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# Bio-Efficacy of Bio-Pesticides against Aphid, *Aphis craccivora* Koch Infesting Fenugreek

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**A B S T R A C T**

Among seven bio-pesticides evaluated against *A. craccivora* on fenugreek, azadirachtin 0.0006%, neem oil 0.3% and garlic bulb extract 3% were found most effective in suppressing the aphid population. Maximum seed yield was registered in plots treated with azadirachtin followed by neem oil and garlic bulb extract. The maximum net realization was obtain in the treatment of azadirachtin and maximum ICBR was registered in neem oil 0.3%.

## Introduction

Fenugreek, *Trigonella foenum-graecum* (L.) is a self-pollinated annual dicotyledonous leguminous crop belonging to the sub family Papilionaceae under the family Fabaceae. It is known as *Methi* (Hindi, Gujarati, Urdu, Punjabi and Marathi), *Hulba* (Arabic), *Moshoseitaro* (Greek), *Uluva* (Malayalam), *Shoot* (Hebrew), *Dari* (Persian) and *Hayseed* in English. Fenugreek is one of the oldest medicinal plants from Fabaceae family originated in Central Asia-4000 BC (Ahmad *et al.,* 2015). The major producers of fenugreek in the worlds are India, Morocco, Spain, Turkey, China and Pakistan. In India, fenugreek is mainly cultivated in Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh. Rajasthan which accounts about 75 to 85 per cent of the total production, while in Gujarat, it is mainly grown in Banaskantha and Mehsana districts and sporadically in Saurashtra region (Anon., 2015). Insect pests attacking the fenugreek crop are Aphid, *Aphis craccivora*; Koch, Leaf hopper, *Empoasca kerri* Pruthi; Whitefly, *Bemisia tabaci* Gennadius; Leaf miner *Liriomyza congesta* Becker, Leaf eating caterpillar, *Spodoptera litura* Fabricius, Weevil, *Hypera branneipennis* Boh.; Mite, *Petrobia lateens* Muller and Thrips, *Thrips tabaci* (Manjula *et al.,* 2015).

## Materials and Methods

In order to determine the relative bio-efficacy of bio-pesticides against *A. craccivora* on fenugreek (Gujarat Methi-2), a field experiment was conducted during *Rabi* 2015-16 at Main Vegetable Research Station, Anand Agricultural University, Anand. Requirement of gross plot area was 3.0 m x 1.8 m and net pot area was 2.8 m x 1.2 m for each treatment plot. Seven different bio-pesticides *viz*., NSKE 5%, Neem oil 0.3 %, Azadirachtin (0.15 EC) 0.0006%, Garlic bulb extract 3%, *Beauveria bassiana* 2 x $10^8$ cfu/g, *Lecanicillium lecanii* 2 x $10^8$ cfu/g and Tobacco decoction 2% were evaluated in comparison with control (water spray) for their relative bio-efficacy against *A. craccivora* on fenugreek crop.

All the recommended agronomical practices were adopted for crop grown. First and second bio-pesticides sprays were applied during January 18, 2016 and January 29, 2016. For the purpose of recording the observations, five plants were randomly selected from net plot area and tagged. Observations on number of aphids present on 10 cm terminal part of central shoot of each tagged plant were recorded prior as well as 3, 5, 7 and 10 days after each spray. Effectiveness of the treatments was judged based on the efficacy of the bio-pesticides against *A. craccivora*, seed yield and economics.

The data on number of aphids per 10 cm central shoot were analyzed after transforming them into square root while, the data on yield were analyzed without any transformation. The data were analyzed by using RBD design periodically, pooled over periods and pooled over sprays to see the consistency of the treatment performance. For determine of increase in yield over control and avoidable losses, following formula given by Poul (1976) were used:

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

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

## Results and Discussion

The results presented in Table 1. There was non-significant difference among different treatments before spay indicating uniform distribution of aphid population among different treatments. Aphid population recorded at 3 DAS clearly indicated that it was significantly decreased in all the bio-pesticides treatments over untreated control. Among the various bio-pesticides, Azadirachtin had minimum number of aphids (16.89/10 cm central shoot) and it was at par with neem oil (22.44), garlic bulb extract (23.02) and neem seed kernel extract (26.33). The maximum population (29.64) was recorded in the plot treated with *L. lecanii* and proved to be least effective. More or less similar type of result was observed at fifth, seventh, tenth as well as pooled over period of first and second sprays. Aphid population was slightly increased between seventh and tenth day after both spray in all treatments. It means bio-pesticides are effectively control the aphid up to seven day, thereafter its effectiveness were decreased. The data on aphid populations pooled over periods and sprays indicated that all the bio-pesticides recorded significantly less aphid population than control. A significantly less number of aphids (6.26 aphid/ central shoot) was recorded in plots treated with azadirachtin showing its superiority over other treatments. Neem oil, garlic bulb extract and neem seed kernel extract were also found better treatments next to azadirachtin in reducing the aphid incidence.

**Table.1 Periodical population of *A. craccivora* on fenugreek in different bio-pesticides treatment**

| Tr. No. | Treatment | Conc. (%) | Before spray | Aphid per 10 cm central shoot after 1st spray | | | | | Aphid per 10 cm central shoot after 2nd spray | | | | | Pooled over periods and sprays |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3 DAS | 5 DAS | 7 DAS | 10 DAS | After 1st spray | 3 DAS | 5 DAS | 7 DAS | 10 DAS | After 2nd spray | |
| $T_1$ | NSKE | 5% | 6.86 (46.56) | 5.18ab (26.33) | 4.38bc (18.68) | 3.72bc (13.34) | 4.11ab (16.39) | 4.35bc (18.42) | 3.72b (13.34) | 3.19bc (9.68) | 2.89b (7.85) | 3.37bc (10.86) | 3.29c (10.32) | 3.82bc (14.09) |
| $T_2$ | Neem oil | 0.3% | 6.96 (47.94) | 4.79ab (22.44) | 3.66ab (12.90) | 2.89ab (7.85) | 3.32a (10.52) | 3.67a (12.97) | 2.79a (7.28) | 2.44ab (5.45) | 2.27ab (4.65) | 2.60ab (6.26) | 2.52ab (5.85) | 3.10ab (9.11) |
| $T_3$ | Azadirachtin 0.15 EC | 0.0006% | 6.61 (43.19) | 4.17a (16.89) | 3.29a (10.32) | 2.39a (5.21) | 2.93a (8.08) | 3.20a (9.74) | 2.41a (5.31) | 1.82a (2.81) | 1.63a (2.16) | 2.12a (3.99) | 1.99a (3.46) | 2.60a (6.26) |
| $T_4$ | Garlic bulb extract | 3% | 6.89 (46.97) | 4.85ab (23.02) | 3.70ab (13.19) | 2.94ab (8.14) | 3.44a (11.33) | 3.73ab (13.41) | 2.91ab (7.97) | 2.48ab (5.65) | 2.35ab (5.02) | 2.73ab (6.95) | 2.63b (6.42) | 3.18ab (9.61) |
| $T_5$ | *Beauveria bassiana* | 0.4% | 6.81 (45.88) | 5.44bc (29.09) | 4.76c (22.16) | 4.27c (17.73) | 4.84b (22.93) | 4.83c (22.83) | 4.41c (18.95) | 4.00c (15.50) | 3.84c (14.25) | 4.11c (16.39) | 4.09d (16.23) | 4.46c (19.39) |
| $T_6$ | *Lecanicillium lecanii* | 0.4% | 6.99 (48.36) | 5.49bc (29.64) | 4.86c (23.12) | 4.43c (19.12) | 4.97b (24.20) | 4.94c (23.90) | 4.57c (20.38) | 4.13c (16.56) | 4.03c (15.74) | 4.24c (17.48) | 4.24d (17.48) | 4.59c (20.57) |
| $T_7$ | Tobacco decoction | 2% | 6.67 (43.99) | 5.47bc (29.42) | 4.50bc (19.75) | 3.87bc (14.48) | 4.13ab (16.56) | 4.49c (19.66) | 3.73bc (13.41) | 3.25bc (10.06) | 3.70bc (13.19) | 3.16b (9.49) | 3.22c (9.87) | 3.85bc (14.32) |
| $T_8$ | Control (Water spray) | - | 6.93 (47.52) | 6.61c (43.19) | 6.95d (47.80) | 7.15d (50.62) | 7.29c (52.64) | 7.00d (48.50) | 6.91d (47.25) | 7.16d (50.77) | 7.83d (60.81) | 7.43d (54.70) | 7.22e (51.63) | 7.11d (50.05) |
| S. Em. ± | T | | 0.44 | 0.39 | 0.32 | 0.36 | 0.40 | 0.22 | 0.29 | 0.32 | 0.30 | 0.29 | 0.18 | 0.24 |
| | P | | - | - | - | - | - | 0.13 | - | - | - | - | 0.10 | 0.17 |
| | S | | - | - | - | - | - | - | - | - | - | - | - | 0.07 |
| | T x P | | - | - | - | - | - | 0.37 | - | - | - | - | 0.28 | 0.23 |
| | T x S | | - | - | - | - | - | - | - | - | - | - | - | 0.20 |
| | P x S | | - | - | - | - | - | - | - | - | - | - | - | 0.11 |
| | T x P x S | | - | - | - | - | - | - | - | - | - | - | - | 0.32 |
| C.D. at 5% | T | | NS | 1.18 | 0.97 | 1.10 | 1.21 | 0.67 | 0.88 | 0.96 | 0.91 | 0.87 | 0.53 | 0.81 |
| | P | | - | - | - | - | - | 0.37 | - | - | - | - | 0.28 | NS |
| | S | | - | - | - | - | - | - | - | - | - | - | - | 0.21 |
| | T x P | | - | - | - | - | - | NS | - | - | - | - | NS | NS |
| | T x S | | - | - | - | - | - | - | - | - | - | - | - | 0.60 |
| | P x S | | - | - | - | - | - | - | - | - | - | - | - | 0.32 |
| | T x P x S | | - | - | - | - | - | - | - | - | - | - | - | NS |
| C.V. % | | | 11.13 | 12.78 | 12.27 | 15.83 | 15.82 | 14.05 | 12.80 | 15.43 | 15.26 | 13.37 | 12.96 | 13.71 |

**Note: Figures in parentheses are retransformed values of $\sqrt{x + 0.5}$**
**Treatment means with letter(s) in common are not significant by lsd at 5 % level of significance**

**Table.2 Impact of various bio-pesticides on fenugreek seed yield due to control of aphid, A. craccivora**

| Tr. No. | Treatments | Seed yield (q/ha) | Increase in yield over control (%) | Avoidable losses (%) |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| $T_1$ | NSKE 5% | 16.12ab | 22.12 | 6.61 |
| $T_2$ | Neem oil 0.3% | 16.87ab | 27.80 | 2.26 |
| $T_3$ | Azadirachtin 0.0006% | 17.26a | 30.76 | 0.00 |
| $T_4$ | Garlic bulb extract 3% | 16.77ab | 27.05 | 2.84 |
| $T_5$ | *Beauveria bassiana* WP 0.4% | 15.13abc | 14.62 | 12.34 |
| $T_6$ | *Lecanicillium lecanii* WP 0.4% | 14.83bc | 12.35 | 14.08 |
| $T_7$ | Tobacco decoction 2% | 16.02ab | 21.36 | 7.18 |
| $T_8$ | Control | 13.20c | 0.00 | 23.52 |
| S. Em. ± | | 0.79 | - | - |
| C.D. at 5% | | 2.39 | - | - |
| C. V. (%) | | 8.64 | - | - |

Note: Treatment means with letter(s) in common are not significant by lsd at 5 % level of significance

**Table.3 Economics of different bio-pesticidal treatments evaluated against *A. craccivora* on fenugreek**

| Treatments | Quantity of pesticides (Lit. or kg/ha) required for two spray | Cost of treatments for two spray (₹ /ha) | Total cost of treatments including labour charges (₹ /ha) | Yield (q/ha) | Net gain over control (q/ha) | Total realization over control (₹ /ha) | Net realization over control | ICBR |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| NSKE 5% | 50 kg | 1000 | 1894 | 16.12 | 2.92 | 8760 | 6866 | 1:4.62 |
| Neem oil 0.3% | 3 Lit. | 450 | 1344 | 16.87 | 3.67 | 11010 | 9666 | 1:8.19 |
| Azadirachtin 0.0006% | 4.0 Lit. | 2400 | 3294 | 17.26 | 4.06 | 12180 | 8886 | 1:3.69 |
| Garlic bulb extract 3% | 30 kg | 2400 | 3294 | 16.77 | 3.57 | 10710 | 7416 | 1:3.25 |
| *Beauveria bassiana* WP 0.4% | 4.0 kg | 880 | 1774 | 15.13 | 1.93 | 5790 | 4016 | 1:2.26 |
| *Lecanicillium lecanii* WP 0.4% | 4.0 kg | 920 | 1814 | 14.83 | 1.63 | 4890 | 3076 | 1:1.69 |
| Tobacco decoction 2% | 20 kg | 200 | 1094 | 16.02 | 2.82 | 8460 | 7366 | 1:6.73 |
| Control | - | - | - | 13.20 | - | - | - | - |

Note: 1. Labour charges @ Rs. 296.80 + 150 = 447 x 2 = 894/- per day/ha for application of bio-pesticides for two sprays
2. Price of fenugreek seed: 3,000 Rs. per quintal

The treatments of *B. bassiana* and *L. lecanii* had significantly higher population of aphids (19.39 and 20.57 aphids/central shoot, respectively) and proved inferior in controlling the pest.

The data (Table 2) on seed yield showed higher seed yield in all the treated plots than untreated check. The maximum seed yield (17.26 q/ha) was found in plots sprayed with azadirachtin followed by neem oil (16.87 q/ha) and other all bio-pesticides treated plots. A minimum seed yield (14.83 q/ha) was obtained in *L. lecanii* followed by *B. bessiana* (15.13 q/ha).

The maximum per cent of increase in yield over control was found in plots treated with azadirachtin (30.76) followed by neem oil (27.80) and garlic bulb extract (27.05). Minimum per cent of increase in yield (12.35) over control was found in plots treated with *L. lecani* followed by *B. bassiana* (14.62). The maximum losses (23.52 %) due to the pest was found in untreated plot, whereas it was minimum in plot treated with neem oil (2.26 %). The details of Incremental Cost Benefit Ratio (ICBR) calculated for different treatments of bio-pesticides are presented in Table 3. Data indicated that maximum realization was found in the treatment of azadirachtin 0.0006% (₹ 12180/ha) followed by neem oil 0.3% (₹ 11010/ha). While, minimum realization was obtain from the *L. lecanii* $2x10^8$ cfu/g (₹ 4890/ha). Maximum ICBR was registered in neem oil 0.3% (1: 8.19) followed by tobacco decoction 2% (1:6.73). While, lowest ICBR was recorded in the plot treated with *L. lecanii* $2x10^8$ cfu/g (1: 1.69) followed by *B. bassiana* $2x10^8$ cfu/g (1: 2.26).

Patel (2002) reported that out of seven azadirachtin based formulations, Gronim 0.075% (azadirachtin 0.15 EC) proved relatively superior in suppressing the population of *A. gossypii* on isabgol. While Patel (2014) reported that the treatment of azadirachtin 0.15 EC (Gronim 0.4%) was superior for the control of *A. gossypii* infesting isabgol. According to Sharma *et al.*, (2012), the minimum aphid (*A. craccivora*) infestation on fenugreek was in the treatment of neem oil (1%) and it was significantly superior over karanj oil 1%, garlic bulb extract 5% and neem leaf extract 5%.

Dalwadi *et al.*, (2008) observed significantly least incidence of *A. craccivora* in Indian bean plots treated with NSKE 5 % followed by NLE. While, in present study, NSKE 5% and NLE 10% proved moderately effective. Patil and Patel (2013) also reported that among all the tested botanical insecticides, neem oil @ 0.5 per cent was superior to other botanicals and registered maximum (7.21 q/ha) seed yield. Selvaraj *et al.*, (2010) reported that *B. bassiana* had significantly reduced the aphid population in fenugreek crop. While, El-Salam *et al.*, (2012) reported *V. lecanii* as the most effective treatment followed by Nimbecidine, *M. anisopliae*, *P. fumosoroseus* and the least effective was *B. bassiana* against *A. craccivora* in broad bean.

The treatment of azadirachtin 0.0006% was found most effective followed by neem oil 0.3% and garlic bulb extract 3% for the control of aphid population, producing seed yield and net realization. Entomopathogenic fungi, *L. lecanii* $2x10^8$ cfu/g and *B. bassiana* $2x10^8$ cfu/g proved to be less effective and failed to control the pest, whereas neem seed kernel extract 5% and tobacco decoction 2% proved moderately effective against *A. craccivora* on fenugreek crop. Maximum ICBR was registered in neem oil 0.3% followed by tobacco decoction 2% and NSKE 5%. While, lowest ICBR was recorded in the plot treated with *L. lecanii* $2x10^8$ cfu/g followed by *B. bassiana* $2x10^8$ cfu/g.

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