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Efficacy of insecticides against sucking pests of Indian bean, *Lablab purpureus* (Linn.)

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Abstract
A field experiment was conducted at Horticulture farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during *kharif* season 2013. The experiment consisted 6 insecticides Thiamethoxam (0.025%), Imidacloprid (0.005%), Malathion (0.05%), Fipronil (0.01%), Acetamiprid (0.004%), Dimethoate (0.03%) against aphid, jassid and whitefly population. The result revealed that out of six insecticides found relative efficacy of imidacloprid (0.005%) was most effective. The treatment of malathion (0.05%) proved least effective. The fruit yield showed that imidacloprid treated plants yielded maximum and it was followed by malathion. The benefit cost ratio was highest in imidacloprid and lowest in thiamethoxam the treatment of imidacloprid reduced First spray the aphid population by 76.02 per cent followed by dimethoate (73.35%). Second spray, the treatment of imidacloprid (77.64%) gave highest reduction in aphid population followed by dimethoate (71.53%) but was comparable to each other. The efficacy of pesticides in ascending order was: malathion, fipronil, thiamethoxam, acetamiprid, dimethoate and Imidacloprid. Against jassid, first spray the treatments of imidacloprid reduced the population by 72.72 per cent and proved most effective, however, remained superior to rest of the treatment. It was followed by dimethoate (70.03%) and second spray the treatment of imidacloprid (74.30%) resulted in highest reduction in jassid population followed by dimethoate (68.37%) and did not differ to each other, The ascending order of efficacy was: fipronil, malathion, thiamethoxam, acetamiprid, dimethoate and imidacloprid. Against whitefly, first spray the treatment of imidacloprid proved most effective with 71.79 per cent reduction followed by dimethoate (66.94%), second spray The treatments of imidacloprid (73.35%) gave highest reduction and proved most effective followed by dimethoate (65.28%) but remained statistically at par with each other. The efficacy of pesticides in ascending order was: malathion, fipronil, thiamethoxam, acetamiprid, dimethoate and imidacloprid.

Keywords: Lablab, aphid, jassid, whitefly, imidacloprid, malathion, thiamethoxam, fipronil, acetamiprid, dimethoate

Introduction
Indian bean, *Lablab purpureus* (Linn.) Sweet commonly known as hyacinth bean, Egyptian bean, dolichos bean or *sem* (Family: Fabaceae) is one of the most ancient crops among cultivated plants Bose *et al.*, 1993 [5]. It is presently grown throughout the tropical regions in Asia and Africa. It is a perennial herbaceous plant, occupies an important place among the fruit vegetable crops grown in the field as well as in kitchen gardens.

In India, *L. purpureus* as a field crop is mostly confined to the peninsular region and cultivated to a large extent in Karnataka and adjoining districts of Tamil Nadu, Andhra Pradesh and Maharashtra. Karnataka contributes a major share, accounting for nearly 90 per cent in terms of both area and production in the country Anonymous, 2012-13 [2]. Insect pests are major constraints in reducing the productivity of Indian bean. The crop is attacked by a number of insect pests *viz.*, aphid, *Aphis craccivora* Koch.; jassids, *Empoasca fabae* (Harris)*; E. krameri* Ross & Moore and *E. kerri* Pruthi; pod borer, *Etiella zinckenella* (Treit.); white fly, *Bemisia tabaci* (Genn.); stem fly, *Ophiomyia phaseoli* (Tryon); hairy caterpillars, *Ascotis imparta* (WaIk.); bihar hairy caterpillar, *Spilosoma obliqua* (Walk.) etc. David and Kumarswami, 1982 [7]. Among these, aphids, jassids and white flies have been reported as one of the major sucking pests infesting Indian bean. Both the nymphs and adults cause damage by sucking the cell sap from the tender portions of plant and also from lower portion of the leaves. In case of severe infestation, these pests attack all parts of the plants including pods which result in stunted growth and decreased yield. Ram and Gupta, 1992 [14]. The honey dew secretion of the aphids provides a suitable media for the development of sooty mould and fungi which ultimately hamper the process of photosynthesis David and Kumarswami, 1982 [7].

The chemical control of aphids, jassids and white flies have been recommended by many workers on different beans to suppress its population effectively Garhwal *et al.*, 1994 [11];

Dhamaniya *et al.*, 2005 [9] and Yadav *et al.*, 2011 [18] but due to continuous and enormous use of same or similar group of pesticides caused problems of resistance, deleterious effect on parasites and predators, residue hazards to men, domestic animals and environment pollution, as such there was a renewed interest in the use of newer molecules of insecticides. The efficacy of newer molecules of insecticides against sucking pests of *L. purpureus*.

Material and Methods. The present investigation was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Rajasthan) on Indian bean crop under field conditions during *Kharif* season 2013. The experiment was laid out in simple Randomized Block Design (RBD) with seven treatments including untreated control, each replicated thrice. The variety, dolichus selection was sown in the third week of July, 2013 in plots of 1.8 X 1.2 m^2 sizes keeping row to row and plant to plant distance of 60 cm and 30 cm, respectively. The different insecticides (name of inceticides, thiamethoxam 25 WG (0.025%), imidacloprid 17.8 SL (0.005%), malathion 50 EC (0.05%), fipronil 5 SC (0.01%), acetamiprid 20 SP (0.004) and dimethoate 30 EC (0.03%) were evaluated against sucking pests of Indian bean under field conditions) were used and different concentrations**.**
All the insecticides were applied as a foliar spray in evening hours on the crop using pre- calibrated knapsack sprayer when the pest population was sufficiently build up. The first spray was made on 20th September, 2013 and second spray was repeated after 15 days of the first. An untreated check was also maintained for comparison.

Method of Observations. the incidence of major sucking pests was recorded from appearance of pests till harvest of the crop. Observations on population of sucking pests were recorded on three leaves one each from top, middle and bottom canopy of the five plants selected randomly in each replications in early hours (before 8.00 AM) at weekly intervals. The details regarding population counts of each pest has been described below: aphid, *Aphis craccivora* Koch Aphid population was counted on the shoot of each of the five tagged plants in each plot. When the aphid population appeared, the observations were recorded early in the morning by visual counting method.

Jassid, *Empoasea fabae* (Ishida)
The population of jassids was recorded by counting both nymphs and adults as per method described by Rawat and Sahu (1973). In the initial stage of the crop, counting of jassids was done on whole plant and in later stage, on three leaves *i.e.* top, middle and bottom of each tagged plant.

Whitefly, *Bemisia tabaci* (Genn.)
the population of whitefly was counted visually on whole plant in the initial stage and in later stage, on three leaves from upper, middle and lower portion of each tagged plant. For counting the whitefly population, the leaf was held at the petiole by thumb and fore fingers and twisted until the entire under side of leaf became clearly visible (Butter and Vir, 1990). The insecticidal solution was prepared according to the following formula.

$$C_1V_1 = C_2V_2$$

Where,
C_1 = Concentration of given formulation (%)
V_1 = Volume/amount of formulation required (ml or g)
C_2 = Concentration of spray fluid required (%)
V_2 = Volume/amount of spray fluid required (500 lit.)

Interpretation of data
The data obtained just before treatment and one, three, seven, 10 and 15 days after the spray were taken into consideration to find out the per cent mortality in pest population using the formula suggested by Henderson and Tilton 1955.

$$\text{Per cent reduction in pest population} = \left(1- \frac{Ta \times Cb}{Tb \times Ca}\right) \times 100$$

Where,
T_a = Population in treated plots after treatment
T_b = Population in treated plots before treatment
C_a = Population in untreated plots after treatment
C_b = Population in untreated plots before treatment

The data were then statistically analyzed. The analysis was carried out by transforming the percentage reduction in pest population data into angular transformation value (Bliss, 1937) [4].
The avoidable loss and increase in yield over control were calculated for each treatment by the following formula given by Pradhan, 1964 [13]:

$$\text{Avoidable loss (\%)} = \frac{\text{Highest yield in treated plot} - \text{Yield in the treatment}}{\text{Highest yield in treated plot}} \times 100$$

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

To determine the most effective and economical treatment, the net profit and benefit-cost ratio were worked out by taking the expenditure on the individual insecticidal treatment and the corresponding yield into account.

Results
The relative efficacy of six insecticides, namely, thiamethoxam (0.025%), imidacloprid (0.005%), malathion (0.05%), fipronil (0.01%), acetamiprid (0.004) and dimethoate (0.03%) were evaluated against sucking pests of Indian bean under field conditions. Two sprays were made with recommended concentrations the first when the sucking pest's population was sufficiently buildup whereas the second spray was applied after 15 days of the first.

Efficacy of insecticides against Aphid, *Aphis craccivora* infesting Indian bean (Table: 1)
First spray
The mean data indicated that the treatment of imidacloprid reduced the aphid population by 76.02 per cent followed by dimethoate (73.35%) however, remained superior to rest of the treatments with non-significant difference between them. The next group in order of efficacy comprised of acetamiprid (70.16%) and thiamethoxam (65.97%) and stood at par with each other. The malathion (57.58%) was found in lowest order of efficacy with respect to reduction in aphid population followed by fipronil (62.32%) but had a non significant difference. The efficacy of pesticides in ascending order was: malathion, fipronil, thiamethoxam, acetamiprid, dimethoate and Imidacloprid.

Second spray

The treatment of imidacloprid (77.64%) gave highest reduction in aphid population followed by dimethoate (71.53%) but was comparable to each other. The least effective treatment was malathion (58.93%) followed by fipronil (60.63%) and thiamethoxam (64.05%) and existed a non significant difference among them. The ascending order of efficacy was: malathion, fipronil, thiamethoxam, acetamiprid, dimethoate and Imidacloprid.

Efficacy of insecticides against jassid, *Empoasea fabae* infesting Indian bean (Table: 2)

First spray

The mean data revealed that the treatments of imidacloprid reduced the population by 72.72 per cent and proved most effective, however, remained superior to rest of the treatment. It was followed by dimethoate (70.03%) however, existed a non-significant difference between them. The malathion (56.02%) was found in lowest order of efficacy followed by fipronil (59.09%) and thiamethoxam (62.21%) but had non significant difference among them. The efficacy of pesticides in ascending order was Malathion, fipronil, thiamethoxam, acetamiprid, dimethoate and Imidacloprid.

Second spray

The treatment of imidacloprid (74.30%) resulted in highest reduction in jassid population followed by dimethoate (68.37%) and did not differ to each other. The least effective treatment was fipronil (56.98%) followed by malathion (57.69%) and thiamethoxam (61.27%) and existed a non significant difference among them. The ascending order of efficacy was: fipronil, malathion, thiamethoxam, acetamiprid, dimethoate and imidacloprid.

Efficacy of insecticides against whitefly, *Bemisia tabaci* infesting Indian bean (Table: 3)

First spray

The mean data revealed that the treatment of imidacloprid proved most effective with 71.79 per cent reduction followed by dimethoate (66.94%) with non-significant difference. The malathion (52.89%) was found in lowest order of efficacy followed by fipronil (55.46%) and thiamethoxam (58.04%) and did not differ. The efficacy of pesticides in ascending order was: malathion, fipronil, thiamethoxam, acetamiprid, dimethoate and imidacloprid**.**

Second spray

The treatments of imidacloprid (73.35%) gave highest reduction and proved most effective followed by dimethoate (65.28%) but remained statistically at par with each other. The least effective treatment was malathion (52.73%) but had a non-significant difference with fipronil (53.76%) and thiamethoxam (56.24%). The ascending order of efficacy was: malathion, fipronil, thiamethoxam, dimethoate, acetamiprid and imidacloprid.

Pod yield and economics of the insecticides (Table: 4)

The maximum increase in yield over untreated check was recorded in imid acloprid treatment (20.96 q ha^{-1}) as revealed in (Table 4.12 and Fig. 4.11) whereas; it was minimum in the malathion (7.81 q ha^{-1}). The gross return was found to be maximum in imidacloprid (Rs. 31440.00 ha^{-1}) followed by dimethoate (Rs. 27165.00 ha^{-1}). the expenditure incurred in maintaining the various treatments ranged from Rs. 1088.80 to 7360.00 ha^{-1}. The expenditure involved the prices of insecticides and labour cost prevailed in the market and has been annexed.

The maximum net return of Rs. 30351.20 ha^{-1} was obtained from the treatment of imidacloprid followed by dimethoate (Rs. 26021.00 ha^{-1}). The minimum net return, Rs. 10619.00 ha^{-1} was obtained with malathion treatment however, the benefit cost ratio was maximum (27.88) with imidacloprid treatment. A minimum benefit cost ratio of (1.67) was obtained from thiamethoxam treatment.

Discussion and conclusion

On the basis of first and second sprays overall efficacy of pesticidal treatments at one, three, seven, 10 and 15 days after each spray against aphid, jassid and whitefly revealed imidacloprid (0.005%) as most effective treatment followed by dimethoate (0.03%) in reducing the population. The treatment of acetamiprid (0.004%) and thiamethoxam (0.025%) existed in the middle order of efficacy. The treatment of malathion (0.05%) proved least effective followed by fipronil (0.01%). The present results are more or less in line with the findings of Decri and Hadi 2000. who reported Cypermethrin, dimethoate and monocrotophos @ 0.05% effective against *A. craccivora* infesting cowpea, while malathion remained least effective. Afzal *et al.* 2002 [1] evaluated efficacy of four insecticides against whitefly, *B. tabaci* on mung bean and found that imidacloprid 25 WP at 200 g/acre was found to be most effective support the present observations. Likewise, Dhamaniya *et al.* 2005 [9] reported that monocrotophos, phosphamidon and dimethoate stood at par with each other in providing the highest control of *Empoasca mottii* and *B. tabaci* infesting *Vigna aconitifolia* support the present findings. Singh *et al.* 2010 [17] studied the bio-efficacy of some insecticides and plant products during *kharif* 2005 against jassid, whitefly and thrips on mothbean crop and revealed that dimethoate 30 EC (0.03%) proved to be the most effective followed by imidacloprid 17.8 SL (0.005%) and thiamethoxam 25 WG (0.025%). As far as efficacy against whitefly was concerned imidacloprid 17.8 SL (0.005%) stood next to thiamethoxam 25 WG (0.025%) support the present findings. Similarly, Yadav *et al.* 2011 [18] also reported that dimethoate, imidacloprid and thiamethoxam treatments were the most effective in reducing the sucking insect pest's *i.e. E. motti*, *B. tabaci* and *A. craccivora* of cluster bean fully support the present obsevations.

Table 1: Efficacy of insecticides against *Aphis craccivora* infesting Indian bean

S. No.	Insecticides	Conc. (%)	Mean per cent reduction in population days after First spray						Mean per cent reduction in population days after Second spray					
			One day	Three	Seven	10	15	Mean	One day	Three	Seven	10	15	Mean
1.	Thiamethoxam 25 WG	0.025	61.87	70.13	81.25	60.15	56.46	65.97	58.94	69.10	78.67	58.27	50.15	64.05
			(51.87)*	(56.87)	(64.34)	(50.85)	(48.71)	(54.31)	(50.14)*	(56.22)	(62.49)	(49.76)	(45.08)	(53.15)
2.	Imidacloprid 17.8 SL	0.005	70.23	81.83	92.37	70.46	65.32	76.02	71.21	83.10	95.00	72.33	66.54	77.64
			(56.93)	(64.77)	(73.96)	(57.07)	(53.92)	(60.68)	(57.55)	(65.72)	(77.07)	(58.26)	(54.65)	(61.77)
3.	Malathion 50 EC	0.05	52.25	61.76	72.00	53.20	48.67	57.58	53.15	63.00	73.44	54.76	50.30	58.93
			(46.28)	(51.80)	(58.02)	(48.83)	(44.23)	(49.36)	(46.80)	(52.53)	(58.98)	(47.73)	(45.17)	(50.14)

4.	Fipronil 5 SC	0.01	57.94	67.20	76.33	56.81	53.33	62.32	56.10	65.91	75.20	54.25	51.68	60.63
			(49.57)	(55.06)	(60.89)	(48.91)	(46.90)	(52.13)	(48.50)	(54.28)	(60.13)	(47.43)	(45.96)	(51.14)
5.	Acetamiprid 20 SP	0.004	65.59	75.94	85.32	64.07	59.87	70.16	66.00	75.21	85.67	64.94	60.45	70.52
			(54.08)	(60.62)	(67.47)	(53.17)	(50.69)	(56.89)	(54.33)	(60.16.)	(67.75)	(53.69)	(51.03)	(57.11)
6.	Dimethoate 30 EC	0.03	68.20	79.67	88.60	67.33	62.94	73.35	66.33	77.20	87.33	66.00	61.10	71.53
			(55.67)	(62.92)	(70.27)	(55.13)	(52.49)	(58.92)	(54.53)	(61.48)	(69.14)	(54.33)	(51.41)	(57.49)
	S.E.m±		0.42	0.61	1.26	0.66	0.64	0.93	1.04	1.42	1.48	1.38	1.12	1.45
	CD at 5%		1.30	1.90	3.85	2.04	1.93	2.82	3.12	4.30	4.50	4.17	3.37	4.38

* Figures in parentheses are angular transformed value

Table 2: Efficacy of insecticides against *Empoasea fabae* infesting Indian bean

S. No.	Insecticides	Conc. (%)	Mean per cent reduction in population days after First spray						Mean per cent reduction in population days after Second spray					
			One day	Three	Seven	10	15	Mean	One day	Three	Seven	10	15	Mean
1.	Thiamethoxam 25 WG	0.025	55.50	67.12	78.65	58.00	51.80	62.21	54.10	65.74	76.70	59.94	49.87	61.27
			(48.15)*	(55.01)	(62.48)	(49.60)	(46.03)	(52.07)	(47.35)*	(54.17)	(61.13)	(48.99)	(44.92)	(51.51)
2.	Imidacloprid 17.8 SL	0.005	67.25	80.00	90.60	65.75	60.00	72.72	68.00	81.33	92.10	67.75	62.33	74.30
			(55.09)	(63.43)	(72.14)	(54.18)	(50.77)	(58.51)	(55.55)	(64.40)	(73.67)	(50.40)	(52.13)	(59.54)
3.	Malathion 50 EC	0.05	50.77	59.10	70.00	52.25	48.00	56.02	52.95	60.00	72.21	53.00	50.31	57.69
			(45.44)	(50.24)	(56.79)	(46.29)	(43.85)	(48.46)	(46.69)	(50.77)	(58.19)	(46.71)	(54.18)	(49.42)
4.	Fipronil 5 SC	0.01	52.64	64.15	74.93	53.60	50.15	59.09	50.00	62.94	71.67	51.44	48.89	56.98
			(46.51)	(53.21)	(59.95)	(47.06)	(45.08)	(50.24)	(45.00)	(52.50)	(57.84)	(45.82)	(44.36)	(49.01)
5.	Acetamiprid 20 SP	0.004	60.00	73.90	82.40	60.15	54.79	66.25	63.00	73.75	83.25	61.47	55.67	67.72
			(50.77)	(59.28)	(65.19)	(50.85)	(47.74)	(54.48)	(52.53)	(58.79)	(65.84)	(51.63)	(48.25)	(55.38)
6.	Dimethoate 30 EC	0.03	64.67	74.10	87.00	64.94	59.45	70.03	63.25	74.94	85.00	62.10	58.00	68.37
			(53.54)	(59.40)	(68.86)	(53.69)	(50.44)	(57.19)	(52.68)	(59.96)	(67.21)	(52.00)	(49.60)	(55.78)
	S.E.m±		1.24	1.36	1.48	1.08	1.01	1.25	0.96	1.54	1.91	1.15	1.03	1.30
	CD at 5%		3.75	4.08	4.50	3.27	3.01	3.83	2.92	4.66	5.80	3.47	3.12	3.95

* Figures in parentheses are angular transformed values

Table 3: Efficacy of insecticides against *Bemisia tabaci* infesting Indian bean

S. No.	Insecticides	Conc. (%)	Mean per cent reduction in population days after First spray						Mean per cent reduction in population days after Second spray					
			One day	Three	Seven	10	15	Mean	One day	Three	Seven	10	15	Mean
1.	Thiamethoxam 25 WG	0.025	52.62	63.10	74.94	52.44	47.10	58.04	50.00	61.54	73.22	50.90	45.54	56.24
			(46.50)*	(52.59)	(59.96)	(46.50)	(43.33)	(49.63)	(45.00)*	(51.67)	(58.83)	(45.51)	(42.44)	(48.58)
2.	Imidacloprid 17.8 SL	0.005	62.10	78.67	87.00	69.10	62.10	71.79	64.54	79.00	89.33	70.89	63.00	73.35
			(52.00)	(62.49)	(68.86)	(56.22)	(52.00)	(57.92)	(53.45)	(62.72)	(70.93)	(57.34)	(52.53)	(58.92)
3.	Malathion 50 EC	0.05	45.75	57.94	68.54	49.00	43.25	52.89	46.00	59.10	69.75	47.80	41.00	52.73
			(42.56)	(49.57)	(55.88)	(44.42)	(41.06)	(46.66)	(42.70)	(50.24)	(56.63)	(43.73)	(39.81)	(46.56)
4.	Fipronil 5 SC	0.01	48.67	60.81	71.00	50.87	45.94	55.46	46.96	59.15	70.00	48.92	43.79	53.76
			(44.23)	(51.24)	(57.62)	(45.50)	(42.67)	(48.13)	(43.25)	(50.27)	(56.79)	(44.38)	(41.43)	(47.16)
5.	Acetamiprid 20 SP	0.004	57.00	68.41	80.10	57.90	50.33	62.75	58.25	70.20	83.10	58.67	51.44	64.34
			(49.02)	(55.80)	(63.50)	(49.54)	(45.19)	(52.39)	(49.74)	(56.91)	(65.72)	(49.99)	(30.95)	(53.33)
6.	Dimethoate 30 EC	0.03	60.25	72.33	85.49	61.67	54.94	66.94	58.90	71.00	83.33	60.15	53.25	65.28
			(50.91)	(58.26)	(67.57)	(51.74)	(47.83)	(54.90)	(50.12)	(57.41)	(65.90)	(50.85)	(46.86)	(53.89)
	S.E.m±		0.92	1.45	1.54	1.50	1.43	1.47	1.15	1.78	1.80	1.62	1.41	1.72
	CD at 5%		2.78	4.36	4.65	4.53	4.27	4.42	3.45	5.39	5.42	4.88	4.28	5.18

* Figures in parentheses are angular transformed values

Table 4: Net return and benefit: cost ratio of different insecticides against sucking pests infesting Indian bean

S. No.	Treatments	Yield (q ha^{-1})	Increase in yield (q ha^{-1})	Gross return (Rs ha^{-1})	Expenditure (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
1.	Thiamethoxam 25 WG	68.37	13.08	19620.00	7360.00	12260.00	1.67
2.	Imidacloprid 17.8 SL	76.25	20.96	31440.00	1088.80	30351.20	27.88
3.	Malathion 50 EC	63.10	7.81	11715.00	1096.00	10619.00	9.69
4.	Fipronil 5 SC	65.72	10.43	15645.00	4000.00	11645.00	2.91
5.	Acetamiprid 20 SP	71.80	16.51	24765.00	1216.00	23549.00	19.36
6.	Dimethoate 30 EC	73.40	18.11	27165.00	1144.00	26021.00	22.74
7.	Untreated check	55.29	_	_	_	_	_

Fruit rate Rs. @ 15 Rs./kg

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