Efficacy of neem oil and turmeric powder against *Sitobion avenae* and *Rhopalosiphum padi*

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**Abstract**

Aphids are considered to be serious pests of arable crops. They remove photoassimilates from crop plants. They are responsible for viral diseases in crops by transmission of a number of plant viruses. The present study was carried out to observe the efficacy of neem and turmeric extracts against two aphid pest species, i.e. *Sitobion avenae* (F.) and *Rhopalosiphum padi*. Wheat (*Triticum aestivum*) of variety (Fareed-06) were grown in pots in glasshouse. Both aphid species were allowed to infest wheat plants separately. Twenty aphids per plant were released on 6-week plants and whole pots were covered with polythene sheets. Two weeks later neem and turmeric extract were applied separately at different concentrations (0, 1, 2, 2.5 and 3 %). Twenty four hrs later, mortality data was recorded. It was found that mortality of *S. avenae* was maximum (77.56%) at 3% concentration of neem oil after 24hrs which was statistically similar to mortality of *R. padi* (77.88%) at 3% concentration of neem oil after 24hrs. Similar results were found after 48 hrs of application of plant extracts, where both aphid species had highest mortality at 3% concentration of neem oil. Mortality of *S. avenae* was maximum (90.58%) 3% concentration of turmeric powder after 24hrs which was statistically similar to mortality of *R. padi* (90.38%) at 3% concentration of turmeric powder after 24hrs. Similarly, mortality of *S. avenae* and *R. padi* at 3% turmeric powder concentration was maximum (92.94%) (93.38%) after 48hrs. The results revealed that neem oil and turmeric powder at 3% concentration can be used for efficient aphid control in wheat plants.

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Introduction

English grain aphid, *Sitobion avenae* (Hemiptera: Aphididae) is a serious pest of wheat crop. It is considered as most dominant aphid specie of wheat crop. *S. avenae* infests the mature leaves and spikes of wheat plants (Tradan and Mileroj, 1999). It was found that aphid cause yield loss upto 20-80% (Akhtar et al., 2010). Voss Todd et al. (1997) reported that *R. padi* cause 19-31% yield losses at boot stage and 15-20% at flowering stage respectively. The bird cherry-oat aphid, *Rhopalosiphum padi* (Hemiptera: Aphididae) is one of the major devastating pests in cereal crops (Qureshi and Michaud, 2005; Bailey, 2007). *R. padi* is responsible for leaf deformation, nutrient and grain loss and transmission of Barley yellow dwarf virus in wheat (Fabre et al., 2006; Borer et al., 2009).

Turmeric, *Curcuma longa* (Zingiberales: Zingiberaceae) has pesticidal properties against insects and parasitic fungi (Damalas, 2011). *Azadirachta indica* (Sapindales: Meliaceae) A. Juss. (L.) is a potential bio-insecticide (El Shafie and Basedow, 2003). All parts of *A. indica* tree, i.e. bark, leaves and fruit are toxic to insect pests (Dimetry, 2012; Amadioha, 2000; Montes-Molinaa et al., 2008). Schmutterer and Singh (2002) reported that about 540 insect pest species of agricultural crops are susceptible to *A. indica*. Digilio et al. (2008) and Sampson et al. (2005) reported the toxic effects of plant essential oils of *A. indica*, *Eucalyptus camaldulensis* and *Laurus nobilis* on different aphid species. Kraiss and Eileen (2008) reported that application of neem products i.e. essential oil and seed oil is responsible for significant mortality rate in *Aphis glycines*.

Use of synthetic insecticides for aphid control is unsuitable in wheat due to the presence of pesticide residues, development of insecticide resistance and environmental pollution (Ambethar, 2009). Previous research indicated the successful use of plant materials such as plant powders, spices, oils and extracts for pest control (Akinneye et al., 2006). Use of botanical insecticides has low persistency in environment and little mammalian toxicity as compared to synthetic insecticides (Nerio et al., 2009). These materials are toxic to insect pests and inhibit their reproduction (Emeasor et al., 2005; Mahdi and Rahman, 2008).

Under the umbrella of above mentioned points, this experiment was conducted to examine the effect of plant extracts, neem and turmeric on aphid species, i.e. *Sitobion avenae* and *Rhopalosiphum padi* in wheat plants. This study will encourage the production of neem and turmeric based bio-pesticide under integrated pest management programs.

Materials And methods

This experiment was carried out in Pir Mehar Ali Shah Arid Agriculture University, Rawalpindi, Pakistan. All the experiments were performed in Oct 2013-Feb 2014.

Cultivar Selection

Two wheat cultivars were selected for this experiment. One of them was tolerant (Fareed-06) to aphid pests and other was susceptible (Uqab-2000) (Hussain et al., 2010). These both cultivars were collected from NARC, Islamabad.

Study Species

Two aphid species, i.e. *Sitobion avenae* and *Rhopalosiphum padi* were used as study species in this experiment. All the experiments were performed in glasshouse situated in experimental field area.

Experimental Layout

Susceptible wheat variety (Uqab-2000) seeds were sown in 50 pots. These pots were placed outside the glasshouse to allow the natural environmental conditions. Aphid species, *S. avenae* and *R. padi* were collected from naturally infested cereal field crops grown in Pir Mehr Ali Shah, Arid Agriculture University, NARC field area and Koont Research Farm. Aphids were collected in glass vials gently with camel hair brush. Aphid cultures were maintained on (Uqab-2000). These aphid cultures were used in the main experiment described further.
Wheat seeds of variety (Fareed-06) were sown in 10 pots having 10 cm diameter. The experiment was conducted following CRD, comprising 5 treatments and 5 replications. About 50 seeds per plant were sown. All the experiments were carried out under controlled conditions (25 ± 2 °C) and 65% RH under an LD 16:8 h. Seeds were germinated after 4-6 days. After 6 weeks of germination the wheat plants were attained the average height of 50cm.

Twenty aphids per plant were released in 6-week old (Fareed-06) plants. Out of hundred pots, fifty pots were subjected to S. avenae infestation while rest of fifty pots were subjected to R. Padi infestation. Aphid infested wheat plants were enclosed with ventilated polythene sheets (18×6 cm). These polythene sheets help to avoid accidental aphid infestation and their escape. Two weeks later, the aphid population was maintained 100 per plant, rest of aphids were removed by using camel hair brush. At this stage, neem and turmeric extracts were applied at different concentrations (Table 1,2).

2.4 Extraction Of Neem Oil
Neem oil was obtained by crushing neem seeds in a single-screw vegetable oil expeller with a three-phase motor (Musabyimana et al., 2001).

Preparation of Different Concentrations of Neem Extract
Emulsions of neem oil of five concentrations (0, 1, 2, 2.5 and 3 %) were prepared by method prescribed by (Musabyimana et al., 2001). Neem extract was prepared from the stock solution by addition of calculated amount of distilled water (vol:vol) and 1% of a liquid detergent was added to it.

Application of Neem Extract
Hundred aphids per plant were left behind on 8-week (Fareed-06) wheat plants. After removing the extra aphids from wheat plants, these plants were sprayed with prepared neem extract separately. All emulsions were sprayed via spray bottle. Wheat plants were allowed to be air dried for 30 minutes after the application of above mentioned treatments.

Preparation of Different Concentrations of Turmeric Extract
Turmeric extracts at different concentrations were prepared by the method prescribed by (Musabyimana et al., 2001). Turmeric extract were prepared in such a way that the known quantities of turmeric powder were soaked in a beaker containing distilled water and stirred overnight by using a magnetic stirrer. The suspensions were strained through fine and clean cheesecloth. Five treatments of turmeric powder with different concentrations (0, 1, 2, 2.5 and 3 %) were prepared from the stock solution by adding calculated amount of distilled water.

Application of Turmeric Extract
Hundred aphids per plant were left behind on 6 week (Fareed-06) wheat plants. After removing the extra aphids from wheat plants, these plants were sprayed with prepared turmeric extract separately. All emulsions were sprayed via spray bottle. Wheat plants were allowed to be air dried for 30 minutes after the application of above mentioned treatments.

Mortality and Repellency Data Collection
Mortality and repellency data of S. avenae and R. padi were collected after 24 hours of application of both plant extracts (Table 1,2). This data was further subjected to statistical analysis.

Percent corrected mortality was calculated by formula described by Abbott (1925).

\[
\% \text{ corrected mortality} = \frac{\text{observed mortality} - \text{control mortality}}{\text{control mortality}} \times 100
\]

Statistical Analysis
The data regarding to aphid mortality subjected to statistical analysis. Statistical programme R 2.15.2 (R Development Core Team, 2013) was used to determine ANOVA. The data obtained was subjected to HSD test at 5% level of significance to compare the difference among the means.

Results
From (Table 1), an interaction was found among two
aphid species, plant extracts and concentrations depicted a significant effect on aphid mortality in 24 hrs ($F=2.93$, $df=4$, $P<0.05$). A highly significant difference was found among both aphid species and concentrations after 24 hrs ($F=5.07$, $df=4$, $P<0.001$). This means that aphid mortality increases with increase in plant extract concentration (Fig 1,2). There was no significant difference in mortality of $R. \ padi$ and $S. \ avenae$ in control (Fig 1,2). A significant difference was found among treatments of both plant extracts and control after 24 hrs of application (Fig 1,2).

Table 1. ANOVA of $Sitobion \ avenae$ and $Rhopalosiphum \ padi$ mortality in 24 and 48 hrs after neem and turmeric application.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Df</th>
<th>F-value</th>
<th>Aphid mortality in 24 hrs</th>
<th>Aphid mortality in 48 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphid Species (A)</td>
<td>1</td>
<td>3.18</td>
<td>4.761*</td>
<td>4.761*</td>
</tr>
<tr>
<td>Plant extracts (B)</td>
<td>1</td>
<td>563.17***</td>
<td>1589.61***</td>
<td>1589.61***</td>
</tr>
<tr>
<td>Concentrations (C)</td>
<td>4</td>
<td>18331.36***</td>
<td>29522.068***</td>
<td>29522.068***</td>
</tr>
<tr>
<td>A × B</td>
<td>1</td>
<td>2.47</td>
<td>0.019</td>
<td>0.019</td>
</tr>
<tr>
<td>A × C</td>
<td>4</td>
<td>5.07***</td>
<td>5.82***</td>
<td>5.82***</td>
</tr>
<tr>
<td>B × C</td>
<td>4</td>
<td>106.309***</td>
<td>76.280***</td>
<td>76.280***</td>
</tr>
<tr>
<td>A × B × C</td>
<td>4</td>
<td>2.93*</td>
<td>0.22</td>
<td>0.22</td>
</tr>
<tr>
<td>Residuals</td>
<td>980</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** $P<0.001$, ** $P<0.01$, * $P<0.05$, . $P<0.1$ and $P<1$.

From (Table 1), an interaction was found among two aphid species, plant extracts and concentrations depicted a significant effect on aphid mortality in 48 hrs ($F=0.22$, $df=4$, $P<1$). A highly significant difference was found among both aphid species and concentrations after 48 hrs ($F=5.82$, $df=4$, $P<0.001$). This means that aphid mortality increases with increase in plant extract concentration (Fig 3,4).

Table 2. Showing the mean and mean corrected mortality of $Sitobion \ avenae$ and $Rhopalosiphum \ padi$ after different concentrations of neem within 24 and 48 hrs of application.

<table>
<thead>
<tr>
<th>Neem oil</th>
<th>$Sitobion \ avenae$</th>
<th>Mean % corrected mortality</th>
<th>$Rhopalosiphum \ padi$</th>
<th>Mean % corrected mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24 hrs</td>
<td>48 hrs</td>
<td>24 hrs</td>
<td>48 hrs</td>
</tr>
<tr>
<td>Control</td>
<td>4.86 ± 0.14i</td>
<td>10.0 ± 0.18i</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>22.04 ± 0.31h</td>
<td>33.58 ± 0.20h</td>
<td>19.01</td>
<td>29.43</td>
</tr>
<tr>
<td>2</td>
<td>42.48 ± 0.26f</td>
<td>48.6 ± 0.19f</td>
<td>41.67</td>
<td>48.25</td>
</tr>
<tr>
<td>2.5</td>
<td>57.60 ± 0.29d</td>
<td>63.48 ± 0.10d</td>
<td>58.41</td>
<td>66.87</td>
</tr>
<tr>
<td>3</td>
<td>77.56 ± 0.29b</td>
<td>84.52 ± 0.21b</td>
<td>80.52</td>
<td>93.20</td>
</tr>
</tbody>
</table>

Treatment means sharing a letter are not significantly different from each other (Tukey’s at $P<0.05$).

Aphid Mortality after neem application

The present study was conducted to study the impact of various concentrations of two plant extracts on two wheat aphid species in two observations. It was found that $Sitobion \ avenae$ exhibited minimum mean mortality (4.86%) and (10.0%) in untreated control in 1st and 2nd observation respectively. The mean mortality of $S. \ avenae$ was found (22.04%) and (33.58%) after 24 and 48 hrs of neem application at 1% concentration respectively. It was found that mean mortality of $S. \ avenae$ was increased to (42.48%) and (48.6%) at 2% neem concentration in 1st and 2nd observation respectively. The $S. \ avenae$ exhibited mean mortality (57.60%) and (63.48%) at 2.5%
concentration after 24 and 48 hrs of neem application. The maximum mean mortality of *S. avenae* was observed at 3% neem concentration. The mean mortality of *S. avenae* was (77.56%) and (84.52%) after 24 and 48 hrs of 3% neem oil concentration respectively. The overall mean mortality of *S. avenae* was ranged from (4.86%) to (77.56%) after 1st observation. While, the overall mean mortality of *S. avenae* was ranged from (10.0%) to (84.52%) after 2nd observation (Table 2).

Table 3. Showing the mean and mean corrected mortality of *Sitobion avenae* and *Rhopalosiphum padi* after different concentrations of turmeric within 24 and 48 hrs of application.

<table>
<thead>
<tr>
<th>Turmeric powder</th>
<th><em>Sitobion avenae</em></th>
<th></th>
<th><em>Rhopalosiphum padi</em></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean % corrected</td>
<td>24 hrs</td>
<td>48 hrs</td>
<td>24 hrs</td>
</tr>
<tr>
<td>Control</td>
<td>4.48 ± 0.14i</td>
<td>10.94 ± 0.22i</td>
<td>-</td>
<td>4.1 ± 0.13i</td>
</tr>
<tr>
<td>1</td>
<td>33.60 ± 0.32g</td>
<td>44.52 ± 0.21g</td>
<td>31.98</td>
<td>49.64</td>
</tr>
<tr>
<td>2</td>
<td>52.18 ± 0.28i</td>
<td>58.64 ± 0.17e</td>
<td>52.39</td>
<td>61.07</td>
</tr>
<tr>
<td>2.5</td>
<td>73.12 ± 0.24c</td>
<td>78.62 ± 0.10c</td>
<td>75.41</td>
<td>65.38</td>
</tr>
<tr>
<td>3</td>
<td>90.58 ± 0.19a</td>
<td>92.94 ± 0.10a</td>
<td>94.50</td>
<td>105.04</td>
</tr>
</tbody>
</table>

Treatment means sharing a letter are not significantly different from each other (Tukey’s at *P* < 0.05).

It was found that *Rhopalosiphum padi* exhibited minimum mean mortality (4.24%) and (10.58%) in untreated control in 1st and 2nd observation respectively. The mean mortality of *R. padi* was found (22.38%) and (33.2%) after 24 and 48 hrs of neem application at 1% concentration respectively. It was found that mean mortality of *R. padi* was increased to (42.24%) and (48.66%) at 2% neem concentration in 1st and 2nd observation respectively. The *R. padi* exhibited mean mortality (58.12%) and (63.7%) at 2.5% concentration after 24 and 48 hrs of neem application. The maximum mean mortality of *R. padi* was observed at 3% neem concentration. The mean mortality of *R. padi* was (77.88%) and (84.5%) after 24 and 48 hrs of 3% neem oil concentration respectively. The overall mean mortality of *R. padi* was ranged from (4.24 %) to (77.88%) after 1st observation. While, the overall mean mortality of *R. padi* was ranged from (10.58%) to (84.5%) after 2nd observation (Table 2).

Aphid Mortality after turmeric application

It was found that *Sitobion avenae* exhibited minimum mean mortality (4.48%) and (10.94%) in untreated control in 1st and 2nd observation respectively. The mean mortality of *S. avenae* was found (33.60%) and (44.52%) after 24 and 48 hrs of turmeric application at 1% concentration respectively.

It was found that mean mortality of *S. avenae* was increased to (52.18%) and (58.64%) at 2% turmeric concentration in 1st and 2nd observation respectively. The *S. avenae* exhibited mean mortality (73.12%) and (78.62%) at 2.5% concentration after 24 and 48 hrs of turmeric application. The maximum mean mortality of *S. avenae* was observed at 3% turmeric concentration. The mean mortality of *S. avenae* was (90.58%) and (92.94%) after 24 and 48hrs of 3% turmeric concentration respectively. The overall mean mortality of *S. avenae* was ranged from (4.48%) to (90.58%) after 1st observation. While, the overall mean mortality of *S. avenae* was ranged from (10.94%) to (92.94%) after 2nd observation (Table 3).
minimum mean mortality (4.1%) and (11.6%) in untreated control in 1st and 2nd observation respectively. The mean mortality of R. padi was found (33.82%) and (44.48%) after 24 and 48 hrs of neem application at 1% concentration respectively. It was found that mean mortality of R. padi was increased to (52.50%) and (58.58%) at 2% neem concentration in 1st and 2nd observation respectively. The R. padi exhibited mean mortality (73.14%) and (78.46%) at 2.5% concentration after 24 and 48 hrs of neem application. The maximum mean mortality of R. padi was observed at 3% neem concentration. The mean mortality of R. padi was (90.38%) and (93.28%) after 24 and 48hrs of 3% neem oil concentration respectively. The overall mean mortality of R. padi was ranged from (4.1%) to (90.38%) after 1st observation. While, the overall mean mortality of R. padi was ranged from (11.6%) to (93.28%) after 2nd observation (Table 3).

Discussion
Tripathi et al. (2001) and Khanikor and Bora (2011) found that the essential oils exhibit contact toxicity on various pest species. Abramson et al. (2006) found 81 and 95% mortality in fennel aphid when two plant essential oils i.e., Citronella and Alfazema were applied at 10,000 ppm concentration. Singh and Sachan (1999) found that Lipaphis erysimi can be controlled by only one spray of A. indica seed kernel extract at 5% concentration. Singh and Arya (2004) found that neem extracts in petroleum ether at 4% concentration exhibited 100% mortality in L. erysimi. Biswas (2013) found that aqueous solution of 50g neem seed/1L H2O and 75g neem seed/1L H2O exhibited 81% and 80% mortality in Lipaphis erysimi in treated plots.

Fig. 2. Mortality of Sitobion avenae after 24 hrs of neem oil and turmeric powder concentration.

Sampson et al. (2005) reported that mortality rate of turnip aphid, Lipaphis pseudobrassicae increases by the application of different essential oils. Lowery et al. (1993) found that commercial formulation of neem (Neem seed oil) is high toxic towards nine aphid species. Reddy et al. (2001) found that Macrosiphum rosaeformis can be easily managed by application of neem oil at 2% and neem seed kernel extract at 5% concentration. Pavela et al. (2005) reported the toxic effects of A. indica essential oil towards Brevicoryne brassicae. Dimetry and Schmidt (1992) also found that A. indica has repellent and deterrent effects on aphids.

Kumari and Yadav (2002) tested the effectiveness of neem seed kernel (5%), neem cake (5%), neem oil (3%) and neem leaf extract (5%) in coriander aphid, Hyadaphis coriandari. Mortality in H. coriandari was found 27.2–73.5, 16–65.1, 22–72.8 and 12–52.1% respectively.

Stark and Rangus (1994) sprayed A. pisum infested plants with neem based botanical insecticide (Margosan-O) and found that A. pisum nymphs become more susceptible than adults and their longevity was significantly reduced as compared to controls. Ebrahimi et al. (2013) found that the essential oil of A. indica was most effective against A. gossypii among three tested plant essential oils. The A. indica 10,000 ppm concentration exhibited 100% aphid mortality after 24 h of application. Santos et al.
Bushra et al. (2004) found that mortality of *A. gossypii* in nymphal stage at 410.0, 1410.0 mg/100 ml concentration was of 60.0% and 100.0%, respectively. Stark and Walter (1995) reported that neem seed oil exhibited 62% nymphal mortality in *Acyrthosiphon pisum* on treated plants. Biswas (2013) found that mortality in *Lipaphis erysimi* was 63.16-72.55% with neem leaf extracts while 73-81% with seed extracts.

![Fig. 4. Mortality of *Sitobion avenae* after 48 hrs of neem oil and turmeric powder concentration.](image)

Our results depicted that mortality of *Sitobion avenae* was maximum (77.56%) at 3% concentration of neem oil after 1st observation which was statistically similar to mortality of *Rhopalosiphum padi* (77.88%) at 3% concentration of neem oil after 1st observation. Similarly, mortality of *S. avenae* was maximum (84.52%) at 3% concentration of neem oil after 2nd observation which was statistically at par with mortality of *R. padi* (84.5%) at 3% concentration of neem oil after 2nd observation. This shows that there is similar effect of neem oil in both aphid species in 24 and 48 hrs of application. Similarly, mortality of *S. avenae* was maximum (90.58%) at 3% concentration of turmeric powder after 1st observation which was statistically similar to mortality of *R. padi* (90.38%) at 3% concentration of turmeric powder after 1st observation. Similarly, mortality of *S. avenae* and *R. padi* at 3% turmeric powder concentration was maximum (92.94%) (93.38%) after 2nd observation. The results revealed that neem oil and turmeric powder at 3% concentration can be used for efficient aphid control in wheat plants.

**Conclusion**

It was found that neem based formulations can efficiently control the aphid population in laboratory and field experiments (Lowery et al. 1993). Tang et al. (2002) found that although high concentrations of neem can cause high mortality in aphids, but neem products are not economically viable. Therefore, intermediate concentrations of neem products must be recommended. Biswas (2013) found that neem extracts cannot minimize aphid population like chemical insecticides but it is an eco-friendly, cheap and safe for aphid natural enemies and environment. Moreover, plant extracts can be used as integrated tool in biological control.

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