)	1.56^{a} (1.93)	1.23^{a} (1.01)	1.39^{a} (1.43)	1.38^{a} (1.40)
T$_6$	Imidacloprid 17.8% SL	3	1.89^{b} (3.07)	1.52^{b} (1.81)	1.70^{b} (2.39)	1.85^{b} (2.92)	1.59^{b} (2.03)	1.72^{b} (2.46)	1.71^{b} (2.42)
T$_7$	Flonicamid 50% WG	3	1.93^{b} (3.22)	1.60^{b} (2.06)	1.76^{b} (2.60)	1.88^{b} (3.03)	1.62^{b} (2.12)	1.75^{b} (2.56)	1.76^{b} (2.60)
T$_8$	Untreated control	-	2.50^{d} (5.75)	2.60^{d} (6.26)	2.55^{e} (6.00)	2.36^{d} (5.07)	2.55^{d} (6.00)	2.45^{d} (5.50)	2.50^{d} (5.75)
S. Em ±		Treatment (T)	0.06	0.05	0.04	0.05	0.06	0.04	0.04
		Period (P)	0.04	0.04	0.03	0.04	0.04	0.03	0.02
		Spray (S)	-	-	0.02	-	-	0.02	0.01
		Year (Y)	-	-	-	-	-	-	0.01
C. D. at 5%		T	0.14	0.13	0.11	0.13	0.13	0.11	0.13
		P	NS	NS	NS	NS	0.09	NS	NS
		S	-	-	0.05	-	-	NS	0.04
		Y	-	-	-	-	-	-	0.04
C. V. %			9.47	8.99	9.18	9.01	9.65	9.28	9.23

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 4: Impact of different insecticides on yield of green gram (Pooled over years)

Tr. no.	Treatment	Dose (g or ml/ 10 l)	Yield (kg/ha)		Increase in yield over control (%)		Avoidable loss (%)	
			Grain	Haulm	Grain	Haulm	Grain	Haulm
T_1	Indoxacarb 14.5% SC	8	869^{c}	1339^{d}	19.69	24.61	21.93	13.05
T_2	Chlorantraniliprole 18.5% SC	3	1114^{a}	1540^{a}	53.30	43.31	0.00	0.00
T_3	Emamectin benzoate 5% SG	5	1045^{ab}	1464^{abc}	43.92	36.16	6.12	4.99
T_4	Flubendiamide 20% WG	6	1074^{a}	1500^{ab}	47.80	39.57	3.59	2.61
T_5	Diafenthiuron 50% WP	12	936^{c}	1412^{bcd}	28.91	31.38	15.91	8.32
T_6	Imidacloprid 17.8% SL	3	961^{bc}	1441^{abcd}	32.33	34.07	13.68	6.45
T_7	Flonicamid 50% WG	3	911^{c}	1387^{cd}	25.45	29.03	18.17	9.97
T_8	Untreated control	-	726^{d}	1075^{e}	0.00	0.00	34.77	30.22
S. Em ±		Treatment (T)	29.27	46.64	-	-	-	-
		Year (Y)	14.64	23.32	-	-	-	-
		T x Y	41.40	65.96	-	-	-	-
C. D. at 5%		T	70.26	111.94	-	-	-	-
		Y	NS	NS	-	-	-	-
		T x Y	NS	NS	-	-	-	-
C. V. %			7.51	8.19	-	-	-	-

Note: Treatment means with the letter(s) in common are not significant at 5% level of significance

Table 5: Economics of different insecticides evaluated against major pests in green gram (Pooled over years)

Tr. no.	Treatment	Quantity required for two sprays (g or ml/ha)	Price of insecticide (₹/kg or l)	Total cost of insecticide (₹/ha)	Labour cost for two sprays (₹/ha)	Total cost (₹/ha)	Yield (kg/ha)		Net gain over control (kg/ha)		Realization (₹/ha)			Net profit (₹/ha)	ICBR
							Grain	Haulm	Grain	Haulm	Grain	Haulm	Total		
T_1	Indoxacarb 14.5% SC	800	3640	2912	2465	5377	869	1339	143	265	10403	1058	11461	6084	1:2.13
T_2	Chlorantraniliprole 18.5% SC	300	13297	3989	2465	6454	1114	1540	387	466	28166	1862	30028	23574	1:4.65
T_3	Emamectin benzoate 5% SG	500	5850	2925	2465	5390	1045	1464	319	389	23207	1555	24762	19372	1:4.59
T_4	Flubendiamide 20% WG	600	7200	4320	2465	6785	1074	1500	347	425	25256	1701	26958	20173	1:3.97
T_5	Diafenthiuron 50% WP	1200	3200	3840	2465	6305	936	1412	210	337	15278	1349	16627	10322	1:2.64
T_6	Imidacloprid 17.8% SL	300	3704	1111	2465	3576	961	1441	235	366	17084	1465	18549	14973	1:5.19
T_7	Flonicamid 50% WG	300	9200	2760	2465	5225	911	1387	185	312	13447	1248	14695	9470	1:2.81
T_8	Untreated control	-	-	-	-	-	726	1075	-	-	-	-	-	-	-

Note: 1. Labour charges: Semi skilled labour @ ₹ 348.20/day x 2 labour = ₹ 696.40/ha, Farm labour @ ₹ 268/day x 2 labour = ₹ 536/ha, Labour cost per spray ₹ 232.40/ha
2. Price of green gram grain = ₹ 72.75/kg
3. Price of green gram haulm = ₹ 4.0/kg

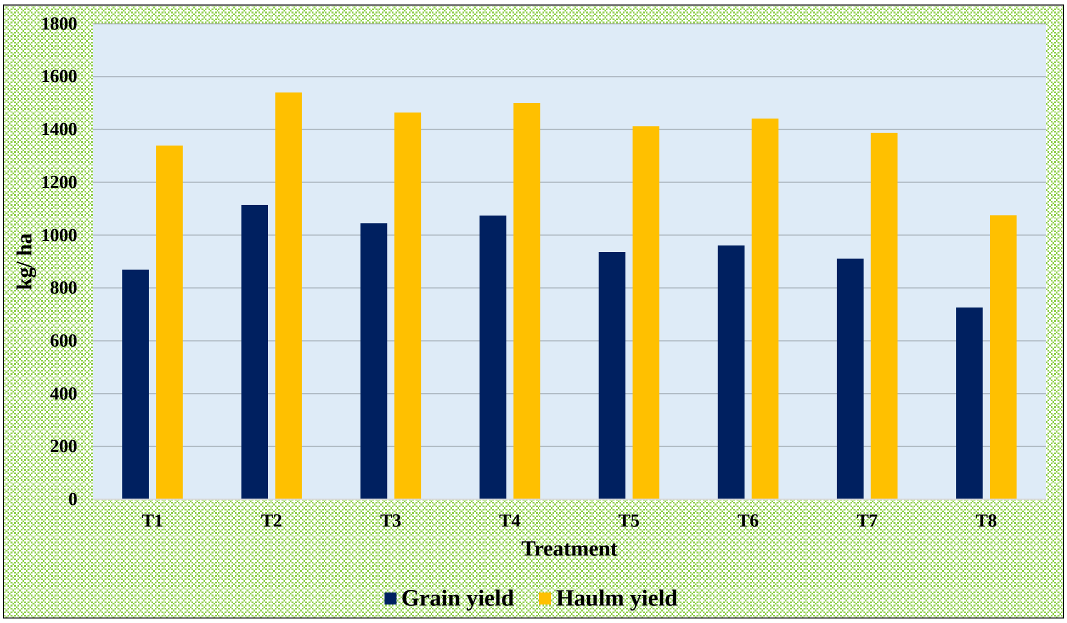

Fig 1: Impact of different insecticides on yield of green gram (Pooled over years)

Conclusion

From the present investigation it can be concluded that major sucking pests of green gram *viz.*, aphid, jassid and whitefly could be effectively managed by spray application of flonicamid 50 WG or imidacloprid 17.8 SL, imidacloprid 17.8 SL or flonicamid 50 WG and diafenthiuron 50 WP, respectively. Chlorantraniliprole 18.5 SC could give higher grain yield and haulm yield as well as maximum per cent increase in yield over control with least avoidable loss. The highest ICBR could be obtained in the treatment of imidacloprid 17.8 SL.

Acknowledgement
We highly acknowledge the help and support received from Professor and Head, Department of Entomology; Principal and Dean, N. M. College of Agriculture; Director of Research, Navsari Agricultural University, Navsari, Gujarat.

References
1. Choudhary S, Sharma M, Kumawat KC, Meena RK. Bioefficacy of novel insecticide molecules against sucking insect pests of Indian bean. The Pharma Innovation Journal. 2022;11(5):833-838.
2. Lal SS. A review of insect pests of mungbean and their control in India. Tropical Pests Management. 1985;31(3):105-114.
3. Meena RK, Meena RK, Singh U, Meena ML, Meena BL, Anokhe A. Evaluation of insecticides against leaf hopper, *Empoasca kerri* Pruthi in green gram. Indian Journal of Entomology. 2020a;82(4):768-770.
4. Paul MD. Studies on the chemical control of mustard pests. Indian Journal of Plant Protection. 1976;4(1):9-14.
5. Shahrajabian MH, Sun W, Cheng Q. A short review of health benefits and nutritional values of mung bean in sustainable agriculture. Polish Journal of Agronomy. 2019;37(3):31-36.
6. Shakya A, Kumar P, Verma AP, Batham P, Singh SP. Efficacy of newer insecticides against sucking insect pests, whitefly (*Bemisia tabaci*), jassid (*Empoasca kerri*) and thrips (*Caliothrips indicus*) of mung bean [*Vigna radiata* (L.) Wilczek]. International Journal of Chemical Studies. 2020;8(1):2464-2466.
7. Steel RGD, Torrie JH. Principles and Procedures of Statistics. Second Edition. Megraw Hill Book Company, New York, USA; c1980.
8. Sujatha B, Bharpoda TM. Evaluation of insecticides against sucking pests in green gram grown during summer. Trends in Biosciences. 2016b;9(13):745-753.
9. Swaminathan R, Singh K, Nepalia V. Insect pests of green gram, *Vigna radiata* (L) Wilczek and their management. Agricultural Sciences. 2012;1(2):126-131.