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Bio-efficacy of insecticides against spotted pod borer, *Maruca vitrata* (Fabricius) in Greengram

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Abstract
An experiment was conducted to evaluate the efficacy of insecticides against spotted pod borer, *Maruca vitrata* infesting Greengram during *Kharif* 2021 at Agronomy Farm, Anand Agricultural University, Anand. Of the evaluated insecticides Spinetoram 0.010 per cent, chlorantraniliprole 0.006 per cent, flubendiamide 0.012 per cent and novaluron + indoxacarb 0.017 per cent were found to be most effective against larvae of spotted pod borer. Spinetoram 0.010 per cent recorded significantly higher grain yield of Greengram and it was at par with chlorantraniliprole 0.006 per cent, flubendiamide 0.012 per cent, novaluron + indoxacarb 0.017 per cent, spinosad 0.013 per cent, emamectin benzoate 0.003 per cent and chlorantraniliprole + lambda-cyhalothrin 0.005 per cent. The highest ICBR of 1:3.73 was obtained with the treatment of chlorantraniliprole 0.006 per cent.

Keywords: Greengram, spotted pod borer, *Maruca vitrata*, insecticides, economics

Introduction
Greengram (*Vigna radiata* (L.) Wilczek) is an important and favorable legume of many people of India. In India, during 2019-20, it occupied an area of 45.81 lakh hectares having total production of 25.09 lakh tonnes of grain with a productivity of 548 kg/ha [1] Such an important pulse crop suffers from the attack of a number of insect pests causing the loss of about 73.86 per cent [2] A total of 64 species of insects have been reported to be attacking greengram in the field condition [3] Among them, the spotted pod borer, *Maruca vitrata* (Fabricius) (Lepidoptera: Crambidae) is the most destructive and major pest as it causes yield loss of 35 to 40 per cent [4]. Twenty to thirty per cent of pods were found to be damaged by this borer [5]. Caterpillars of *M. vitrata* complete their development inside the web formed by rolling and webbing together of leaves, flower and buds. As a result, once the pest has entered the flowers, pods and the entrance hole has been filled with excreta, this insect is tough to eradicate. As a result, effective insecticides are required to control the pest. Newer synthetic chemicals are being introduced to the market in large numbers. Despite the fact that the spotted pod borer attacks Greengram on a regular basis, producing significant losses in marketable yield, not much attention has been given.

Materials and Methods
A field experiment to evaluate the bio-efficacy of insecticides against spotted pod borer of Greengram (Var. GM-6) was conducted at Agronomy Farm, Anand Agricultural University, Anand during *kharif* 2021. The crop was grown at spacing of 45 × 10 cm with three replications and total ten treatments with control (Table 1) in Randomized Block Design. The first spray was applied on the appearance of the spotted pod borer and the second spray was applied after 15 days of the first spray. All the insecticides were applied as a foliar spray using a manually operated knapsack sprayer fitted with a hollow cone nozzle. The observations were recorded one day before spray as well as 3, 7, 10 and 14 days after each spray.

For recording observations on pod damage, five plants were selected randomly from each net plot area and healthy as well as damaged pods per plant were counted. The observations were recorded one day before spray as well as 3, 7, 10 and 14 days after second spray. Before harvest of crop, five plants were randomly selected from each net plot area and number of healthy and damaged pods were counted. Based on this per cent pod damage was worked out. Grain and haulm yield were recorded from each net plot area.

Results and Discussion

Results are presented in Table 1 and fig. 1 (a,b,c and d damaged flowers) 2 (First spray), 3 (Second spray) and 4 (Pooled data).

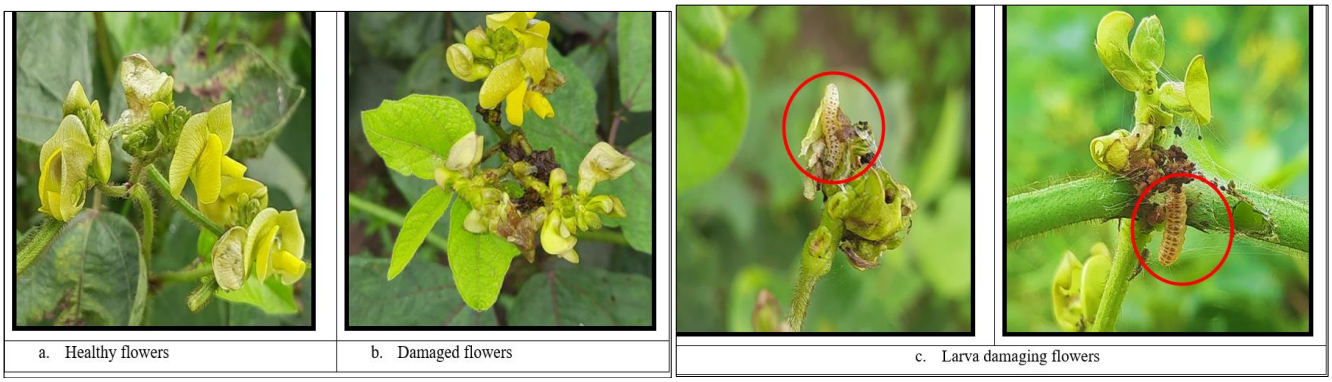

Fig 1: Flower damage caused by *M. vitrata* in greengram

Effect of insecticides on larval population of *M. vitrata*

The pooled data indicated that the differences among the treatments were significant.

Spinetoram 0.010 per cent with the spotted pod borer population of 0.33 larva/plant emerged as the significantly most effective treatment, however it was at par with chlorantraniliprole 0.006 per cent (0.38 larva/plant), flubendiamide 0.012 per cent (0.54 larva/plant) and novaluron + indoxacarb 0.017 per cent (0.60 larva/plant). The next treatment in the order of effectiveness was spinosad 0.013 per cent (0.82 larva/plant) which was at par with flubendiamide 0.012 per cent and novaluron + indoxacarb 0.017 per cent as well as emamectin benzoate 0.003 per cent (0.87 larva/plant), chlorantraniliprole + lambda-cyhalothrin 0.005 per cent (1.01 larvae/plant). The treatment of chlorpyrifos + cypermethrin 0.110 per cent (1.38 larvae/plant) was the least effective insecticide against spotted pod borer and it was at par with flubendiamide + deltamethrin 0.007 per cent (1.32 larvae/plant), chlorantraniliprole + lambda-cyhalothrin 0.005 per cent (1.01 larvae/plant), emamectin benzoate 0.003 per cent (0.87 larva/plant) and spinosad 0.013 per cent (0.82 larva/plant). Significantly highest spotted pod borer population (2.16 larvae/plant) was recorded in control plots.

Effect of insecticides on per cent pod damage

Differences among the treatments were significant and all insecticidal treatments were significantly superior over control (Table 4). The pod damage before harvest of the crop was significantly lower (3.02%) in the treatment of spinetoram 0.010 per cent which was at par with chlorantraniliprole 0.006 per cent (3.23%), flubendiamide 0.012 per cent (4.04%), novaluron + indoxacarb 0.017 per cent (4.85%). Spinosad 0.013 per cent (10.04%), emamectin benzoate 0.003 per cent (11.55%) and chlorantraniliprole + lambda-cyhalothrin 0.005 per cent (11.81%) were mediocre and they remained at par with one another. Among the evaluated insecticides, significantly the higher pod damage (16.12%) was noticed in plots treated with chlorpyrifos + cypermethrin 0.110 per cent and it remained at par with flubendiamide + deltamethrin 0.007 per cent (15.57%), chlorantraniliprole + lambda-cyhalothrin 0.005 per cent (11.81%) and emamectin benzoate 0.003 per cent. The control plots had a pod damage of 27.78 per cent which was significantly highest.

Earlier [6] reported that flubendiamide 20 WG @ 60 g a.i./ha provided better protection and registered significantly less larval population of *M. vitrata* and pod damage over control in blackgram. [7] also reported that the chlorantraniliprole 18.5 SC @ 20 g a.i./ha was superior in reducing larval population and pod damage in blackgram [8]. concluded that the chlorantraniliprole 18.5 SC 0.006 per cent and emamectin benzoate 5 WG 0.0015 per cent were significantly effective against *M. vitrata* in greengram [9]. reported that the application of spinetoram 12 SC @ 36 g a.i./ha reduced the incidence of *M. vitrata* on pigeonpea. [10] also reported the lowest pod damage of *M. vitrata* in blackgram was observed in the treatment of chlorantraniliprole 18.5 SC @ 20 g a.i./ha. Thus, the results of the present findings are in agreement with earlier findings.

Yield

Data on grain and haulm yield of greengram are presented in Table 5 and fig. 2. The higher (1042 kg/ha) grain yield of greengram was recorded in the plots treated with spinetoram 0.010 per cent which was at par with chlorantraniliprole 0.006 per cent (1025 kg/ha), flubendiamide 0.012 per cent (1005 kg/ha), novaluron + indoxacarb 0.017 per cent (986 kg/ha), spinosad 0.013 per cent (956 kg/ha) emamectin benzoate 0.003 per cent (943 kg/ha) and chlorantraniliprole + lambda-cyhalothrin 0.005 per cent (916 kg/ha). Among evaluated insecticides lowest yield was recorded in the treatment of chlorpyrifos + cypermethrin 0.110 per cent (856 kg/ha) which was at par with flubendiamide + deltamethrin 0.007 per cent (880 kg/ha). Looking to the haulm yield, higher (1414 kg/ha) yield was recorded from the plot treated with spinetoram 0.010 per cent which was at par with all remaining treatments, except control (1015 kg/ha), which recorded significantly lowest haulm yield. The maximum (46.78) per cent increase in grain yield over control was worked out for spinetoram 0.010 per cent followed by chlorantraniliprole 0.006 per cent (44.39%), flubendiamide 0.012 per cent (41.62%) and novaluron + indoxacarb 0.017 per cent (38.89%). The minimum (18.79) per cent increase in yield was calculated for the treatment of chlorpyrifos + cypermethrin 0.110 per cent.

Table 1: Bio-efficacy of insecticides against spotted pod borer in greengram after first spray

Tr. No.	Treatments	Concentration (%)	No. of larvae/plant before spray	No. of larva(e)/plant at indicated days after spray				
				3 DAS	7 DAS	10 DAS	14 DAS	Pooled
T_1	Spinetoram 11.7% SC	0.010	1.33 (1.27)	0.87^{a} (0.26)	0.90^{a} (0.31)	0.96^{a} (0.42)	0.97^{a} (0.44)	0.93^{a} (0.35)
T_2	Chlorantraniliprole 18.50% SC	0.00 6	1.37 (1.38)	0.89^{a} (0.29)	0.92^{a} (0.35)	0.97^{ab} (0.44)	1.05^{ab} (0.60)	0.96^{a} (0.42)
T_3	Emamectin benzoate 5% SG	0.003	1.36 (1.35)	1.13^{c} (0.78)	1.19^{bcd} (0.92)	1.20^{bcd} (0.94)	1.24^{bc} (1.04)	1.19^{bcd} (0.92)
T_4	Flubendiamide 20% WG	0.012	1.38 (1.40)	0.91^{a} (0.33)	1.07^{ab} (0.64)	1.10^{abc} (0.71)	1.13^{ab} (0.78)	1.06^{ab} (0.60)
T_5	Spinosad 45% SC	0.013	1.32 (1.24)	1.12^{bc} (0.75)	1.18^{bc} (0.89)	1.19^{bcd} (0.92)	1.23^{abc} (1.01)	1.18^{bc} (0.89)
T_6	Chlorantraniliprole 9.30% + lambda-cyhalothrin 4.60% ZC	0.005	1.26 (1.09)	1.20^{cd} (0.94)	1.28^{cde} (1.14)	1.29^{cd} (1.16)	1.31^{bc} (1.22)	1.27^{cde} (1.11)
T_7	Flubendiamide 8.33% + deltamethrin 5.56% SC	0.007	1.40 (1.46)	1.31^{d} (1.22)	1.38^{de} (1.40)	1.40^{d} (1.46)	1.47^{c} (1.66)	1.40^{de} (1.46)
T_8	Chlorpyrifos 50% + cypermethrin 5% EC	0.110	1.36 (1.35)	1.34^{d} (1.30)	1.41^{e} (1.49)	1.42^{d} (1.52)	1.48^{c} (1.69)	1.42^{e} (1.49)
T_9	Novaluron 5.25% + indoxacarb 4.50% SC	0.017	1.34 (1.30)	0.96^{ab} (0.42)	1.09^{abc} (0.69)	1.13^{abc} (0.78)	1.16^{ab} (0.85)	1.09^{abc} (0.67)
T_{10}	Control	-	1.38 (1.40)	1.62^{e} (2.12)	1.64^{f} (2.19)	1.67^{e} (2.29)	1.77^{d} (2.63)	1.68^{f} (2.30)
S. Em. ± (Treatments) T		-	0.08	0.05	0.06	0.07	0.08	0.03
(Periods) P		-	-	-	-	-	-	0.02
T × P		-	-	-	-	-	-	0.07
F Test (T)		-	NS	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. (%)		-	10.86	8.11	9.15	9.26	11.00	9.32

Notes: (1) Figures outside the parentheses are $\sqrt{X+0.5}$ transformed values and those inside the parentheses are retransformed values
(2) NS: Non-significant, DAS: Days after spray
(3) Treatment means followed by the same letter within a column are not significantly different by DNMRT at 5% level of significance
(4) Significant parameters and interaction: Nil

Table 2: Bio-efficacy of insecticides against spotted pod borer in greengram (second spray)

Tr. No.	Treatments	Concentration (%)	No. of larva(e)/plant at indicated days after spray				
			3 DAS	7 DAS	10 DAS	14 DAS	Pooled
T_1	Spinetoram 11.7% SC	0.010	0.83^{a} (0.21)	0.89^{a} (0.29)	0.91^{a} (0.33)	0.93^{a} (0.36)	0.89^{a} (0.29)
T_2	Chlorantraniliprole 18.50% SC	0.006	0.87^{a} (0.26)	0.92^{a} (0.35)	0.94^{a} (0.38)	0.96^{ab} (0.42)	0.92^{a} (0.35)
T_3	Emamectin benzoate 5% SG	0.003	1.07^{bc} (0.67)	1.12^{b} (0.75)	1.16^{bc} (0.85)	1.19^{cde} (0.94)	1.14^{bcd} (0.80)
T_4	Flubendiamide 20% WG	0.012	0.89^{a} (0.29)	0.99^{ab} (0.48)	1.03^{ab} (0.56)	0.98^{abc} (0.46)	0.97^{ab} (0.44)
T_5	Spinosad 45% SC	0.013	1.06^{bc} (0.62)	1.09^{b} (0.69)	1.15^{bc} (0.82)	1.18^{bcde} (0.89)	1.12^{bcd} (0.75)
T_6	Chlorantraniliprole 9.30% + lambda-cyhalothrin 4.60% ZC	0.005	1.12^{cd} (0.75)	1.16^{bc} (0.85)	1.19^{bc} (0.92)	1.26^{ed} (1.09)	1.18^{cd} (0.89)
T_7	Flubendiamide 8.33% + deltamethrin 5.56% SC	0.007	1.26^{d} (1.09)	1.30^{c} (1.19)	1.32^{c} (1.24)	1.33^{e} (1.27)	1.30^{d} (1.19)
T_8	Chlorpyrifos 50% + cypermethrin 5% EC	0.110	1.28^{d} (1.14)	1.31^{c} (1.22)	1.33^{c} (1.27)	1.34^{e} (1.30)	1.32^{d} (1.24)
T_9	Novaluron 5.25% + indoxacarb 4.50% SC	0.017	0.94^{ab} (0.38)	1.03^{ab} (0.56)	1.06^{ab} (0.62)	1.04^{abcd} (0.58)	1.02^{abc} (0.54)
T_{10}	Control	-	1.63^{e} (2.16)	1.59^{d} (2.03)	1.57^{d} (1.96)	1.60^{f} (2.07)	1.60^{e} (2.07)
S. Em. ± (Treatments) T		-	0.05	0.06	0.06	0.07	0.02
(Periods) P		-	-	-	-	-	0.01
T × P		-	-	-	-	-	0.06
F Test (T)		-	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. (%)		-	8.11	8.37	9.41	10.23	9.12

Notes: (1) Figures outside the parentheses are $\sqrt{X+0.5}$ transformed values and those inside the parentheses are retransformed values
(2) DAS: Days After Spray
(3) Treatment means followed by the same letter within a column are not significantly different by DNMRT at 5% level of significance
(4) Significant parameters and interaction: Nil

Table 3: Bio-efficacy of insecticides against spotted pod borer in greengram (pooled over periods)

Tr. No.	Treatments	Concentration (%)	No. of larva(e)/plant after indicated spray		
			First	Second	Pooled over periods and sprays
T_1	Spinetoram 11.7 % SC	0.010	0.93^{a} (0.35)	0.89^{a} (0.29)	0.91^{a} (0.33)
T_2	Chlorantraniliprole 18.50% SC	0.006	0.96^{a} (0.42)	0.92^{a} (0.35)	0.94^{a} (0.38)
T_3	Emamectin benzoate 5% SG	0.003	1.19^{bcd} (0.92)	1.14^{bcd} (0.80)	1.17^{bcde} (0.87)
T_4	Flubendiamide 20% WG	0.012	1.06^{ab} (0.60)	0.97^{ab} (0.44)	1.02^{ab} (0.54)
T_5	Spinosad 45% SC	0.013	1.18^{bc} (0.89)	1.12^{bcd} (0.75)	1.15^{bcd} (0.82)
T_6	Chlorantraniliprole 9.30% + lambda-cyhalothrin 4.60% ZC	0.005	1.27^{cde} (1.11)	1.18^{cd} (0.89)	1.23^{cde} (1.01)
T_7	Flubendiamide 8.33% + deltamethrin 5.56% SC	0.007	1.40^{de} (1.46)	1.30^{d} (1.19)	1.35^{de} (1.32)
T_8	Chlorpyrifos 50% + cypermethrin 5% EC	0.110	1.42^{e} (1.49)	1.32^{d} (1.24)	1.37^{e} (1.38)
T_9	Novaluron 5.25% + indoxacarb 4.50% SC	0.017	1.09^{abc} (0.67)	1.02^{abc} (0.54)	1.05^{abc} (0.60)
T_{10}	Control	-	1.68^{f} (2.30)	1.60^{e} (2.07)	1.63^{f} (2.16)
S. Em ± (Treatments) T		-	0.03	0.02	0.02
(Periods) P		-	0.02	0.01	0.01
(Sprays) S		-	-	-	0.01
T × P		-	0.06	0.06	0.04
T × S		-	-	-	0.03
P × S		-	-	-	0.02
T × P × S		-	-	-	0.06
F test (T)		-	Sig.	Sig.	Sig.
C. V. (%)		-	9.32	9.12	9.19

Notes: (1) Figures outside the parentheses are √(X+0.5) transformed values and those inside the parentheses are retransformed values
(2) Treatment means followed by the same letter within a column are not significantly different by DNMRT at 5% level of significance
(3) Significant parameters and interaction: S, P and T × S

Table 4: Effect of insecticides on pod damage due to spotted pod borer in greengram

Tr. No.	Treatments	Concentration (%)	Pod damage (%) before second spray	Pod damage (%) at indicated days after second spray					Pod damage (%) before harvest
				3 DAS	7 DAS	10 DAS	14 DAS	Pooled	
T_1	Spinetoram 11.7% SC	0.010	10.68 (3.43)	10.30^{a} (3.20)	10.52^{a} (3.33)	10.90^{a} (3.58)	11.72^{a} (4.13)	10.86^{a} (3.55)	10.00^{a} (3.02)
T_2	Chlorantraniliprole 18.50% SC	0.006	10.98 (3.63)	10.77^{ab} (3.49)	11.22^{a} (3.79)	11.75^{a} (4.15)	11.93^{a} (4.27)	11.42^{ab} (3.92)	10.36^{a} (3.23)
T_3	Emamectin benzoate 5% SG	0.003	20.19 (11.91)	18.17^{c} (9.72)	18.48^{b} (10.05)	20.05^{b} (11.75)	20.11^{b} (11.82)	19.2^{d} (10.82)	19.87^{bc} (11.55)
T_4	Flubendiamide 20% WG	0.012	12.13 (4.42)	11.68^{ab} (4.10)	12.14^{a} (4.42)	12.69^{a} (4.83)	13.00^{a} (5.06)	12.38^{b} (4.60)	11.60^{a} (4.04)
T_5	Spinosad 45% SC	0.013	18.77 (10.35)	16.92^{c} (8.47)	18.13^{b} (9.68)	19.14^{b} (10.75)	19.69^{b} (11.35)	18.47^{d} (10.04)	18.47^{b} (10.04)
T_6	Chlorantraniliprole 9.30% + lambda-cyhalothrin 4.60% ZC	0.005	20.40 (12.15)	18.65^{c} (10.23)	19.54^{b} (11.19)	19.98^{b} (11.68)	20.65^{b} (12.44)	19.71^{d} (11.37)	20.10^{bc} (11.81)
T_7	Flubendiamide 8.33% + deltamethrin 5.56% SC	0.007	23.45 (15.84)	22.72^{d} (14.92)	24.04^{c} (16.60)	24.41^{c} (17.08)	24.79^{c} (17.58)	23.99^{e} (16.53)	23.24^{c} (15.57)
T_8	Chlorpyrifos 50% + cypermethrin 5% EC	0.110	23.80 (16.28)	23.72^{d} (16.18)	24.64^{c} (17.38)	24.79^{c} (17.58)	25.23^{c} (18.17)	24.59^{e} (17.32)	23.67^{c} (16.12)
T_9	Novaluron 5.25% + indoxacarb 4.50% SC	0.017	13.64 (5.56)	13.29^{b} (5.28)	13.81^{a} (5.70)	13.94^{a} (5.80)	13.85^{a} (5.73)	13.82^{c} (5.71)	12.72^{a} (4.85)
T_{10}	Control	-	32.02 (28.11)	33.48^{e} (30.43)	33.78^{d} (30.91)	34.02^{d} (31.30)	33.88^{d} (31.08)	33.79^{f} (30.93)	31.81^{d} (27.78)
S. Em. ± (Treatment) T		-	1.20	0.95	1.10	1.00	1.11	0.44	1.15
(Period) P		-	-	-	-	-	-	0.32	-
T × P		-	-	-	-	-	-	1.02	-
F Test (T)		-	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. (%)		-	11.23	9.14	10.26	8.99	9.83	9.44	10.98

Notes: (1) Figures outside in parentheses are arc sine transformed values and those inside parentheses are retransformed values
(2) DAS: Days After Spray
(3) Treatment means with the letter(s) within a column are not significantly different by DNMRT at 5% level of significance
(4) Significant parameters and interaction: Nil

The per cent avoidable loss in grain yield was nil for the treatment of spinetoram 0.010 per cent. The second-best treatment in terms of per cent avoidable loss was chlorantraniliprole 0.006 per cent (1.63%) which was closely followed by flubendiamide 0.012 per cent (3.58%) and novaluron + indoxacarb 0.017 per cent (5.37%). Chlorpyrifos + cypermethrin 0.110 per cent (19.12%) exhibited higher avoidable loss. The maximum (31.85%) avoidable loss was found in control plots. Flubendiamide 48 SC, 0.01 per cent recorded significantly higher grain yield of blackgram [11-12] observed that spinetoram 12 SC @ 45 g a.i./ha alone and in combination with quinalphos 25 EC @ 350 g a.i./ha recorded significantly higher grain yield. Thus, the above reports are in conformity with the results of present findings.

Economics

Data on economics of various insecticides evaluated against spotted pod borer in greengram are presented in Table 6.

The highest ICBR (1:3.73) was obtained with the treatment of chlorantraniliprole 0.006 per cent followed by emamectin benzoate 0.003 per cent (1:3.39), flubendiamide 0.012 per cent (1:3.28), flubendiamide + deltamethrin 0.007 per cent (1:2.92). The ICBR value for the treatment of novaluron + indoxacarb 0.017 per cent, chlorantraniliprole + lambda-cyhalothrin 0.005 per cent, chlorpyrifos + cypermethrin 0.110 per cent, spinetoram 0.010 per cent, spinosad 0.013 per cent, were 1:2.91, 1:2.72, 1:2.37, 1:2.13, 1:1.87 and 1:1.55, respectively.

Table 5*:* Impact of insecticides on yield of greengram

Tr. No.	Treatments	Concentration (%)	Yield (kg/ha)		Increase in yield over control (%)	Avoidable loss (%)
			Grain	Haulm		
T_1	Spinetoram 11.7 % SC	0.010	1042^{a}	1414^{a}	46.78	-
T_2	Chlorantraniliprole 18.50% SC	0.006	1025^{ab}	1390^{a}	44.39	1.63
T_3	Emamectin benzoate 5% SG	0.003	943^{abc}	1247^{a}	32.83	9.69
T_4	Flubendiamide 20% WG	0.012	1005^{abc}	1345^{a}	41.62	3.58
T_5	Spinosad 45% SC	0.013	956^{abc}	1254^{a}	34.66	8.99
T_6	Chlorantraniliprole 9.30% + lambda-cyhalothrin 4.60% ZC	0.005	916^{abc}	1251^{a}	29.03	12.09
T_7	Flubendiamide 8.33% + deltamethrin 5.56% SC	0.007	880^{bc}	1243^{a}	23.95	15.54
T_8	Chlorpyrifos 50% + cypermethrin 5% EC	0.110	856^{c}	1227^{a}	18.79	19.12
T_9	Novaluron 5.25% + indoxacarb 4.50% SC	0.017	986^{abc}	1305^{a}	38.89	5.37
T_{10}	Control	-	710^{d}	1015^{b}	-	31.85
S. Em. ±		-	46.46	70.72	-	-
F Test		-	Sig.	Sig.	-	-
C. V. (%)		-	8.63	9.65	-	-

Note*:* Treatment means followed by same letter(s) within a column are not significantly different by DNMRT at 5% level of significance

Table 6*:* Economics of insecticides evaluated against spotted pod borer in greengram

Tr. No.	Treatments	Quantity of insecticide required for two sprays (kg or L/ha)	Price (₹/kg or L)	Cost of insecticide for two sprays (₹/ha)	Labour cost for two sprays (₹/ha)	Total cost of insecticide application (₹/ha)	Yield (kg/ha)		Net gain in yield over control (kg/ha)		Realization over control (₹/ha)			Net profit (₹/ha)	ICBR
							Grain	Haulm	Grain	Haulm	Grain	Haulm	Total		
T_1	Spinetoram 11.7 % SC	0.9	10490	9441	2465	11906	1042	1414	332	399	24153	1197	25350	13444	1:2.13
T_2	Chlorantraniliprole 18.50% SC	0.3	13297	3989	2465	6454	1025	1390	315	375	22916	1125	24041	17587	1:3.73
T_3	Emamectin benzoate 5% SG	0.5	5490	2745	2465	5210	943	1247	233	232	16951	696	17647	12437	1:3.39
T_4	Flubendiamide 20% WG	0.6	7300	4380	2465	6845	1005	1345	295	330	21461	990	22451	15606	1:3.28
T_5	Spinosad 45% SC	0.3	24986	7496	2465	9961	956	1254	246	239	17897	717	18614	8653	1:1.87
T_6	Chlorantraniliprole 9.30% + lambda-cyhalothrin 4.60% ZC	0.4	8245	3298	2465	5763	916	1251	206	236	14987	708	15695	9932	1:2.72
T_7	Flubendiamide 8.33% + deltamethrin 5.56% SC	0.5	3996	1998	2465	4463	880	1243	170	228	12368	684	13052	8589	1:2.92
T_8	Chlorpyrifos 50% + cypermethrin 5% EC	2.0	1140	2280	2465	4745	856	1227	146	212	10622	636	11258	6513	1:2.37
T_9	Novaluron 5.25% + indoxacarb 4.50% SC	1.75	2700	4725	2465	7190	986	1305	276	290	20079	870	20949	13759	1:2.91
T_{10}	Control	-	-	-	-	-	710	1015	-	-	-	-	-	-	-

Notes: (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 ₹ 1232.40/ha

(2) Price of greengram = ₹ 72.75/kg, (3) Price of haulm = ₹ 3/kg

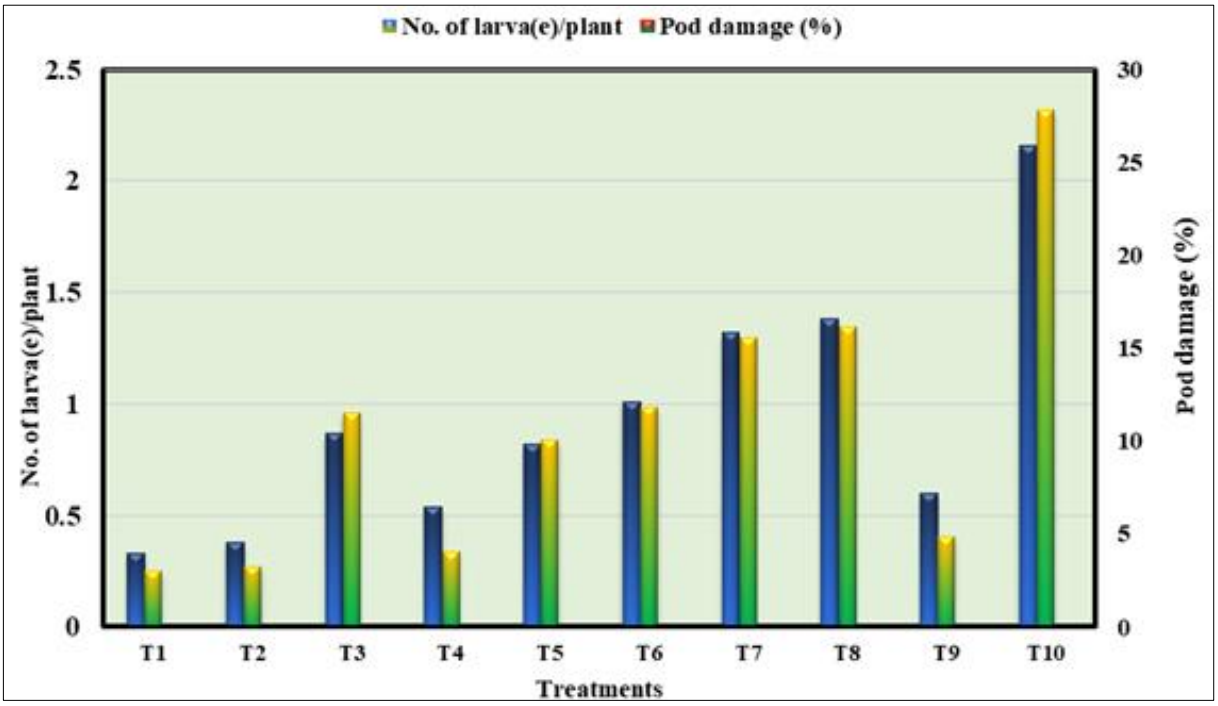

Fig 1: Bio-efficacy of insecticides against *M. vitrata* in greengram

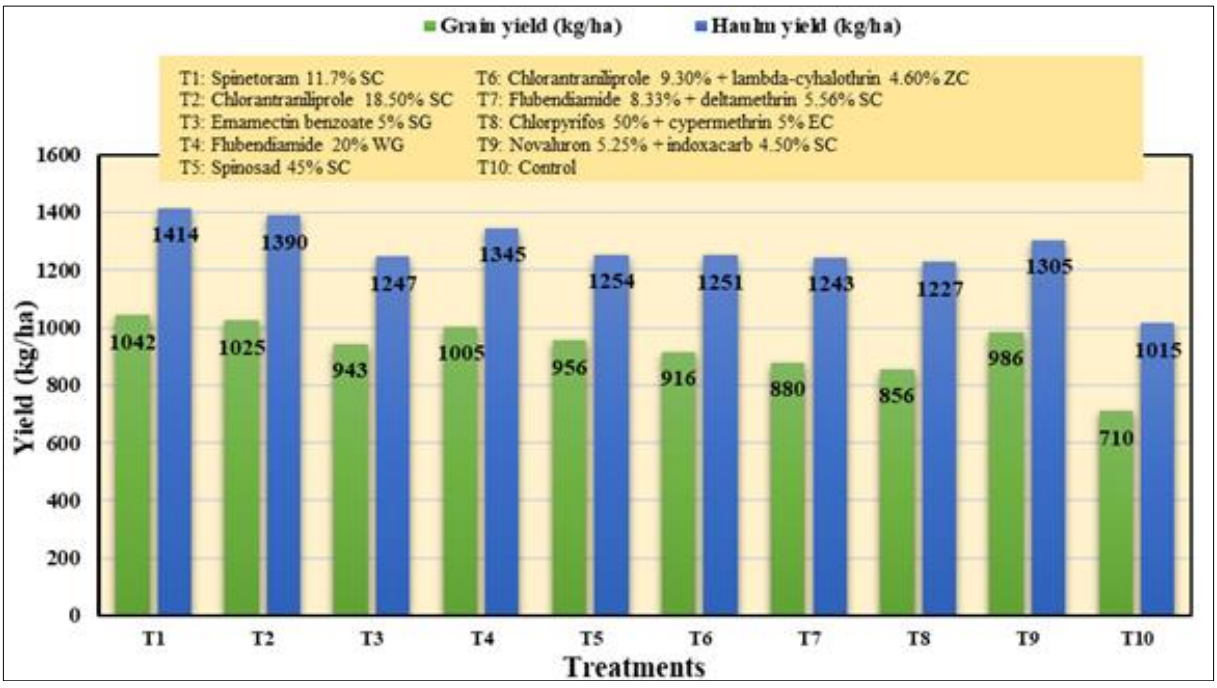

Fig 2: Effect of different insecticides on yield of greengram

Conclusion

The result obtained from this study demonstrates that spinetoram was the most effective in managing *M. vitrata* in greengram through reducing larval population, pod damage and facilitated higher yield. As per the ICBR chlorantraniliprole was obtained highest ICBR ratio 1:3.73.

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Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. Anonymous. All India estimates of area, production and yield of foodgrains; c2020. Retrieved from https://eands.dacnet.nic.in/APY_96_To_06.htm
2. Pandey SN, Singh R, Sharma VK, Kanwat PM. Losses due to insect pests in some Kharif pulses. Indian J Entomol. 1991;53(4):629-631.
3. Anonymous AESA based IPM package for blackgram and greengram. National Institute of Plant Health Management, Rajendranagar, Hyderabad; c2014. p. 2.
4. Bindra OS. A note on the study of varietal resistance in pulses to different insect pests. "Second Annual Workshop on Pulse Crops". IARI, New Delhi; c1968. p. 25-31.

5. Rahman MM. Pest complex of flower and pods of pigeonpea and their control through insecticide application. Bangladesh J sci. Ind. Res. 1998;7(1):27-32.
6. Swamy SVSG, Ramana MV, Krishna YR. Efficacy of insecticides against the spotted pod borer, *Maruca vitrata* (Fabricius), in black gram (*Vigna mungo* (L.) Hepper) grown in rice fallow. Pest Manag Sci Pest. 2010;18(1/2):157-164.
7. Mahalakshmi MS, Rao CV, Adinarayana M, Sateesh Babu J, Koteswara Rao Y. Evaluation of Coragen (DPX-E2Y45) against legume pod borer, *Maruca vitrata* (Geyer) (Lepidoptera: Pyralidae) on blackgram. Int J Plant Animal Env. Sci. 2013;3(4):51-54.
8. Patel HC. Life table and management of spotted pod borer, *Maruca vitrata* (Geyer) in green gram, Vigna radiata (Linnaeus) Wilczek. (Doctoral thesis, Anand Agricultural University, Anand, Gujarat); c2014.
9. Kumar AS, Pavviya A. Field evaluation of spinetoram 12 SC against *Maruca vitrata* on pigeonpea. Legum Rese. 2018;41(3):447-453.
10. Swathi K. Study on seasonal incidence and insecticidal management of major insect pests of rice fallow black gram (*Vigna mungo* L.) in north coastal Andhra Pradesh. (Master's thesis, Acharya N. G. Ranga Agricultural University, Lam Guntur, Andhra Pradesh); c2018.
11. Anonymous. Evaluation of various insecticides against lepidopteran insect pests in black gram. Annual report, Department of Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand; c2013. p. 92-99.
12. Kumar AS, Muthukrishnan N. Field evaluation of spinetoram 12 SC against pod borer complex on pigeonpea. Indian J Entomol. 2018;80(1):24-26.