Repellency effects of four *Ocimum* spp leaves and oils against brown planthopper, *Nilaparvata lugens* (stal.)

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**Abstract**

Repellency test against freshly emerged BPH adults was carried out with four essential oils and fresh leaves of *Ocimum* spp in six armed olfactometer to know repellency/attractancy in laboratory conditions at Indian Institute of Rice Research, IIRR, Hyderabad, Telangana during 2016-2017. Repellency test with leaves and essential oils of four *Ocimum* spp against female BPH the obtained data showed that highest repellency percentage was recorded in *Ocimum gratissimum* both in leaves and essential oils at time interval of 10, 20, 30, 40, 50, 60 minutes after release of BPH female. The average repellency percentage of BPH with leaves was 87.37% which is significant repellency compared to control 48.45% followed by *O sanctum* 77.76% *O basilicum* 71.36%, *O americanum* 61.29%. The average repellency percentage of BPH with essential oils was 88.31% which is significant repellency compared to control 29.50% followed by *O sanctum* 76.84% *O americanum* 58.61%. *O basilicum* 58.23%. The highest repellency percentage was recorded in *O gratissimum* in both leaves as well as essential oils, the highest repellency percentage was due to there may possibility of presences of odd chemical compounds like eugenol, methyl chavicol, methyl eugenol in *Ocimum gratissimum* plant.

**Keywords:** Repellency/attractancy, essential oils, *O sanctum*, *O basilicum*, *O americanum*, *O gratissimum*, brown planthopper, six arm olfactometer

1. **Introduction**

Rice (*Oryza sativa* L.) (2n = 24) belonging to the family Graminae is the staple food crop for one third world’s population and occupies almost one fifth of the total land area covered under cereals. It is grown under diverse cultural conditions and over wide geographical range. More than 90% of the world’s production was consumed in Asia, which constitutes more than half of the global population [1]. Approximately 11% of the world’s arable land is planted annually with rice, production of 748.0 million tons next to it ranks wheat. In India, area under rice is estimated to be 44.9 million ha with a production of 272 million tons [2], India ranks 1st in area (44.95 million ha) and 2nd in production (272.61 million tonnes), after China (2nd advance estimate, 2015-16, Department of Agriculture, Cooperation and Farmer’s Welfare, Ministry of Agriculture, GOI, Rice, being the staple food for more than 70 percent of the population and the source of livelihood for 120-150 million rural households, is the backbone of the Indian agriculture.

Brown planthopper *Nilaparvata lugens* (Stal.) is one of the most menacing insect pests of rice (*Oryza sativa* L.) among various leafhoppers and plant hopper species. The Brown planthopper was aminor pest in most tropical countries of Asia earlier. Brown planthopper *N lugens* is mainly a pest of irrigated rice but it can also become abundant in rain fed environment and upland rice [3]. At low infestation of this insect, plant height, crop vigour, tiller production reduces, whereas heavy infestation turns plants yellow, which dry up rapidly. Under severe infestation, circular patches of hopper burn are evident in the field. Severely affected plants do not bear any grains. The most commonly practical method of controlling BPH is through application of insecticides [4]. It is imperative to evolve and evaluate some useful plant products from *Ocimum* species for management of pest, so that quantity of insecticide used to control the brown planthopper can be reduced. Hence, these useful practices could be utilized as the major components of an effective pest management strategy, against the BPH.

2. **Objective of study**

To evaluate repellency activity of extracts from different *Ocimum* L. spp against BPH, *Nilaparvata lugens*, (Stal.).
3. Materials and methods

Repellency/attractancy activity against freshly emerged BPH adults was carried out with four essential oils and fresh leaves of different *Ocimum* spp in six arm olfactometer at Indian Institute of Rice Research, IIRR, Hyderabad, Telangana in November month, 2016.

Matured leaves were collected from middle portion of plants of same size, same branch, same age from different *Ocimum* spp viz. *O.sanctum*, *O.basilicum*, *O.americanum*, and *O.gratissimum* plate.1. The collected leaves were cut into dimensions of (2.5x1.5 cm) then kept it in the different arms of olfactometer and labeled the treatments of respective leaves on arms of olfactometer. Twenty female brown planthopper adults were starved for 2 hours before released in the middle of the olfactometer with the help of the aspirator and covered with black cloth. Then switch on vacuum pressure machine movement of BPH adults was observed for 10 minutes interval. The response of the brown planthoppers (attracted or repelled) to leaves of different *Ocimum* spp was recorded (plate 2).

Essential oils from four *Ocimum* spp viz. *O.sanctum*, *O.basilicum*, *O.americanum*, and *O.gratissimum*, are used at 2µl concentration with help of a micro pipette respective oils are poured at end of filter paper strip then dry it under fan then kept it in the different arms of olfactometer and labeled the treatments of respective oil on arms of olfactometer. Twenty female brown planthopper adults starved for 2 hours and released in the middle of the olfactometer with the help of the aspirator and covered with black cloth (Plate 2) After switch on vacuum pressure machine movement of BPH adults was observed for 10 minutes interval. The response of the brown planthoppers (attracted or repelled) to essential oils of different *Ocimum* spp was recorded for 1 hour after release.

![Plate 1](image1.png)

Plate 1. Different *Ocimum* spp viz. *O.americanum*, *O.basilicum*, *O.gratissimum*, and *O.sanctum* used in repellency test against BPH.

![Plate 2](image2.png)

Plate 2: Repellency test against BPH in six arm olfactometer.

4. Statistical analysis

In olfactory repellency test obtained data converted into percentage followed *t* test and CRD design obtained data analyzed by using arc sine transformation.

5. Results and discussion

5.1. Repellency with four *Ocimum* spp leaves

Results of the olfactory tests carried out to know the repellency of *Ocimum* spp leaves to female BPH are presented in Table (4.1). The same trend in response of BPH to *Ocimum* leaves was observed after 20,30,40,50 and 60 minutes of release (Fig 1). Highest average repellency (87.35%) was recorded in *O.gratissimum* followed by *O.sanctum* (77.76%) and when compared to 48.45% in control.

Response of female BPH *N.lugens* after 10 min to different *Ocimum* spp leaves revealed that the *O.gratissimum* leaf volatiles showed higher repellency (97.45%) than the other treatments and control (40.58%). Percent repellency in other treatments in *O.sanctum* (86.25%) *O.basilicum* (79.56%), *O.americanum* (70.95%).

Repellency of female BPH, *N.lugens* after 20 min to different *Ocimum* spp leaves showed that *O.gratissimum* leaf showed higher repellency (93.54%) than the other treatments 84.22
and control (55.36%). Repellency percent in other treatments in O.sanctum (84.22%) O.basilicum (76.36%) and O.americanum (68.96%).

Effects of leaf volatiles on repellency of female BPH after 30 min data revealed that higher repellency was showed by O.gratissimum (89.25%) then the other treatments and control (50.32%). Percent repellency in other treatments in O.sanctum (87.25%), O.basilicum (80.21%), O.americanum (67.56%).

After 40 min response female BPH on different Ocimum spp leaf volatiles showed that higher repellency showed by O.gratissimum (96.21%) significantly higher repellency compared to control (45.86%). Repellency percentage in other treatment O.sanctum (78.56%), O.basilicum (70.45%), O.americanum (70.25 %).

After 50 min also same trend of repellency was noticed, higher repellency showed by O.gratissimum (82.00%) compared to control (50.21%). The repellency percentage in other treatments followed as O.sanctum (80.25%), O.basilicum (74.36%), O.americanum (55.65%).

The response of female BPH to different Ocimum spp leaf volatiles after sixty min showed that higher repellency observed in O.gratissimum (76.00%) showed significant repellency compared with control (43.00%). Response in other treatments in O.sanctum (68.25%), O.basilicum (65.89%), O.americanum (50.49%).

Reports on repellency of Ocimum spp (selected for study) leaves against BPH or even plant-hoppers are almost not available. However, Ocimum canum growing in Zimbabwe was reported to exhibit repellency against adults of Aedes aegypti Luckwa, Nat all [9].

Hassanli et al. [6] reported that the constituents of a related species Ocimum suave leaves acted as repellants and used as grain protectants in parts of Eastern Africa. Results of repellency study are in conformity with the reports mentioned that surely leaf volatiles of Ocimum are responsible for repellency, in this case O.gratissimum.

5.2. Repellency with four Ocimum spp oils

Data on response of BPH females to different essential oils of Ocimum spp in olfactometer test revealed that the O.gratissimum oil exhibited highest average repellency of 88.31% followed by O.sanctum oil with 76.84% while it was in control (29.50%) Table 2. Significantly higher repellency was recorded in O.gratissimum oil than in other Ocimum spp and control after 10, 20, 30, 40, 50nd 60 min of release (fig 2.).

The data on repellency of female BPH to different Ocimum spp oils after ten min. showed that highest repellency noticed in O.gratissimum oil 95.13%. Where as in to control (35.25%). Repellency in other treatments in O.sanctum (80.12%) O.basilicum (70.14%), O.americanum (60.41%).

After twenty minutes also same trend of repellency was followed by female BPH. Highest repellency was showed by O.gratissimum oil (92.23%) as compared to control (30.12%). Repellency in other treatments followed as in O.sanctum (71.06%), O.americanum (65.35%) O.basilicum (55.25%). The repellency of female Nilaparvata lugens to different Ocimum spp oils after 30 min higher repellency was recorded in O.gratissimum oil 85.26% compared to control 25.45%. Repellency in other treatments was O.sanctum (85.42%), O.basilicum (60.25%), O.americanum (55.28).

After 40 min also same trend of repellency was noticed against female BPH higher repellency showed by O.gratissimum (85.26%) compared to control (21.45%). The repellency percentage in other treatments in O.sanctum (65.82%), O.basilicum (55.25%), O.americanum (50.24%).

Response of female BPH to Ocimum spp oils after fifty minute highest repellency was recorded in O.gratissimum oil (78.54%) compared with control (35.47%). Response in other treatments in O.sanctum (80.42%), O.basilicum (58.25%), O.americanum (55.28%).

The data on repellency of female after sixty min showed that highest repellency noticed in O.gratissimum oil 81.74%. Where as in to control (21.29%). Repellency in other treatments in O.sanctum (78.19%), O.americanum (65.12%), O.basilicum (50.26%).

The highest repellency percent was recorded in O.gratissimum both in leaves and oils so there is possibilities of presence of odd substances in O.gratissimum. Very few reports are available on repellency of essential oil from Ocimum spp to plant hoppers. Esther et al. [7] observed that oil extracted from the leaves of tropical shrub, Ocimum suave was repellent to tick. Manzoor et al. [8] reported that the O.sanctum oil acted as repellent agent against termite, Heterotermes indicola. This report is in conformity with present results where O.sanctum oil considerable repellency to BPH after O.gratissimum. Major chemical component in both oils is eugenol which varies from 46-84% in Indian species and this compound may mainly responsible for repellent activity.

Gamayolla Sainath [9] work reports about repellency of other essential oils- eucalyptus and lemon grass oils when tested in six-way olfactometer at 10 μl showed very high efficacy to BPH females.

Bhimrao [10] tested different plant derivatives against brown plant hopper and found that neem oil @ 2.0% had the highest repellent action to Nilaparvata lugens repell 90% of the population from the treated area.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Treatments</th>
<th>Percent repellency</th>
<th>Average</th>
</tr>
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<tr>
<td></td>
<td></td>
<td>10min 20min 30min 40min 50min 60min</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>O.sanctum</td>
<td>86.25b (59.57) 84.22ab (57.35) 87.25b (60.73) 78.56b (51.76) 80.25a (53.35) 68.25b (43.02)</td>
<td>77.76ab* (51.03)***</td>
</tr>
<tr>
<td>2</td>
<td>O.basilicum</td>
<td>79.56b (52.69) 76.36ac (49.76) 80.21ab (53.31) 70.45c (44.77) 74.36b (48.02) 65.89b (41.20)</td>
<td>71.36**ab (45.51)</td>
</tr>
<tr>
<td>3</td>
<td>O.americanum</td>
<td>70.95bc (45.18) 68.96cd (43.58) 67.56cd (42.48) 70.25bc (44.61) 55.65cd (33.80) 50.49c (30.31)</td>
<td>61.29bc (37.78)</td>
</tr>
<tr>
<td>4</td>
<td>O.gratissimum</td>
<td>97.45a (77.00) 93.54a (69.26) 89.25a (63.16) 96.21a (74.15) 82.00a (55.06) 76.00a (49.44)</td>
<td>87.35c (60.84)</td>
</tr>
<tr>
<td>5</td>
<td>Control</td>
<td>40.58c (25.83) 55.36e (33.60) 50.32a (30.20) 45.86d (27.29) 50.21c (30.13) 43.00e (25.46)</td>
<td>48.45a (28.97)</td>
</tr>
<tr>
<td></td>
<td>SEMz</td>
<td>13.52 12.78 13.94 13.80 10.98 9.45</td>
<td>14.34</td>
</tr>
<tr>
<td></td>
<td>CD (0.05%)</td>
<td>6.60 2.32 3.46 2.27 3.33 1.58</td>
<td>8.95</td>
</tr>
</tbody>
</table>

*Mean followed by same letter are not significantly different at P=0.0. ** Figures are average means of five replication. ***Figures in parenthesis are arc sign transformed value.
Fig 1: Olfactory response of BPH, *N. lugens* females to leaves of different *Ocimum* spp.

Table 2: Olfactory response of BPH *N. lugens* females to different oils from *Ocimum* spp.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Treatments</th>
<th>Percent repellency</th>
<th>Average Repellency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>10min</td>
<td>20min</td>
</tr>
<tr>
<td>1</td>
<td><em>O. sanctum</em></td>
<td>80.12ab (53.11)</td>
<td>71.06ab (44.41)</td>
</tr>
<tr>
<td>2</td>
<td><em>O. basilicum</em></td>
<td>70.14bc (44.41)</td>
<td>55.25bc (36.86)</td>
</tr>
<tr>
<td>3</td>
<td><em>O. americanum</em></td>
<td>60.41bc (36.86)</td>
<td>65.35bc (40.53)</td>
</tr>
<tr>
<td>4</td>
<td><em>O. gratissimum</em></td>
<td>95.13a (71.78)</td>
<td>92.23a (71.78)</td>
</tr>
<tr>
<td>5</td>
<td>Control</td>
<td>35.25c (20.48)</td>
<td>30.12c (17.45)</td>
</tr>
</tbody>
</table>

*Mean followed by same letter are not significantly different at P=0.05
** Figures are average means of five replication.
***Figures in parenthesis are arc sign transformed value

6. Conclusion
The results showed that repellent activity of different *Ocimum* spp leaf volatiles against freshly emerged female brown planthoppers among different species highest repellency percentage was recorded in *O. gratissimum* treatment only 87.35% followed by *O. sanctum* 77.76%, *O. basilicum* 71.36%, then in *O. americanum* 61.29% in leaf volatiles against BPH all treatments showed significant highest repellency percentage compared with control 48.45%. Repellent activity of four essential oils of *Ocimum* spp *O. gratissimum* was showed maximum repellency 88.31% followed by *O. sanctum* 76.84%, *O. americanum* 58.61% then *O. basilicum* 58.21% compared with control 29.50%. Repellency percentage with both leaf volatiles and essential oils against BPH *Ocimum gratissimum* treatment was recorded with highest percentage of repellency compared with control.

7. Acknowledgement
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8. References
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