Effect of four essential oils viz, Ginger (Zingiber officinale), Garlic (Allium sativum), Lemon (Citrus aurantifolia) & Mint (Mentha sp.) for fatality rate on hibiscus mealybug, Maconellicoccus hirustus (Hemiptera: Pseudococcidae)

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ABSTRACT: Hibiscus mealybug, Maconellicoccus hirustus (Hemiptera: Pseudococcidae), is a serious pest of many crops and ornamental plants worldwide. The experiment aimed to determine the efficacy of essential oils as a natural insecticide against mealybugs. The study was conducted by exposing mealybugs to different concentrations of four essential oils and observing their mortality rates. The essential oils were ginger (Zingiber officinale), garlic (Allium sativum) lemon (Citrus aurantifolia) and mint (Mentha sp.) was used to control measure for the essential oils. Mortality effect were calculated using a completely randomized design with 4 treatments The data was then submitted to statistical analysis and the test significance level was P<0.001. The apparent results show that in term of mortality rate was 5ml lemon oil causing 90% mortality within 24 hours of application and in terms of mortality rate the treatment with 5 ml ginger oil showed best results causing 72% mortality within day 1. The result shows present mortality were (Mortality rate = Lemon > Ginger > Garlic > Mint)

Keywords: hibiscus plant (Hibiscus rosa-sinesis), Maconellicoccus hirustus, Essential oils (Zingiber officinale, Allium sativum, citrus aurantiifolia, Mentha sp.) , Control.

INTRODUCTION

Mealy bugs, Maconellicoccus hirustus (Hemiptera: Pseudococcidae) are small, soft bodied plant sap- sucking insects, with more than 2,000 described species and 290 genera (Ben-Dov 2006; Downie and Gullan 2004). Their name is derived from the mealy wax secretion and it covers their whole body. The mealybugs are small insect measuring around 1 to 4 mm in size. The body usually covered with mealy wax secretion and white cottony in appearance. Due to waxy secretion from the mealybug’s they appear like small spots of cotton on the plant. (D.Sartiami , G.W.Watson et al; 2015) They are known for their ability to feed on the sap of plants, which can cause significant damage to crops and ornamental plants. They are covered in a white, waxy coating that gives them a powdery appearance. This coating serves to protect the insects from predators and environmental stressors, as well as to aid in water conservation. (Carey, 2001)

Mealybug species that feed on fruit trees negatively effect fruit production by sucking sap from the phloem, excreting large amounts of sugar and water as a sugary, carbohydrates – rich substance know as honeydew. This substance causes severe secondary damage, as it promotes the growth of sooty mold (black fungus), which decreases photosynthesis and effects the development of the host plant ( Mathulwe, L.; Malan, A.; Stokwe; et al; 2021). Fruits stained with sooty mold or suspected of containing mealybugs are rejected when exported, due to strict phytosanitary regulations ; and these economic losses due to Infestations by mealybugs have increased dramatically in recent years (Daane, A.; Almeida, R.; Bell, V.; Botton, M.; Fullahzadeh, M.; Mani et al; 2012)

Essential oils are concentrated plant extracts that are used for their various therapeutic and aromatic benefits. They are derived from different parts, such as the flowers, leaves, barks or roots and are often used in aromatherapy, massage and other healing natural practices. Essential oils can be used as a natural insecticide to repel or kill insects such as mosquito, ants, flea and bugs. These oil can be used to control mealybugs which are small, white, cotton like insects That can infest household plants and garden plants. Some of the most effective essential oils for controlling mealybugs include neem oil, peppermint oil, citrus oil like lemon and orange. These oil can be added to carrier oil such as olive oil and sprayed onto the plant to kill the mealybugs. It is important to test the mixture on a small area of the plant first to ensure that it does not cause any damage. (W.L.; S.G.; Park et al.; 2004)

MATERIAL AND METHODS

The experiment was designed in two parts –

1. Rearing of mealybugs.
2. Preparation of Essential oils.

The study was conducted during April 2023 at 26 – 28 °C and 57 – 66% humidity. The design of the experiment was completely randomized with 4 essential oils mentioned above and one control was taken. Water was taken as control. The experiment is followed by Author (El- Ashram et al.,2020).

1. REARING OF MEALYBUGS

The higher infestation of *M.hirustus* was seen in the hibiscus plant in our college campus in the month of March 2023. hibiscus saplings were obtained from a local nursery were used as the host plant for *M.hirustus*. In this study, 40 hibiscus saplings pots which is (14cm wide and 15 cm height) were purchased from nursery. The plant which is heavily infested with mealybug, took mealybugs from it and put it in hibiscus sapling pot for 24 hours. Kept those mealy bugs for 24 hours so that they get settled on it. Left it for 15 – 20 days, so that it can form its colony and grow, after 15 – 20 days new *M.hirustus* were produced in large quantities. 30 mealybugs from hibiscus saplings used for each treatment. The length of the hibiscus saplings was 2-4 feet tall. The 2nd and 3rd mealybug instars including male and females were identified based on size, color, and mobility and release on the hibiscus saplings where insect was allowed to mate and reproduce during the rearing process, temperature and relative humidity were 26-28 °C and 57 – 66 %, respectively. male mealybugs have 2 long tail filament. (P. J Gullan et al; 2000)

2. PREPARATION OF ESSENTIAL OILS

To make essential oils four ingredients such as ginger (*Zingiber officinale*), garlic (*Allium sativum*), lemon (*Citrus aurantiifolia*) and mint (*Mentha sp.*) were taken. Preparation of essential oils were made by using steam distillation method (R.W. Mwasnauta et al; 2023) which involves heating plant material with water to release the essential oils and then collecting the oils as they evaporate. In this experiment water was used as a control.

The number of dead *M. hirustus* was recorded after 24, 48, and 72 hours of applying essential oils. The data were converted to the percentage mortality of *M. hirustus*. the mortality rate was calculated as the proportion of mean no. of insects dead to the total number of insects treated.

**Statistical Analysis**

Data were submitted to one way analysis of variance by using SPSS software. When the ANOVA statistics were significant (P< 0.001). The calculation was performed by using IBM SPSS software.

**OBSERVATION**

Table 1 – showing mean mortality and average percentage mortality of mealy bugs after exposure of *Zingiber officinale*

<table>
<thead>
<tr>
<th>OIL</th>
<th>CONC.</th>
<th>MEAN±S.E.</th>
<th>AVERAGE MORTALITY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 1</td>
<td>Day 2</td>
<td>Day 3</td>
<td>Day 1</td>
</tr>
<tr>
<td><em>Zingiber officinale</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.3±1.45</td>
<td>6.6±1.16</td>
<td>7.6±0.33</td>
<td>21%</td>
</tr>
<tr>
<td>3ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.0±1.15</td>
<td>12.6±0.88</td>
<td>9.6±1.45</td>
<td>40%</td>
</tr>
</tbody>
</table>
Graph 1 - Graph showing the mortality of the mealybugs after exposure to *Zingiber officinale*

Table 2 - showing mean mortality and average percentage mortality of mealy bugs after exposure of *Allium sativum*

<table>
<thead>
<tr>
<th>OIL</th>
<th>CONC.</th>
<th>MEAN±S.E.</th>
<th>AVERAGE MORTALITY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 1</td>
<td>Day 2</td>
<td>Day 3</td>
<td></td>
</tr>
<tr>
<td><em>Allium sativum</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1ml</td>
<td>4.6±1.20</td>
<td>5.6±1.20</td>
<td>5.6±0.66</td>
<td>15.3%</td>
</tr>
<tr>
<td>3ml</td>
<td>10.3±1.20</td>
<td>10.0±0.57</td>
<td>10.6±0.88</td>
<td>34.3%</td>
</tr>
<tr>
<td>5ml</td>
<td>14.3±0.66</td>
<td>13.6±1.20</td>
<td>12.6±0.66</td>
<td>47.6%</td>
</tr>
</tbody>
</table>

Graph 2 - Graph showing the mortality of the mealybugs after exposure to *Allium sativum*
Table 3- showing mean mortality and average percentage mortality of mealy bugs after exposure of *Citrus aurantiifolia*

<table>
<thead>
<tr>
<th>OIL</th>
<th>CONC.</th>
<th>MEAN±S.E.</th>
<th>AVERAGE PERCENTAGE MORTALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 1</td>
<td>Day 2</td>
<td>Day 3</td>
</tr>
<tr>
<td><em>Citrus aurantiifolia</em></td>
<td>1ml</td>
<td>12.0±0.5</td>
<td>14.0±0.57</td>
</tr>
<tr>
<td></td>
<td>3ml</td>
<td>18.3±1.85</td>
<td>18.0±1.73</td>
</tr>
<tr>
<td></td>
<td>5ml</td>
<td>27.0±1.15</td>
<td>26.3±1.66</td>
</tr>
</tbody>
</table>

Graph 3- Graph showing the mortality of the mealybugs after exposure to *Citrus aurantiifolia*
Table 4 showing mean mortality and average percentage mortality of mealy bugs after exposure of *Menth*

<table>
<thead>
<tr>
<th>OIL</th>
<th>CONC.</th>
<th>MEAN±S.E.</th>
<th>AVERAGE PERCENTAGE MORTALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Day 1</td>
<td>Day 2</td>
</tr>
<tr>
<td>Menth</td>
<td>1ml</td>
<td>5.3±0.88</td>
<td>5.6±0.33</td>
</tr>
<tr>
<td></td>
<td>3ml</td>
<td>8.3±0.66</td>
<td>8.6±1.20</td>
</tr>
<tr>
<td></td>
<td>5ml</td>
<td>13.0±0.57</td>
<td>12.6±0.66</td>
</tr>
</tbody>
</table>

Graph 4- Graph showing the mortality of the mealybugs after exposure to *Menth*
### Average Percentage Mortality

<table>
<thead>
<tr>
<th>CONTROL</th>
<th>CONC.</th>
<th>MEAN±S.E.</th>
<th>AVERAGE MORTALITY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Day 1</td>
<td>Day 2</td>
<td>Day 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0±0.57</td>
<td>1.0±0.00</td>
<td>0.6±0.33</td>
</tr>
</tbody>
</table>

Graph 5 showing mortality of mealybugs after exposure of water.
RESULTS

The results of the application of essential oil showed a significant effect on controlling *M. hirustus* in hibiscus plant. This data was projected for analysis of Variance (ANOVA). Based on observation and results, the highest mortality was observed in the treatment of Lemon oil i.e., 90% maximum mortality was observed within Day 1 & Day 3.

The second most effective essential oil is Ginger oil which shows 72 % mortality in 5 ml and least effective is 21 % in 1 ml. In 3 ml it shows the Mortality rate were 40% 42% and 32% respectively.

The third essential oil which garlic oil shows the lower effects when applying on mealybugs. From table it shows 47.6% mortality rate at 5 ml. At 1 ml the Mortality percentage were 15.3%, 18.66%, & 18.66% respectively.

The fourth essential oil is mint oil that shows lower effects as compared to other three essential oils. The Mortality percentages were at 5 ml shows 43.33%, 42%, 44.3%. At 1 ml the Mortality percentages were 17.66%, 18.66% & 15.33%. The results shows present mortality were (Lemon > Ginger > Garlic > Mint)

DISCUSSION

The results of this study showed the highest mortality rate *M. hirustus* was observed in the treatment of lemon essential oil (90%). In a similar experiment. (El – Ashram et al, 2020) found the treatment of lemon oil caused the highest mortality rate 61.5% which stands true for this experiment. This result is also supported by the study conducted from (R.W., Mwanauta.et al; 2023) which showed that percentage of mortality rate of citrus oil is 91%. It can be mentioned that lemon is effective product that can be utilized to control *M. hirustus* in the hibiscus plant.

Other treatment showed comparative less mortality effect and was observed to less effective than as compared to lemon oil. mortality effect of *M. hirustus* in the treatment with ginger oil is less effective 72%. This confirmed by the study conducted by (El- Ashram et al,2020) where it is mentioned that zinger oil is less potent than lemon oil. On the other treatment with garlic oil showed 47% mortality effect comparatively to Lemon.

In similar experiment (Hollingsworth, R.G. et al; 2005) found the treatment limonene, insecticidal soap & horticulture oil shows 95%, 89% & 88% mortality respectively.

Conclusion

Lemon essential oil should be considered for eradicating the mealybug, *Maconellicoccus hirustus* in agricultural setting. Several terpenes and geraniol are present in Lemon essential oil, and it attract to insects like thrips, fungus gnats, mealybug scale, and Japanese beetles. Ginger oils is less effective than lemon oil. Ginger oil can be applied directly to active infestation. It will kill all stages of Mealybugs on contact, ginger oil extracted from the ginger rhizome after a steam distillation process, when spraying on mealybug it can kill the mealybug. Garlic oil can help to prevent and repel pests, and kill them. Garlic oil causes intoxication and necrosis of the pests.

From overall study result, it is concealed that lemon oil (*citrus aurantiifolia*) show highest toxic effect on mealybug with mortality rate is 90% within 24 hours. It indicates that lemon oil (*citrus aurantiifolia*) could be valuable natural agent for controlling mealybug, *Maconellicoccus hirustus*. Ginger oil (*Zingiber officinale*), garlic oil (*Allium sativum*) and mint (*Mentha sp.*) Indicates lower mortality rate as compared to lemon oil (*Citrus aurantiifolia*). The effectiveness of essential oils were (lemon>Ginger > Garlic > Mint)

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