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# Efficacy of Biopesticides and Botanicals against Hadda beetle (*Henosepilachna vigintioctopunctata* Fab.) on Indian ginseng

**Neelam Kumari*[1], K C Kumawat[1] and Neetu Choudhary[1]**

## ABSTRACT

The present study investigated "Efficacy of biopesticides and botanicals against Hadda beetle, *Henosepilachna vigintioctopunctata* (Fab.) on Indian ginseng, *Withania somnifera* (L.) Dunal" at Sri Karan Narendra Agriculture University, Jobner, Rajasthan during *Kharif*, 2021. Out of eight biopesticides and botanicals tested against hadda beetle on Indian ginseng crop, revealed that azadirachtin (0.03 EC) 5 ml/ l proved to be most effective followed by Neem oil and Neem seed kernel extract (5%). The treatment of *Beauveria bassiana* (1.15 WP), *Lecanicillium lecanii* (1.15 WP) and *Metarhizium anisopliae* (1.15 WP) ranked in middle order of efficacy, while the plant products, *viz.,* Karanj seed extract (5.0 %) and Karanj oil proved to be the least effective. The highest benefit cost ratio of 30.81 was obtained from Neem oil treated plots followed by *B. bassiana* 1.15 WP (12.52) and Azadirachtin (11.47), while lowest (1.36) in the KSE 5% treated plots.

**Keywords:** Indian ginseng, Azadirachtin, Neem seed kernel extract, Karanj seed extract

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## INTRODUCTION

Indian ginseng or Indian winter cherry (*Withania somnifera* L.) Dunal commonly known as Ashwagandha or Ashgandh belongs to family Solanaceae is an important ancient medicinal plant. The roots of which have been employed in Indian traditional systems of medicines, Ayurveda and Unani. It is being cultivated for centuries in India and used in ayurvedic indigenous medicine for more than 3,000 years (Umadevi *et al.*, 2012). The species name *somnifera* means 'sleep-making' in Latin, attributed to sedating properties (Pratibha *et al.*, 2013). It is a xerophytic plant found in arid parts of India, Sri Lanka, Afghanistan, Baluchistan and Sind, and is also distributed in the Mediterranean regions (Singh *et al.*, 2015). The pharmacological property of plant is attributed due to the presence of several alkaloids mainly 'Withanine' which ranges from 0.13 to 0.31% (Nigam and Kandalkar, 1995). Ashwagandha possesses adaptogenic, immune-modulator and anti-stress properties (Chadha, 2001). It also increases haemoglobin level, recovers anaemia, reduces greying of hairs and improves sexual performance in human beings. Roots are prescribed as medicine for the treatment of hiccup several female disorders, bronchitis, dropsy, stomach ailments, lung inflammation, tuberculosis,arthritis and skin diseases.

The crop, Indian ginseng is reported to be attacked by *Henosepilachna vigintioctopunctata* Fab, *Myllocerus discolor* Fab., *Deilephila nerii* Linn., Leaf miner, *Oxyra chistarandus* Fab., *Ferrisia virgata*, *Nezara virudula*, Aphids, *Tetranychus urticae* Koch. and *Helicoverpa* sp. (Manjoo and Swaminathan, 2007, Ramanna *et al.*, 2010, Murali Baskaran *et al.*, 2007; Sharma *et al.*, 2014). The hadda beetle, *Henosepilachna vigintioctopunctata* (Fab.) is one of the major pest of Ashwagandha, causing severe damage to crop (Manjoo and Swaminathan, 2007). Sharma and Pati (2011) reported that a large number of plants from family solanaceae have been recorded as the favourable hosts of hadda beetle,*Henosepilachna vigintioctopunctata* (Fab.) which include ashgandh or Indian ginseng, *Withaniasomnifera* and some other plants. The beetles and the grubs of *H. vigintioctopunctata* cause considerable damage by scraping away the green leaf tissue resulting in drying of leaves which may result in complete defoliation of the plant. The grubs of *Henosepilachna* spp. attack on the lower surface of leaves, however, adults usually feed on the upper surface of the leaves.

The chemical control has been recommended by some workers to combat with insect pests of this crop but due to one or other reasons could not become fool proof strategy as toxic chemicals render harmful residual effects which are quite undesirable on the medicinal crop. Therefore, some safer methods, like biopesticides and botanicals are intended to be studied under the present investigation to solve the problem of hadda beetle on Indian ginseng crop grown for medicinal purpose.

## MATERIALS AND METHODS

The experiment was laid out in a simple Randomized Block Design (RBD) with 9 treatments including untreated control, each replicated thrice. The local variety was sown on 1st August, 2021 in plots of 2.1 m x 1.8m size keeping row to row

[1]Department of Entomology, Sri Karan Narendra Agriculture University, Jobner [Rajasthan] 303 329 (India)
*Corresponding Author E-mail: choudharyneelam277@gmail.com

and plant to plant distance of 30 cm and 15 cm, respectively. The treatments (first spray) were applied as foliar spray in evening hours (4 to 6 Pm) on the crop using pre-calibrated knapsack sprayer when the pest population was sufficiently build up and second spray was repeated after 15 days of first spray. An untreated control was also maintained for comparison. The insecticidal solution was prepared as per formula given below (Rasheed *et al.*, 2024):

$$C_1V_1 = C_2V_2$$

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 (600 l/ha)

The population of hadda beetle was recorded one day before treatment (pre-treatment) and 1, 3, 7 and 15 days after treatment (post-treatment). The Indian ginseng dry root yield was recorded after harvesting. The data obtained just before treatment and one, three, seven and fifteen days after the spray were taken into consideration to find out the per cent reduction in the population which was determined by applying formula given by Abbott (1925).

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

Where,

Ta = Population in treated plots after treatment

Tb = Population in treated plots before treatment

Ca = Population in untreated plots after treatment

Cb = Population in untreated plots before treatment

The data were then statistically analyzed by transforming the per cent data of population reduction into angular transformation values (Bliss, 1937).

## RESULTS AND DISCUSSION

The effectiveness of different biopesticides and botanicals against hadda beetle population was evaluated under field conditions. The treatments were compared on the basis of per cent reduction in pest population at different intervals after spraying.

### First spray

The effect of different biopesticides and botanicals on the population of hadda beetle after the first spray is presented in Table 1. Among the different biopesticides and botanicals tested maximum reduction of 42.50 per cent was recorded in the treated plots with azadirachtin 0.03 EC followed by, Neem oil and NSKE which exhibited 41.70 and 40.40 per cent reduction, respectively and these were found statistically at par with each other in their efficacy after 1 day of spray. The treatments of entomopathogenic fungi, *viz., B. bassiana* 1.15 WP, *L. Lecanii* 1.15 WP and *M. anisopliae* 1.15 WP were observed to be next effective treatments which registered 36.10, 34.80 and 33.33 per cent reduction in hadda beetle population, respectively and these treatments were at par with each other. The minimum reduction in hadda beetle population was recorded in the treatment of Karanj oil (21.18%) followed by *KSE* (24.45%) and both were differed non significantly with each other. Similar trend of reduction in hadda beetle population was observed on 3, 7 and 15 days of insecticidal spray. The findings are in line with Ghosh and Chakarborty (2011) who found that azadirachtin was very effective against the epilachna beetle on potato, achieving more than 60% mortality at 4 days after spraying followed by *Pongamia pinnata* L. (*Karanj).* In addition, Mane and Kulkami (2010) reported that NSKE treatments was significantly superior compared to *Neem* gold, Nimbicidin, Achook, and *Neem* leaf extract in controlling *E.vigintioctopunctata* on brinjal.

The mean per cent reduction in hadda beetle population was ranged from 32.73 to 50.12 per cent. The descending order of effectiveness of biopesticides and botanicals based on first spray of biopesticides and botanicals was found to be: azadirachtin 0.03 EC, Neem oil 1%, NSKE 5%, *B. bassiana* 1.15 WP, *L. lecanii* 1.15 WP, *M. anisopliae* 1.15 WP, KSE 5 per cent and *Karanj* oil 1 per cent.

**Table 1:** Efficacy of biopesticides and botanicals against hadda beetle, *Henosepilachna vigintioctopunctata* (Fab.) on Indian ginseng (I spray)

| S.No. | Treatments | Formulation | Conc./ Dosage | Mean per cent reduction after | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | One day | Three day | Seven day | Fifteen day | Mean |
| 1 | *Beauveria bassiana* | 1.15 WP | 1g/l | 36.10 | 48.16 | 51.00 | 39.60 | 43.71 |
| | | | | (36.90) | (43.92) | (45.55) | (38.97) | (41.36) |
| 2 | *Lecanicillium lecanii* | 1.15 WP | 1g/l | 34.80 | 46.02 | 49.90 | 37.10 | 41.95 |
| | | | | (36.12) | (42.69) | (44.92) | (37.49) | (40.34) |
| 3 | *Metarhizium anisopliae* | 1.15 WP | 1g/l | 33.33 | 45.14 | 48.80 | 36.96 | 41.05 |
| | | | | (35.21) | (42.19) | (44.29) | (37.41) | (39.82) |
| 4 | NSKE | Lab. prepared | 5.0% | 40.40 | 53.00 | 50.20 | 43.96 | 46.89 |
| | | | | (39.44) | (46.70) | (45.09) | (41.50) | (43.19) |

| S.No. | Treatments | Formulation | Conc./ Dosage | Mean per cent reduction after | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | One day | Three day | Seven day | Fifteen day | Mean |
| 5 | *Neem* oil | - | 1ml/l | 41.70 | 54.50 | 52.00 | 44.14 | 48.08 |
| | | | | (40.20) | (47.56) | (46.12) | (41.61) | (43.88) |
| 6 | Azadirachtin | 0.03 EC | 5ml/l | 42.50 | 57.70 | 54.30 | 46.00 | 50.12 |
| | | | | (40.66) | (49.41) | (47.45) | (42.68) | (45.05) |
| 7 | *Karanj* seed extract | Lab. Prepared | 5 % | 23.35 | 44.16 | 37.35 | 33.57 | 34.60 |
| | | | | (28.84) | (41.62) | (37.64) | (35.37) | (36.00) |
| 8 | *Karanj* oil | - | 1ml/l | 20.08 | 43.16 | 35.44 | 32.24 | 32.73 |
| | | | | (26.55) | (41.04) | (36.50) | (34.56) | (34.86) |
| 9 | Untreated control | - | - | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| S.Em.± | | | 1.08 | 1.03 | 1.17 | 1.09 | 0.90 | |
| CD p=0.05) | | | 3.22 | 3.12 | 3.54 | 3.24 | 2.72 | |

Figures in the parentheses are angular transformed values

**Second spray**

The data (Table 2) indicated that all the treatments of biopesticides and plant products were found significantly superior over untreated control at all the intervals of observations, however, significant difference existed among them in their efficacy. The maximum reduction was recorded in the treatment of azadirachtin 0.03 EC (45.77%) followed by Neem oil (41.00%) and NSKE (40.46%), these were found statistically at par with each other in their efficacy after 1 day of spray. The treatments of entomopathogenic fungi, *viz., B. bassiana* 1.15 WP, *L. lecanii* 1.15 WP and *M. anisopliae* 1.15 WP were observed as next effective treatments which registered 37.00, 35.30 and 34.33 per cent reduction, respectively in hadda beetle population and found at par with each other. The minimum reduction was recorded in the treatment of *Karanj* oil (19.35%) followed by KSE (21.00), both differed non significantly with each other. Similar trend of reduction in hadda beetle population was observed on 3, 7 and 15 days of insecticidal spray. The findings are in line with Rajendran and Gopalan (1998) who examined the effects of *Neem* oil on the fecundity and egg hatchability of *H. vigintioctopunctata* on brinjal and reported that *Neem* oil (4%) reduced fecundity by 62.8 per cent over control. In addition, Kodandaram *et al.* (2014) tested bio efficacy of different botanicals and microbial pesticides under field conditions during *rabi* season and found that neem oil was the most effective treatment for the controlling epilachna beetle on vegetable cowpea.

**Table 2:** Efficacy of biopesticides and botanicals against hadda beetle, *Henosepilachna vigintioctopunctata* (Fab.) on Indian ginseng ( II spray)

| S.No. | Treatments | Formulation | Conc./ Dosage | Mean per cent reduction after | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | One day | Three day | Seven day | Fifteen day | Mean |
| 1 | *Beauveria bassiana* | 1.15 WP | 1g/l | 37.00 | 48.77 | 50.11 | 37.45 | 43.33 |
| | | | | (37.43) | (44.27) | (45.04) | (37.70) | (41.14) |
| 2 | *Lecanicillium lecanii* | 1.15 WP | 1g/l | 35.30 | 45.15 | 48.65 | 35.30 | 41.10 |
| | | | | (36.42) | (42.19) | (44.20) | (36.42) | (39.85) |
| 3 | *Metarhizium anisopliae* | 1.15 WP | 1g/l | 34.33 | 44.30 | 47.00 | 33.06 | 39.67 |
| | | | | (35.83) | (41.70) | (43.26) | (35.06) | (39.01) |
| 4 | NSKE | Lab. prepared | 5.0% | 40.46 | 52.35 | 49.42 | 38.56 | 45.19 |
| | | | | (39.47) | (46.33) | (44.64) | (38.36) | (42.21) |
| 5 | *Neem* oil | - | 1ml/l | 41.00 | 55.03 | 51.48 | 41.02 | 47.13 |
| | | | | (39.79) | (47.87) | (45.83) | (39.80) | (43.33) |

| S.No. | Treatments | Formulation | Conc./ Dosage | Mean per cent reduction after | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | One day | Three day | Seven day | Fifteen day | Mean |
| 6 | Azadirachtin | 0.03 EC | 5ml/l | 45.77 | 58.70 | 53.50 | 44.00 | 50.49 |
| | | | | (42.55) | (49.99) | (46.99) | (41.53) | (45.26) |
| 7 | *Karanj* seed extract | Lab. Prepared | 5 % | 21.00 | 41.20 | 38.30 | 31.70 | 33.05 |
| | | | | (27.22) | (39.90) | (38.20) | (34.23) | (35.06) |
| 8 | *Karanj* oil | - | 1ml/l | 19.35 | 39.67 | 35.57 | 30.10 | 31.17 |
| | | | | (26.03) | (39.01) | (36.58) | (33.24) | (33.90) |
| 9 | Untreated control | - | - | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| S.Em.± | | | | 1.11 | 1.09 | 1.13 | 1.02 | 1.11 |
| CD (p=0.05) | | | | 3.32 | 3.30 | 3.42 | 3.05 | 3.30 |

Figures in the parentheses are angular transformed values

The mean per cent reduction in hadda beetle population in treated plots with different treatments ranged from 31.17-50.49 per cent. The descending order of effectiveness of biopesticides and botanicals in second spray was found to be: azadirachtin 0.03 EC, *Neem* oil 1 per cent, NSKE 5 per cent, *B. bassiana* 1.15 WP, *L. lecanii* 1.15 WP, *M. anisopliae* 1.15 WP, *KSE* 5 per cent and *Karanj* oil 1 per cent.

**Dry root yield**

In the present investigation (Table 3) all the plots treated with biopesticides and botanicals gave significantly higher dry root yield over untreated control (2.0 q/ ha). The maximum dry root yield (3.70 q/ ha) was obtained in the plots treated with azadirachtin 0.03 EC followed by *Neem* oil (3.50 q/ ha) and NSKE 5% (3.30 q/ ha).

The dry root yield obtained in the treatment of *B. bassiana* 1.15 WP, *L. lecanii* 1.15 WP and *M. anisopliae* were 2.80, 2.70 and 2.65 q $ha^{-1}$ existed in the middle order. The minimum dry root yield (2.30 q $ha^{-1}$) was obtained in the plots treated with *Karanj* oil followed by *Karanj* seed extract 5.0 per cent (2.35 q $ha^{-1}$).

**Table 3:** Dry root yield of Indian ginseng as influenced by application of biopesticides and botanicals in managing Hadda beetle, *Henosepilachna vigintioctopunctata* (Fab.)

| S. No. | Treatments | Formulation | Concentration / Dosage | Yield (q/ha) |
|---|---|---|---|---|
| 1 | *Beauveria bassiana* | 1.15 WP | 1g/l | 2.80 |
| 2 | *Lecanicillium lecanii* | 1.15 WP | 1g/l | 2.70 |
| 3 | *Metarhizium anisopliae* | 1.15 WP | 1g/l | 2.65 |
| 4 | NSKE | Lab prepared | 5.0% | 3.30 |
| 5 | *Neem* oil | - | 1ml/l | 3.50 |
| 6 | Azadirachtin | 0.03 EC | 5ml/l | 3.70 |
| 7 | *Karanj* seed extract | Lab. Prepared | 5.0 % | 2.35 |
| 8 | *Karanj* oil | - | 1ml/l | 2.30 |
| 9 | Untreated control | - | - | 2.00 |
| S.Em.± | | | | 0.12 |
| CD (p=0.05) | | | | 0.33 |

**Analysis of economics and benefit-cost ratio of biopesticides and botanicals for managing hadda beetle**

The data presented in Table 4 showed that maximum increase in yield over control was recorded in azadirachtin 0.03 EC treated plots (1.70 q ha-1), whereas, minimum was in Karanj oil 1 per cent (0.30 q ha-1). The maximum net return of 54,730 per ha. was recorded in the treatment of azadirachtin 0.03 EC followed by Neem oil (50850) and NSKE 5 per cent (` 40,550.0), whereas minimum was in KSE 5% (6,850) and Karanj oil (8,850).

**Table 4:** Incremental cost Benefit ratio (ICBR ratio) of different biopesticides and botanicals in managing hadda beetle, *Henosepilachna vigintioctopunctata* (Fab.) on Indian ginseng

| S. No. | Biopesticides/ botanicals | Dry root yield (q/ha) | Increased yield over control (q/ha) | Increased returns over control (`/ha) | Total cost of treatments (`/ha) | Net returns (`) | ICBR ratio |
|---|---|---|---|---|---|---|---|
| 1 | Beauveriabassiana | 2.80 | 0.80 | 28000.00 | 2070.00 | 25930.00 | 12.52 |
| 2 | Lecanicillium lecanii | 2.70 | 0.70 | 24500.00 | 2010.00 | 22490.00 | 11.18 |

| S. No. | Biopesticides/ botanicals | Dry root yield (q/ha) | Increased yield over control (q/ha) | Increased returns over control (`/ha) | Total cost of treatments (`/ha) | Net returns (`) | ICBR ratio |
|---|---|---|---|---|---|---|---|
| 3 | Metarhiziumanisopliae | 2.65 | 0.65 | 22700.00 | 2046.00 | 20654.00 | 10.09 |
| 4 | NSKE | 3.30 | 1.30 | 45500.00 | 4950.00 | 40550.00 | 8.19 |
| 5 | Neem oil | 3.50 | 1.50 | 52500.00 | 1650.00 | 50850.00 | 30.81 |
| 6 | Azadirachtin | 3.70 | 1.70 | 59500.00 | 4770.00 | 54730.00 | 11.47 |
| 7 | Karanj seed extract | 2.35 | 0.35 | 12250.00 | 5400.00 | 6850.00 | 1.26 |
| 8 | Karanj oil | 2.30 | 0.30 | 10500.00 | 1650.00 | 8850.00 | 5.36 |
| 9 | Untreated | 2.00 | 0.00 | - | - | - | - |

Market price of indian ginseng root: ` 350/kg

The maximum Incremental Cost Benefit Ratio (30.81) was obtained in *Neem* oil was followed by *Beauveria bassiana 1.15 WP* which resulted in a benefit: cost ratio of 12.52. Azadirachtin 0.03 EC, *L. lecanii, M. anisopliae*, NSKE and *Karanj* oil were resulted in 11.47, 11.18, 10.09, 8.19 and 5.36 benefit : cost ratio, respectively. The lowest benefit: cost ratio of 1.26 was recorded from plots treated with KSE. Chaudhari *et al*. (2015) found maximum incremental benefit cost ratio in the treatment of *Neem* seed kernel extract and *Neem* leaf extract.

## CONCLUSION

Out of eight biopesticides and botanicals evaluated against hadda beetle**,** *H. vigintioctopunctata* azadirachtin 0.03 EC was found most effective followed by *Neem* oil, NSKE 5% and *B. bassiana* 1.15 WP in terms of per cent reduction in the population and dry root yield. *Karanj* oil and KSE 5% were least effective against hadda beetle. The highest benefit cost ratio of 30.81 was obtained from *Neem* oil treated plots followed by *B. bassiana* 1.15 WP (12.52) and azadirachtin (11.47), *vis-à-vis*, lowest (1.26) in the KSE 5% treated plots. Therefore, azadirachtin and neem based products can be recommended as ecofriendly and effective components for the management of hadda beetle under field conditions.

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