International Journal of Advanced Biochemistry Research

**ISSN Print:** 2617-4693
**ISSN Online:** 2617-4707
IJABR 2024; 8(7): 92-95
www.biochemjournal.com
Received: 14-04-2024
Accepted: 18-05-2024

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# Efficacy of organic inputs against aphid, *Lipaphis pseudobrassicae* Davis infesting broccoli

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**DOI:** https://doi.org/10.33545/26174693.2024.v8.i7b.1449

**Abstract**
In the era of sustainable and organic agriculture, the management of insect-pests infesting different crops is now focused more prominently on use of non-chemical measures. It has benefits not only to the target crops but also to natural enemies, human beings as well as whole ecosystem also. Inspired from this, current research experiment was conducted for eco-friendly management of aphids infesting broccoli. Various non-chemical organic inputs *viz.*, cow urine, *neemastra*, botanicals (neem seed kernel extract and neem oil) and entomopathogenic fungi (*Lecanicillium lecanii*, *Metarhizium anisopliae* and *Beauveria bassiana*) were evaluated under field condition for their efficacy against aphid, *Lipaphis pseudobrassicae* infesting broccoli. Of all organic components tested, *L. lecanii* found the most effective in reduction of aphid population followed by *M. anisopliae* which also exhibiting higher yield as compared to other treatments.

**Keywords:** Broccoli, aphid, *Lipaphis pseudobrassicae* Davis, ecological management, sustainable management, plant extracts, entomopathogenic fungus

## Introduction
India is the second largest producer of vegetables in the world after China (Rai and Pandey, 2007) [6]. Amongst vegetable crops, cruciferous vegetables are the crops which have important values for daily consumption owing to their rich functional bioactive profile (Kumar *et al.*, 2022) [3]. The cruciferous vegetables are primarily known for their richness in the sulforane compounds which are the potential functional compounds. Crucifers are rich source of Glucosinolates (GLCs), S-methylcystine sulfoxide (SMCSO), flavonoids, anthocyanins, carotenoids, polyphenols, vitamins, minerals, coumarins, therapeutic antioxidant enzymes, and terpenes (Shree *et al*., 2022) [9].
Broccoli (*Brassica oleracea* var. *italica* L.*)* is an important fancy and highly nutritive exotic vegetable. It is a rich source of folic acid, vitamin-C, vitamin-A and a compound, sulphoraphane which is associated in reducing the risk of cancer (Guo *et al.*, 2001) [1]. The 3, 3 - Di indolylmethane found in broccoli is a potent modulator of the innate immune response system with anti-viral, anti-bacterial and anti-cancer activity (Riby *et al*., 2006) [7].
Broccoli is commonly attacked by several insect-pests, such as different species of aphids like turnip aphid, *Lipaphis erysimi* Kaltenbach; cabbage aphid, *Brevicoryne brassicae* Linnaeus and green peach aphid, *Myzus persicae* Sulzer which economically damage these crops. Aphids mainly colonize on young plant tissues, causing reduced leaf size, delayed growth of the plant and reduced yield. The damage can be caused in two ways: feeding on plant sap by sucking (direct damage), and also transmitting virus to the plant (indirect damage) Moreover, aphids can cause an economic effect on a crop at levels of population densities that would decline the yield and affect marketability by physical contaminations with cast skins of aphid as well as honeydew (Sharma *et al*., 2017) [8].
Use of synthetic insecticides for management of aphid reduces the activity of honey bees and natural enemies. Additionally, due to a low input crop, great export potential and used for human consumption, use of costly and persistent insecticides is not advisable. In current era of environmental awareness; more emphasis is given to use of bio pesticides, as they are biodegradable and less harmful to natural enemies as well as the environment. Therefore, looking to the devastation due to aphids in broccoli, this experiment was conducted to evaluate different organic inputs against aphid.

## Materials and Methods

A two years field experiment was carried out on broccoli (*cv*. Palam Samruddhi) by adopting all standard agronomical practices at Horticulture Farm, College of Horticulture, Anand Agricultural University, Anand during *Rabi*, 2020-21 and 2021-22 following randomized block design with three replications and eight different treatments (Table 1).

First spray was made at initiation of aphid population and second spray after 15 days of first spray by using manually operated knapsack sprayer. The population of aphids was recorded before first spray as well as 5, 10 and 14 days after each spray. For the purpose, five plants were selected randomly from each net plot area. For each plant, three leaves were observed critically by adopting standard method of zero to four indices (Patel *et al.*, 2011) [5].

Adopting standard method of zero to four indices

| Indices | Description |
|---|---|
| 0 | Plant free from aphids |
| 1 | Aphids present but colonies were not builds up |
| 2 | Small colonies of aphid present |
| 3 | Large colonies of aphid present on tender parts (counting of the aphid colonies was possible and tender plant parts show the damage symptoms due to aphids) |
| 4 | Entire plants were covered by aphids (counts of aphids in colonies was impossible and plants show the damage symptoms due to aphids) and finally plant dies |

The average aphid index was worked out by following formula.

$$\text{Average aphid index} = \frac{0N + 1N + 2N + 3N + 4N}{\text{Total number of plants observed}}$$

Where,
0, 1, 2, 3, 4 are aphid index
N = number of plants showing respective aphid index

The data thus obtained were statistically analyzed after adopting square root transformation.

## Results

The population of aphid was homogeneous before first spray in all the treatments in pooled data of both years as treatment difference was non-significant. All the treatments significantly reduced the aphid population than control in pooled results of periods, sprays and years (Table 2).

The data on pooled over periods and years of first spray resulted that the lowest (0.80 aphid index) incidence of aphids was noticed in the treatment of *L. lecanii* 1.15% WP than the all the tested organic inputs. While, treatment of *M. anisopliae* 1.15% WP (1.13 aphid index) was found next in order to effectiveness. The remaining treatments, neem oil 0.3% (1.66 aphid index), neem seed kernel extract 5% (1.72 aphid index), cow urine 5% (1.57 aphid index) and *neemastra* (1.56 aphid index) were found least effective against aphid and at par with each other.

Pooled over periods and years of second spray revealed that that the lowest (0.60 aphid index) incidence of aphids was noticed in the treatment of *L. lecanii* 1.15% WP than the all the tested organic inputs. While, treatment of *M. anisopliae* 1.15% WP (0.87 aphid index) was found next in order to effectiveness. The remaining treatments, neem oil 0.3% (1.94 aphid index), neem seed kernel extract 5% (1.76 aphid index), cow urine 5% (1.92 aphid index) and *neemastra* (1.78 aphid index) were found least effective against aphid.

The data on pooled over periods, sprays and years revealed that the lowest (0.70 aphid index) incidence of aphids was noticed in the treatment of *L. lecanii* 1.15% WP than the all the tested organic inputs. While, treatment of *M. anisopliae* 1.15% WP (1.00 aphid index) was found next in order to effectiveness. The remaining treatments, neem oil 0.3% (1.80 aphid index), neem seed kernel extract 5% (1.74 aphid index), cow urine 5% (1.75 aphid index and *neemastra* (1.67 aphid index) were found least effective against aphid and at par with each other.

The data on pooled over years on curd yield of broccoli exhibited that the highest yield was obtained from the plots treated with *L. lecanii* 1.15% (15.78 t/ha) and it was at par with *M. anisopliae* 1.15% (14.52 t/ha). It was followed by the treatments of neem oil 0.3% (13.43 t/ha) and *B. bassiana* 5% (13.29 t/ha) which were mediocre in effect on aphid and thereby stood next in the order of yield of broccoli curd. Whereas, the lowest curd yield was recorded in plot treated with cow urine 5% (11.94 t/ha) and it was found to remain at par with *neemastra* (12.31 t/ha) and neem seed kernel extract 5% (12.40 t/ha).

For sustainable management of aphids infesting broccoli, of all evaluated organic inputs, *L. lecanii* 1.15% WP @40 g/ 10 litre water found the most effective against aphids. While, *M. anisopliae* 1.15% WP @40 g/ 10 litre water was found the next best in order of its effectiveness against aphids. Muthyala and Mahale (2024) [4] found the highest reduction in mean aphid (*Brevicoryne brassicae* Linnaeus) population in broccoli (*var.* Sakata) plants treated with neem oil 10,000 ppm @ 2 ml/litre (32.56 aphids/ plant) followed by *Beauveria bassiana* 1.15% WP @5 g/litre (35.60 aphids/ plant), *Lecanicillium lecanii* 1.15% WP @ 5 g/litre (39.36 aphids/ plant) and *Metarhizium anisoplae* 1.15% WP @5 g/litre (43.31 aphids/ plant) among all biopesticides in Maharashtra. Out of all botanical extracts evaluated against cabbage aphid (*B. brassicae*), Kumar and Tayde (2019) [2] recorded the highest mean per cent reduction in neem seed kernel extract 5% (49.06% and 74.08%) followed by neem oil 2% (48.60% and 71.80%) after first and second spray, respectively in Uttar Pradesh. The slight deviation in earlier findings from the concurrent outcomes might be due to variation in the crop selected, variety of broccoli, species of aphids, experimental site and environmental conditions.

**Table 1:** Organic inputs utilized in the experiment

| Tr. No. | Name of treatments | Spore load (cfu/g) | Quantity required (ml or g/10 litre) |
|---|---|---|---|
| 1. | Neem seed kernel extract 5% | - | 500 |
| 2. | Neem oil 0.3% | - | 30 |
| 3. | *Lecanicillium lecanii* 1.15% WP | 1 x $10^9$ cfu/g | 40 |
| 4. | *Metarhizium anisopliae* 1.15% WP | 1 x $10^9$ cfu/g | 40 |
| 5. | *Beauveria bassiana* 5% WP | 1 x $10^9$ cfu/g | 40 |
| 6. | Cow urine 5% | - | 500 |
| 7. | *Neemastra* (200 lit water + 10 lit cow urine + 2 kg fresh cow dung + 10 kg neem leaves) | - | 500 litre/ ha |
| 8. | Untreated (control) | - | - |

**Note:** 500 litres water per hectare was used and sticker 0.1% was added in the solution

**Table 2:** Effect of organic inputs against aphid infesting broccoli and yield (Pooled: 2020-21 and 2021-22)

| Tr. No. | Treatments | Aphid index (0-4) at indicated days after spray | | | | | | | | | | Yield (t/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Before spray | First spray | | | | Second spray | | | | Pooled over periods, sprays and years | |
| | | | 5 | 10 | 14 | Pooled over periods | 5 | 10 | 14 | Pooled over periods | | |
| 1 | Neem Seed Kernel Extract 5.0% | 1.46 | $1.36^{b}$ | $1.53^{b}$ | $2.26^{b}$ | $1.72^{b}$ | $1.90^{b}$ | $1.60^{b}$ | $1.80^{b}$ | $1.76^{c}$ | $1.74^{bc}$ | $12.40^{c}$ |
| 2 | Neem oil 0.3% | 1.50 | $1.34^{b}$ | $1.36^{bc}$ | $2.30^{ab}$ | $1.66^{b}$ | $2.06^{b}$ | $1.83^{b}$ | $1.93^{b}$ | $1.94^{b}$ | $1.80^{b}$ | $13.43^{bc}$ |
| 3 | *L. lecanii* 1.15% WP | 1.36 | $0.76^{d}$ | $0.56^{e}$ | $1.06^{e}$ | $0.80^{e}$ | $0.80^{e}$ | $0.36^{d}$ | $0.63^{e}$ | $0.60^{f}$ | $0.70^{f}$ | $15.78^{a}$ |
| 4 | *M. anisopliae* 1.15% WP | 1.33 | $1.06^{c}$ | $0.93^{d}$ | $1.40^{d}$ | $1.13^{d}$ | $1.10^{d}$ | $0.63^{d}$ | $0.86^{d}$ | $0.87^{e}$ | $1.00^{e}$ | $14.52^{ab}$ |
| 5 | *B. bassiana* 5% WP | 1.30 | $1.20^{bc}$ | $1.20^{c}$ | $1.90^{c}$ | $1.43^{c}$ | 1.53c | $1.16^{c}$ | $1.40^{c}$ | $1.36^{d}$ | $1.40^{d}$ | $13.29^{bc}$ |
| 6 | Cow urine 5.0% | 1.40 | $1.20^{bc}$ | $1.33b^{c}$ | $2.20^{bc}$ | $1.57^{bc}$ | $2.00^{b}$ | $1.80^{b}$ | $1.96^{b}$ | $1.92^{b}$ | $1.75^{bc}$ | $11.94^{cd}$ |
| 7 | *Neemastra* | 1.46 | $1.23^{bc}$ | $1.46^{bc}$ | $2.00^{bc}$ | $1.56^{bc}$ | $1.80^{b}$ | $1.70^{b}$ | $1.86^{b}$ | $1.78^{bc}$ | $1.67^{c}$ | $12.31^{c}$ |
| 8 | Untreated Control | 1.47 | $1.70^{a}$ | $2.10^{a}$ | $2.63^{a}$ | $2.14^{a}$ | $3.00^{a}$ | $3.10^{a}$ | $3.23^{a}$ | $3.11^{a}$ | $2.62^{a}$ | $10.33^{d}$ |
| S.Em.± | Treatment (T) | 0.09 | 0.07 | 0.08 | 0.10 | 0.05 | 0.08 | 0.09 | 0.07 | 0.05 | 0.03 | 0.53 |
| | Period (P) | - | - | - | - | 0.03 | - | - | - | 0.03 | 0.03 | - |
| | Spray (S) | - | - | - | - | - | - | - | - | - | 0.02 | - |
| | Year (Y) | 0.05 | 0.03 | 0.04 | 0.05 | 0.02 | 0.04 | 0.04 | 0.03 | 0.02 | 0.01 | - |
| | T x P | - | - | - | - | 0.08 | - | - | - | 0.08 | 0.08 | 0.29 |
| | T x S | - | - | - | - | - | - | - | - | - | 0.04 | - |
| | P x S | - | - | - | - | - | - | - | - | - | 0.03 | - |
| | T x Y | 0.14 | 0.10 | 0.11 | 0.14 | 0.07 | 0.12 | 0.13 | 0.10 | 0.07 | 0.03 | 0.83 |
| | P x Y | - | - | - | - | 0.04 | - | - | - | 0.04 | 0.04 | - |
| | S x Y | - | - | - | - | - | - | - | - | - | 0.02 | - |
| | T x P x S | - | - | - | - | - | - | - | - | - | 0.07 | - |
| | T x P x Y | - | - | - | - | 0.12 | - | - | - | 0.12 | 0.12 | - |
| | T x S x Y | - | - | - | - | - | - | - | - | - | 0.06 | - |
| | T x P x S x Y | - | - | - | - | - | - | - | - | - | 0.10 | - |
| C.D. at 5% | T | NS | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| C. V. (%) | | 17.34 | 15.30 | 15.60 | 12.73 | 11.70 | 12.52 | 15.35 | 10.33 | 12.82 | 10.16 | 11.16 |

**Notes:** 1. Treatment mean(s) with the letter(s) in common are not differing significantly by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance
2. Significant parameters and its interactions: P, SxP, SxT and SxPxT
3. NS: Non-significant, Sig.: Significant

## Conclusion

The study demonstrates significant efficacy of various organic treatments in managing aphids on broccoli. Initially homogeneous aphid populations across treatments underscored the robustness of the experimental design. Over pooled periods and years, *Lecanicillium lecanii* 1.15% WP consistently exhibited the highest efficacy, with Metarhizium anisopliae 1.15% WP following closely behind. Conversely, neem oil 0.3%, neem seed kernel extract 5%, cow urine 5%, and neemastra showed comparatively lower effectiveness. Moreover, *L. lecanii* 1.15% WP also yielded the highest broccoli curd production, suggesting dual benefits in pest control and crop yield enhancement. For sustainable aphid management in broccoli, *L. lecanii* 1.15% WP @ 40 g/10 litre water emerges as the optimal choice, highlighting its potential for integrated pest management strategies in agricultural practices.

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