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REPELLENCY EFFECTS OF CUCURBITA MAXIMA ON GUAVA MEALYBUG (HOMOPTERA: COCCIDAE)

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Abstract

This research undertakes the pioneering investigation into the dilution of pumpkin oil and its effectiveness against mealybugs on Guava (*Psidium guajava* L.) a widely cultivated and highly favored fruit known for its delectable taste. Guava plants are frequently targeted by various pests, including the guava mealybug. In this study, *Cucurbita maxima* oil was diluted with methanol. The results demonstrated a significant reduction in the *F. virgata* population following exposure to pumpkin oil derived essential oil. As exposure time increased, Mealybug populations declined. The highest average *F. virgata* count (17.30 ± 3.57) was observed after 24 hours of exposure. Subsequent counts decreased to 8.30 ± 1.51 and 4.50 ± 1.15 after 48 and 72 hours, respectively. A third application of the spray further reduced the Mealybug population, with the lowest *F. virgata* count (2.20 ± 0.93) observed after 72 hours. This was followed by counts of 1.20 ± 0.63 and 0.30 ± 0.20 after 48 and 24 hours, respectively. The effectiveness of the sprayers varied. However, a consistent spraying technique proved crucial in reducing the *F. virgata* population. The essential oil demonstrated its greatest impact on the third spray, followed by the second and first. The average *F. virgata* counts after these sprays were 2.20 ± 0.93, 3.80 ± 0.88, and 17.30 ± 3.57, respectively. Comparative analysis between the control and treatment groups revealed significant differences following treatment application. While the treatment group demonstrated notable variations across application times, the control group exhibited no significant differences. The persistency of the pumpkin essential oil treatment varied with dilution. Undiluted oil demonstrated the highest degree of persistency, reaching a maximum of 85%. Dilutions iii, ii, and i exhibited mean persistency percentages of 65%, 45%, and 35%, respectively. Each dilution level exhibited unique persistency characteristics when used to dilute the essential oil.

Key words: crop pest, guava trees, farmer practice, Mealybugs, parasitoids, predator.

Introduction

The guava plant (*Psidium guajava* L.), a perennial shrub or small tree belonging to the Myrtaceae family, is cultivated primarily for its delicious and nutritious fruits. Prized for its culinary and health benefits around the world, guava thrives in warm climates characteristic of tropical and subtropical zones (Muhammad *et al*., 2022). Introduced to India in the early 17th century, guava cultivation has since expanded to numerous countries, including Mexico, Brazil, Cuba, Venezuela, Australia, South Africa, Thailand, Malaysia, Indonesia, China, Sri Lanka, the Philippines, Bangladesh, Myanmar, the Dominican Republic, the United States, and Pakistan (Yadav *et al*., 2022).

Guava is one of India's most important fruit crops, ranking fifth in production and widely cultivated throughout the country (Yadav *et al*., 2022). The guava fruit itself is about 80% water and 20% dry matter, with the dry matter consisting of 1% ash, 0.7% fat, and 1.5% protein (Upadhyay *et al*., 2019). Appreciated worldwide for its exceptional quality, guava fruit is consumed fresh as a dessert or processed into a variety of products, including puree, juice concentrate, jam, jelly, and an array of other delicacies (Yousaf *et al*., 2020). Beyond its culinary value, the guava plant holds additional significance. Various parts, such as the root, bark, leaves, and fruit, exhibit pharmacological properties (Kim *et al*., 2021). These properties have been harnessed in traditional medicine to treat a wide range of ailments, including malaria, gastroenteritis, vomiting, diarrhea, wounds, ulcers, toothache, sore throat, swollen gums, and many others (Melo *et al*., 2020).

However, this valuable crop faces a significant threat *Ferrisa virgata*. These soft-bodied insect pests, belonging to the Order Hemiptera and Family Pseudococcidae, are characterized by their mealy or waxy secretions. Native to Central America, *F. virgata* are not considered a major threat in that region due to the presence of natural enemies. However, the wingless female mealybug, a small insect that feeds on the sap of various plants, is highly adaptable and can infest a vast array of host families (Lopes *et al*., 2019). Initially reported in Kenya, the mealybug pest has rapidly spread across the country, reaching epidemic levels and affecting various crops, including guava (Mwanauta *et al*., 2023).

The traditional approach to controlling mealybug infestations relies heavily on chemical pesticides. However, this method raises serious concerns. The use of chemical pesticides has been linked to numerous negative health effects, including dermatological issues, gastrointestinal problems, neurological disorders, increased risk of cancer, respiratory complications, reproductive disorders, and disruptions to the endocrine system. Furthermore, the excessive use of pesticides leads to soil and water contamination, which not only affects crops but also poses a threat to human health by entering the food chain (Sharma *et al*., 2019).

Additionally, the release of pesticides into the air is influenced by factors such as the physical and chemical properties of the active compound, the application method, and the ever-changing environmental conditions (Tudi *et al*., 2021). Given the multifaceted importance of the guava plant and the detrimental effects of chemical pesticides, exploring alternative, sustainable methods for controlling mealybug infestations are crucial. This little effort delves into the potential of biocontrol agents to safeguard guava crops and ensure the continued availability of this valuable fruit.

Materials and methods

A research study was carried out at the experimental farm of the Center for Agriculture and Bioscience International Organization, located in the vicinity of Larkana. The study took place in October, 2022 when guava trees were in their square-bearing stage. Additionally, the presence of *F. virgata* on the trees was observed.

Oil extraction and working solution preparation

Pumpkin seed oil was acquired from Nafees Products, a registered company located in Karachi, Pakistan. These seeds were then subjected to a drying process in a shaded area at a temperature range of 5 ± 50 degrees Celsius and a relative humidity of 20 ± 5 percent. Prior to the extraction of oil, the seeds underwent a meticulous cleaning and sorting procedure. Only healthy and uniform seeds were selected for the extraction process followed by A.A. Warra, 2012. The resulting oil was stored in a cool and shaded environment and utilized within a span of six months from the date of extraction. A glass vial was used for this purpose, where 1mL of essential oil was added, followed by the chosen dilution. The vial was vigorously shaken for duration of 30 minutes and then left undisturbed for 24 hours to ensure proper dilution. To achieve requires concentration double distilled water was added to the mixture, resulting in a final volume of 100 mL. The same dilution process was repeated using each solvent, following the method.

Laboratory experiment

The pumpkin oil underwent dilution using double distilled water to find out the persistency of the oil. In a glass vial,100% oil solution was diluted to 5%, the dilution ratio was 5/100 = 1/20 to get 1 part oil for every 20 parts water (dilution), 1/10 (dilution ii) for 10% and 1/05 (dilution iii) for 20% (Skoog *et al.,* 2007). The vial was vigorously shaken for duration of 30 minutes and then left undisturbed for 24 hours to ensure proper dilution (Wenzel, 2013). This dilution process was repeated using each.

Formula for calculate dilution:

$$\text{Dilution ratio} = \frac{\text{desired concentration}}{\text{original concentration}}$$

Field experiment

A practical approach was implemented using handheld sprayers to combat Mealybug infestation on delicate Guava leaves. The solution was swiftly applied within one hour after preparation. The population of *F. virgata* was documented both before and at intervals of 24, 48, and 72 hours following the application of the spray.

Data analysis

The collected data underwent analysis by using Statistix 8.1 software, and visual representations were created using Microsoft Excel 365 for Windows 10.

Results

The results indicated that the essential oil derived from pumpkin oil had a significant impact on reducing the population of *F. virgata*. As the duration of exposure increased, there was a corresponding decrease in the Mealybug population. Initially, the highest number of *F. virgata* was observed after 24 hours of exposure, with an average count of 17.30 ± 3.57. This was followed by 48 hours and 72 hours of exposure, with average counts of 8.30 ± 1.51 and 4.50 ± 1.15, respectively (refer to Figure 1). Furthermore, the application of the aforementioned spray resulted in a significant decrease in the Mealybug population. The lowest number of *F. virgata* was observed after 72 hours of exposure, with an average count of 3.80 ± 0.88. This was followed by 48 hours and 24 hours of exposure, with average counts of 1.40 ± 0.58 and 1.40 ± 0.62, respectively (refer to Figure 1).

In addition, a third spray was applied after the second one, taking into consideration the control of Mealybug population on Guava. The minimum number of *F. virgata* was observed after 72 hours of exposure, with an average count of 2.20 ± 0.93. This was followed by 48 hours and 24 hours of exposure, with average counts of 1.20 ± 0.63 and 0.30 ± 0.20, respectively (refer to Figure 1).

We noticed notable variations among the sprayers used. The consistent spraying technique proved to be effective in reducing the population of *F. virgata*. The essential oil exhibited its maximum impact on the third spray, followed by the second and first spray, with an average number of 2.20±0.93,3.80

± 0.88, and 17.30 ± 3.57, respectively (refer to Figure 2).

The findings revealed a notable distinction between the control group and the treatment group when the treatments were compared to the control. When examining the application times, the treatment group displayed a significant difference, whereas there was no significant distinction observed in the controlled applications (refer to Figure 3).

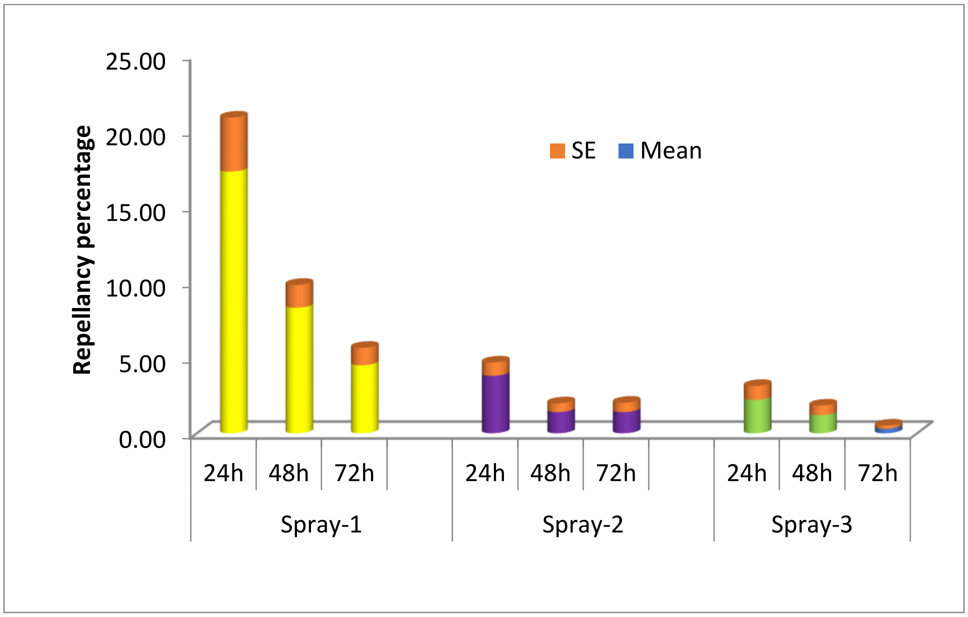

Figure 1: Mortality% *F. virgata* on pumpkin essential oil

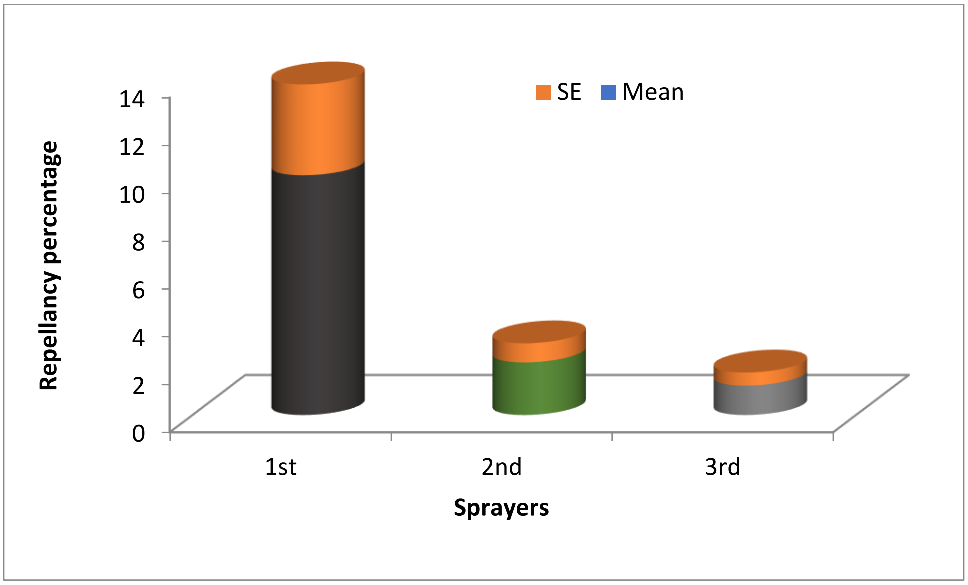

Figure 2: Comparative analysis of effectiveness of first, second and third sprays

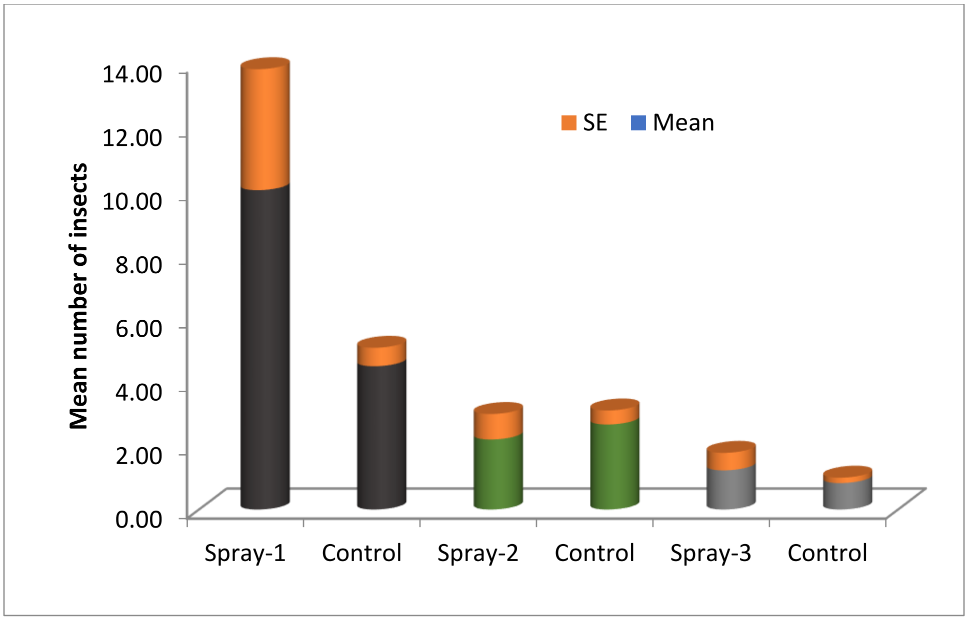

Figure 3: Comparison of repellency percentages between treatment and control

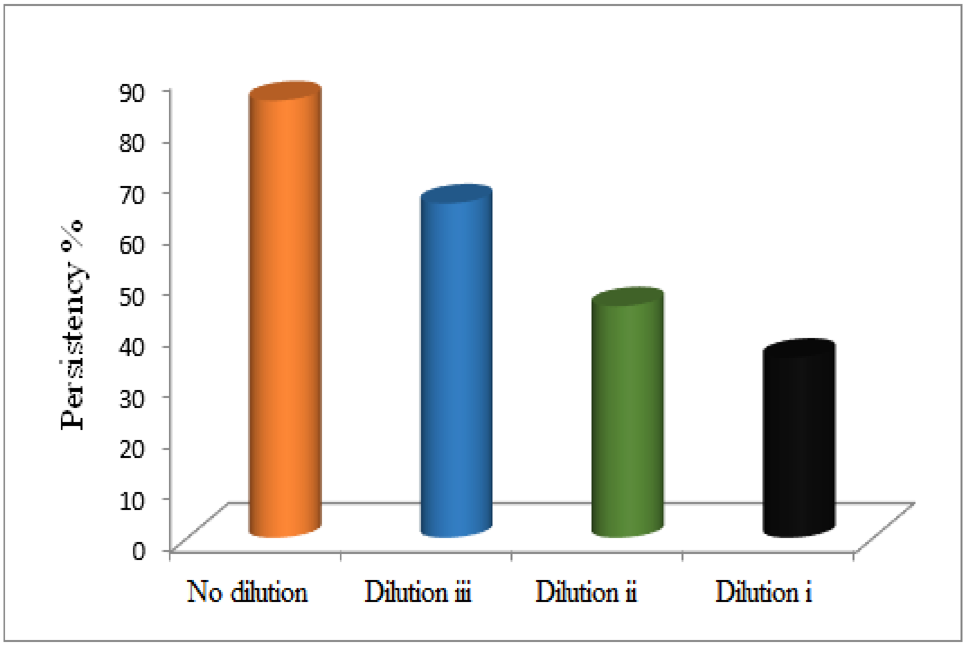

Figure 4: Persistency of pumpkin essential oil with various dilutions

The dilution of pumpkin essential oil resulted in varying the persistency of treatment. Undiluted oil exhibited the highest degree of persistency, with a maximum percentage of 85%. It was followed by dilution iii, dilution ii, and dilution i, which showed mean percentages of persistency of essential oil at 65%, 45%, and 35% respectively (refer to Figure 4). Each dilution displayed distinct levels of persistency when used to dilute with the essential oil.

Discussion

Pumpkin oil essential oil demonstrated significant efficacy in reducing Mealybug populations on Guava plants. The results indicated that longer exposure times to the oil led to a marked decrease in the Mealybug count. After 24 hours of exposure, the average Mealybug count was 17.30 ± 3.57. This number decreased to 8.30 ± 1.51 and 4.50 ± 1.15 after 48 and 72 hours of exposure, respectively. Mohamed *et al*. (2018) found that different plant essential oils had varying levels of toxicity against *F. virgata*. Thymus vulgaris, Mentha longifolia, and Cyperus articulates were found most toxic after 24 and 72 hours.

Hayat *et al*. (2015) reported that neem oil caused complete mortality of cotton *F. virgata* within 48 hours. These findings align with the current study's results, suggesting the potential of plant-based products for managing cotton mealybug infestations. To further enhance the control of *F. virgata*, multiple sprays of the pumpkin oil essential oil were applied. This strategy resulted in an even lower Mealybug population. The lowest average count was observed after 72 hours of exposure, with only 2.20 ± 0.93 *F. virgata* per plant.

This was followed by 48 and 24 hours of exposure, with average counts of 1.20 ± 0.63 and 0.30 ± 0.20, respectively. These findings match previous studies by Yang *et al*. (2009) and Magda *et al*. (2016). Yang *et al*. found that garlic oil effectively killed adult *Triboliumcastaneum* beetles. Magda *et al*. tested different essential oils and found they were harmful to *E. cautella*larvae. Another study by Ganesh *et al*. (2016) showed that nanoparticles of essential oil made of nickel were effective against *Callasobruchus maculates*, killing 97.31% of them. However, Carvalho *et al*. (2012) found that neem oil in nano form was not as effective against Bemisiatabaci eggs and nymphs.We noticed notable variations among the sprayers used. The consistent spraying technique proved to be effective in reducing the population of *F. virgata*. The essential oil exhibited its maximum impact on the third spray, followed by the second and first spray, with an average number of 2.20±0.93,3.80 ± 0.88, and 17.30 ± 3.57, respectively (refer to Figure 2).

Louni *et al*. (2018) found batter results on insecticidal efficacy of nanoemulsion containing Mentha longifolia essential oil against *Ephestiakuehniella*. Arwar (2012) explained that the primary way to combat insect pests is with synthetic pesticides. However, the emergence of insect resistance to these chemicals, coupled with high costs and environmental harm, has necessitated alternative pest control strategies. Essential oils offer a promising solution for managing a variety of field and household insect pests (Arwar *et al*. 2005).

The repellency percentage in our findings showed a clear difference between the treated and untreated groups. When looking at the timing of the treatments, the treated group had a significant effect, but there was no significant difference in the untreated group. Repellency of pests was observed in various previous researches, Eucalyptus plants have been shown to repel several insects (Batish *et al*., 2008). Sharifiyan found that *C. citratus*oil was the most effective repellent, followed by M. piperita and E. globulus oils, with RT50 values of 47.7 minutes. The repellent activity of *C. citratus* is due to the presence of citral a, citral b, linalool, and linalyl acetate, which are monoterpene aldehydes. Rani and Osmani (1980) also found citral to be an effective repellent against the pest. Oyedele *et al*. (2002) successfully used *C. citratus* oil to control Aedes aegypti, achieving 100% repellency at higher concentrations and over 90% repellency at lower concentrations.

The strength of pumpkin oil affected how long it worked as a treatment. Undiluted oil was the most effective, with 85% of it still working. The oil became less effective as it was diluted. Dilution iii was the next most effective, followed by dilution ii and dilution i Each dilution had a different level of effectiveness. Similar study was found that different plant oils lost their insect-killing power at different speeds. The persistency of *S. hortensis*essential oil was probably due to its concentration. Essential oil from *S. hortensis* lasted the longest, while oil from *T. polium* lasted the most persistent (Obeng-Ofori *et al*., 1997). The researchers think that the persistency depends on what it's made of. Oils with more hydrogenated compounds break down faster, while those with more oxygenated compounds last longer (Huang and Ho, 1998; Regnault-Roger *et al*., 2002).

Author's contribution

All authors contributed equally.

Conflict of Interest

There is no conflict of interest to show

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