

Original Research Article

<https://doi.org/10.20546/ijcmas.2017.610.150>

Evaluation of Insecticides against Sucking Pests Grown During Kharif

B. Sujatha and T.M. Bharpoda*

Department of Agricultural, Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand-388110, Gujarat, India

*Corresponding author

ABSTRACT

Keywords

Insecticides,
Aphids, Jassids,
Whitefly, Thrips,
Flower thrips.

Article Info

Accepted:
14 September 2017
Available Online:
10 October 2017

Investigations were carried out at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during Kharif, 2015 for evaluation of various insecticides on the incidence of sucking pests viz., aphids (*Aphis craccivora* Koch), jassids (*Empoasca kerri* Pruthi), whiteflies (*Bemisia tabaci* Gennadius), thrips (*Thrips palmi* Karny), flower thrips (*Megalurothrips usitatus* Bagnall) in green gram. Among the various insecticides evaluated for their field efficacy against sucking pests, thiamethoxam 25 WG (0.01%) and imidacloprid 70 WG (0.014%) were found more effective followed by dimethoate 30 EC (0.03%). The effectiveness of these treatments also reflected on green gram yield. Higher Incremental Cost Benefit Ratio (ICBR) was also obtained in these treatments.

Introduction

Pulse crops have a unique position in sustainable crop production as they provide highly nutritive food and keep the soil alive as well as productive and also in the agricultural economy of India being the major source of protein in Indian dietary.

The General Assembly of the United Nations has recognised pulses as an essential source of protein and a part of improving nutrition globally and declared 2016 as “The International Year of Pulses” (IYP 2016) (Anon., 2016a).

India is the world’s largest producer (18.5 million tonnes), largest importer (3.5 million tonnes) and largest consumer (22.0 million tonnes) of pulses (Anon., 2016b).

The sucking pests like aphids, *Aphis craccivora* Koch; jassids, *Empoasca kerri* Pruthi; white flies, *Bemisia tabaci* Gennadius, thrips, *Thrips palmi* Karny and flower thrips, *Megalurothrips usitatus* Bagnall are known to cause significant damage to green gram crop. Whitefly, a potential vector of mung bean yellow mosaic virus (MYMV), can cause losses ranging from 30 – 70 per cent (Swaminathan *et al.*, 2012) and 80 to 100 per cent in green gram and black gram (Naimuddin, 2001). Sreekanth (2002) reported that thrips caused at least 40 per cent yield loss in green gram. The annual yield loss due to the insect pests has been estimated to the tune of 30 per cent by Soundararajan and Chitra (2011) in green gram and Justin, *et al.*, (2015) in urd bean and green gram. So

there is a need to investigate the tools for the sucking pests of green gram to develop an effective management strategy as well as focused on the use of safer chemicals and pesticides.

Materials and Methods

To evaluate the efficacy of various insecticides *viz.*, Flonicamid 50 WG @ 0.015%, Thiamethoxam 25 WG @ 0.01%, Imidacloprid 70 WG @ 0.014%, Clothianidin 50 WDG @ 0.02%, Diafenthiuron 50 WP @ 0.05%, Profenophos 50 EC @ 0.05%, Acephate 75 SP @ 0.075%, Dinotefuran 20 SG @ 0.008%, Dimethoate 30 EC @ 0.03% and Control (water spray) against sucking pests in green gram, the experiment was laid out in a Randomized Block Design with three replications having gross and net plot area 3.0 m × 2.7 m and 2.4 m × 1.8 m, respectively during *Kharif*, 2015 at College Agronomy Farm, B. A. College of Agriculture, AAU, Anand. Green gram cultivar, Meha was grown with spacing 45 cm × 15 cm under recommended agronomical practices.

Method of application

First spray application of respective insecticides was given on the initiation of the pests and subsequently another one spray was given after 25 days using manually operated knapsack sprayer having duromist nozzle with slight runoff stage. The required chemicals were collected from Department of Entomology and were sprayed.

Method of recording observations

For recording the observations of aphids, jassids, whiteflies and thrips population was counted from three (upper, middle and lower leaves) and flower thrips per five flowers from the five randomly selected plants in each sector. The observations on sucking pests as well as natural enemies population were

recorded prior to one day of first spray as well as after 3, 5 and 10 days after each spray.

Yield was recorded after threshing and separating of green gram seeds from each plot weighed separately and converted into quintals per hectare for further statistical analysis. The per cent increase over control was also calculated by following formula:

$$\frac{\text{Yield of treatment} - \text{Yield of control}}{\text{Yield of control}} \times 100$$

The economics of different treatments were evaluated against sucking pests infesting green gram and Incremental Cost Benefit Ratio (ICBR) was worked out. Total cost of insecticides treatment per hectare was calculated for each treatment based on the prevailing market price. The net gain (yield) over control was calculated by subtracting the yield obtained in control treatment from the yield obtained in each insecticidal treatment. Then, the realization was worked out for each treatment based on increased yield (q/ha) over control. The net realization (Rs./ha) for each treatment was computed by deducting the cost of insecticides treatment from the value of realization over control. The gross ICBR *i.e.* net gain in rupees per rupee cost of insecticides treatment was calculated by dividing net profit with the cost of treatment. To calculate the value of net ICBR (NICBR) *i.e.* additional profit gained per rupee cost of treatment, 1 rupee was subtracted from ICBR obtained in each treatment.

Results and Discussion

Efficacy of various synthetic insecticides on aphids, *A. craccivora*

The data on aphids population recorded periodically was pooled and presented in Table 1 (column 2) revealed that all the

insecticidal treatments were significantly superior to control. Among the various insecticides, thiamethoxam 25 WG @ 0.01% and imidacloprid 70 WG @ 0.014% were found significantly superior than rest of the insecticidal treatments and recorded lower (0.38 and 0.42 aphids/ 3 leaves, respectively) population. Dimethoate 30 EC @ 0.03% (1.35), diafenthiuron 50 WP @ 0.05% (1.46) and flonicamid 50 WG @ 0.015% (1.54) were at par with each other. Next in order of effectiveness was acephate 75 SP @ 0.075% followed by profenophos 50 EC @ 0.05% and recorded somewhat higher aphids population (2.49 to 2.56 aphids/ 3 leaves). Clothianidin 50 WDG @ 0.02% and dinotefuran 20 SG @ 0.008% were comparatively less effective by recording higher (3.04 and 3.95 aphids/ 3 leaves, respectively) population in green gram. However, all the insecticides were significantly more effective as compared to control (10.06). Justin *et al.*, (2015) in black gram and Kabir *et al.*, (2014) in green gram reported higher efficacy of thiamethoxam. Higher efficacy of imidacloprid was also reported in cowpea by Khade *et al.*, (2014) and Reddy *et al.*, (2014). Khutwad *et al.*, (2002) also reported higher efficacy of thiamethoxam and imidacloprid in green gram.

Efficacy of various synthetic insecticides on jassids, *E. kerri*

The chronological order of various insecticides based on number of jassids per 3 leaves (given in bracket) was recorded at different periods over sprays Table 1 (column 3) was also pooled thiamethoxam 25 WG @ 0.01% (0.11) > imidacloprid 70 WG @ 0.014% (0.12) > flonicamid 50 WG @ 0.015% (0.62) > dimethoate 30 EC @ 0.03% (0.69) > diafenthiuron 50 WP @ 0.05% (0.78) > acephate 75 SP @ 0.075% (1.38) > dinotefuran 20 SG @ 0.008% (1.43) > profenophos 50 EC @ 0.05% (1.49) >

clothianidin 50 WDG @ 0.02% (2.29) > control (4.30). Among the tested insecticides, thiamethoxam 25 WG @ 0.01% and imidacloprid 70 WG @ 0.014% were found significantly superior and recorded lower population of jassids. Next best effective chemicals were flonicamid 50 WG @ 0.015%, dimethoate 30 EC @ 0.03% and diafenthiuron 50 WP @ 0.05% against this pest. In addition, there was no significant difference among them. Acephate 75 SP @ 0.075%, dinotefuran 20 SG @ 0.008% and profenophos 50 EC @ 0.05% were comparatively less effective insecticides against jassids. Among the tested insecticides, clothianidin 50 WDG @ 0.02% recorded significantly the highest population and proved to be least effective against jassids infesting green gram. Khattak *et al.*, (2004) reported the highest reduction of jassids in the green gram plots treated with thiamethoxam followed by imidacloprid and diafenthiuron. Sutaria *et al.*, (2010) in soybean, Patel *et al.*, (2012) in cowpea, Sharma and Singh (2015) in urdbean, Iqbal *et al.*, (2013) and Ahirwar *et al.*, (2016) in green gram also reported higher efficacy of thiamethoxam and imidacloprid. Anusha *et al.*, (2014) in cowpea reported higher efficacy of imidacloprid and diafenthiuron and lower efficacy of profenophos. Justin *et al.*, (2015) reported the higher efficacy of thiamethoxam in black gram.

Efficacy of various synthetic insecticides on whiteflies, *B. tabaci*

The data on whiteflies population recorded at 3, 5 and 10 DAS was also pooled and summarized in Table 1 (column 4). All the insecticidal treatments were significantly superior to control. Thiamethoxam 25 WG @ 0.01% (0.06/ 3 leaves) and imidacloprid 70 WG @ 0.014% (0.08) treated plots recorded significantly lower population of whiteflies and found more effective chemicals.

Diafenthiuron 50 WP @ 0.05% (0.36) was next best effective insecticide and at par with flonicamid 50 WG @ 0.015% (0.46). Dimethoate 30 EC @ 0.03%, clothianidin 50 WDG @ 0.02%, acephate 75 SP @ 0.075% and profenophos 50 EC @ 0.05% were next in order and also recorded lower (0.89 to 0.99/ 3 leaves) population of whiteflies. Further, these chemicals were at par with each other so far their effectiveness is concerned. Among all the insecticides, dinotefuran 20 SG @ 0.008% proved to be least effective by recording the highest (1.52) whiteflies population in green gram. Ganapathy and Karuppiyah (2005) in green gram, Patel *et al.*, (2012) in cowpea, Gotyal and Prasad (2013) in soybean and Yadav *et al.*, (2015) in black gram reported minimum population of whiteflies in thiamethoxam treated plots.

Muhammad *et al.*, (2002), Sreekanth *et al.*, (2004), Khattak *et al.*, (2004) and Shah *et al.*, (2007) reported higher efficacy of imidacloprid to control whiteflies in green gram. The higher effectiveness of diafenthiuron on whiteflies was reported by Gopaldaswamy *et al.*, (2012). Mandal *et al.*, (2015) in green gram and Parmar *et al.*, (2015) in black gram also tested the clothianidin on this pest for its effectiveness.

Efficacy of various synthetic insecticides on thrips, *T. palmi*

The data on thrips population recorded at different periods over sprays was also pooled and presented in Table 1 (column 5). The chronological order of various insecticides based on number of thrips per three leaves (given in bracket) was: thiamethoxam 25 WG @ 0.01% (0.48) > imidacloprid 70 WG @ 0.014% (0.54) > diafenthiuron 50 WP @ 0.05% (2.81) > flonicamid 50 WG @ 0.015% (3.03) > dimethoate 30 EC @ 0.03% (3.15) > acephate 75 SP @ 0.075% (5.31) > profenophos 50 EC @ 0.05% (5.45) >

clothianidin 50 WDG @ 0.02% (5.60) > dinotefuran 20 SG @ 0.008% (7.85) > control (12.17). Among the tested insecticides, thiamethoxam 25 WG @ 0.01% and imidacloprid 70 WG @ 0.014% were found significantly superior and recorded lower population of thrips. Diafenthiuron 50 WP @ 0.05%, flonicamid 50 WG @ 0.015% and dimethoate 30 EC @ 0.03% were mediocre in their effectiveness against the pest. Rest of the insecticides *i.e.*, acephate 75 SP @ 0.075%, profenophos 50 EC @ 0.05% and clothianidin 50 WDG @ 0.02% were comparatively less effective insecticides against thrips. Among the tested insecticides, dinotefuran 20 SG @ 0.008% recorded significantly the highest population and proved to be least effective against thrips infesting green gram. Ahirwar *et al.*, (2016) reported the higher efficacy of thiamethoxam against thrips in green gram. Kaushik *et al.*, (2015) and Anusha *et al.*, (2014) in cowpea and Nataraja *et al.*, (2014) in groundnut also reported higher efficacy of thiamethoxam and imidacloprid followed by diafenthiuron. Damasia *et al.*, (2013) reported the higher effectiveness of dimethoate against thrips in green gram followed by thiamethoxam and imidacloprid.

Efficacy of various synthetic insecticides on flower thrips, *M. usitatus*

The data on flower thrips population recorded periodically was pooled and presented in Table 1 (column 6). It is clearly indicated that all the insecticidal treatments significantly differed from the control. Among the various insecticides, thiamethoxam 25 WG @ 0.01% (0.33) was found significantly superior than the rest of the insecticides under study and at par with imidacloprid 70 WG @ 0.014% (0.46). Diafenthiuron 50 WP @ 0.05% (1.11), flonicamid 50 WG @ 0.015% (1.19) and dimethoate 30 EC @ 0.03% (1.35) stood next in order so far their effectiveness against flower thrips is concerned.

Table.1 Efficacy of insecticides against different sucking pests in green gram in *Kharif* (Pooled over periods and sprays)

Treatments	No. of sucking pests/ 3 leaves				No. of flower thrips/ 5 flowers
	Aphids	Jassids	Whiteflies	Thrips	
1	2	3	4	5	6
Flonicamid 50 WG 0.015%	1.43 b (1.54)	1.06 b (0.62)	0.98 b (0.46)	1.88 b (3.03)	1.30 b (1.19)
Thiamethoxam 25 WG 0.01%	0.94 a (0.38)	0.78 a (0.11)	0.75 a (0.06)	0.99 a (0.48)	0.91 a (0.33)
Imidacloprid 70 WG 0.014%	0.96 a (0.42)	0.79 a (0.12)	0.76 a (0.08)	1.02 a (0.54)	0.98 a (0.46)
Clothianidin 50 WDG 0.02%	2.06 d (3.74)	1.67 d (2.29)	1.19 c (0.92)	2.47 c (5.60)	2.10 d (3.91)
Diafenthiuron 50 WP 0.05%	1.40 b (1.46)	1.13 b (0.78)	0.93 b (0.36)	1.82 b (2.81)	1.27 b (1.11)
Profenophos 50 EC 0.05%	1.75 c (2.56)	1.41 c (1.49)	1.22 c (0.99)	2.44 c (5.45)	1.77 c (2.63)
Acephate 75 SP 0.075%	1.73 c (2.49)	1.37 c (1.38)	1.21 c (0.96)	2.41 c (5.31)	1.70 c (2.39)
Dinotefuran 20 SG 0.008%	2.11 d (3.95)	1.39 c (1.43)	1.42 d (1.52)	2.89 d (7.85)	2.19 d (4.30)
Dimethoate 30 EC 0.03%	1.36 b (1.35)	1.09 b (0.69)	1.18 c (0.89)	1.91 b (3.15)	1.36 b (1.35)
Control (water spray)	3.25 e (10.06)	2.19 e (4.30)	1.73 e (2.49)	3.56 e (12.17)	2.58 e (6.16)

	F-Test (T)	Sig	Sig	Sig	Sig	Sig
S.Em.±	Treatment (T)	0.06	0.04	0.04	0.07	0.06
	Period (P)	0.03	0.01	0.02	0.03	0.03
	T x P	0.09	0.04	0.05	0.94	0.09
C. D. at 5%	Treatment (T)	0.17	0.14	0.12	0.19	0.17
	Period (P)	0.08	0.03	0.05	NS	0.08
	T x P	NS	0.10	NS	NS	NS
	C.V.%	10.49	8.43	10.42	13.15	10.49

Note: Figures in parentheses are retransformed values; those outside are $\sqrt{x + 0.5}$ transformed values. Treatment mean with letter(s) in common are not significant by DNMRT at 5 % level of significance within a column; Non-Significant; S: Significant

Table.2 Impact of insecticides on coccinellids, *Chrysoperla* spp. and seed yield of green gram

Treatments	No. of coccinellids (grubs + adults)/ plant	No. of <i>Chrysoperla</i> spp. grubs/ plant	Seed yield (q/ ha)	Increase over control (%)
1	2	3	4	5
Flonicamid 50 WG 0.015%	1.14 (0.80)	1.05 (0.60)	8.64 bcde	28.59
Thiamethoxam 25 WG 0.01%	1.24 (1.04)	1.07 (0.64)	10.26 a	39.86
Imidacloprid 70 WG 0.014%	1.25 (1.06)	1.14 (0.80)	9.80 ab	37.04
Clothianidin 50 WDG 0.02%	1.09 (0.69)	0.92 (0.35)	7.79 de	20.80
Diafenthiuron 50 WP 0.05%	1.13 (0.78)	1.03 (0.56)	8.87 bcd	30.44
Profenophos 50 EC 0.05%	1.07 (0.64)	1.00 (0.50)	8.03 de	23.16
Acephate 75 SP 0.075%	1.17 (0.87)	1.06 (0.62)	8.41 cde	26.63
Dinotefuran 20 SG 0.008%	1.26 (1.09)	1.16 (0.85)	7.41 e	16.73
Dimethoate 30 EC 0.03%	1.11 (0.73)	1.00 (0.50)	9.42 abc	34.50
Control (water spray)	1.50 (1.75)	1.17 (0.87)	6.17 f	-

F-Test (T)		NS	NS	Sig	-
S.Em.±	Treatment (T)	0.08	0.06	0.39	-
	Period (P)	-	-	-	-
	T x P	-	-	-	-
C. D. at 5%	Treatment (T)	0.24	0.18	1.17	-
	Period (P)	-	-	-	-
	T x P	-	-	-	-
	C.V.%	20.24	9.25	8.00	-

Note: Figures in parentheses are retransformed values; those outside are $\sqrt{x + 0.5}$ transformed values. Treatment mean with letter(s) in common are not significant by DNMR at 5 % level of significance within a column; Non-Significant; S: Significant

Table.3 Economic of various synthetic insecticides used for control of sucking pests infesting green gram

Insecticides (%)	Conc. (%)	Total cost treatment (Rs./ha)	Yield of seed (q/ha)	Net gain over control (q/ha)	Realization (Rs./ha)	Net Realization (Rs./ha)	ICBR	NICBR
1	2	3	4	5	6	7	8	9

Flonicamid 50 WG	0.015	4094	8.64	2.47	14820	10726	1:2.62	1:1.62
Thiamethoxam 25 WG	0.01	2784	10.26	4.09	24540	21756	1:7.81	1:6.81
Imidacloprid 70 WG	0.014	2906	9.80	3.63	21780	18874	1:6.49	1:5.49
Clothianidin 50 WDG	0.02	7104	7.79	1.62	9720	2616	1:0.37	1:-0.63
Diafenthiuron 50 WP	0.05	5084	8.87	2.70	16200	11116	1:2.19	1:1.19
Profenophos 50 EC	0.05	2024	8.03	1.86	11160	9136	1:4.51	1:3.51
Acephate 75 SP	0.075	2288	8.41	2.24	13440	11152	1:4.87	1:3.87
Dinotefuran 20 SG	0.008	4784	7.41	1.24	7440	2656	1:0.56	1:-0.44
Dimethoate 30 EC	0.03	1648	9.42	3.25	19500	17852	1:10.83	1:9.83
Control (water spray)	-	-	6.17	-	-	-	-	-

Market price of green gram grain: Rs. 60/ kg (Rs. 6000/ quintal)

Labour charges: For spraying Rs. 296/labour/day

Two labour per hectare required for each spray, two sprays were given (500 litre spray solution is required for one spray for one hectare)

Acephate 75 SP @ 0.075% (2.39), profenophos 50 EC @ 0.05% (2.63), clothianidin 50 WDG @ 0.02% (3.91) and dinotefuran 20 SG @ 0.008% (4.30) were found comparatively less effective in controlling flower thrips population. However, all the insecticides were significantly more effective as compared to control (6.16). Higher efficacy of imidacloprid and dimethoate against flower thrips in cowpea was reported by Oyewale *et al.*, (2014).

Effect of various synthetic insecticides on Coccinellids (grubs and adults) and *Chrysoperla* spp. (grubs)

The data on coccinellids recorded periodically was also pooled and summarized in Table 2 (Column 2). The chronological order of various synthetic insecticides in comparison to control based on population of coccinellids (grubs and adults) per plant (in bracket) was: control (1.75) > dinotefuran 20 SG @ 0.008% (1.09) > imidacloprid 70 WG @ 0.014% (1.06) > thiamethoxam 25 WG @ 0.01% (1.04) > acephate 75 SP @ 0.075% (0.87) > flonicamid 50 WG @ 0.015% (0.80) > diafenthiuron 50 WP @ 0.05% (0.78) > dimethoate 30 EC @ 0.03% (0.73) > clothianidin 50 WDG @ 0.02% (0.69) > profenophos 50 EC @ 0.05% (0.64). As far as ANOVA presented in Table 36 is concerned, all the treatments including control were at par with each other. Numerical data showed that there was slight reduction of population in the plots treated with synthetic insecticides (0.64 to 1.09/ plant) when compared with control plots (1.75). The population of *Chrysoperla* spp. (grubs) was observed at 10 DAS and summarized in the Table 2 (Column 3) revealed that all the synthetic insecticides under investigation were more or less did not impose any significant adverse effect on the activity of this predator in green gram with reduction in the population of this natural

enemy in the plots receiving synthetic insecticides (0.35 to 0.85/ plant) than the control plots. Mithu *et al.*, (2015) in cowpea and green gram, Bharpoda *et al.*, (2014) in *Bt* cotton, Chakraborty *et al.*, (2013) in pulse crops as well as Sitaramaraju *et al.*, (2010) in cotton reported less toxicity of thiamethoxam and imidacloprid; Pawar and Bharpoda (2013) reported the less toxicity of flonicamid against coccinellids in safflower. Scanty information is available on *Chrysoperla* spp. (grubs) in green gram.

Impact of various synthetic insecticides on seed yield, per cent increase in yield over control and economics

The efficacy of various chemicals against sucking pests reflected on seed yield (Table 2 and Column 4) as well as per cent increase in yield over control (Table 2 and Column 5) of green gram. Plots treated with different insecticides yielded significantly higher seed yield (7.41 to 10.26 q/ ha) than control (6.17). The chronological order of various insecticidal treatments in comparison to control based on seed yield (q/ ha) as well as per cent increase in yield over control was: thiamethoxam 25 WG @ 0.01% > imidacloprid 70 WG @ 0.014% > dimethoate 30 EC @ 0.03% > diafenthiuron 50 WP @ 0.05% > flonicamid 50 WG @ 0.015% > acephate 75 SP @ 0.075% > profenophos 50 EC @ 0.05% > clothianidin 50 WDG @ 0.02% > dinotefuran 20 SG @ 0.008% > control. Thiamethoxam 25 WG @ 0.01% treated plots harvested significantly the highest yield and was at par with imidacloprid 70 WG @ 0.014% and dimethoate 30 EC @ 0.03%. Rest of the insecticides *i.e.* diafenthiuron 50 WP @ 0.05%, flonicamid 50 WG @ 0.015%, acephate 75 SP @ 0.075%, profenophos 50 EC @ 0.05% and clothianidin 50 WDG @ 0.02% were at par with each other. Among the synthetic insecticides, dinotefuran 20 SG @ 0.008% recorded the

lowest yield. Maximum yield loss could be avoided with spray application of thiamethoxam 25 WG @ 0.01%, imidacloprid 70 WG @ 0.014%, dimethoate 30 EC @ 0.03% and diafenthiuron 50 WP @ 0.05%.

The economics of various synthetic insecticides (Table 3) revealed that the highest (24,540.00 Rs./ ha) realization was obtained from the treatment thiamethoxam 25 WG @ 0.01% followed by imidacloprid 70 WG @ 0.014% (21,780.00 Rs./ ha), dimethoate 30 EC @ 0.03% (19,500.00 Rs./ha) and diafenthiuron 50 WP @ 0.05% (16,200.00 Rs./ ha). The highest ICBR was calculated from the plots treated with dimethoate 30 EC @ 0.03% (1: 10.83). Thiamethoxam 25 WG @ 0.01% (1:7.81), imidacloprid 70 WG @ 0.014% (1:6.49), acephate 75 SP @ 0.075% (1:4.87) and profenophos 50 EC @ 0.05% (1:4.51) also recorded higher ICBR. Dinotefuran 20 SG @ 0.008% (1:0.56) and clothianidin 50 WDG @ 0.02% (1:0.37) recorded lower ICBR and proved to be non-economical insecticidal treatments. The highest (9.83) NICBR was calculated from the plots treated with dimethoate 30 EC @ 0.03%. Thiamethoxam 25 WG @ 0.01% (6.81) and imidacloprid 70 WG @ 0.014% (5.49) also recorded higher NICBR. Dinotefuran 20 SG @ 0.008% (0.56) and clothianidin 50 WDG @ 0.02% (0.37) recorded lower NICBR and found not much economical insecticidal treatments.

Sreekanth *et al.*, (2003), Shah *et al.*, (2007) and Hossain *et al.*, (2013) from green gram and Gopalaswamy *et al.*, (2012) in black gram reported higher yield in the plots treated with imidacloprid. Mandal *et al.*, (2015) reported higher yield and net return of green gram in thiamethoxam followed by dimethoate and clothianidin. Ahirwar *et al.*, (2016) reported higher yield of green gram in thiamethoxam followed by imidacloprid, dimethoate and acephate. Kumar *et al.*, (2007) reported that

dimethoate in black gram was more effective and economical. Bairwa *et al.*, (2006) reported higher yield and higher ICBR in plots treated with dimethoate followed by acephate and imidacloprid in moth bean. Sharma and Singh (2015) reported higher yield in plots treated with imidacloprid followed by thiamethoxam in urdbean.

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How to cite this article:

Sujatha, B. and Bharpoda, T.M. 2017. Evaluation of Insecticides against Sucking Pests Grown During Kharif. *Int.J.Curr.Microbiol.App.Sci*. 6(10): 1258-1268.
doi: <https://doi.org/10.20546/ijcmas.2017.610.150>