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Efficacy of Different Essential Oils Against Nymphal Stage of Aphid (*Aphis craccivora* Koch) in Green Gram (*Vigna radiata* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: Study the mortality rate of aphid, *Aphis craccivora* Koch when treated with different essential oils against the nymphal stage.
Study Design: Complete randomized design.
Place and Duration of Study: Biswanath College of Agriculture, Biswanath Chariali during 2022-23

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Methodology: All essential oils were applied at three different concentrations *viz.,* 1%,3% and 5% and recorded the mortality percentage after 4,12, 24, 48 and 72 hours of application.
Results: The result showed that neem oil had the best effect on the mortality of nymph (96.67%,100%,100%) in 1,3 and 5 per cent concentration after 72 hours after treatment. The second highest mortality was recorded against nymphs in mint oil (83.33%) followed by clove (80.00%), garlic (76.67%), ginger (73.33%) and eucalyptus (66.67%) oil against nymphs at 72 hours after treatment.
Conclusion: In the present study essential oils showed that mortality rate increased with increasing concentration and times.

Keywords: Aphis craccivora; essential oil; mortality; nymph; treatment.

1. INTRODUCTION

Green gram [*Vigna radiata* (L) Wilczek] commonly known as mung bean is an important pulse crop of India after chickpea and pigeon pea which provide a protein-rich diet to the Indian vegetarian people [1] with 211 calories and 14.2 grams of proteins and rich source of minerals, irons and fiber. In India, green gram has been regarded as the only source of protein for the underprivileged with an annual yield of 13 to 15 million tonnes [2]. Among all insect pest species aphids are one of the most destructive pests of green gram [3]. Aphids consume plant sap, which results in the deformation and curling of leaves, particularly when their population is substantial. The secretion of honeydew, a sweet substance by aphids, promotes the development of sooty mold (specifically *Capnodium* spp.) on both harvestable plant parts and leaves, thus diminishing their overall quality [4]. The utilization of chemical pesticides has the potential to negatively impact beneficial organisms that control pests, potentially leading to the resurgence of pests or outbreaks. Consequently, integrated pest management (IPM) is gaining increased recognition as an environmentally friendly approach, which involves the synergistic use of biopesticides and biocontrol agents. This strategy combines predators and parasitoids with botanical extracts for pest management [5]. Essential oils demonstrate promising capabilities in managing insect and mite pests. They have proven to be effective through methods like fumigation and topical application, and they also possess properties that deter feeding and repel these pests [6]. The efficacy of essential oils in managing stored product pests and various other pest species is widely recognized and Their usefulness in the control of aphids has been reported for repellency and feeding deterrent activity [7]. Their lipophilic nature allows them to disrupt fundamental metabolic, biochemical, physiological, and behavioral functions in insects [8].

2. MATERIALS AND METHODS

For the development of aphid population, green gram crop (var. IPM2-3) was grown in two plots, measuring 10 sqm (2.0 x 5.0 m) each. A gap of 1m was obtained between the two plots. The crop was raised without any insecticidal treatment, so that population of the pest could build up freely. Observation were taken daily to record the appearance of the pest. Accordingly need based aphid population was collected in order to carry out the experiments in laboratory. All essential oils viz., neem oil (*Azadirachta indica* A. Juss.), mint oil (*Mentha piperita* L.), garlic oil (*Allium sativum* L.), ginger oil (*Zingiber officinale* Roscoe), eucalyptus oil (*Eucalyptus gobulus* Labill.) and clove oil (*Syzygium aromaticum* L. Myrtaceae) were collected from the local market. Emulsifier tween 20 (0.02%) was used as surfactant as the oil does not readily mix with water. Then distilled water was added to get different concentrations such as 1, 3 and 5 per cent. All solutions were stirred well so that oil and water can mix thoroughly. All essential oils were applied at three different concentrations *viz.,* 1%, 3% and 5%. The healthy leaves of green gram crop were collected from the experimental plot for the investigation on bio-assay against the tested insect, *A. craccivora*. The collected leaves were washed thoroughly with tap water and dried under laboratory conditions. The washed and dried leaves were examined under binocular microscope and presence of any living micro-organisms were removed from the surface of the leaves. After visual confirmation, leaves were cut into disces (2.5 cm dia. each) and these discs were treated with already prepared different oil solutions at 1, 3 and 5 per cent concentration. The treated disc were kept upside down on a wet filter paper (110 mm) placed in a petri dish (9 cm dia.). A water soaked cotton swab also kept in each petridish in order to maintain the hydrated conditions. In this way, a total of 21 numbers of petridish were ready for investigation. These were arranged in

three replications along with seven treatments. Such type of arrangements were set up in three different batches for testing the efficacy of essential oils at 1, 3 and 5 per cent concentrations. Petridishes containing aphids (both nymph and adults) were carefully closed and kept at 25±1^0 C to count died individuals and recorded the mortality percentage after 4, 12, 24, 48 and 72 hours of application. Mortality was confined by touching the tested individuals with a fine brush. Aphids that did not show the realistic movement were considered as dead.The data so generated were subjected to analysis of variance (ANOVA) following Completely Randomized Design (CRD) after angular transformation. The data on mortality also subjected to Abbot's correction (Abbot, 1925) whenever the mortality in the untreated was obtained.The per cent mortality was calculated as per the following formula-

$$\text{Per cent Mortality} = \frac{\text{No of dead tested individual}}{\text{Total no.of tested individual}} \times 100$$

3. RESULTS AND DISCUSSION

The data in Table 1 showed that the highest mortality was recorded in neem oil (96.67%) followed by clove (63.33%), mint (60.00%) and garlic oil (53.33%) at 72HAT. During the experimentation, no mortality was recorded in the control. The data in Table 2 indicated that the highest mortality was recorded in neem oil (100%) and mint oil (73.33%) followed by clove (66.67%), garlic (63.33%), ginger (60.00%) and eucalyptus oil (53.33%). However, no mortality was recorded in control during the experimentation at 72HAT. The data in Table 3 indicated that 100 per cent mortality was recorded in neem oil. The second highest mortality was recorded against nymphs in mint oil (83.33%) followed by clove (80.00%), garlic (76.67%), ginger (73.33%) and eucalyptus oil (66.67%) oil against nymphs. at 72HAT. However, no mortality was recorded in the control at 72HAT during the investigation. Our present study observed a dose and time dependent mortality on application of essential oil on nymphs. The highest nymph mortality of 100 per cent was recorded at 3 and 5 per cent concentration after 72 hours of treatment on neem oil followed by mint oil (83.33%), clove oil (80.00%), garlic oil (76.67%), ginger oil (73.33%) and eucalyptus oil (66.67%). Our results are in close conformity with the results obtained by Singh and Arya [9] who reported 100% mortality of mustard aphid, *Lipaphis erysimi* at 4% concentration. Bhuiyah *et al.* [10] had also studied the methanol extracts of leaves of *Azadirachta indica*, at both concentrations of 5 and 10% gave 100% protection to lentil and

Table 1. Effect of essential oils (1%) on nymph mortality of *A. craccivora*

Treatment	Mortality (% ± S.Em) at 1%				
	4HAT	**12HAT**	**24HAT**	**48HAT**	**72HAT**
Neem oil	0.00±0.00 (0.00)	26.67±5.77 (31.00)	43.33±11.55 (41.07)	70.00±10.00 (57.00)	96.67±5.77 (83.80)
Mint oil	0.00±0.00 (0.00)	23.33±20.82 (24.15)	23.33±20.82 (24.15)	40.00±20.00 (38.86)	60.00±10.00 (50.85)
Garlic oil	0.00±0.00 (0.00)	0.00±0.00 (0.00)	10.00±10.00 (15.00)	46.67±23.09 (42.7)	53.33±11.55 (46.92)
Ginger oil	0.00±0.00 (0.00)	23.33±15.28 (28.08)	33.33±11.55 (35.01)	50.00±10.00 (45.00)	50.00±10.00 (45.00)
Eucalyptus oil	0.00±0.00 (0.00)	0.00±0.00 (0.00)	30.00±10.00 (33.00)	36.67±5.77 (37.22)	46.67±5.77 (43.08)
Clove oil	0.00±0.00 (0.00)	13.33±11.55 (17.71)	40.00±10.00 (39.15)	53.33±5.77 (46.92)	63.33±5.77 (52.78)
Control	0.00±0.00 (0.00)	0.00±0.00 (0.00)	0.00±0.00 (0.00)	0.00±0.00 (0.00)	0.00±0.00 (0.00)
S.E.d (±)	3.28	8.76	8.76	6.46	4.87
C.D (P=0.05)	NS	18.79	18.80	13.86	10.44

Data represented are the mean of three replications with 10 insects each
Mean within parentheses are the angular transformed values
Significant at P=0.05, NS-Non-significant
HAT- Hours after treatment
S.E.d- Standard error of deviation
C.D.- Critical Difference
S.Em- Standard error means

Table 2. **Effect of essential oils (3%) on nymph mortality of *A. craccivora***

Treatment	Mortality (% ± S.Em) at 3%				
	4HAT	**12HAT**	**24HAT**	**48HAT**	**72HAT**
Neem oil	10.00±0.00 (18.43)	26.67±15.28 (30.29)	56.67±5.77 (48.85)	73.33±11.55 (59.21)	100±0.00 (90.00)
Mint oil	3.33±5.77 (6.14)	20.00±10.00 (26.07)	40.00±10.00 (39.15)	56.67±5.77 (48.85)	73.33±5.77 (59.00)
Garlic oil	0.00±0.00 (0.00)	16.67±5.77 (23.86)	30.00±10.00 (33.00)	53.33±5.77 (46.92)	63.33±5.77 (52.78)
Ginger oil	0.00±0.00 (0.00)	13.33±5.77 (21.14)	26.6.67±5.77 (31.00)	50.00±10.00 (45.00)	60.00±10.00 (50.85)
Eucalyptus oil	0.00±0.00 (0.00)	10.00±00 (18.43)	23.33±5.77 (28.78)	43.33±5.77 (41.15)	53.33±11.55 (46.92)
Clove oil	6.67±11.55 (8.86)	20.00±10.00 (26.07)	36.67±5.77 (37.22)	53.33±15.28 (47.01)	66.67±5.77 (54.78)
Control	0.00±0.00 (0.00)	0.00±0.00 (0.00)	0.00±0.00 (0.00)	0.00±0.00 (0.00)	0.00±0.00 (0.00)
S.E.d (±)	7.14	5.05	3.48	4.37	3.35
C.D (P=0.05)	NS	10.84	7.47	9.36	7.19

Data represented are the mean of three replications with 10 insects each
Mean within parentheses are the angular transformed values
Significant at P=0.05, NS-Non-significant
HAT- Hours after treatment
S.E.d- Standard error of deviation
C.D.- Critical Difference
S.Em- Standard error means

Table 3. **Effect of essential oils (5%) on nymph mortality of *A. craccivora***

Treatment	Mortality (% ± S.Em) at 5%				
	4HAT	**12HAT**	**24HAT**	**48HAT**	**72HAT**
Neem oil	16.67±5.77 (23.86)	40.00±17.32 (38.86)	76.67±15.28 (61.92)	90.00±10.00 (75.00)	100±0.00 (90.00)
Mint oil	10.00±10.00 (15.00)	33.33±5.77 (35.22)	60.00±10.00 (50.85)	76.67±5.77 (61.22)	83.33±5.77 (66.14)
Garlic oil	6.67±11.55 (8.86)	30.00±17.32 (32.71)	56.67±11.55 (48.93)	63.33±5.77 (52.78)	76.67±5.77 (61.22)
Ginger oil	6.67±5.77 (12.29)	26.67±5.77 (31.00)	46.67±15.28 (42.99)	60.00±17.32 (50.94)	73.33±5.77 (59.00)
Eucalyptus oil	3.33±5.77 (6.14)	20.00±10.00 (26.07)	43.33±11.55 (41.07)	56.67±5.77 (48.85)	66.67±5.77 (54.78)
Clove oil	10.00±10.00 (15.00)	30.00±10.00 (33.00)	53.33±5.77 (46.92)	70.00±0.00 (56.79)	80.00±0.00 (63.93)
Control	0.00±0.00 (0.00)	0.00±0.00 (0.00)	0.00±0.00 (0.00)	0.00±0.00 (0.00)	0.00±0.00 (0.00)
S.Ed (±)	9.02	5.76	5.59	5.57	3.36
C.D (P=0.05)	NS	12.35	12.00	11.95	7.20

Data represented are the mean of three replications with 10 insects each
Mean within parentheses are the angular transformed values
Significant at P=0.05, NS-Non-significant
HAT- Hours after treatment
S.E.d- Standard error of deviation
C.D.- Critical Difference
S.Em- Standard error means

chickpea seeds from *Callsobruchus chinensis* L. Higher aphid mortality with increasing duration and concentration of essential oils on aphid was observed in this experiment. As azadirachtin is the main biologically active component of neem-derived insecticides, although several other limonoids in complete neem seed oil show insecticidal properties [11]. When leaf surfaces were exposed to neem products, anti-peristaltic waves were seen in the digestive tract, which caused an activity that made the insect feel like vomit because of the presence of azadirachtin, salanin and melandriol and insect does not prefer to feed on the neem treated surface as thus swallowing abilities was also hindered [12]. Neem seeds contain a complex tetranortriterpenoid limonoid called azadirachtin, which is primarily what causes the poisonous effects on insects [13]. These findings agreed with Gospodarek *et al.* [14] who reported that peppermint oil at 0.5 per cent causes about 80 per cent mortality of nymphs and wingless females against *Aphis fabae* Scop. Our results are also in close conformity with Haddi et al*.* [15] who reported that clove oil has the insecticidal toxicity effect for controlling *Sitophilus zeamais* Motschulsky due to the presence of eugenol and the sesquiterpene b-caryophyllene as the primary constituents, because of these molecules act on the insects' nervous system by disturbing the functions of GABAergic and by inhibiting the actions of acetylcholinesterase [16].

4. CONCLUSION

Neem oil exhibited the highest nymph mortality of 96.67 per cent, 100 per cent, 100 per cent at 1 per cent, 3 per cent and 5 per cent, respectively. Mint oil also displayed notable efficacy with mortality rates of 73.33 per cent, 73.33 per cent, and 83.33 per cent at 1 per cent, 3 per cent, and 5 per cent concentrations, respectively after 72 hours of treatment. Clove and garlic oils exhibited moderate nymph mortality while eucalyptus oil showed the lowest impact on nymph mortality. All oils demonstrated significantly higher mortality rates compared to the control group. These natural compounds proved to be potent alternatives for controlling aphid populations and can contribute to integrated pest management strategies in agricultural systems. Further research and development can lead to the formulation of effective and economically viable essential oil-based products that can benefit farmers while promoting sustainable agricultural practices. Future research can be done on the effect of essential oils on morphology and physiological behaviour of aphid.

5. FUTURE SCOPE

The future of natural oils in pest management is promising, provided there is continued research, collaboration, and support from regulatory bodies and the agricultural community. The transition from laboratory to field applications holds the potential for more sustainable and environmentally friendly pest control practices.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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