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# ECOFRIENDLY APPROACHES FOR CONTROLLING MUSTARD APHID (*LIPAPHIS ERYSIMI* KALT.) INFESTATION

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**ABSTRACT**

Brassica oilseed crops are grown all over the world, but the aphids of cabbage, *Brevicoryne brassicae* L. and Turnip aphid *Lipaphis erysimi* Kalt, cause mischief to the crops everywhere in the world. A field experiment was conducted at the Agricultural Farm Area of Airport Campus of Ghazi University Dera Ghazi Khan during mid-November 2019 to test eco-friendly management methods for mustard aphids. The experiment was laid out in a randomized complete block design with three replications and five treatments in 2 m ×2.7 m size plots. Seeds of the Khanpur Raya variety were sown in mid-November 2019. The treatments included (i) Neem leaf extract, (ii) Dimethoate, (iii) Lemongrass oil, (iv) Mustard Cake, and (v) Control (untreated). The overall results of the experiment showed that after the second spray, the aphids became immune to synthetic pesticides. However, bio-pesticides had some control over the aphids, with Lemongrass oil producing the best results, achieving almost 80 percent control, followed by about 72 percent control with neem extract and almost 67 percent control with mustard cake. This suggests that Lemongrass oil can be used to control aphids on mustard plants and, since it is a bio-pesticide, it has many biological benefits. Therefore, it can be concluded that using botanical products for managing mustard aphids can be an effective and eco-friendly approach.

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## INTRODUCTION

Brassica oilseed crops are cultivated all over the world. Canola (*Brassica napus* L.) is a variety of rapeseed and is also referred to as sweet mustard. It was introduced by the Pakistan Agricultural Research Council in Pakistan during 1980-81 and is currently a major oilseed yield in Pakistan (Aslam et al., 2007, 2009; Syed et al., 1999). Rapeseed (*B. campestris* L. var. toria) is a shiny yellow-flowering member of the family Brassicaceae, cultivated mainly for its oil-rich seed. It is the third-largest supplier of vegetable oil in the world. It is an annual crop and is generally an herb with a lengthy and tapering root. The leaves are glabrous, bushy, and pale to dark green in color. The flower is yellow to light yellow with four sepals and four petals, along with tetradynamous stamens. The seed is brown to yellow, depending on the variety. Rapeseed contains 40-45% oil and 24% protein. It is considered safe for people with weak hearts and those suffering from chronic diseases. Rapeseed and mustard are essential

oilseed crops and contribute significantly to the production of edible oil in our country. The demand for oilseeds has made production characteristics unsatisfactory due to a variety of pests attacking the crops. In the world, more than forty-five insect pest species infest mustard crops, including around a dozen as major pests (Parwar and Sachan, 2004).

The three most prolific and widely distributed types of aphids are cabbage aphid (*Brevicoryne brassicae* L.), turnip aphid (*Lipaphis erysimi* Kalt.), and green peach aphid (*Myzus persicae* Sulz.) (Rehman et al., 1987). The cabbage aphid, *B. brassicae* L., and turnip aphid, *L. erysimi*, are destroying these crops around the globe (Hainan, 2007). Kelm and Gadomski (1995) pointed out that plants pervaded by aphids had shown restraint in development and growth, and seed yield misfortune had gone up to 9-77%. Aphids have also contributed to an 11 percent drop in seed oil content.

The primary limiting factor for rapeseed production is the mustard aphid, *L. erysimi* (Homoptera: Aphididae), which sucks plant sap from the delicate shoots of the plant at the beginning and then sucks the sap from the immature pods, causing considerable damage to the plant. Flowers that are infested become vulnerable and scrubby, and many infested flowers do not bloom at all. Excessive honeydew discharge by the aphids results in leaves being unable to photosynthesize. Under certain agro-climatic conditions, yield loss due to this pest can be as high as 97.6 percent (Patel et al., 2004). Likewise, aphid-borne infections are responsible for additional quantitative and qualitative damage, resulting in yield losses ranging from 35.4 to 96 percent depending on weather conditions. *L. erysimi*, once the most severe insect pest of rapeseed-mustard, is responsible for these losses (Das, 2018). The use of insect control chemicals leads to environmental contamination issues, pest resurgence, hazardous effects for pollinators and natural enemies, and also affects human health. The adverse effects of dangerous chemical pesticides have led to the search for environmentally friendly insect pest control, including microbial processes with aggressive entomopathogenic fungi and botanical pesticides as excellent alternatives (Bakhetia and Sekhon, 1989).

The objective of the study is to control and manage the population of mustard aphid (*Lipaphis erysimi*) with some botanicals in a way that is environmentally sustainable and does not harm the natural balance of the ecosystem. The objective aims to reduce the damage caused by the pest to mustard crops and promote the growth and yield of the plants while minimizing the use of chemical pesticides that may have adverse effects on the environment and human health.

## MATERIALS AND METHODS

The current experiment was conducted in the farm field of Ghazi University, Dera Ghazi Khan Airport Campus, from mid-November 2019 to March 2020 to explore the utility of biopesticides against mustard aphid in an environmentally friendly manner. The following details regarding the experimental materials and methods are provided.

### Location and duration of the experimental site

The research was conducted in the farm area of Ghazi University, Dera Ghazi Khan Airport Campus, during the Rabi season of 2019-20 (from mid-November 2019 to March 2020).

### Soil characteristics of the experimental site

The experimental site was located in the farm area of Ghazi University. It had medium-high elevation, fertile soil, good drainage, and a fairly level surface.

### Field Preparation

The experimental plot was opened using a power tiller-driven rotovator, plowed and cross-plowed, and then raked to obtain a good tilth. The corners were marked, weeds and stubbles were removed, and large pieces of soil were broken into smaller ones to achieve the desired tilth for seed sowing. The land was divided into five 2.0 m × 2.7 m plots with a plot width of 30 cm. There were nine rows in each plot.

### Fertilizer Application

Nitrogen, Phosphorus, and Potash fertilizers were applied as prescribed. Half of the urea fertilizer was used as a basal dose during final soil preparation, and the remaining half was top-dressed 20 days after germination.

### Experiment Design and Layout

The experiment was conducted using a Randomized Complete Block Design with three replications. Five treatments were used, and each treatment was applied to five plots measuring 2 m × 2.7 m (5.4 $m^2$). The adjacent and neighboring blocks were separated by 30 cm.

### Treatments

Five treatments were evaluated in this study against mustard aphid. The group-wise insecticides with their

specific doses applied as treatment are given in Table 1.

**Planting materials**

The mustard variety Khanpur Raya was cultivated in the designated field to investigate the effects of the above-mentioned treatments.

**Seed sowing**

Seeds of the Khanpur Raya variety of mustard were sown in the selected field in November 2019, with a distance of 30 cm between rows. After sowing, the field was irrigated.

Table 1: Detail of treatments used against mustard aphid.

| Treatment | Insecticide | Dose | Application interval |
|---|---|---|---|
| T1 | Neem leaf extract | 25g per liter of water | 3, 6, 9 days |
| T2 | Dimethoate | 20 ml per liter of water | 3, 6, 9 days |
| T3 | Lemongrass oil | 15 ml per liter of water | 3, 6, 9 days |
| T4 | Mustard cake | 1 kg per liter of water | 3, 6, 9 days |
| T5 | Control | - | 3, 6, 9 days |

**Intercultural operation**

The weeds observed in the mustard were manually removed. Thinning of the mustard seedlings was executed as required during the growing season, and care was taken to maintain a uniform plant population per plot. Flood irrigation was given three times at the vegetative stage.

**Application of treatments**

The selected treatments comprising different insecticides with their assigned doses were applied in the respective plots when the aphids first appeared in the mustard field. The first incidence or appearance of aphids was determined by visiting and direct visual observation of mustard plants on a daily basis.

**Data collection and calculation**

Data collection began when aphids were first observed. Ten plants were randomly selected, and the number of aphids was counted at the inflorescence level using the direct visual count method throughout the growing period of mustard in the field before spraying of insecticides. Observations were taken from 10 cm of central apical inflorescence shoots of 10 randomly selected plants of each plot. The findings for the mustard aphid were recorded both before and after treatment.

**Statistical analysis**

The collected data were entered into an Excel sheet, and then they were analyzed with the help of the statistical tool R. The data were analyzed using ANOVA (Analysis of Variance) to check for differences among the means.

**RESULTS**

**Aphid population before and after first spray**

The results indicate that the population of aphids varied across the treatments and the control group. Before treatment, the population of aphids ranged from 17.30 to 28.60, with T3 having the highest population and T4 the lowest. After three days of treatment, all treatments showed a decrease in the population of aphids compared to before treatment, with the exception of T2, which showed a slight increase. After six days, the population of aphids further decreased for all treatments, except T4, which showed an increase. On the ninth day, the population of aphids continued to decrease for T1 and T3, while T2 and T4 showed an increase in the population of aphids compared to the 6$^{th}$ day. The control group (T5) showed little change in the population of aphids over time (Table 2).

**Aphid population after second spray**

Table 3 presents the results of aphid population counts at three different time points (3$^{rd}$, 6$^{th}$, and 9$^{th}$ day) after the second spray treatment. Based on the Table 3, it can be seen that the aphid populations were generally reduced after the second spray treatment compared to the control treatment. Among the treatments, T4 had the most significant reduction in aphid populations, with values significantly lower than those of other treatments and the control at all three time points. T3 also had lower aphid populations than T1 and T2, but the differences were only significant at the 3$^{rd}$ and 6$^{th}$ day. T1 and T2 had similar aphid populations, with T2 having a significant reduction at the 6$^{th}$ day. The control treatment (T5) had the highest aphid populations, significantly higher than all other treatments at all three time points.

**Aphid population after third spray**

The results are presented in the Table 4 for three different time periods after the third spray treatment, which were the 3$^{rd}$ day, 6$^{th}$ day, and 9$^{th}$ day. The

population of aphids was measured in each treatment group at these time points. For example, on the 3rd day, the population of aphids in T1 was 12.10. The population in T2 was 16.10 while the population in T3 was 14.20, and in T4 were 20.20. However, the population in the control group was 76.00.

Table 2. Aphid population before and after first spray.

| Treatment | Aphid population | | | |
|---|---|---|---|---|
| | Before | 3rd day | 6th day | 9th day |
| T1 | 18.40[a] | 15.60[a] | 13.60[a] | 12.10[a] |
| T2 | 21.00[a] | 12.80[a] | 11.30[a] | 14.10[a] |
| T3 | 28.60[c] | 24.90[c] | 24.40[c] | 21.00[c] |
| T4 | 17.30[b] | 12.40[b] | 19.10[b] | 27.60[b] |
| T5 (control) | 22.90[c] | 27.50[c] | 20.80[c] | 22.30[c] |
| Mean | 21.64 | 18.64 | 17.84 | 19.42 |
| P-value | 0.002 | 0.002 | 0.107 | 0.007 |
| CV % | 27.29 | 31.28 | 39.52 | 35.91 |
| LSD | 3.80 | -3.80 | 2.00 | 3.38 |

Means sharing same letters do not differ significantly. CV= Coefficient of Variance, LSD= Least Significant Difference

Table 3. Aphid population after second spray.

| Treatment | Aphid population | | |
|---|---|---|---|
| | 3rd day | 6th day | 9th day |
| T1 | 13.20[a] | 13.10[a] | 11.70[a] |
| T2 | 16.00[a] | 10.20[a] | 13.10[a] |
| T3 | 17.80[b] | 15.30[b] | 12.70[b] |
| T4 | 19.80[c] | 22.50[c] | 16.50[c] |
| T5 (control) | 34.30[d] | 45.40[d] | 49.10[d] |
| Mean | 20.22 | 21.30 | 20.62 |
| P-value | 0.08 | 0.08 | 0.52 |
| CV % | 41.64 | 61.50 | 71.04 |
| LSD | 1.08 | 0.68 | 0.40 |

Means sharing same letters do not differ significantly. CV= Coefficient of Variance, LSD= Least Significant Difference

Table 4. Aphid population after third spray.

| Treatment | Aphid population | | |
|---|---|---|---|
| | 3rd day | 6th day | 9th day |
| T1 | 12.10[a] | 21.30[a] | 17.10[a] |
| T2 | 16.10[b] | 15.90[b] | 23.20[b] |
| T3 | 14.20[c] | 9.80[c] | 6.40[c] |
| T4 | 20.20[d] | 19.30[d] | 20.30[d] |
| T5 (control) | 76.00[e] | 90.80[e] | 100.50[e] |
| Mean | 27.72 | 31.42 | 34.70 |
| P-value | 0.00 | 0.00 | 0.01 |
| CV % | 88.7 | 97.7 | 95.1 |
| LSD | -3.70 | 3.28 | 6.98 |

Means sharing same letters do not differ significantly. CV= Coefficient of Variance, LSD= Least Significant Difference

From the results, it can be observed that the population of aphids in the control group was much higher than in any of the treatment groups at all three time periods. This suggests that the treatments were effective in

reducing the population of aphids. Additionally, it can be seen that some treatments were more effective than others. For example, on the 6th day, T1 had a population of 21.30, while T2 had a population of 15.90, and T3 had a population of 9.80. T1 and T2 were not significantly different from each other, but both were significantly different from T3, indicating that T3 was the least effective treatment at that time period.

**DISCUSSION**

Aphids are a well-known and major pest that can be found on Brassica crops (Bakhetia and Ghorbandi, 1987; Bakhetia and Sekhon, 1989). While traditional specific organic insecticides can provide good control of these aphids (Bhadra and Parna, 2010; Kumar et al., 2020), some chemicals can pose serious hazards to the environment and the safety of the population due to their prolonged resistance and high toxicity (Kulkarni and Joshi, 1998).

The results of this study indicate that, out of the 5 treatments, neem leaf extract (T1), dimethoate (T2), lemongrass oil (T3), mustard cake (T4), and control (T5), dimethoate provided the best results for controlling aphids during the first 2 sprays, but it gave minimum results on the third spray due to the resistance developed by aphids over time. Lemongrass oil provided the best results throughout the experiment, with almost 80% control, followed by neem extract with about 72% and mustard cake with almost 67%. The extract of neem leaf caused a reduction of 63.16-72.55% in the population of mustard aphid (Biswas, 2013), which supports the present findings. In the control treatment, as no controlled strategy was used, the number of aphids increased linearly with time and after each spray.

In this study, the results revealed that the mortality rate of aphids was higher when treated with Neem leaf extract during the first spray, and the increasing trend in aphid death was observed best on day 3 and day 6, which showed significant results. The increase in the death rate of aphids with the passage of time was due to the killing activity of Neem leaf extract on the aphid population. Mustard aphids were killed at a higher rate when the fields were sprayed with Neem leaf extract. Jahan et al. (2011) reported a 50.58% decrease in the population of Mustard aphid after treating the twigs with Neem leaf extract for 96 hours. Pandey et al. (1987) revealed that neem oil was 1.5% effective against *L. erysimi* under standard laboratory conditions. Lowery and Isman (1994) reported that neem seeds and their extracts in crude formulation contained limonoids which have antifeedant and repellent activities. The development and growth of Mustard aphids were inhibited due to an imbalance of hormonal regulation and growth failure of the reproductive system.

The results of this study showed that Lemon grass oil (T2) had an effect on the activity of aphids. Before the application of lemon grass oil, and on day 3, the results were significant. On day 6 and day 9, the results were non-significant during the first spray. During the second spray, all the results were non-significant throughout the time period. However, during the third spray, all the values were significant. The table showed that fields which were sprayed with lemon grass oil had a reduced number of aphids with the passage of time up to day 9. However, at day 9, an increase in the number of aphids was observed. This phenomenon occurred because lemon grass oil has a killing effect on these aphids and caused a reduction in their numbers due to its antagonistic activity with mustard aphids. The increase in the number of aphids at day 9 during all three sprays was due to the resistance of mustard aphids which developed against lemon grass oil with the advancement of time. Kafle (2015) reported that the use of lemon grass oil was effective against killing mustard aphids. He found that the population of aphids decreased day by day after the application of lemon grass oil. Such findings also support the results of this experiment. Srivastava and Guleria (2003) studied the same effect of lemon grass and other bio-plants for aphid control in the field of mustard. They concluded that the number of aphids on the plant leaves reduced when they sprayed them with lemon grass oil.

The results revealed that, before the application of Mustard cake, significant effects on the activity of aphids were observed on day 3, whereas on day 6 and day 9, the effects were non-significant during the first spray. During the second spray, all results were non-significant throughout the time period. However, during the third spray, all values were significant. Aziz et al. (2014) found that 1% mustard cake is sufficient to kill a great population of mustard aphids.

The effect of Dimethoate (T4) on the activity of aphids showed significant results before its application and on day 3. On day 6 and day 9, the effects were non-significant during the first spray. During the second spray, all results were non-significant throughout the

time period, whereas during the third spray, all values were significant. Dimethoate is an insecticide that gave the best results during the first two sprays. However, during the third spray, it gave no significant results. This may be because aphids have developed resistance against this insecticide. Harun et al. (2003) tested mustard plants with dimethoate (0.025% concentration) to check the death rate of mustard aphids and concluded that dimethoate gave the best result when used against aphids.

The number of mustard aphids increased in the control treatment with the passage of time from day 3 to day 9. Mustard plants without any spray of chemicals suffered a big attack and loss from aphids (Mandal et al., 2019).

## CONCLUSION

After analyzing the results of the experiment, it can be inferred that Lemon grass oil proved to be the most effective treatment in reducing the population of aphids on mustard plants, followed by neem extract and mustard cake. Hence, it can be concluded that the use of Lemon grass oil can be a potential solution for controlling aphid infestation in mustard crops, while neem extract and mustard cake can also be considered as viable alternatives.

## AUTHORS' CONTRIBUTION

MSN and AR designed, formulated and laid out the study, MSN and KS conducted the experiments, MSN, MRH and SM collected, arranged and analyzed the data, AR provided technical assistance, MSN and AR supervised the work, MSN and SM wrote the manuscript, AR proofread the paper.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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