Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(2): 882-886
Received: 15-01-2019
Accepted: 19-02-2019

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Relative efficacy of new generation insecticides against sucking insect pests of Green gram

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Abstract
A field experiment was conducted to determine the relative efficacy of different newer insecticides against sucking insect pest viz., white fly (*Bemisia tabaci*), jassid (*Empoasca kerri*), infesting Green gram at Agronomy Farm, S. K. N. College of Agriculture, Jobner (Rajasthan) during *Kharif*. The efficacy of eight insecticides tested against insect pest of green gram revealed that acetamiprid (0.004%) proved to be the most effective followed by imidacloprid (0.005%) and fipronil (0.01%). The treatments of thiamethoxam (0.005%) and dimethoate (0.03%) stood in middle order of efficacy followed by the treatments of spiromesifen (0.001%) and fenpropathrin (0.05%) which were proved to be least effective against insect pest of green gram. The total avoidable loss and percent avoidable loss was found to be zero in the treatment of acetamiprid (0.04%), whereas, maximum in spiromesifen (0.001%).

Keywords: Insecticides, sucking insect pests, jassid, whitefly, spiromesifen, fenpropathrin

Introduction
Green gram [*Vigna radiata* (L.) Wilczek], (synonyms, *Phaseolus aurius* Roxb., *Phaseolus radiatus* L.) It is one of important pulse crops for diversifying cereal-based cropping systems worldwide. In India pulses have been considered poor men meat, also play major role in sustainable agriculture because pulses improve soil fertility through nitrogen fixation. It is estimated that, in India pulses are grown in 25.22 million ha, area yielding 19.27 million tones with an average yield of 764 kg ha^{-1} (Anonymous 2013-14 a). In India during 2013-14 Green gram was cultivated on 3.28 million ha area and its production and productivity was 1.55 million tones and 317 kg ha^{-1}, respectively (Anonymous 2013-14 a). It enhances the soil fertility by absorbing the atmospheric nitrogen, so it is used as a green manure crop. It is also used as cattle feed along with roughage crops.
The most serious insect pests attacking on green gram includes white fly (*Bemisia tabaci*), jassid (*Empoasca kerri*). Although there are various risk associated with Insecticide application but, still is has been considered as one of the most effective and quickest method of reducing insect pest population in the field. More often it forms the only solution to manage the out breaks of insect pests. Keeping this view present study was conducted to find out the efficacy of certain newer insecticides against sucking insects pests of green gram
The indiscriminate use of insecticides has resulted in severe problems like development of resistance by insects to insecticides, resurgence of insect pests, outbreak of secondary pests, problem of residues, toxicity to non target organisms, environmental pollution etc. However, in spite of these, newer insecticides have come to stay in our modern farming, which may not be dispensed off due to their efficacy and economic.

Materials and Methods
The present investigations were carried out at S. K. N. college of Agriculture, Jobner, during *kharif*, 2015. Being a leguminous crop, green gram needs a small quantity of nitrogen for early growth period. Fertilizers were applied at the rate of 20 kg of nitrogen per hectare as a starter dose and 40 kg phosphorus per hectare in the soil before sowing.
The details regarding insecticides and their concentration or dosage have been presented in table 1. There were eight treatments including control (untreated). The insecticides were applied when sufficient population of jassid and whitefly were built up on the plants. The crop was sprayed for the first time on 13th August by using a foot sprayer and second application was made three weeks after first application. The re-build up of population was observed at this stage. The spray solution used for spraying the crop was 600 l ha^{-1}.

Table 1: Details of insecticides used

S. No.	Common name	Trade name	Concentration (%)
1.	Imidacloprid 17.8 SL	Confidor	0.005
2.	Thiamethoxam 25 WG	Actara	0.005
3.	Spiromesifen 22.9 SC	Oberon	0.001
4.	Fenpropathrin 30 EC	Danitol	0.05
5.	Fipronil 5 SC	Regent	0.01
6.	Acetamprid 20 SP	Assail	0.004
7.	Dimethoate 30 EC	Rogor	0.03
8.	Control	-	-

The observations on the jassid and whitefly population were recorded as discussed *Vide Supra* 3.1.7, one day before application (pre-treatment population) and one, three, seven and fifteen days after application of insecticides. The second spray was done after rebuild up of pest population and again the observations were recorded at one day before and one, three, seven and fifteen days after the application of treatments. The yield data were recorded after harvest of the crop and was computed per hectare.

The observations on survival of jassid and whitefly after each insecticidal treatments at definite time interval were recorded. The data obtained one day before and 1, 3, 7 and 15 days after the application of insecticides were taken into consideration to find out percent reduction in jassid and whitefly population which was done by applying a correction factor given by Henderson and Tilton (1955) [16] referring it to be a modification of Abbott's formula (1925) [1].

$$\text{Percentage reduction} = 100\left[1 - \frac{T_a \times C_b}{T_b \times C_a}\right]$$

Where, Ta = Number of insects on treated plant after treatment, Tb = Number of insects on treated plant before treatment

C_a = Number of insects on untreated plat after treatment, C_b = Number of insects on untreated plant before treatment

The economies of various treatments were also worked out by computing the cost of insecticides as well as their cost of application. The gross income was worked out by multiplying the yield with the wholesale rate of green gram prevailing in the market at the time of threshing.

Results

Table 2: Efficacy of different insecticides against jassid, *Empoasca motti* on green gram

S. No.	Treatment	Conc.	Mean percent reduction days after							
			First spray				Second spray			
			One	Three	Seven	Fifteen	One	Three	Seven	Fifteen
1	Imidacloprid 17.8 SL	0.005	74.20	93.46	89.20	71.25	76.80	84.34	81.17	74.30
			(59.47)	(75.18)	(70.81)	(57.58)	(61.21)	(66.69)	(64.28)	(59.54)
2	Thiamethoxam 25 WG	0.005	66.25	84.18	81.42	69.14	69.14	78.58	72.30	64.37
			(54.48)	(66.56)	(64.46)	(56.25)	(56.25)	(62.43)	(58.24)	(53.35)
3	Spiromesifen 22.9 SC	0.001	58.36	71.46	70.24	56.40	59.75	66.14	65.16	58.28
			(49.81)	(57.70)	(56.93)	(48.68)	(50.62)	(54.42)	(53.82)	(49.76)
4	Fenpropathrin 30 EC	0.05	61.30	76.20	72.40	59.54	63.32	71.25	67.42	60.48
			(51.53)	(60.80)	(58.30)	(50.50)	(52.73)	(57.58)	(55.19)	(51.05)
5	Fipronil 5 SC	0.01	68.47	86.16	88.14	70.96	74.80	83.42	80.44	73.24
			(55.84)	(68.15)	(69.85)	(57.39)	(59.87)	(65.97)	(63.75)	(58.84)
6	Acetamiprid 20 SP	0.004	76.40	95.80	90.25	72.40	78.40	86.58	82.25	75.46
			(60.94)	(78.17)	(71.81)	(58.31)	(62.31)	(68.51)	(65.08)	(60.31)
7	Dimethoate 30 EC	0.03	65.52	83.20	80.12	65.26	67.36	74.20	70.86	62.18
			(54.04)	(65.80)	(63.52)	(53.88)	(55.15)	(59.47)	(57.32)	(52.04)
8	Control	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	SEm±		1.14	1.26	0.89	1.12	1.27	1.05	0.94	0.75
	CD (p=0.05)		3.46	3.83	2.71	3.39	3.84	3.17	2.85	2.26

Figures in the parentheses are angular transformation values

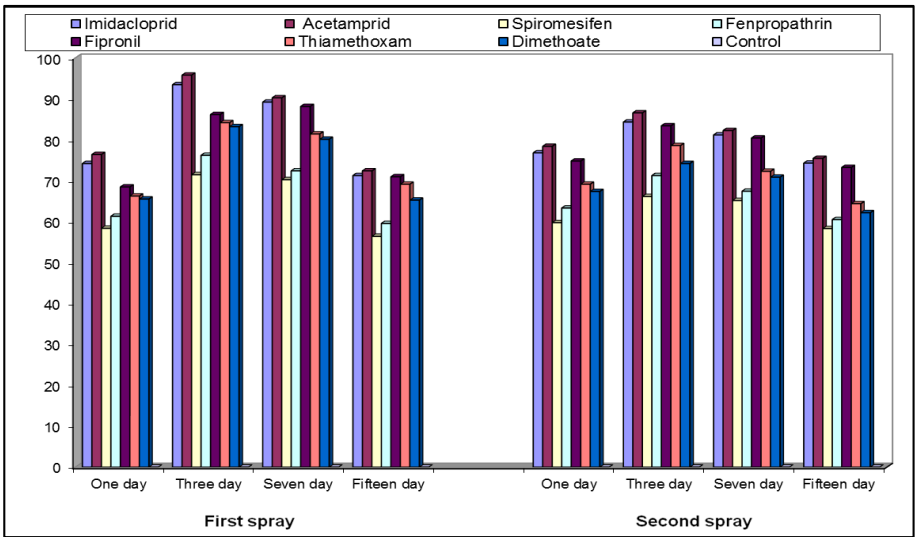

Fig 1: Efficacy of different insecticides against jassid, *Empoasca motti* on green gram

Jassid, *Empoasca motti* Pruthi - The overall order of effectiveness of insecticides in first spray against jassid was found to be acetamiprid 0.004 percent > imidacloprid 0.005 percent > fipronil 0.01 percent > thiamethoxam 0.005 percent > dimethoate 0.03 percent > fenpropathrin 0.05 percent > spiromesifen 0.001 percent as shown in (Table 2 and Fig. 1).

The overall order of effectiveness of insecticides in second spray against jassid was found to be acetamiprid 0.004 percent> imidacloprid 0.005 percent> fipronil 0.01 percent> thiamethoxam 0.005 percent> dimethoate 0.03 percent> fenpropathrin 0.05 percent> spiromesifen 0.001 percent (Table 2 and Fig. 1).

Table 3: Efficacy of different insecticides against whitefly, *Bemisia tabaci* on green gram

S. No.	Treatments	Conc.	Mean percent reduction days after							
			First sparay				second spray			
			One	Three	Seven	Fifteen	One	Three	Seven	Fifteen
1	Imidacloprid17.8 SL	0.005	89.40	91.85	81.18	68.12	78.80	84.40	82.45	72.40
			(70.99)	(73.41)	(64.28)	(55.62)	(62.58)	(66.74)	(65.23)	(58.30)
2	Thiamethoxam 25 WG	0.005	86.18	85.32	72.80	63.45	72.24	78.45	75.80	68.15
			(68.17)	(67.47)	(58.56)	(52.80)	(58.20)	(62.34)	(60.53)	(55.64)
3	Spiromesifen 22.9 SC	0.001	61.35	73.16	62.18	54.44	59.20	67.20	63.12	63.20
			(51.56)	(58.79)	(52.04)	(47.55)	(50.30)	(55.06)	(52.61)	(52.56)
4	Fenpropathrin 30 EC	0.05	62.80	75.40	60.38	51.18	62.75	72.58	66.27	65.50
			(52.42)	(60.24)	(50.99)	(45.68)	(52.39)	(58.42)	(54.49)	(54.02)
5	Fipronil 5 SC	0.01	88.20	90.24	79.16	66.40	73.20	85.10	81.15	74.58
			(69.90)	(71.79)	(62.83)	(54.57)	(58.82)	(67.29)	(64.26)	(59.72)
6	Acetamiprid 20 SP	0.004	90.24	93.20	82.34	69.80	77.34	86.70	84.20	73.84
			(71.80)	(74.88)	(65.15)	(56.66)	(61.53)	(68.61)	(66.58)	(59.23)
7	Dimethoate 30 EC	0.03	80.23	83.14	71.40	61.14	70.16	76.28	73.16	68.62
			(63.60)	(65.75)	(57.67)	(51.44)	(56.88)	(60.85)	(58.79)	(55.93)
8	Control	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	SEm+		1.07	1.28	0.93	1.14	1.20	1.12	0.97	0.95
	CD (p=0.05)		3.26	3.87	2.81	3.46	3.65	3.40	2.93	2.87

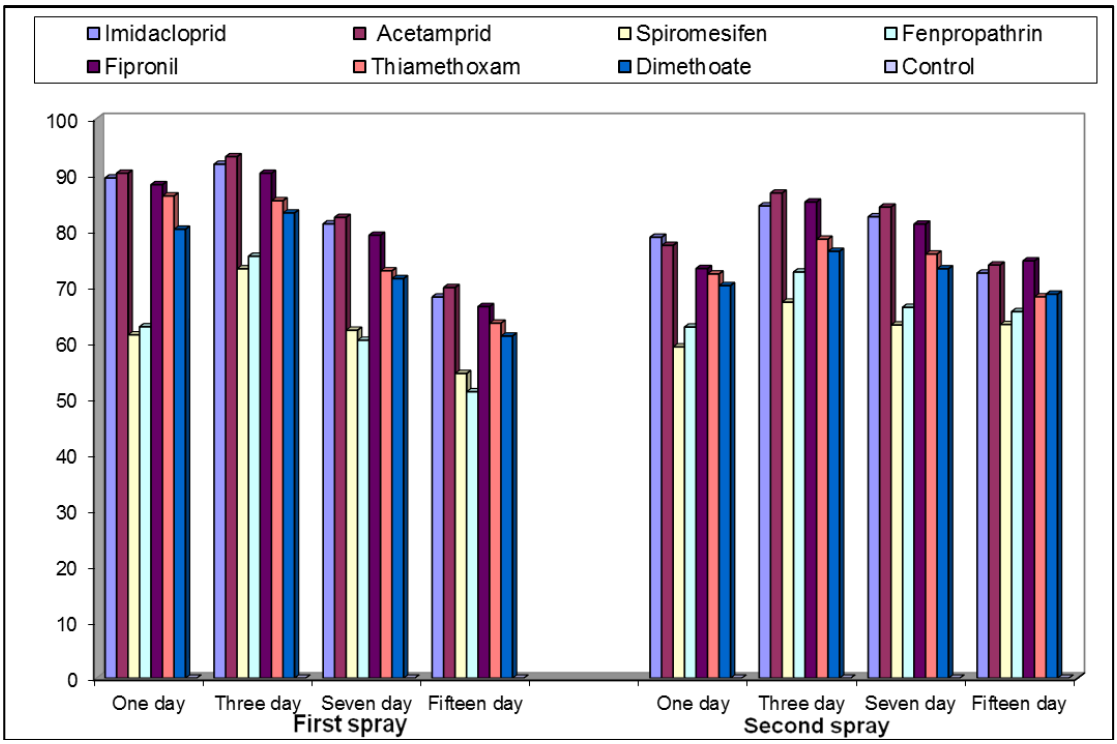

Fig 2: Efficacy of different insecticides against whitefly, *Bemisia tabaci* on green gram

First spray: The overall order of effectiveness of insecticides in first spray against whitefly was found to be acetamiprid 0.004 percent> imidacloprid 0.005 percent> fipronil 0.01 percent> thiamethxam 0.005 percent> dimethoate 0.03 percent> fenpropathrin 0.05 percent> spiromesifen 0.001 percent.

Second spray: The overall order of effectiveness of insecticides in second spray of against whitefly was found to be imidacloprid 0.005 percent> acetamiprid 0.004 percent> fipronil 0.01 percent> thiamethoxam 0.005 percent> dimethoate 0.03 percent> fenpropathrin 0.05 percent> spiromesifen 0.001 percent.

Discussion

In order to evaluate the effectiveness of any insecticides for the control of insect pests on a specific crop different criteria could be used. In the present investigation the following criteria were taken into consideration for evaluation of insecticides against insect pests of green gram.

1. Effect of insecticides application on the percent reduction of insect pests.
2. Effect of insecticides application on the seed yield of green gram.
3. economics of insecticides

Jassid (*Empoasca motti*): The treatment of acetamiprid (0.004%), imidacloprid (0.005%) and fipronil (0.01%) were found to be the most effective in reducing the jassid population. Khedkar and Ukey (2003) [15] and Afzal *et al.* (2014) [3] found acetamiprid as best insecticide against jassid corroborates the present investigation. The present do corroborates with the finding of Afzal *et al.* (2014) [3] and Ahirwar *et al.* (2015) [5] who reported that thiamethoxam and acetamiprid were most effective insecticides against jassid. Jamshaid *et al*. (2013) [10], who reported that imidacloprid (0.005%) was the most effective insecticide for the control of jassid. The findings are in agreement with that of *Sathyan et al.*, (2016) [18] who reported that fipronil as best insecticide against jassid.

The effectiveness of imidacloprid (0.005%) and thiamethoxam (0.025%) against jassids, *E. motti* was reported by Brar *et al.* (1999) [6], Afzal *et al.* (2002) [4] and Ganapathy and Karuppiah (2004) [8]. The effectiveness of dimethoate (0.03%) and imidacloprid (0.005%). These results are in agreement with that of Ahirwar *et al.* (2015) [5] who reported that dimethoate @ 300 ml was effective in controlling jassids. The treatment of fenpropathrin (0.05%), spiromesifen (0.001%), were found least effective group of insecticides. These results are in partial conformity with Pachundkar *et al*., (2013) [17].

Whitefly (*Bemisia tabaci*): The treatment of acetamiprid (0.004%) followed by imidacloprid (0.005%) and fipronil (0.01%) were found to be the most effective in controlling the whitefly, *B. tabaci* which corroborates with the findings of Ahirwar *et al.* (2015) [5] reported that acetamiprid and imidacloprid were most effective against whitefly, Sathyan *et al*. (2016) [18] observed that fipronil (0.01%) was most effective for the control of whitefly. Likewise, the moderatly effectiveness of thiamethoxam (0.025%) against whitefly was reported by Ahirwar *et al.* (2015) [5] was also found that dimethoate (0.03%) also show the moderate effect against whitefly and that only significantly reduced season number of *B. tabaci*, also reported by Afzal *et al.* (2014) [3]. The treatment of fenpropathrin and spiromesifen were found least effective group of insecticides. These results are in partial agreement with Pachundkar *et al.*, (2013) [17].

Conclusion

The different insecticides tested against jassid and whitefly on green gram, acetamiprid 0.004 percent followed by imidacloprid 0.005 percent, fipronil 0.01 percent and thiamethoxam 0.025 percent were proved most effective, while thiamethoxam 0.005 percent and dimethoate 0.03 percent were stood in middle order of efficacy. The treatments of spiromesifen 0.001 percent was proved least effective followed by fenpropathrin 0.05 percent against jassid and whitefly. The maximum seed yield of 5.80 q ha^{-1} was obtained in acetamiprid 0.004 percent, followed by imidacloprid 0.005 percent, fipronil 0.01 percent and thiamethoxam 0.005 percent which resulted in 5.75, 5.40 and 5.25 q grain yield ha^{-1}, respectively. The other treatments were also significantly superior over control 4.00q ha^{-1}, however spiromesifen 0.001 percent gave lowest yield 4.60 q ha^{-1}.

The 'avoidable losses' in yield of green gram due to the jassid and whitefly was maximum (4.00 q ha^{-1}) in untreated plot followed by spiromesifen 0.001 and fenpropathrin 0.05. the total avoidable loss from the plot treated with acetamiprid 0.004 was taken as zero. The percent increase in yield over untreated check was maximum (45%) in acetamiprid followed by imidacloprid (43.75%) and fipronil (35%) whereas, it was minimum (15%) in plant treated with spiromesifen followed by fenpropathrin (20%). The highest benefit cost ratio (3.78) was obtained from the plot treated with dimethoate followed by acetamiprid (2.53) and fipronil (2.38). These treatment were proved to be most economic. The lowest benfit cost ratio was computed in the plot treated with imidacloprid (1.96) and thiamethoxam (2.06).

Eight insectides were evaluated against jassid and whitefly. Two spray of each treatment *viz*. acetamiprid (0.004%) and imidacloprid (0.005%) were found highly effective in crop protection, whereas spiromesifen (0.001%) was least effective against jassid and whitefly. The highest benefit cost ratio of 3.78 was obtained from dimethoate treated plots while it was minimum 1.96 in imidacloprid

Acknowledgement

The authors are thankful to the Dean, S.K.N. College of Agriculture, Jobner for providing necessary facilities and permission to conduct the study.

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