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Bio-efficacy of different biopesticides against aphid, *Aphis craccivora* Koch in Indian bean

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Abstract
A field experiment was conducted at Entomology farm, Department of Agricultural Entomology, A. College of Agriculture, Anand Agriculture University, Anand during *rabi* 2021-22 to study the bio-efficacy of different biopesticides against aphid, *Aphis craccivora* Koch infesting Indian bean. Different ten treatments were evaluated. Indian bean (*Gujarat Papdi* -1) crop was grown. Among the evaluated biopesticides, Neem Seen Kernel Extract (NSKE) 5%, neem oil 0.5% and *Lecanicillium lecanii* 1% WP emerged out as the best biopesticidal treatments. Whereas, aqueous bidi tobacco dust extract, Garlic bulb extract (GBE) 5%, *B. bassiana* 1% WP were mediocre in their effectiveness against aphid population. The less effective treatments were Ginger rhizome extract (GRE) 5%, *aakdo*, *C. procera* 10% and cow urine 10%.

Keywords: Aphids, Indian bean, bio-efficacy, biopesticides

1. Introduction
Indian bean is an important legume crop with multiple benefits. Indian bean, *Lablab purpureus* (Linn.) Sweet is 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 [4]. It is mostly grown for its delicate pods, though it is also grown as a fodder or green manure crop (Morris, 1999) [7]. It is one of the most ancient among the cultivated legume species-possibly more than 3000 years old (Ayyangar and Nambiar, 1935) [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 [6]. Among the different pests infesting the *Dolichos* bean crop, aphid, *A. craccivora* is the most serious pest which is a cosmopolitan in warmer regions of the world. It is a very important polyphagous pest, feeding on over 80 plant families with preference for the family Fabaceae (Blackman and Eastop, 2007) [3]. Both nymphs and adults of *A. craccivora* damage bean crops from vegetative to fruiting stages and may cause yield loss up to cent per cent in different species of legumes (Attia *et al.*, 1986) [1]. Both nymphs and adults suck the cell sap from leaves, petioles, tender stems, inflorescences and tender pods. Constant sap loss causes impacted leaves to curl up and plants remain stunted. Crops that are severely infested wither and dry up. The enormous aphid population's constant feeding causes the tender pods to yellow, curl, and then dry up (York, 1992) [11]. Pest outbreaks, environmental degradation and health risks issues are arised from the indiscriminate use of pesticides, which leave residues in vegetables and leads to insect outbreaks, environmental damage, and health problems. Due to the significant output loss caused by insect pests, the negative consequences of insecticides, and the inability of small- scale farmers to afford expensive chemical pesticides, it is necessary to develop a sustainable method for managing insect pests. Now a days, botanicals have become promising to control pests by offering several advantages compared to chemical pesticides being a less residue problem. Therefore, the experiment was undertaken to check out effect of different biopesticides against Indian bean aphid.

2. Material and Methods
The field experiment was conducted under at Entomology farm, B. A. College of Agriculture, AAU, Anand during *rabi* 2021-22, for the evaluation of bio-efficacy of different biopesticides against aphid, *A. craccivora* in Indian bean, *Gujarat Papdi* -1 variety was grown in plot size of

3.6 x 6.0 m using Randomized Complete Block Design (RBD) with 3 replications by following all the recommended agronomical practices. Nine different biopesticides *viz.*, Neem oil 0.5%, Neem Seed Kernel Extract (NSKE) 5%, Ginger Rhizome Extract (GRE) 5%, *Aakdo*, *Calotropis procera* 10%, Garlic Bulb Extract (GBE) 5%, Cow urine 10%, Aqueous bidi tobacco dust extract 10%, *Beauveria bassiana* 1% WP, *Lecanicillium lecanii* 1% WP along with untreated check were evaluated. First spray of biopesticides was made at initiation of pest and second spray was given after 10 days. The population of aphid was recorded before first spray and 3,5,7 and 10 days after each spray. For the purpose, five plants were selected randomly and tagged from each net plot area. Number of aphids present on three randomly 10 cm twig per plant were recorded and mean number of aphids per twig was calculated. The data on aphid population was subjected to ANOVA after square root $\sqrt{X+0.5}$ transformation.

3. Result and Discussion

The data on bio-efficacy of different biopesticides against aphid population after 1st spray is mentioned in Table 1 indicated that before spray all the treatments had well distributed population of aphids and statistically at par with one another. Third day after spray, all the biopesticides treated plots had significantly lower aphid population than untreated check. From the biopesticidal treatments, NSKE 5% showed lowest aphid population (16.64/10 cm twig) and it remained at par with neem oil 0.5% (16.72/10 cm twig), *L. lecani* 1% WP (17.31/10 cm twig), garlic bulb extract (GBE) 5% (20.84/10 cm twig), aqueous bidi tobacco dust extract 2% (21.40/10 cm twig) and *B. bassiana* 1% WP (21.78/10 cm twig). While the highest (32.91/10 cm twig) aphid population was found from the plot treated with cow urine 10% followed by *aakdo*, *C. procera* 10% (31.42/10 cm twig) and remained at par with ginger rhizome extract GRE [(5%) (30.75/10 cm twig)]. Fifth day after spray, the biopesticidal treatment of NSKE 5% recorded the lowest (12.32/10 cm twig) aphid population and it was at par with the treatment of neem oil 0.5% (12.60/10 cm twig) and *L. lecanii* 1% (12.90/10 cm twig) followed by aqueous bidi tobacco dust extract 2% (19.12/10 cm twig) that remained at par with GBE 5% (19.48/10 cm twig) and *B. bassiana* 1% (19.75/10 cm twig). The maximum population of aphid was found in the plot treated with cow urine 10% (28.55/10 cm twig) and it was at par with the treatment of *aakdo* 10% (28.34 *aphids*/10 cm twig) followed by GRE 5% (27.06/10 cm twig). Seventh day after first spray, NSKE 5% (9.87/10 cm twig), neem oil 0.5% (10.39/10 cm twig) and *L. lecanii* 1% (10.79/10 cm twig) were found the most effective and at par with each other. Whereas, aqueous bidi tobacco dust extract 2% (17.48/10 cm twig), GBE 5% (17.99/10 cm twig) and *B. bassiana* 1% (18.86/10 cm twig) were mediocre in their effectiveness. The treatments of GRE 5% (26.96/10 cm twig), *aakdo* 10% (27.38/10 cm twig) and cow urine 10% (28.23/10 cm twig) were found less effective in reducing aphid population. At 10 DAS, the lowest population of aphid was noticed in the plot treated with NSKE 5% (15.10/10 cm twig), neem oil 0.5% (15.58/10 cm twig) and *L. lecanii* 1% (15.82/10 cm twig) followed by aqueous bidi tobacco dust extract 2% (23.51/10 cm twig) and GBE 5% (23.61/10 cm twig) that remained at par with *B. bassiana* 1% (24.10/10 cm twig) and found mediocre in their effectiveness. However, the maximum aphid population were observed in treatments of cow urine 10% (33.96/10 cm twig) and it remained at par with *aakdo* 10% (33.49/10 cm twig) and GRE 5% (33.14/10 cm twig). After first spray (Table 1), it was concluded that NSKE 5% recorded the lowest population (13.41/10 cm twig) and it was at par with neem oil 0.5% (13.79/10 cm twig) and *L. lecanii* 1% (14.09/10 cm twig). The least effective treatments were cow urine 10% (30.86/10 cm twig), *aakdo* 10% (30.08/10 cm twig) and GRE 5% (29.53/10 cm twig).

Table 1: Bio-efficacy of different biopesticides against aphid, *A. craccivora* in Indian bean (after first spray)

Tr. No.	Treatments	Before	No. of aphids/10 cm twig/plant at indicated days after spray				
			3	5	7	10	Pooled
T1	Neem oil 0.5%	5.18 (26.33)	4.15a (16.72)	3.62ab (12.60)	3.30a (10.39)	4.01ab (15.58)	3.78a (13.79)
T2	Neem seed kernel extract (NSKE) 5%	5.28 (27.38)	4.14a (16.64)	3.58a (12.32)	3.22a (9.87)	3.95a (15.10)	3.73a (13.41)
T3	Ginger rhizome extract (GRE) 5%	5.82 (33.37)	5.59bc (30.75)	5.25de (27.06)	5.24cd (26.96)	5.80de (33.14)	5.48c (29.53)
T4	*Aakdo*, *Calotropis procera* 10%	5.78 (32.91)	5.65c (31.42)	5.37ef (28.34)	5.28cd (27.38)	5.83de (33.49)	5.53c (30.08)
T5	Garlic bulb extract (GBE) 5%	5.34 (28.02)	4.62a (20.84)	4.47cd (19.48)	4.30b (17.99)	4.91bcd (23.61)	4.58b (20.48)
T6	Cow urine 10%	5.83 (33.49)	5.78cd (32.91)	5.39ef (28.55)	5.36de (28.23)	5.87ef (33.96)	5.60c (30.86)
T7	Aqueous bidi tobacco dust extract 2%	5.21 (26.64)	4.68a (21.40)	4.43bcd (19.12)	4.24b (17.48)	4.90bcd (23.51)	4.57b (20.38)
T8	*Beauveria bassiana* 1% WP	5.16 (26.13)	4.72ab (21.78)	4.50d (19.75)	4.40bc (18.86)	4.96cde (24.10)	4.65b (21.12)
T9	*Lecanicillium lecanii* 1% WP	5.17 (26.23)	4.22a (17.31)	3.66abc (12.90)	3.36a (10.79)	4.04abc (15.82)	3.82a (14.09)
T10	Untreated check	5.94 (34.78)	6.63d (43.46)	6.20f (37.94)	6.24e (38.44)	6.81f (45.88)	6.47d (41.36)
S.Em. ± Treatment (T)		0.33	0.27	0.25	0.27	0.28	0.14
Period (P)		-	-	-	-	-	0.09
T × P		-	-	-	-	-	0.28
F Test (T)		NS	Sig.	Sig.	Sig.	Sig.	Sig.
CV (%)		10.36	9.48	9.26	10.22	9.63	10.24

Notes: 1. Figures in parentheses are retransformed values and those outside $\sqrt{X+0.5}$ are transformed values

B. Treatment mean with letter (s) in common are differing significant as per Duncan's New Multiple Range Test (DNMRT) at 5% level of significance

Significant parameters and its interaction: P

The data bio-efficacy of different biopesticides against aphid population after 2nd spray is mentioned in Table 2 revealed that all the treatments were significantly superior over control. Among different biopesticidal treatments, NSKE 5% was found best among all treatments with the lowest population (9.30/10 cm twig) and it remained at par with neem oil 0.5% (9.68/10 cm twig) and *L. lecanii* 1% (10.26/10 cm twig). After five days of second spray, the aphid population was recorded the lowest (5.70/10 cm twig) in the plot treated with NSKE 5% and it remained at par with neem oil 0.5% (5.95/10

cm twig), *L. lecanii* 1% (6.63/10 cm twig). Seventh day after second spray, the treatment of NSKE 5% recorded the lowest number of aphid population (4.84/10 cm twig) which was at par with neem oil 0.5% (5.40/10 cm twig) and *L. lecanii* 1% (5.65/10 cm twig). Tenth day after second spray, the lowest aphid population found in treatment of NSKE 5% (3.95/10 cm twig) and remained at par with neem oil 0.5% (4.47/10 cm twig) and *L. lecanii* 1% (4.70/10 cm twig). The treatments of cow urine 10% (23.71/10 cm twig), *aakdo* 10% (22.83/10 cm twig) and GRE 5% (22.06/10 cm twig) were found the least effective in reducing the aphid population. The data on pooled over periods presented in Table 2 indicated that the treatment of NSKE 5% found the most effective and recorded the lowest population (5.80/10 cm twig) and it was at par with neem oil 0.5% (6.26/10 cm twig) and *L. lecanii* 1% (6.6810 cm twig). Thus, these all the treatments were found most effective than the rest of the treatments.

Table 2: Bio-efficacy of different biopesticides against aphid, *A. craccivora* in Indian bean (after second spray)

Tr. No.	Treatments	No. of aphids/10 cm twig/plant at indicated days after spray				
		3	5	7	10	Pooled
T1	Neem oil 0.5%	3.19a (9.68)	2.54a (5.95)	2.43a (5.40)	2.23a (4.47)	2.60a (6.26)
T2	Neem seed Kernel Extract (NSKE) 5%	3.13a (9.30)	2.49a (5.70)	2.31a (4.84)	2.11a (3.95)	2.51a (5.80)
T3	Ginger rhizome extract (GRE) 5%	5.24c (26.96)	5.05c (25.00)	4.91c (23.61)	4.75c (22.06)	4.99c (24.40)
T4	*Aakdo*, *Calotropis procera* 10%	5.28c (27.38)	5.07c (25.20)	4.98c (24.30)	4.83c (22.83)	5.04c (24.90)
T5	Garlic bulb extract (GBE) 5%	4.22b (17.31)	4.05b (15.90)	3.94b (15.02)	3.79b (13.86)	4.00b (15.50)
T6	Cow urine 10%	5.32cd (27.80)	5.11cd (25.61)	5.05cd (25.00)	4.92cd (23.71)	5.10c (25.51)
T7	Aqueous bidi tobacco dust extract 2%	4.15b (16.72)	4.01b (15.58)	3.85b (14.32)	3.72b (13.34)	3.93b (14.94)
T8	*Beauveria bassiana* 1% WP	4.29b (17.90)	4.14b (16.64)	4.06b (15.98)	3.85b (14.32)	4.09b (16.23)
T9	*Lecanicillium lecanii* 1% WP	3.28a (10.26)	2.67a (6.63)	2.48a (5.65)	2.28a (4.70)	2.68a (6.68)
T10	Untreated check	6.18d (37.69)	5.93d (34.66)	5.84d (33.61)	5.71d (32.10)	5.92d (34.55)
S.Em. Treatment(T)		0.26	0.25	0.25	0.25	0.12
Period (P)		-	-	-	-	0.07
T × P		-	-	-	-	0.24
F Test (T)		Sig.	Sig.	Sig.	Sig.	Sig.
CV (%)		10.21	10.55	10.70	11.17	10.52

Notes: 1. Figures in parentheses are retransformed values and those outside $\sqrt{X+0.5}$ are transformed values
Treatment mean with letter (s) in common are differing significant as per Duncan's
New Multiple Range Test (DNMRT) at 5% level of significance
Significant parameters and its interaction: P

The data on pooled over periods and sprays presented in Table 3 indicated that minimum aphid population were recorded in treatment of NSKE 5% (9.23/10 cm twig) and remained at par with neem oil 0.5% (9.66/10 cm twig) and *L. lecanii* 1% (10.05/10 cm twig). The treatments of aqueous Bidi tobacco dust extract 2% (17.56/10 cm twig), GBE 5% (17.89/10 cm twig) and *B. bassiana* 1% (18.57/10 cm twig) were at par with each other and found mediocre in reducing aphid population. The plots treated with cow urine 10% recorded the maximum (28.16/10 cm twig) aphid population and it was at par with *aakdo* 10% (27.46/10 cm twig) and GRE 5% (26.88/10 cm twig).

Table 3: Bio-efficacy of different biopesticides against aphid, *A. craccivora* in Indian bean (Pooled over periods and sprays)

Tr. No.	Treatments	No. of aphids/10 cm twig/plant at indicated spray		
		First	Second	Pooled over periods and sprays
T1	Neem oil 0.5%	3.78a (13.79)	2.60a (6.26)	3.19a (9.66)
T2	Neem seed Kernel Extract (NSKE) 5%	3.73a (13.41)	2.51a (5.80)	3.12a (9.23)
T3	Ginger rhizome extract (GRE) 5%	5.48c (29.53)	4.99c (24.40)	5.23c (26.88)
T4	*Aakdo*, *Calotropis procera* 10%	5.53c (30.08)	5.04c (24.90)	5.29c (27.46)
T5	Garlic bulb extract (GBE) 5%	4.58b (20.48)	4.00b (15.50)	4.29b (17.89)
T6	Cow urine 10%	5.60c (30.86)	5.10c (25.51)	5.36c (28.16)
T7	Aqueous bidi tobacco dust extract 2%	4.57b (20.38)	3.93b (14.94)	4.25b (17.56)
T8	*Beauveria bassiana* 1% WP	4.65b (21.12)	4.09b (16.23)	4.37b (18.57)
T9	*Lecanicillium lecanii* 1% WP	3.82a (14.09)	2.68a (6.68)	3.25a (10.05)
T10	Untreated check	6.47d (41.36)	5.92d (34.55)	6.19d (37.82)
S. Em. ± Treatment (T)		0.14	0.12	0.09
Period (P)		0.09	0.07	0.05
Spray (S)		-	-	0.04
T × P		0.28	0.24	0.18
T × S		-	-	0.13
P × S		-	-	0.08
T × P × S		-	-	0.26
F Test (T)		Sig.	Sig.	Sig.
C. V. (%)		10.24	10.52	10.33

Note: 1. Figures in parentheses are retransformed values and those outside are $\sqrt{X+0.5}$ transformed values
2. Treatment mean with letter (s) in common are not significant by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance
3. Significant parameters and its interaction: P, S, P × S and T × P

The results of present investigation corroborates with the reports of Sewak and Sharma (2021) [10] and Dalwadi *et al.* (2008) [5] who reported that Neem Seed Kernel Extract (NSKE) 5% was found most effective against aphid infesting Chrysenthamum and Indian bean. Whereas, Sarvaiya *et al.* (2018) [9] against aphid found that neem oil 0.3% was found most effective. According to Pissinati and Ventura (2015) [8], neem oil 1% showed less cabbage aphid population than control.

3.1 Economics of different biopesticides

The economics of various bio-pesticides evaluated (Table 4) against aphid infesting Indian bean revealed that the highest (29800 ₹/ha) realization was obtained from the plot treated with the biopesticidal treatment of NSKE 5% and it was followed by neem oil 0.5% (29300 ₹/ha), *L. lecanii* 1% WP (28900 ₹/ha). The lowest (10720 ₹/ha) realization was obtained in the treatment of cow urine and it was followed by *aakdo* 10% (10920 ₹/ha) and GBE 5% (11380 ₹/ha). The highest ICBR (1:10.05) was obtained in treatment of NSKE 5% followed by aqueous bidi tobacco dust extract 2% (1:9.39) and neem oil 0.5% (1:6.56). Whereas, the lowest ICBR was obtained in the plot treated with *B. bassiana* 1% WP (1:1.89).

Table 4: Economics of the different biopesticides evaluated against aphid *A. craccivora* in Indian bean

Tr. No.	Treatments	Quantity of biopesticides required for 2 applications (kg or l/ha)	Price (₹/ kg or litre)	Cost of biopesticides (₹/ha)	Labour Cost (₹/ha)	Total cost (₹/ha)	Green pod yield (kg/ha)	Net gain over control (kg/ha)	Realization (₹/ha)	ICBR
T1	Neem oil 0.5%	05	400	2000	2465	4465	3589	1465	29300	1:6.56
T2	Neem Seed Kernel Extract 5%	50	10	500	2465	2965	3614	1490	29800	1:10.05
T3	Ginger Rhizome Extract 5%	50	40	2000	2465	4465	2693	569	11380	1:2.54
T4	*Aakdo, Calotropis procera* 10%	100	---	---	2733	2733	2670	546	10920	1:3.99
T5	Garlic Bulb Extract 5%	50	60	3000	2465	5465	3318	1194	23880	1:4.36
T6	Cow urine 10%	100	---	---	2733	2733	2660	536	10720	1:3.92
T7	Aqueous bidi tobacco dust extract 2%	20	10	200	2465	2665	3376	1252	25040	1:9.39
T8	*Beauveria bassiana* 1% WP	05	900	4500	2465	6965	2783	659	13180	1:1.89
T9	*Lecanicillium lecani* 1% WP	05	900	4500	2465	6965	3569	1445	28900	1:4.14
T10	Untreated check	-	-	-	-	-	2124	-	-	-

Note: 1. Labour charges @ ₹ 348.20/- per day × 2 labours = 696.40 ₹/ha and ₹ 268/- per day × 2 labours = 536 ₹/ha, Total 696.40 + 536 = 1232.40₹/ha for one application.
2. Price of Indian bean pods = ₹ 20 per Kg
3. Labour cost for collection of *aakdo* leaves and cow urine ₹ 268/-

4. Conclusion

The present investigation revealed that lowest aphid population was found with the biopesticidal treatments of NSKE 5%, neem oil 0.5% and *L. lecanii* 1% WP.

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