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Efficacy of spray at 50% Flowering stage with certain Indigenous leaf extracts and newer Insecticides against *Maruca vitrata* in Greengram

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Abstract

Metaflumizone 22% SC 0.044 per cent spray at 50% flowering stage of greengram was the most effective and significantly superior over the other treatments by recording the lowest (1.98) no. of larvae with highest (72.27) per cent reduction in population and lowest (7.53%) pod damage with highest (87.76) per cent reduction over untreated control. The next better treatment was chlorfenapyr 10% SC 0.015 per cent spray with mean number of larvae 3.35 and 63.17 per cent reduction in population, 16.83% pod damage and 72.62 per cent reduction over untreated control. The Neem Leaf Extract and Karanj Leaf Extract sprayed at 50% flowering stage, recorded 19.58 % and 26.05% pod damage with 68.05 and 55.74 per cent reduction in pod damage over untreated control. The sprays at 50% flowering stage recorded 0.69 (KLE – 573 kg/ha) – 1.35 (metaflumizone - 1126 kg/ha) kg plot yields with an increase of 59 – 189 per cent yield increase and 1.12 – 2.04 CBR over untreated control. The standard control (Chlorpyriphos 20 % EC 0.05%) @ 2.5 ml + DDVP 76% EC 0.076% @1 ml/l) sprayed at 50% flowering stage, recorded 18.28% pod damage with 70.11 per cent reduction in pod damage and recorded 0.85 kg/plot (707 kg/ha) yield with an increase of 92 per cent yield with 1.27 CBR over untreated control.

Key words: Greengram, 50% flowering stage, *Maruca,* leaf extracts, metaflumizone, chlorphenapyr.

Introduction

Mung bean or greengram (*Vigna radiata* L.) is the important pulse crop of India and it occupies an area of about 3 m.ha with a production of 0.25 m.t and 425 kg ha^{-1} productivity[1]. Andhra Pradesh is the 4th major state of India contributing about 15.5% of the national production of greengram with 351 kg/ha average productivity. It is largely grown as intercrop or sole crop, relay crop in *Kharif* rice fallows. With the introduction of Bt cotton, most of the farmers are preferring greengram after completion of Bt cotton crop (February - April) by virtue of its short duration and drought tolerance in summer. The low productivity in greengram may be attributed to factors like limited varietal improvement, low resilience to soil moisture stress, pest infestation etc. Among them, ravage of insect pests is important. There are more than 200 insect pests belonging to 48 families in Lepidoptera, Coleoptera, Thysanoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, Isopteran, Orthoptera and 7 mites of order Acarina attack greengram and inflicting heavy damages at different growth stages in different agro climatic conditions[2], among which pod borers are important. Among the pod borers, legume pod borer, *Maruca vitrata* (G.) is the devastating pest of pulses. It feeds on plant species belonging to 20 genera and 6 families, the majority of which belonging to Papilionaceae. Because of its extensive host range and destructiveness, it became as a persistent pest in pulses particularly on greengram, as it is cultivating throughout the year in different seasons. Under field condition *Maruca* observed to bore into the unopened flowers. The mean number of eggs laid by *Maruca* each female was 3.8 in greengram 2.9 in blackgram 3.2 in pigeonpea (redgram) and 4.1 in cowpea and mean no of eggs per egg mass was the highest (37.6) in greengram[3]. Since the attack by the early instar larvae of *Maruca* on the flower buds and flowers is internal; there are no signs of damage until the flower wilts and drops. The intensity was the highest on flowers followed by flower buds, terminal shoots and pods. The infestation of *M. vitrata* was first noticed in vegetative stage of the blackgram, where it webs the tender leaves at growing tip and feed on the chlorophyll content and make small holes, then shifts to the inflorescence and webs the floral parts and feed on them, due to which flower buds fail to open and dropped off from the inflorescence[4]. It is known to cause economic loss of 20 - 25 % and yield loss of 2 - 84% in greengram[5]. Farmers are adopting chemical control against *Maruca* after causing damage without knowing its occurrence on crop.

Over and indiscriminate use of insecticides in the past posed problems like resistance in *M. vitrata* to conventional insecticides and residues[6]. Therefore, evaluation of certain indigenous plant extracts, newer insecticides and selection of economically viable and eco-friendly approaches in the management of *Maruca* on greengram has become imperative. There are some reports on aqueous extracts of neem seeds and leaf extracts had an adverse effect on the biology of *M. testulalis.* The flower infestation by *M. testulalis* and *Megalurothrips* sp. was reduced by 10 % aqueous neem leaf extract applied with broom (an indigenous farmers' practicing) four times during flowering on two cowpea cultivars during *rabi* season[7]. On average, neem applications reduced *Maruca* pod damage by 12% in cultivar I T 86 D-715 and by 16 % in IT 87 D-941-1. They also reported that neem can be effective in reducing *M. testulalis* damage particularly in combination with host plant resistance. Neem oil EC (@ 5, 10 and 20%) exhibited a high degree of insecticidal activity on *M. testulalis* larva. All the treated flowers were protected from larval damage two days after treatment, as compared to the 100 % damage recorded on untreated flowers[8].

Material and Methods

The experiment was laid out in a R.B.D with 18 treatments including untreated and standard controls and replicated twice. The greengram variety, MGG-295 sown on 02.11.2009 and 20.10.2010 during *rabi* season with 30 X 10 spacing between row to row and plant to plant. The size of each plot was 12 m^2 (Ten rows of 4 m length). To prepare 5% aqueous leaf extract, 50 g leaves of neem, *Azadirachta indica* and Karanj, *Pongamia glabra* were collected, cleaned and soaked in one litre of water for 10 minutes and ground in a mixer grinder and filtered through muslin cloth and obtained about 20ml of 5% aqueous filtrate and made it 2 litre of spray fluid for each plot. The plot in each treatment was sprayed with a knapsack high volume sprayer by ensuring uniform coverage of insecticide. A total of two sprays were given at bud initiation and 50 % flowering stage during the course of season at ten days interval.

Treatments and Spray Schedule Particulars: T_1 = Neem Leaf Extract (NLE) @ 5% at Bud Initiation (BI) stage, T_2 = Karanj Leaf Extract (KLE) @ 5 % at BI stage, T_3 = Chlorfenapyr 10% SC @ 1.5 ml /l at BI stage (**Trade Name:** Intrepid 0.015%), T_4 = Metaflumizone 22% SC @2.0 ml/l at BI stage (**Trade Name:** Varismo 0.044%), T_5 = NLE @ 5% at 50% flowering stage, T_6 = KLE @ 5 % at 50% flowering stage, T_7 = Chlorfenapyr @ 1.5 ml /l at 50% flowering stage, T_8 = Metaflumizone 22% SC @ 2.0 ml /l at 50% flowering stage, T_9 = NLE @ 5% at BI and 50% flowering stage, T_{10} = NLE @ 5% at BI and 5 % KLE at 50% flowering stage, T_{11} = NLE @ 5% at BI and chlorfenapyr @ 1.5 ml/l at 50% flowering stage, T_{12} = NLE @ 5% at BI and metaflumizone 22% SC @ 2.0 ml /l at 50% flow. Stage, T_{13} = KLE @ 5 % at BI and 50% flowering stage, T_{14} = KLE @ 5 % at BI and 5% NLE at 50% flowering stage, T_{15} = KLE @ 5 % at BI and chlorfenapyr @ 1.5 ml /l at 50% flowering stage, T_{16} = KLE @ 5 % at BI and metaflumizone @ 2.0 ml/l at 50% flowering stage, T_{17} = Chlorpyriphos 20 % EC (**Trade Name :** Classic 0.05%) @ 2.5 ml + DDVP 76% EC (**Trade Name:** Luvon 0.076%) @1 ml/l at BI and 50% flowering stage (Standard control), T_{18} = Untreated control.

Observations were recorded on the no. of larvae per plant one day before and 1st and 9th day after each spray from randomly selected 10 plants per plot. At the time of harvest, per cent pod damage was recorded from randomly selected 100 pods from each plot. Data recorded by counting the no. of coccinellids and spiders from randomly selected 25 plants per plot. The net plots were harvested replication wise excluding two border rows, and yield per plot was recorded, based on which yield per hectare was calculated. The yield data in each treatment was recorded separately and subjected to statistical analysis to test the significance of mean yield in different treatments. Cost benefit ratio was calculated by dividing the extra benefit attained from enhanced yield by the extra cost incurred for each treatment. The cost included were price of insecticides and labour charges for insecticide application. Data obtained in various investigations were subjected to statistical analysis[9].

Results and Discussion

Efficacy of Treatments against *M. vitrata* at 50% Flowering Stage: During *rabi*, 2009-10, the results on efficacy of the treatments at 50% flowering stage, are presented in table-1. The pre treatment count data on *Maruca* larval population recorded one day prior to the spray showed more or less uniform distribution of the pest in the crop. The mean number of larvae ranged from 0.20 to 5.10 per plant in all the treatments including untreated control.

The per cent increase in yield over control in various treatments was calculated by using the following formula.

$$\text{Per cent increase of Yield in treatment Over control} = \frac{\text{Yield in treatment} - \text{Yield in control}}{\text{Yield in control}} \times 100$$

The per cent reduction of pod damage over control was calculated by modified Abbott's formula[10].

Percentage reduction of Pod damage =

$$1- \left[\left(\frac{\text{Post treatment Pod damage in treatment}}{\text{Pre treatment Pod damage in treatment}} \times \frac{\text{Pre treatment Pod damage control}}{\text{Post treatment Pod damage in control}} \right) \times 100 \right]$$

These percentages were transformed to the corresponding arc sine values and the data were subjected to statistical analysis.

Table-1
Efficacy of treatments on *M. vitrata* larval population on greengram at 50% flowering stage during *rabi*, 2009-10

Treatments	Larval incidence (no. per plant *) at 50% flowering stage				**Per cent Reduction Over control		
	PTC	1DAS	9DAS	Mean	1DAS	9DAS	Mean
T_1 NLE @ 5% at Bud initiation stage	0.75 (1.32)	0.78 (1.33)	1.12 (1.45)	0.95 (1.39)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_2KLE @ 5 % at Bud initiation stage	0.90 (1.38)	0.94 (1.39)	1.36 (1.54)	1.15 (1.47)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_3Chlorfenapyr 10% SC @ 1.5 ml /l at Bud initiation stage	0.30 (1.14)	0.31 (1.15)	0.45 (1.20)	0.38 (1.18)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_4Metaflumizone 22% SC @ 2.0 ml /l at Bud initiation stage	0.20 (1.95)	0.21 (1.99)	0.30 (1.14)	0.25 (1.12)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_5NLE @ 5% at 50% flowering stage	4.35 (2.31)	3.70 (2.17)	0.75 (1.32)	2.23 (1.75)	18.12 (25.11)	88.41 (70.42)	53.26 (47.64)
T_6KLE @ 5 % at 50% flowering stage	4.80 (2.40)	4.10 (2.26)	0.80 (1.34)	2.45 (1.80)	17.75 (24.90)	88.98 (70.74)	53.37 (47.76)
T_7Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	4.80 (2.40)	3.20 (2.05)	0.45 (1.20)	1.83 (1.63)	35.91 (36.81)	93.80 (75.59)	64.85 (56.19)
T_8Metaflumizone 22% SC @ 2.0 ml /l at 50% flowering stage	1.50 (2.57)	0.90 (1.38)	0.15 (1.07)	0.53 (1.23)	37.45 (37.37)	93.38 (75.09)	65.41 (56.41)
T_9NLE @ 5% at B. I and 50% flowering stage	0.75 (1.32)	0.50 (2.25)	0.40 (1.18)	0.45 (1.20)	32.65 (34.62)	60.68 (51.36)	46.66 (43.01)
T_{10} NLE @ 5% at B. I and 5 % KLE at 50% flowering stage	0.75 (1.32)	0.55 (1.25)	0.30 (1.14)	0.43 (1.19)	29.55 (32.92)	73.44 (58.98)	51.49 (45.95)
T_{11} NLE @ 5% at B. I and Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	0.75 (1.32)	0.55 (1.25)	0.10 (1.05)	0.33 (1.15)	29.55 (32.92)	91.11 (72.67)	60.33 (52.79)
T_{12} NLE @ 5% at B. I and Metaflumizone @ 2.0 ml /l at 50% flowering stage	0.75 (1.32)	0.60 (1.26)	0.03 (1.01)	0.31 (1.14)	23.02 (28.67)	97.31 (80.90)	60.16 (54.61)
T_{13} KLE @ 5 % at B. I and 50% flowering stage	0.90 (1.38)	0.70 (1.30)	0.55 (1.24)	0.63 (1.28)	25.43 (30.26)	59.39 (50.42)	42.41 (40.35)
T_{14} KLE @ 5 % at B. I and 5% NLE at 50% flowering stage	0.90 (1.38)	0.70 (1.30)	0.55 (1.25)	0.63 (1.28)	25.43 (30.25)	59.45 (50.44)	42.44 (40.36)
T_{15} KLE @ 5 % at B. I and Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	1.00 (1.41)	0.50 (2.25)	0.08 (1.37)	0.29 (1.13)	51.90 (46.11)	95.09 (77.34)	73.49 (61.64)
T_{16} KLE @ 5 % at B.I and Metaflumizone @ 2.0 ml/l at 50% flowering stage	0.90 (1.38)	0.45 (1.20)	0.07 (1.04)	0.26 (1.12)	50.70 (45.41)	94.63 (77.02)	72.66 (61.00)
T_{17} Chlorpyriphos @ 2.5 ml+DDVP @ 1 ml/ l at B.I and50% flow (Std. Control)	0.90 (1.38)	0.70 (1.30)	0.50 (1.22)	0.60 (1.27)	25.43 (30.25)	63.45 (52.84)	44.44 (41.54)
T_{18} Untreated control	5.10 (2.47)	5.30 (2.51)	7.70 (2.96)	6.50 (2.73)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
General Mean	1.68	1.37	0.87	1.12	22.38	58.84	40.61
SEm $\pm$	0.061	0.043	0.045	0.180	3.40	2.48	8.91
CD (p= 0.05)	0.182	0.128	0.133	0.537	10.15	7.41	26.60
CV %	5.5	4.1	4.9	18.3	19.89	7.31	34.95

F test	NS	Sign	Sign	Sign	Sign	Sign	Sign

The data recorded one day after spray at 50% flowering stage, revealed that larval population ranged from 0.21–5.30. The population reduction ranged from 18.12–37.45 per cent over untreated control. The standard control recorded 25.43 per cent reduction over untreated control. Metaflumizone 22% SC 0.044 per cent spray at 50% flowering stage recorded 0.90 no. of larvae/pl and 37.45 per cent reduction in population followed by chlorfenapyr 10% SC 0.015 per cent spray with 3.20 no. of larvae/pl and 35.91 per cent reduction. The sprays with Neem and Karanj leaf extract at 50% flowering stage showed low efficacy by recording lesser per cent population reduction i.e. 18.12 and 17.75 per cent respectively. This lower efficacy of treatments might be due to the continuation of *Maruca* infestation from bud initiation stage.

The data recorded nine days after spray at 50% flowering stage, indicated that the *Maruca* infestation reduced drastically and ranged from 0.15 (metaflumizone) – 0.80 (KLE). Metaflumizone was the most effective and significantly superior over all the other treatments by recording 93.80 per cent reduction which was on par with chlorfenapyr with 93.38 per cent. KLE 5% spray recorded 88.98 % and NLE 5% with 88.41 per cent reduction over untreated control.

The cumulative mean data of 1 and 9 days after spray at 50% flowering stage, revealed that the mean number of larvae ranged from 0.53 (metaflumizone) – 6.50 (untreated control). Metaflumizone 22% SC 0.044 per cent spray recorded 65.41 per cent reduction in the population followed by chlorfenapyr 10% SC 0.015 per cent spray with 64.85 per cent, KLE @ 5 per cent with 53.37 per cent and NLE @ 5 per cent with 53.26 per cent reduction over untreated control. The standard control recorded 44.44 per cent reduction over untreated control.

During *rabi*, 2010-11 results also showed similar trend (table-2). The pre treatment count data one day prior to the spray at 50% flowering stage on the mean number of *Maruca* larvae ranged from 0.35 to 5.35 per plant in all the treatments including untreated control.

The data recorded one day after spray, revealed that larval population ranged from 0.90 – 6.10. The population reduction was ranged from 19.96 – 67.75 per cent over untreated control. The standard control recorded 66.03 per cent reduction over untreated control. Metaflumizone spray at 50% flowering stage recorded 0.90 no. of larvae / pl and 67.75 per cent reduction in population. The sprays with chlorfenapyr, Neem and Karanj leaf extracts at 50% flowering stage showed low efficacy by recording lesser per cent population reduction i.e. 49.31, 25.13 and 19.96 per cent respectively.

The data recorded nine days after the spray at 50% flowering stage, indicated that metaflumizone was the most effective and significantly superior over all the other treatments by recording 90.51 per cent reduction. Chlorfenapyr 10% SC 0.015 per cent recorded 78.53 per cent reduction which was on par with Neem leaf extract 5 per cent spray, which recorded 73.67 per cent and Karanj leaf extract 5 per cent spray with 50.94 per cent reduction over untreated control.

The mean data of 1 and 9 days after spray showed that the mean number of larvae ranged from 0.63 (metaflumizone) – 7.08 (untreated control). Metaflumizone spray recorded 79.13 per cent reduction in the population at 50% flowering stage. The standard control recorded 51.91 per cent reduction over untreated control.

Cumulative results on mean efficacy of the treatments: The cumulative two years results on mean efficacy of the treatments are presented in table-3. The data on pre treatment count showed significant variation between the years. The mean number of larvae ranged from 0.28 to 5.23 per plant.

The cumulative 1 and 9 DAS mean data at bud initiation stage, revealed that the mean number of larvae ranged from 0.35 (metaflumizone) – 6.79 (untreated control). The per cent population reduction was ranged from 0.00 –72.27. The standard control recorded 0.52 mean no. of larvae and 48.18 per cent reduction over untreated control.

Efficacy of Treatments on Pod Damage caused by *M. vitrata:* The year wise results on efficacy of treatments on pod damage caused by *M. vitrata* (table-4) revealed that there is significant difference between the treatments, as well as treatments and control. The mean data on per cent pod damage ranged from 5.05– 60.25 and 5.70 – 62.60 with 53.94 – 91.62 and 56.06 – 91.35 per cent reduction and standard control recorded 17.05 and 19.50 per cent pod damage with 71.70 and 68.51 per cent reduction in pod damage over untreated control during 2009-10 and 2010-11 respectively.

The two years pooled data revealed that spray with metaflumizone at 50% flowering stage recorded the 7.53% pod damage with the highest (87.76) per cent reduction in pod damage over untreated control followed by chlorfenapyr (72.62). Metaflumizone was discovered in the early 1990s and belongs to the new class of semicarbazone insecticides with a novel mode of action i.e. sodium channel blocker, specially developed against *Leptinotarsa decimilineata* and the most Lepidopteron species damaging horticultural crops. Due to its lack of cross resistance with conventional insecticides, it can be used in insecticide resistance management programmes[11,12]. The NLE and KLE sprayed at 50% flowering stage recorded 68.05 and 55.74 per cent reduction in pod damage over untreated control. The standard control (Chlorpyriphos 20 % EC 0.05%) @ 2.5 ml + DDVP 76% EC 0.076% @1 ml/l) sprayed at 50% flowering stage, recorded 18.28% pod damage with 70.11 per cent reduction in pod damage over untreated control.

Cumulative results on Yield of Greengram and Cost Benefit Ratio (CBR): The cumulative results showed that there was significant difference between treatments (table-5) data pertaining to the yield and CBR obtained from all the plots ranged between 0.45 to 1.86 kg/plot and 0.0 - 2.71 including untreated control. All the treatments showed significant yields compared to untreated control. The spray schedules recorded higher yields compared to the individual treatments. The sprays at 50% flowering stage the plot yield ranged from 0.69 (KLE with 1.12 CBR) - 1.35 (metaflumizone with 2.04 CBR) kg with an increase of 59 – 189 per cent yield over untreated control. The spray with NLE was recorded the CBR 1.48, which is on par with the chlorfenapyr spray with 1.52 CBR. The standard control recorded 0.85 kg/plot (707 kg/ha) yield with an increase of 92 per cent yield with 1.27 CBR over untreated control.

Table-2
Efficacy of treatments on *M. vitrata* larval population on greengram at 50% flowering stage during *rabi,* 2010-11

Treatments	Larval incidence (no. per plant *) at 50% flowering stage				**Per cent Reduction Over control		
	PTC	1DAS	9DAS	Mean	1DAS	9DAS	Mean
T_1 NLE @ 5% at BI stage	0.90(1.38)	1.03(1.42)	1.35(1.53)	1.19(1.45)	0.00(0.00)	0.00(32.12)	0.00(16.23)
T_2KLE @ 5 % at BI stage	0.95(1.39)	1.08(1.44)	1.43(1.56)	1.26(1.50)	0.00(0.00)	0.00(37.65)	0.00(18.83)
T_3 Chlorfenapyr 10% SC @ 1.5 ml /l at BI stage	0.90(1.38)	1.03(1.42)	1.36(1.54)	1.19(1.48)	0.00(0.00)	0.00(61.75)	0.00(30.85)
T_4Metaflumizone 22% SC @ 2.0 ml /l at BI stage	0.35(1.16)	0.40(1.18)	0.48(1.21)	0.44(1.19)	0.00(0.00)	10.05(58.42)	5.03(29.17)
T_5 NLE @ 5% at 50% flowering stage	1.40(1.55)	1.20(1.45)	0.45(1.20)	0.83(1.34)	25.13(30.08)	78.53(62.40)	51.83(46.24)
T_6 KLE @ 5 % at 50% flowering stage	2.30(1.82)	2.10(1.77)	1.70(1.64)	1.90(1.70)	19.96(26.23)	50.94(45.54)	35.45(36.03)
T_7Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	1.90(1.70)	1.10(1.45)	0.75(1.32)	0.93(1.39)	49.31(44.60)	73.67(59.15)	61.49(51.87)
T_8 Metaflumizone 22% SC @ 2.0 ml /l at 50% flowering stage	2.45(1.86)	0.90(1.38)	0.35(1.16)	0.63(1.27)	67.75(55.43)	90.51(72.10)	79.13(63.73)
T_9 NLE @ 5% at B I and 50% flowering stage	1.10(1.45)	0.95(1.39)	0.55(1.24)	0.75(1.32)	24.04(29.34)	66.36(54.61)	45.20(41.95)
T_{10} NLE @ 5% at B. I and 5 % KLE at 50% flowering stage	1.70(1.64)	1.05(1.43)	0.60(1.27)	0.83(1.35)	45.81(42.60)	76.64(61.14)	61.23(51.85)
T_{11}NLE @ 5% at B. I and Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	1.35(1.53)	0.70(1.30)	0.35(1.16)	0.53(1.23)	54.72(47.71)	82.85(65.53)	68.78(56.62)
T_{12} NLE @ 5% at B. I and Metaflumizone @ 2.0 ml /l at 50% flowering stage	1.50(1.58)	0.50(1.22)	0.15(1.08)	0.33(1.15)	70.77(57.27)	93.56(75.32)	82.17(66.29)
T_{13} KLE @ 5 % at B. I and 50% flowering stage	1.25(1.49)	0.90(1.38)	0.55(1.25)	0.73(1.31)	36.79(37.34)	70.64(57.20)	53.72(47.27)
T_{14} KLE @ 5 % at B.I and 5% NLE at 50% flowering stage	1.10(1.45)	0.80(1.34)	0.45(1.20)	0.63(1.28)	35.77(36.68)	72.86(58.60)	54.31(47.66)
T_{15} KLE @ 5 % at B. I and Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	1.20(1.48)	0.55(1.24)	0.35(1.16)	0.45(1.20)	59.77(50.65)	80.56(63.91)	70.17(57.24)
T_{16} KLE @ 5 % at B.I and Metaflumizone @ 2.0 ml/l at 50% flowering stage	0.75(1.32)	0.20(1.12)	0.15(1.08)	0.18(1.08)	76.49(61.01)	86.24(68.66)	81.37(64.61)
T_{17} Chlorpyriphos @ 2.5 ml +DDVP@ 1 ml/ l at B.I and 50% flow (Std.Control)	0.65(1.28)	0.25(1.12)	0.60(1.26)	0.43(1.19)	66.03(54.35)	37.80(37.92)	51.91(46.14)
T_{18} Untreated control	5.35(2.52)	6.10(2.67)	8.05(3.01)	7.08(2.84)	0.00(0.00)	0.0(0.00)	0.00 (0.00)
General Mean	1.51	1.16	1.09	1.13	35.13	53.95	44.54
SEm $\pm$	0.042	0.032	0.030	0.079	1.28	2.54	9.21
CD (p= 0.05)*	0.126	0.094	0.089	0.237	3.82	7.56	27.47
CV %	3.9	3.1	3.0	8.0	5.67	6.63	30.33
F test	NS	Sign	Sign	Sign	Sign	Sign	Sign

PTC = Pre Treatment count DAS= Day After Spraying Sign= Significant
NS= Non Significant
Figures in Parentheses are * $\sqrt{X+1}$ ** Arc sin Transformed Values

Table-3
Efficacy of treatments on *M. vitrata* larval population on greengram at 50% flowering stage (Pooled for 2009-10 and 2010-11)

Treatments	Larval incidence (no. per plant)*						Mean Per cent Reduction** Over control		
	PTC			Mean 1 and9 DAT					
	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
T_1 NLE @ 5% at BI stage	0.75 (1.32)	0.90 (1.38)	0.83 (1.35)	0.95 (1.39)	1.19 (1.45)	1.07 (1.42)	0.00 (0.00)	0.00 (16.23)	0.00 (0.00)
T_2KLE @ 5 % at BI stage	0.90 (1.38)	0.95 (1.39)	0.93 (1.39)	1.15 (1.47)	1.26 (1.50)	1.21 (1.49)	0.00 (0.00)	0.00 (18.83)	0.00 (0.00)
T_3 Chlorfenapyr 10% SC @ 1.5 ml /l at BI stage	0.30 (1.14)	0.90 (1.38)	0.60 (1.26)	0.38 (1.18)	1.19 (1.48)	0.79 (1.33)	0.00 (0.00)	0.00 (30.85)	0.00 (0.00)
T_4Metaflumizone 22% SC @ 2.0 ml /l at BI stage	0.20 (1.95)	0.35 (1.16)	0.28 (1.56)	0.25 (1.12)	0.44 (1.19)	0.35 (1.16)	0.00 (0.00)	5.03 (29.17)	2.52 (2.52)
T_5 NLE @ 5% at 50% flowering stage	4.35 (2.31)	1.40 (1.55)	2.88 (1.93)	2.23 (1.75)	0.83 (1.34)	1.53 (1.55)	53.26(47.64)	51.83(46.24)	52.5(46.94)
T_6 KLE @ 5 % at 50% flowering stage	4.80 (2.40)	2.30 (1.82)	3.55 (2.11)	2.45 (1.80)	1.90 (1.70)	2.18 (1.75)	53.37 (47.76)	35.45 (36.03)	44.4 (41.90)
T_7Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	4.80 (2.40)	1.90 (1.70)	3.35 (2.05)	1.83 (1.63)	0.93 (1.39)	1.38 (1.51)	64.85 (56.19)	61.49 (51.87)	63.17 (54.03)
T_8 Metaflumizone 22% SC @ 2.0 ml /l at 50% flowering stage	1.50 (2.57)	2.45 (1.86)	1.98 (2.22)	0.53 (1.23)	0.63 (1.27)	0.58 (1.25)	65.41 (56.41)	79.13 (63.73)	72.27 (60.07)
T_9 NLE @ 5% at B I and 50% flowering stage	0.75 (1.32)	1.10 (1.45)	0.93 (1.39)	0.45 (1.20)	0.75 (1.32)	0.60 (1.26)	46.66 (43.01)	45.20 (41.95)	45.93 (42.48)
T_{10} NLE @ 5% at B. I and 5 % KLE at 50% flowering stage	0.75 (1.32)	1.70 (1.64)	1.23 (1.48)	0.43 (1.19)	0.83 (1.35)	0.63 (1.27)	51.49 (45.95)	61.23 (51.85)	56.36 (48.90)
T_{11}NLE @ 5% at B. I and Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	0.75 (1.32)	1.35 (1.53)	1.05 (1.43)	0.33 (1.15)	0.53 (1.23)	0.43 (1.19)	60.33 (52.79)	68.78 (56.62)	64.56 (54.71)
T_{12} NLE @ 5% at B. I and Metaflumizone @ 2.0 ml /l at 50% flowering stage	0.75 (1.32)	1.50 (1.58)	1.13 (1.45)	0.31 (1.14)	0.33 (1.15)	0.32 (1.15)	60.16 (54.61)	82.17 (66.29)	71.17 (60.45)
T_{13} KLE @ 5 % at B. I and 50% flowering stage	0.90 (1.38)	1.25 (1.49)	1.08 (1.44)	0.63 (1.28)	0.73 (1.31)	0.68 (1.30)	42.41 (40.35)	53.72 (47.27)	48.07 (43.81)
T_{14} KLE @ 5 % at B.I and 5% NLE at 50% flowering stage	0.90 (1.38)	1.10 (1.45)	1.00 (1.42)	0.63 (1.28)	0.63 (1.28)	0.63 (1.28)	42.44 (40.36)	54.31 (47.66)	48.38 (44.01)
T_{15} KLE @ 5 % at B. I and Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	1.00 (1.41)	1.20 (1.48)	1.10 (1.45)	0.29 (1.13)	0.45 (1.20)	0.37 (1.17)	73.49 (61.64)	70.17 (57.24)	71.83 (59.44)
T_{16} KLE @ 5 % at B.I and Metaflumizone @ 2.0 ml/l at 50% flowering stage	0.90 (1.38)	0.75 (1.32)	0.83 (1.35)	0.26 (1.12)	0.18 (1.08)	0.22 (1.10)	72.66 (61.00)	81.37 (64.61)	77.02 (62.81)
T_{17} Chlorpyriphos @ 2.5 ml +DDVP@1ml/ l at B.I and 50% flow (Std.Control)	0.90 (1.38)	0.65 (1.28)	0.78 (1.33)	0.60 (1.27)	0.43 (1.19)	0.52 (1.23)	44.44 (41.54)	51.91 (46.14)	48.18 (43.84)
T_{18} Untreated control	5.10 (2.47)	5.35 (2.52)	5.23 (2.50)	6.50 (2.73)	7.08 (2.84)	6.79 (2.79)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
General Mean	1.68	1.51	11.61	1.12	1.13	1.40	40.61	44.54	36.99
SEm $\pm$	0.061	0.042	0.20	0.180	0.079	0.08	8.91	9.21	2.76
CD (p= 0.05)*	0.182 NS	0.126 NS	0.58 *	0.537 *	0.237 *	0.23 *	26.60 *	27.47 *	8.23*
CV %	5.5	3.9	17.12	18.3	8.0	7.8	34.95	30.33	10.5

PTC = Pre Treatment count DAT= Days After Treatment * = Significant NS= Non Significant
Figures in Parentheses are $\sqrt{* X+1}$ ** Arc sin Transformed Values

Table-4
Efficacy of spray schedules on pod damage by *M. vitrata* on greengram

Treatments	Per cent Pod damage by *M. vitrata*			Per cent Reduction over control		
	2009-10	2010-11	Pooled Mean	2009-10	2010-11	Pooled Mean
T_1 NLE @ 5% at BI stage	22.75 (28.49)	20.50 (26.92)	21.63	62.24 (52.09)	67.04 (54.98)	64.64
T_2KLE @ 5 % at BI stage	24.75 (29.83)	26.00 (30.65)	25.38	58.92 (50.14)	58.26 (49.76)	58.59
T_3 Chlorfenapyr 10% SC @ 1.5 ml /l at BI stage	11.05 (19.42)	13.50 (21.53)	12.28	81.66 (64.64)	78.47 (62.36)	80.07
T_4Metaflumizone 22% SC @ 2.0 ml /l at BI stage	8.55 (17.00)	9.00 (17.43)	8.78	85.81 (67.87)	85.65 (67.74)	85.73
T_5 NLE @ 5% at 50% flowering stage	18.65 (25.59)	20.50 (26.92)	19.58	69.05 (56.20)	67.04 (54.98)	68.05
T_6 KLE @ 5 % at 50% flowering stage	25.6 (30.37)	26.50(30.97)	26.05	53.94(47.26)	57.53(49.33)	55.74
T_7Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	14.65 (22.50)	19.00 (25.83)	16.83	75.69 (60.46)	69.54 (56.50)	72.62
T_8 Metaflumizone 22% SC @ 2.0 ml /l at 50% flowering stage	8.05 (16.48)	7.00 (15.30)	7.53	86.64 (68.56)	88.87 (70.52)	87.76
T_9 NLE @ 5% at B I and 50% flowering stage	15.05 (22.83)	22.50 (28.28)	18.78	75.02 (60.01)	64.12 (53.20)	69.57
T_{10} NLE @ 5% at B. I and 5 % KLE at 50% flowering stage	15.4 (23.11)	27.50 (31.61)	21.45	74.44 (59.63)	56.06 (48.48)	65.25
T_{11}NLE @ 5% at B. I and Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	7.05 (15.40)	7.65 (16.06)	7.35	88.3 (70.00)	87.65 (69.46)	87.98
T_{12} NLE @ 5% at B. I and Metaflumizone @ 2.0 ml /l at 50% flowering stage	5.05 (12.99)	5.70 (13.78)	5.38	91.62 (73.17)	90.94 (72.48)	91.28
T_{13} KLE @ 5 % at B. I and 50% flowering stage	14.65 (22.50)	16.50 (23.95)	15.58	75.69 (60.46)	73.64 (59.11)	74.67
T_{14} KLE @ 5 % at B.I and 5% NLE at 50% flowering stage	16.1 (23.66)	18.00 (25.07)	17.05	73.28 (58.87)	70.7 (57.34)	71.99
T_{15} KLE @ 5 % at B. I and Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	9.05 (17.51)	5.00 (11.60)	7.03	84.98 (67.20)	91.35 (74.80)	88.17
T_{16} KLE @ 5 % at B.I and Metaflumizone @ 2.0 ml/l at 50% flowering stage	7.9 16.32)	8.50 (16.94)	8.20	86.89 (68.77)	86.38 (68.34)	86.64
T_{17} Chlorpyriphos @ 2.5 ml +DDVP@ 1 ml/ l at B.I and 50% flow (Std.Control)	17.05 (24.39)	19.50 (26.20)	18.28	71.7 (57.86)	68.51 (55.90)	70.11
T_{18} Untreated control	60.25 (50.9)	62.60 (52.35)	61.43	0.00 (0.00)	0.00 (0.00)	0.00
General Mean	50.9	18.64	17.70	57.95	70.10	71.05
SEm $\pm$	0.39	1.87	1.76	0.11	2.10	2.84
CD (p= 0.05)*	1.18*	5.57*	5.26 *	0.32*	6.26*	8.47 *
CV %	2.39	10.7	14.09	0.26	5.20	5.65

Figures in Parentheses are Arc sin Transformed Values * = Significant

Table-5
Influence of spray schedules on greengram yield their Cost Benefit Ratio during *rabi* (Pooled)

Treatments	Yield			Total Cost of plant protection	Gross Returns	C:B Ratio
	Kg/Plot	Kg/ha	Per cent increase over control			
T_1 NLE @ 5% at BI stage	0.76	625	72	25316	20750	1.22
T_2KLE @ 5 % at BI stage	0.69	569	58	23034	20750	1.11
T_3 Chlorfenapyr 10% SC @ 1.5 ml /l at BI stage	1.05	875	125	35438	22125	1.60
T_4Metaflumizone 22% SC @ 2.0 ml /l at BI stage	1.22	1017	157	41175	22375	1.84
T_5 NLE @ 5% at 50% flowering stage	0.91	759	105	30713	20750	1.48
T_6 KLE @ 5 % at 50% flowering stage	0.69	573	59	23193	20750	1.12
T_7Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	1.00	829	124	33581	22125	1.52
T_8 Metaflumizone 22% SC @ 2.0 ml /l at 50% flowering stage	1.35	1126	189	45566	22375	2.04
T_9 NLE @ 5% at B I and 50% flowering stage	0.98	813	118	32906	21500	1.53
T_{10} NLE @ 5% at B. I and 5 % KLE at 50% flowering stage	0.86	711	90	28769	21500	1.34
T_{11}NLE @ 5% at B. I and Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	1.38	1218	217	49299	22875	2.16
T_{12} NLE @ 5% at B. I and Metaflumizone @ 2.0 ml /l at 50% flowering stage	1.66	1378	257	55775	23125	2.41
T_{13} KLE @ 5 % at B. I and 50% flowering stage	0.97	803	119	32481	21500	1.51
T_{14} KLE @ 5 % at B.I and 5% NLE at 50% flowering stage	0.83	690	87	27925	21500	1.30
T_{15} KLE @ 5 % at B. I and Chlorfenapyr @ 1.5 ml /l at 50% flowering stage	1.29	1056	198	42755	22875	1.87
T_{16} KLE @ 5 % at B.I and Metaflumizone @ 2.0 ml/l at 50% flowering stage	1.86	1546	329	62600	23125	2.71
T_{17} Chlorpyriphos @ 2.5 ml +DDVP@ 1 ml/ l at B.I and 50% flow (Std.Control)	0.85	707	92	28603	22475	1.27
T_{18} Untreated control	0.45	371	0	15528	20000	--
General Mean	1.04	870	133			
SEm $\pm$	0.17	144.37	37.07			
CD (p= 0.05)*	0.50 *	431 *	110.6 *			
CV %	22.56	23.47	39.38			
F test	Sign	Sign	Sign			

Conclusion

Metaflumizone spray at 50% flowering stage found to be effective to manage the *M. vitrata* in greengram as it recorded the highest per cent population reduction (72.27) and the lowest (7.53) pod damage with the highest (87.76) per cent reduction in pod damage and highest CBR (2.04) compared to the standard control (48.18 per cent population reduction and 70.11 per cent reduction in pod damage) over untreated control.

The spray with NLE was recorded the CBR 1.48, which is on par with the chlorfenapyr spray with 1.52 CBR. Use of indigenous leaf extracts as pesticides in the short duration, non-commercial crops like mungbean is needed to manage the insect pests.

References

1. National Agricultural Innovation Project report submitted by Central Research Institute for Dry land Agriculture **(2012)**
2. Lal S.S and Sachan J.N., Recent advances in Pest management in pulses, *Indian Farming,* **37(7),** 29-32 **(1987)**
3. GanapathyN., Bio-ecology and Management of spotted pod borer, *Maruca vitrata* (Geyer) (Lepidoptera: Pyralidae) in pigeonpea. *Ph.D Thesis*, Tamilnadu Agricultural University, Coimbatore **(1996)**
4. Dillirao S., Bio-ecology and management of spotted pod borer, *Maruca vitrata* (Geyer) on blackgram, *M. Sc.(Ag.) Thesis,* Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad **(2001)**

5. Vishakanthaiah M. and Jagadeesh babu C.S., Bionomics of the tur webworm, *Maruca testulalis* (Lepidoptera: Pyralidae), *Mysore Journal of Agricultural Sciences,* **14,** 529-532 **(1980)**

6. Manjunath C., Studies on Relative toxicity of certain Insecticides to Spotted Pod borer (*Maruca vitrata* (Geyer). *M.Sc.(Ag.) Thesis,* Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad (**2008)**

7. Bottenberg, H and Singh, B.B., Effect of neem leaf extract applied using the broom method on cowpea pests and yield, *International Journal of Pest Management,* **42,** 207-209 **(1996)**

8. Jackai, L.E.N and Oyediran, I.O., The potential of neem *Azadirachta indica* A. Juss. for controlling post-flowering pests of cowpea, *Vigna unguiculata* Walp.-I. The pod borer *Maruca testulalis*, *Insect Science and its Application,* **12,** 103-109 **(1991)**

9. Rangaswamy, R., *A Text Book of Agricultural Statistics.* New Age International Publishers Limited, New Delhi. 89-101**(1995)**

10. Flemming R. and Retnakaran, A.,Evaluating single treatment data using Abbott's formula with reference to insecticides, *Journal of Economic Entomology,* **78**: 1179-1181**(1985)**

11. Marchi A., Gentili E., Tarlazzi S and Manaresi M., Metaflumizone: a new broad spectrum insecticide for potato and vegetables, *Giornate Fitopatologiche,* **1,** 23-28 **(2008)**

12. Takagi K., Hamaguchi H., Nioshimatsu and Konno T.O., Discovery of Metaflumizone, A novel semi-carbazone insecticide, *Veterinary Parasitology,* **150(3),** 177-181 **(2007)**