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# REPELLENCE EFFECTS OF RED CHILI AND BLACK PEPPER OLEORESINS AGAINST AGRICULTURALLY IMPORTANT SUCKING PESTS

**R. RAMAKRISHNAN [a*], T. SELVAMUTHUKUMARAN [a] AND NUSRAT IQBAL [b]**

[a] Phytoinsecticide Research Laboratory, Department of Entomology, Faculty of Agriculture, Annamalai University, Chidambaram, Tamil Nadu, India.

[b] Institute of Pesticide Formulation Technology, Gurgram, Haryana, India.

**AUTHORS' CONTRIBUTIONS**

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

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## ABSTRACT

A study was carried out to evaluate red chili and black pepper oleoresins' repellence against Citrus psyllids (*Diaphorina citri* Kuwayama), Red spider mites *(Tetranychus urticae* Koch), Cotton aphids (*aphis gosippi* Glover) and Cotton mealy bug (*Phenacoccus solenopsis* Tinsley) at laboratory conditions. In filter paper half of the portion was treated with one ml of respective solution using pipette and air dried under room condition. After they placed into 80 mm petriplates. Then the insects (15 nos ) were released into it and the repellency was recorded at 6 hrs interval. The results revealed that at 1% concentration, the red chili oleoresin possessed the highest repellence against aphids (100%), followed by red spider mites (86.66%) and psyllids (69.33%). The highest repellence (51.20%) in mealybugs was noticed only at the maximum concentration tested (5%).At 1% concentration, repellence was very minimal (25.33%). A similar trend was recorded in black pepper oleoresin also. Both the spice oleoresins had the highest repellence against cotton aphids. Phytotoxicity studies on 25 and 45 days old cotton plants revealed no symptoms at concentrations from 0.1 to 1%. At higher concentrations tested, some minor leaf and boll injuries appeared, and later, the plants recovered.

**Keywords:** Spice oleoresins; sucking pests; repellence; phytotoxicity.

**Corresponding author: Email: rramki84@gmail.com;*

## 1. INTRODUCTION

Agricultural crops suffer from biotic stresses, including pests and diseases, and depend heavily on remedial measures such as pesticide applications. The per capita usage of pesticides increased from 2.2 g a.i. /ha in the 1950s to 310 g a.i /ha in 2017 [1]. Numerous insecticides are currently used in pest control worldwide [2]. This over reliance has led to resistance, resurgence, and residue issues, affecting crop yield [3,4]. Further, the issues of secondary pest outbreaks and changes in the pest spectrum due to climate change shifted focus towards sucking pests. Among them, mealy bugs, aphids, psyllids, and mites are the major ones [5]. Apart from their direct damage, they cause serious damage as vectors of diseases [6].

Botanicals with a wide array of secondary metabolites are better alternatives to synthetic insecticides [7]. However, their commercialization hangs in the balance due to biomass non-availability and varying active ingredient concentrations in the crude extracts. Spice oleoresins offer suitable answers to these drawbacks and are viable candidates for formulation development. They have volatile compounds and are good repellents and insecticides, especially against sucking pests [8,9]. Hence, the study evaluated selected spice oleoresins' repellent action against certain sucking pests. As they are the concentrated forms of plant extracts, their phytotoxicity effects on crops were also studied.

## 2. MATERIALS AND METHODS

The experiment set up was carried out under laboratory condition (CRD design). Totally five treatment one positive control (Neem oil 0.5 %) and a un treated control (Water) with three replications were maintained for this study.

### 2.1 Culturing of Test Insects

Sucking pests *viz.*, citrus psyllids (*Diaphorina citri* Kuwayama), red spider mites *(Tetranychus urticae* Koch), cotton aphids (*Aphis gossypii* Glover), and cotton mealybugs (*Phenacoccus solenopsis* Tinsley) were cultured in 25 days old citrus, bhendi, and cotton seedlings respectively. The seedlings were raised in cement pots (30 cm dia.), watered, and manured regularly. Field-collected insects were used to initiate the culture and were released onto the respective seedlings enclosed by mylar film cages covered on top using a cotton cloth. The cages were maintained parasitoid free. The insects were allowed to grow on the seedlings for a month, reintroduced to new plants, and held at 25+2°C and 65+5 % RH (Wakgari and Yigezu, 2018).

### 2.2 Extraction of Spice Oleoresins and Content Estimation

The red chili fruits (Variety: Teja, M/S. Mahyco seed company, Mumbai) were collected from the farmers' fields at Sankarankovil, Tenkasi district, Tamil Nadu (9.4497°N lat. And 77.8360 °E long.). They were shade dried for three days, deseeded, and the pericarp was powdered. The powder was filled in a 40 mm x 500 mm long glass column and extracted using ethylene dichloride solvent. The column was extracted for 1hr for the first wash, followed by five subsequent washes for 15 minutes each. The extracts were collected, filtered, and evaporated under reduced pressure in a boiling water bath. Then, the extractives were mixed with aqueous methanol at a 1:1 ratio in a magnetic stirrer (Remi, MS 500, Maharashtra) for 20 minutes. The solution was again poured into a column. The pure capsaicin oleoresin, which settled at the bottom, was collected, and the paprika at the top was discarded. Capsaicin oleoresin content was determined in a UV spectrophotometer (Pharmacia biotech, Ultrospec 2000, Sweden) by following the AOAC method (1996). Similarly, the black pepper oleoresin piperine was extracted, and the content was determined.

### 2.3 Preparation of Oleoresin Concentrations

The extracted oleoresin containing 40% concentration was taken as stock. The concentrations *viz.*, 5.0, 3.0, 1.0, 0.7, 0.5, 0.3, and 0.1% were prepared by diluting 1250, 750, 250, 175, 125, 75, and 25 µl of the stock in emulsified water (10 ml).

### 2.4 Repellence Bioassay

A Whatman no.40filter paper was cut in half, and one ml of the respective oleoresin concentration was added separately on one side of one of the halves using a micropipette. It was air-dried and placed inside a Petri plate (80 mm dia.) with the treated surface up. One ml water-drenched other half of the filter paper was placed inside the same Petri plate adjacent to the treated one. Uniformly aged nymphs of each test insect/mite @ 15 numbers/Petri plate were released on the treated filter paper. The insects/mites were allowed to settle, and their movement was observed. The number of insects/mites settling on the treated half of the filter paper and on the water-treated filter paper was recorded 2, 4, and 6 hours after release [10]. The Percent repellence (PR) was computed using the formula;

Percent Repellency $=\frac{(Nc-Nt)}{(Nc+Nt)}\ x\ 100$ [11]

Neem oil 0.5% treatment (Positive control) and an untreated control were maintained. The experiment was replicated three times and conducted as a Completely Randomized Design (CRD).

**Chart 1. Damage levels**

| Rated | Per cent injury levels |
|---|---|
| 0 | 0 |
| 1 | 1-10 |
| 2 | 11-20 |
| 3 | 21-30 |
| 4 | 31-40 |
| 5 | 41-50 |
| 6 | 51-60 |
| 7 | 61-70 |
| 8 | 71-80 |
| 9 | 81-90 |
| 10 | 91-100 |

*[12]*

## 2.5 Phytotoxicity Bioassay

The oleoresins' phytotoxic effects were evaluated on 25 and 45 days old potted cotton plants. Totally ten concentrations (seven concentrations, 10, 5, 3, 1, 0.7, 0.5, 0.3, 0.1, positive and untreated check) were tested. The prepared concentrations were sprayed @ 15 ml/seedling. The data on leaf tip injury, surface wilting, necrosis, epinasty and hyponasty were recorded on 1, 3, 7 and 14 days after spraying. The per cent damage was calculated and rated as detailed below;

Per cent leaf injury = $\frac{Total grade points}{maximum grade x No. of leaves observed}\ x\ 100$

## 2.6 Statistical Analysis

All the percentage data were subjected to arc-sine transformation. Analysis was done with ANOVA and the means were compared by following Duncan's multiple range test (DMRT) at p=0.05 [13].

# 3. RESULTS AND DISCUSSION

## 3.1 Repellence Bioassay

The repellence activity of chili oleoresin was dose dependent and a gradual increase was noticed from 0.1 per cent to 1 per cent concentration. However when compared with black pepper oleoresin the repellence was pronounced more in chili oleoresin. Both the oleoresins had imparted significantly higher repellence against cotton aphids (100% at 1%) compared with other sucking pests. The mites were the next most repelled ones in both the oleoresins.

**Table 1. Repellency effects of spice oleoresins against different sucking pests**

| Concentrations | Per cent repellency at 6 HATs | | | | | |
|---|---|---|---|---|---|---|
| | Chili oleoresin | | | Black pepper oleoresin | | |
| | Psyllids | Red spider mites | Aphids | Psyllids | Red spider mites | Aphids |
| | 69.33 | 86.66 | 100 | 65.33 | 86.66 | 100 |
| **1%** | (56.21) | (68.36) | (90.00) | (53.77) | (68.36) | (90.00) |
| **0.7%** | 65.33 | 77.86 | 95.33 | 60.00 | 77.86 | 90.93 |
| | (53.83) | (61.51) | (77.19) | (50.74) | (61.51) | (71.83) |
| **0.5%** | 38.66 | 65.33 | 86.66 | 33.33 | 69.33 | 82.26 |
| | (38.17) | (53.83) | (68.18) | (35.18) | (56.74) | (64.93) |
| **0.3%** | 25.33 | 42.26 | 73.33 | 12.00 | 42.26 | 69.33 |
| | (30.06) | (40.43) | (58.74) | (20.26) | (40.43) | (56.21) |
| **0.1%** | 16.00 | 38.66 | 60.00 | 6.66 | 33.33 | 51.22 |
| | (23.56) | (38.17) | (50.74) | (14.95) | (35.10) | (45.63) |
| **Neem oil @ 0.5 %** | 25.33 | 51.22 | 51.20 | 20.00 | 46.66 | 42.26 |
| | (30.13) | (45.59) | (45.59) | (26.55) | (42.81) | (40.43) |
| **Control** | 0 | 0 | 0 | 0 | 0 | 0 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| **CD 5%** | 0.22 | 0.36 | 0.28 | 0.10 | 0.35 | 0.37 |
| **SE(m)** | 0.10 | 0.16 | 0.13 | 0.05 | 0.16 | 0.17 |

** Values are mean of three replication*
*Values in parentheses are arc sin transformation,*
*HAT= Hours after treatment*

**Table 2. Repellence effects of spice oleoresins against cotton mealy bug**

| Per cent repellency at 6 HAT | | |
|---|---|---|
| **Concentrations** | **Chili oleoresin** | **Black pepper oleoresin** |
| **5%** | 51.20 | 42.26 |
| | (45.59) | (40.43) |
| **3%** | 42.26 | 38.66 |
| | (40.49) | (38.17) |
| **1%** | 25.33 | 25.33 |
| | (30.06) | (30.06) |
| **0.7%** | 16.00 | 12.00 |
| | (23.56) | (20.26) |
| **0.5%** | 6.66 | 6.66 |
| | (14.64) | (14.64) |
| **Positive control** | 20.00 | 20.00 |
| | (26.55) | (26.55) |
| **Control** | 0 | 0 |
| | (0.00) | (0.00) |
| **CD 5%** | 0.31 | 0.32 |
| **SE(m)** | 0.14 | 0.15 |

**Values are mean of three replication*
*Values in parentheses are arc sin transformation*
*HAT= Hours after treatment*

**Table 3. Phytotoxic effects of spice oleoresins on potted cotton plants**

| **Concentrations** | **Phytotoxicity rating*** | | | |
|---|---|---|---|---|
| | **Chili oleoresin** | | **Black pepper oleoresin** | |
| | **25 days old plant** | **45 days old plant** | **25 days old plant** | **45 days old plant** |
| **10%** | 2 | 3 | 3 | 3 |
| **5%** | 2 | 2 | 3 | 3 |
| **3%** | 1 | 1 | 1 | 1 |
| **1%** | 0 | 0 | 0 | 0 |
| **0.7%** | 0 | 0 | 0 | 0 |
| **0.5%** | 0 | 0 | 0 | 0 |
| **0.3%** | 0 | 0 | 0 | 0 |
| **0.1%** | 0 | 0 | 0 | 0 |
| **Positive control** | 0 | 0 | 0 | 0 |
| **Control** | 0 | 0 | 0 | 0 |

**Observed at 1, 3, 7 and 14 days after application*

In psyllids and mealybugs the repellence was comparatively less pronounced (69.33; 65.33 & 51.20, 42.26 in chili and black pepper oleoresins against psyllids and mealybugs, respectively) (Tables 1 & 2). Mutalib et al. [14] also reported black pepper and chili extracts were found effectively in repelling *Tapinoma sessile*.

### 3.2 Phytotoxicity Bioassay

Concentration from 0.1-1%of both the spice oleoresins did not show any phytotoxicity symptoms on 25 and 45 days old cotton plant. However, at 3, 5, and 10% concentrations, it injuries the boll, leaf margins, and leaf tips appeared. These injuries were rated "1, 2 and 3" and level. Further, these injuries improved and the crop was found healthy one week after spray.

## 4. CONCLUSION

The study evaluated selected spice oleoresins' repellent action against certain sucking pests. As they are the concentrated forms of plant extracts, their phytotoxicity effects on crops were also studied. The results concluded that both the oleoresins possessed significant repellence and were non-phytotoxic at lower concentrations.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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