

# Potency of Three Essential Oils against *Aphis craccivora* Koch (Homoptera: Aphididae) in Bean Plant

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**Abstract:** Essential oils derived from aromatic plants are interesting and favourable substitute for pest management. The present study investigated the efficiency of essential oils derived from, three plant species i.e., neem oil (*Azadirachta indica*), lemongrass oil (*Cymbopogon citratus*), citronella oil (*Cymbopogon winterianus*) at the concentration of 1% and 2% are tested by spraying on phloem sucking aphid (*Aphis craccivora*) to see repellent action of oils under laboratory condition. Essential oil is derived from aromatic plants has observed as risk free substitute. The result showed that all three oils significantly reduced the population of *A. craccivora*. The lemongrass oil was found most effective oil showing significant reduction at 2% concentration in 48 hrs which is (96.00%) while neem oil and citronella oil treatments also showed significant reductions of (70.00%) and (40.00%) respectively accompanied by a control. From the result it was observed that the order of toxicity of three oils were Lemongrass >Neem >Citronella.

**Keywords:** Biopesticides, Essential oils, lemongrass, Mortality, Aphids

## 1. Introduction

Green beans, scientifically named *Phaseolus vulgaris*, are members of the legume family Fabaceae. They are a diverse genus of annual plants that thrive in a wide range of climates. However crops are vulnerable to different insect pests causing huge economical damage (Yasmin, Bachchu, & Hossain, 2017).

There are about 4000 different species of aphids whereas among them 250 are plant pests. Aphids are worldwide in distribution and they make their colonies in very less time which results in increasing their population to very large in less time. They damage a wide range of vegetable and ornamental plants. Aphids usually feeds on plant sap and are found to curl and distort the leaves particularly when there is a large number of population. (Aly, Ismail, El-Kady, & Hefnawy, 2022)

The most serious posed by aphids is vectoring of plant viruses. Virus infected plant often show an aphid yellowing and have increased free amino acids (Riyaz & Riyat, 2021). Among the insect pest of legume crops, bean aphid *Aphis craccivora* is considered the most destructive pest. *Aphis craccivora* (cowpea aphid) is a small, polyphagous bug dark brown aphid with a shiny black dorsal shield.

Commonly it occurs on legumes but is much more polyphagous than *A. pisum*, having a broader range of hosts. It is known to attract at least 50 crops including 19 families (Emden & Harrington, 2017). In addition honeydew secreted by this insect pest supply a means for the progression of black sooty mold which wrap around the leaves leading to diminish photosynthesis and causing more impairment to plants (Aziz, Shalaby, & Tawfik, 2018). Additionally the pest might pass on virus diseases to plants (Sultana, Uddin, & Islam, 2020).

Though many insecticides have been approved for controlling aphid population, new substitutes are being briskly searched. It is due to resistance of aphids versus several classes of insecticides and also the reality that aphid mostly feed on underside of leaves, which are usually not cured by insecticidal application (Chalise, Pudasaini, Dawadi, & Khanal, 2019).

In order to avoid negative effects / drawbacks of chemical insecticides on animals as well as humans, which is caused by debris or residues that remain on plant crops essential oils are used as an alternate. (Solimany, Solimany, A., & Abolfadel, 2022)

Plant derived extract are an substitute to chemical insecticides they are more selective and biodegradable as well as have less or negligible negative effects on no target species (Aly, Ismail, El-Kady, & Hefnawy, 2022)

Use of natural products are an great source for controlling insect pests. Essential plant oils have been found to show excessive insecticidal activity against insect pests (Yasmin, Bachchu, & Hossain, 2017). Essential oils also behave as toxins, antifeedants and repellants for numerous aphid species (Solimany, Solimany, A., & Abolfadel, 2022).

They are less expensive, environmental friendly, and also perform function through a array of processes in a more targeted way (Aly, Ismail, El-Kady, & Hefnawy, 2022)

Therefore, the current research aimed to evaluate the efficiency of some different concentrations of three different essential oils viz. lemongrass, Neem, Citronella for controlling bean aphids (*Aphis craccivora*) on bean plant.

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## 2. Materials and Methods

**Experimental design** – Completely randomized design was chosen, The design used in experiment included 3 treatments of essential oils and three replication per treatment.

**Growing of host plants** – 42 seeds of green bean (phaseolus bean) were sown firstly in plastic bottles of 1 litre. 2 seeds in each bottle.

- 1) 21 Plastic bottles of 1 litre of dimension (27.9 L×10.2 W× 7.6 H) were taken and cotton was placed inside the bottle at the bottom.
- 2) Seeds were placed above the cotton and mildly sprayed with water.
- 3) Top of the bottle was covered with muslin cloth fixed with a rubber band and opened whenever needed to water the seeds.
- 4) The plants were kept and cared ( $20\pm 2$  °c), until 10 days after sowing.
- 5) After 10 days, when plants started reaching to the height of bottle's top, plants shifted to seed infused plastic polythene bag filled with garden soil to provide them proper nutrition for their growth.
- 6) Plants are kept and cared, Until 15 days after transferring to seed infused plastic polythene bag.
- 7) No pesticide was applied on host plants during growth.



**Figure 1:** Bean plants grown in seed infused plastic bag



**Figure 2:** Colony of cowpea aphids infesting bean plant



**Figure 3:** Aphids introduced in Bean plants covered with plastic folders



**Figure 4:** Materials required during experiment Fixed with muslin clothes

**Culture and rearing of Aphids:** After this much age of bean plants, *A. craccivora* were collected from already infested bean plants from a local farm. Infested part of the bean plant sheltering with *A. craccivora* colonies were brought and newly hatched aphids were transferred for rearing by a fine paint brush to the fresh bean twigs of a single bean plant which were maintained in seed infused plastic polythene bag and covered with plastic folders whose tops were covered with muslin cloth and fixed with cello tape to prevent insect escape till experimental requirements at ( $27\pm 2$ °c &  $34\pm 5$  % R. H).

Among all newly hatched aphids (50) were then transferred to each fresh bean plants which were grown in seed infused polythene bags for treatment and similarly all plants were covered with plastic folders in same manner as earlier.

### Essential oils

Three essential oils were selected as available in the market and also considering previous research papers showed potential toxicity to *A. craccivora*.

Among the chosen oils Neem oil (*Azadirachta indica*) was purchased from local market of lucknow and other two Citronella (*Cymbopogon winterianus*), lemongrass (*Cymbopogon citratus*) was purchased online from the company essancia.

Two concentrations of each oil were prepared separately v/v (1.0, 2.0 %). For the preparation of concentration 1.0, 2.0 ml of neem, citronella and lemongrass oils were taken in conical flask (100ml) separately and added 99 and 98 ml of distilled water for each oil and concentrations.

Method was followed which was similar to (Hossain, Yasmin, Bachchu, & Alim, 2021). A single drop of detergent was added as emulsifier. As a comparison positive control group was used which included distilled water and one drop detergent?

**Application method (Spraying)**

Two concentrations and 3 replicas were used for each treatment of each concentration.

- 1) Fifty individuals (both adult and nymph) of *A. craccivora* for each replicate were treated.
- 2) The plants were sprayed with the essential oil solutions using a hand held sprayer until the leaves were completely wet.
- 3) The entire experiment set up was sealed by plastic folders and top of the folder was covered with muslin

cloth fixed with tape to prevent the escape of aphids as well as treated oils.

- 4) Whole experiment was conducted for 48hr hrs which was divided into 2 time slots (24hr, 48hr).
- 5) Dead aphids were identified by lightly touching the pest with a small brush and noticing any movement of legs or antennae.

**Table 1: List of treatment oils**

S. No	Essential oils	Scientific name
T1	Neem	<i>Azadirachta indica</i>
T2	Citronella	<i>Cymbopogon winterianus</i>
T3	Lemongrass	<i>Cymbopogon citratus</i>
T4	Control	Distilled water and detergent

The relative efficiency of the essential oils are displayed in table 2, it was clear that mean mortality% increased with increasing concentration and time duration. It was very evident in the result that in all treatments 2% conc. resulted in highest mortality % at duration period of 48 hrs (2 days)

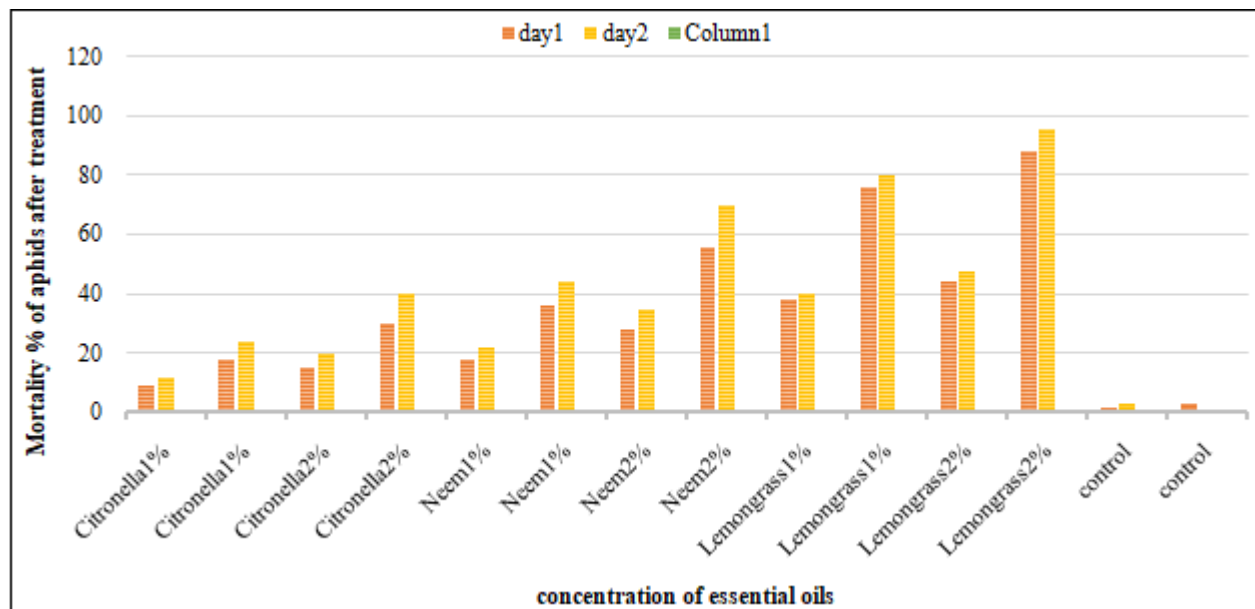
**3. Results**

**Table 2: Toxicity effects of different doses of essential oils against *A. craccivora* at different HATs (Interaction of oils, doses and times)**

Essential oils	No. of aphids introduced	Doses (%)	Mortality (mean± S. E) of aphids after treatment application		Average mortality % (mean±S. E of aphids)	
			24hrs (day1)	48hrs (day 2)	24hrs (day 1)	48 hrs (day 2)
Citronella	50	1%	9.00±.57	12.00±1.00	18.00±.57	24.00±1.00
	50	2%	15.00±1.73	20.00±1.15	30.00±1.73	40.00±1.15
Neem	50	1%	18.00±1.73	22.00±3.46	36.00±1.73	44.00±3.46
	50	2%	28.00±3.05	35.00±2.51	56.00±3.05	70.00±2.51
Lemongrass	50	1%	38.00±4.35	40.00±4.72	76.00±4.35	80.00±4.72
	50	2%	44.00±3.51	48.00±.57	88.00±3.51	96.00±3.51
Control	50	0	1.66±.33	3.00±.57	3.32±.33	6.00±.57

The highest mortality was recorded in lemongrass oil while the lowest in citronella oil. From the result it was observed that the order of toxicity of three oils were Lemongrass >Neem >Citronella. The mortality was dose dependent as however highest mortality of bean aphids was seen in lemongrass at (2%), low mortality was reported in citronella (40.00%) as compared to other two oils and almost negligible mortality was recorded in control (positive). The

interaction effect of oil doses and time significantly the highest mortality (96.00%) was calculated in lemongrass oil at 2.0% concentration while lowest (6%) in the control (Table 2). Results of statistical tests with one way Anova shows that there are significant differences between the research groups (F calculate 35.250 in day 1 and 41.076 in day 2 and significance value <.001).



**Graph 1:** Mean mortality % of *A. craccivora* due contact toxicity of different essential oils

### Statistical analysis

Mortality percentage of treated aphids were expressed in terms of number in table 1 of all the aphids treated (i. e 50). After that, what observed values were allowed to make a comparison with control to find out correct mortality of aphids. All graphs were done using excel spreadsheet. Data was submitted to one way analysis of variance using SPSS software, for knowing the significance of the difference between the mortality research groups. The mean separation was performed by Duncan's multiple range test at 0.05 probability level.

### 4. Discussion

Essential oils of plant have been the interest of analysis by many disciplines because of their broad array of bio activities including fungicidal as well as medicinal, aromatic effects. Here in this review, from the results we found that lemongrass and neem oils were most effective against bean aphids. The higher efficiency of such certain oil as compared to other oil can be attributed to the presence of higher amount of effective monoterpenes (Prayash Pathak et. al 2019)

The lemongrass oil offered promising toxicity by spraying highest dose of 2.0% against the nymph. Our results of lemongrass oil are in agreement with other authors as (Prayash Pathak chalise et. al 2019) reported highest mortality of *Aphis fabae* by the action of lemongrass oil. Also in closer proximity with (M. S Yasmin et al 2017) who showed neem oil to be effective against *Aphis craccivora*. Another author (Gorskiand Tomezak, 2010) who showed application of lemongrass resulted in complete mortality of fox glove aphids and 92.72% mortality of cabbage aphid. These findings support the notion of (Shannag, H. S. et. al 2014) who showed different formulation of neem oil to be effective against green peach aphid.

### 5. Conclusion

It is therefore concluded that the essential oils used in the current study had direct significant effects in controlling in green beans. Lemongrass oil (*Cymbopogon citratus*) clearly showed the best result among the three essential oil tested, but neem (*Azadirachta indica*) also showed significant efficiency against *A. craccivora*. According to the result of this research concentration of 2% lemongrass oil is recommended in order to increase the death rate of cow pea aphids. Therefore, these two oils might be used for controlling bean aphids. Further studies are needed to determine the optimal concentration and application frequency of these essential oils or effective pest management.

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