Research Article

Efficacy of Lemongrass and Common Lantana Extract and Oil in Controlling the *Tetranychus urticae* Mites on Cucumber

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Abstract | This study aimed to control two-spotted red mite, *T. urticae*, using extracts and oils of lemongrass and dendritic myrtle. Laboratory experiments were conducted using lemongrass and lantana extract or essential oil at two concentrations, 2.5% and 5%, to evaluate the effects of treatments on adult mite mortality and egg hatchability. The results of the study showed significant effects of the plant extracts and oils used on adult mite mortality and egg hatchability. Lemongrass extract and oil recorded the best results with the highest mortality rate of 60.4% and 73.63% compared to dendritic myrtle extract and oil, which recorded 37.1% and 26.44%, respectively. The 5% concentration recorded a significantly higher mortality rate compared to the 2.5% concentration. Lemongrass extract or oil had the highest effect on egg hatchability, recording the lowest number of hatched eggs (31.11% and 25.6%) compared to enamel, which allowed 48.33% and 45.6% hatchability, respectively. Furthermore, reduced hatchability was consistently associated with higher concentrations. In general, the highest mortality rates in adult mites and the lowest egg hatchability rates were always recorded at the highest concentration of 5%, with a significant difference from those recorded at 2.5%, regardless of the plant species or the preparation. These results support the encouraging trend of studies on the use of biocontrol agents to reduce the damage and spread of this pest.

Received | April 09, 2025; **Accepted** | July 29, 2025; **Published** | February 23, 2026
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Citation | Abdullah, Z.M. and H.R. Meteab. 2026. Efficacy of lemongrass and common lantana extract and oil in controlling the *Tetranychus urticae* mites on cucumber. *Pakistan Journal of Agricultural Research,* 39(1): 98-104.
DOI | https://dx.doi.org/10.17582/j.pjar/2026/39.1.98.104
Keywords | Botanicals, *Cucumis*, C. citratus, *L. camara*, Spider mites

Introduction

The two-spotted red spider mite (*Tetranychus urticae*) is a major pest of many important economic crops, such as cucumber, tomato, pepper, and beans, among other crops, in open fields and protected areas, such as ornamentals (Zhang, 2021). This pest poses an economic threat if appropriate mitigation measures are not implemented. It attacks 1,200 plant species, of which approximately 150 are economically important (Gauraha and Singh, 2011).

Symptoms of infestation begin on the leaves of the host plant at the base of the blade and adjacent to the main veins, appearing as pale green spots on the upper surface of the leaves. This is a result of the mite feeding on the underside of the leaf. As feeding continues and the infestation intensifies, the spots

turn purple-red, and the mite produces more webs for protection and locomotion, which increases dust accumulation and reduces leaf efficiency. This results in the plant becoming completely dusty (Ibrahim *et al*., 2008).

To avoid the risks of developing resistance to many chemical pesticides (Alpkent and Ertürk, 2024), biopesticides have been used, particularly those that are non-polluting, environmentally friendly, and perform well in reducing the impact of agricultural pests (Said *et al*., 2025). The most important of these preparations is the use of plant extracts and oils to reduce the impact of this pest. The efficacy of extracts of lupinus termis and lemongrass (C. citratus) on the mortality of *T. urticae* and red-spotted mites was studied (Mahmoud, 2020). Teng *et al*. (2024) found that lemongrass oil had a lethal and repellent effect on the brown grain mite (*Aleuroglyphus ovatus*), and that contact with the oil was more effective than vaporization. Thyme, clove, cumin, and eucalyptus essential oils also showed good results in reducing the incidence of the two-spotted red mite, with mortality rates increasing at concentrations above LC90 in eggplant greenhouses (Mostafa *et al*., 2025; Alwan *et al*., 2025; Talib *et al*., 2025).

Lemongrass and peppermint oils were also found to be more toxic to the mite *Oligonychus mangiferus* than to its predator, *Cydnoseius negevi*. Exposure of *O. mangiferus* to the LC50 of these oils resulted in a significant increase in peroxidase enzymes. And catalase, but it inhibits the detoxification enzymes, α-esterase, β-esterase, and glutathione s-transferase (Ahmed and Abdelwines, 2024). Several plant extracts were also evaluated, showing high toxicity against adult females of the two-spotted red mite, with mortality rates ranging from 39.5% to 99.5%, while it reached 0.5% in the control treatment. Moreover, the oviposition-inhibiting activity of the plant extracts was reflected in a lower number of eggs laid in the plant extract treatments (9.1-255.5 eggs) compared to the control treatment, which recorded 504.8 eggs (Puspitarini *et al*., 2024). Therefore, this study aimed to evaluate the possibility of controlling the two-spotted red mite, *T. urticae*, using different concentrations of extracts and oils of lemongrass and dendritic enamel.

Materials and Methods

Preparation of a permanent culture of the two-spotted red mite (T. urticae)

Cucumber plants (Super Saif variety) were grown in 5 kg plastic pots containing 2Vsterile soil: 1Vpeat moss, maintained in a growth chamber to meet the growth requirements of the red spider mite: at 25 ± 2˚C and a humidity of 65 ± 5% (Meena *et al*., 2013). After 15 days of growth, the plants were infested with *T. urticae*, collected from infected cucumber plants in Najaf Governorate. The red mite culture was reared and maintained in special rearing tanks. The rearing tank was designed by installing three 2 cm plastic tubes inside a 20 x 10 cm plastic tank in a linear pattern, as the tubes were immersed in water. Newly grown cucumber plants were fixed inside the tubes, and 10 individual mites per plant (Meteab *et al*., 2023).

Plant materials

Plant samples were collected from lemon grass, *Cymbopogon citratus,* which was obtained from a local farm in the Abbasiya district/Sharman area, while common lantana, *Lantana camara,* plants were collected from Najaf local nurseries. A sufficient amount of newly grown leaves was taken, transported to the laboratory, and dried in an electric oven at 45˚C until the weight was constant. The dry leaves for each plant type were then ground separately using an electric blender and stored in the refrigerator until use.

Preparation of the plant extract and essential oil

Extraction was carried out according to the Harborne method (1984), using 50 g of lemongrass or common lantana leaves, powdered using a Soxhlet extractor. The extract was then added to 500 mL of 95% ethyl alcohol (Saqr and Shiban, 2018) for 24 hours, after which the sample was concentrated in a rotary evaporator at less than 50 ˚C under reduced pressure. 5 ml of ethyl alcohol was added to the resulting solution, and the sample was transferred to a glass bottle of known weight and placed in an oven at 50 ˚C to obtain the dry extract. A 25 mg/ml stock solution was prepared by dissolving 2.5 g of the dry sample of each extract in 5 ml of 95% ethyl alcohol, then bringing the volume to 100 ml with distilled water. The remaining concentrations (10, 5, and 2.5 mg/ml) were prepared from this solution. The essential oil of lemongrass and common lantana was also prepared at

concentrations of 2.5% and 5% using distilled water and 1 ml/L dishwashing liquid.

Effect of plant extracts and oils on T. urticae mobile adult mortality

Ten individuals of two-spotted red mite adults present on infected cucumber leaves were transferred to cucumber leaves in experimental tanks using a small needle moistened with water. They were sprayed with concentrations of plant extracts or essential oil (2.5% and 5%) independently, in three replicates for each treatment. The control treatment was sprayed with sterile distilled water. All treatments were incubated at 25 ± 2 ˚C and a relative humidity of 65 ± 5 ˚C. Data were taken 2, 4, 6, and 8 days after treatment to record the number of dead individuals. The percentage of dead individuals was calculated in each replicate within a single treatment, and the values were corrected (Sun and Shepard, 1947).

Effect of plant extract and essential oil on T. urticae egg hatchability

To conduct this experiment, clean leaves free of any mite infestation were selected from the upper part of a cucumber plant. Five adult female fertilized dendritic mynas were transferred to each leaf and left for 24 hours. They were then removed after oviposition, leaving only 10 eggs per leaf. All leaves were sprayed with plant extracts (lemongrass and dendritic myna) at concentrations of 2.5% and 5%, each separately, until the leaves were completely wet, at a rate of 1.5 ml/replicate. Treated leaves were transferred to an incubator after drying to ensure the ideal temperature (25 ± 5 ˚C) and relative humidity (65 ± 5%) for egg hatching. A control treatment was carried out following the same steps as previously, spraying with sterile distilled water. The percentage of hatched eggs was calculated in each replicate 3 and 6 days after treatment.

Results and Discussion

Effect of plant extracts and oils on T. urticae mobile adult mortality

The results showed that the plant extracts used in this study had a significant effect in increasing the percentage of mortality of the two-spotted red spider mite adults compared to the untreated control, especially with the effect of lemongrass extract treatment compared to common lantana extract (Table 1). Lemongrass extract recorded the highest percentage of adult mortality of 60.4% compared to 37.1% mortality by the common lantana extract. The plant extract at a concentration of 5% was significantly superior, with an average mortality rate of 66.3% compared to a concentration of 2.5% which resulted in an average of 31.2%. It was also noted that the average mortality of

Table 1: *Adult mortality rate of the two-spotted red mite T. urticae on cucumber leaves as affected by alcohol extract of lemongrass and common lantana.*

Plant extract	Concentration %	Adult mortality % post treatment days				Average
		2	4	6	8	
C. citratus	2.5	13.3	37.0	48.1	63.0	60.4
	5	62.2	74.1	85.2	100	
L. camara	2.5	3.3	18.5	29.6	37.0	37.1
	5	30.7	40.7	59.3	77.8	
Average		27.4	42.6	55.6	69.4	
L.S.D ($P \leq 0.05$)		Time= 5.95, extract= 4.21, concentration= 4.21, Interaction= 11.91				

Oil at a concentration of 5% after 8 days recorded complete mortality (100%) in the red spider mite adults with significant differences from all other repellent treatments and interactions (Table 1). Adults increased with the increase in the period after treatment, with the highest average mortality of 69.4% after 8 days of treatment.

The results showed that lemongrass oil showed a significant effect in increasing the mortality percentage of the two-spotted red mite *T. urticae* adults compared to the common lantana oil treatment (Table 2). The highest mortality rate of 73.63% was recorded in the lemongrass oil treatment compared to 26.44% mortality by the common lantana oil treatment. Using the extract at 5% was significantly superior to the concentration of 2.5% in adult mortality rate, recording 60.56% and 39.52%, respectively. In general, the mite's mortality rate increased with the increase in the period after the treatment (Table 2).

Effect of plant Alcohol Extract and essential oil on T. urticae egg hatching.

The results indicate that lemongrass extract had a slightly higher effect on egg hatching than common lantana extract after 3 days of treatment when used at a concentration of 2.5%, with hatching rates of 13% and 16%, respectively (Figure 1). Meanwhile, the 5%

Table 2: *Adult mortality rate of the two-spotted red mite T. urticae on cucumber leaves as affected by the essential oil of lemongrass and common lantana.*

Plant oil	Concentration %	Adult mortality % days post treatment					Average
		1	2	3	4	5	
C. citratus	2.5	27.04	42.96	62.96	85.19	88.89	73.63
	5	65.56	85.93	88.89	88.89	100.00	
L. camara	2.5	3.33	7.04	18.52	25.92	33.33	26.44
	5	6.67	17.78	37.03	55.56	59.26	
Average		25.65	38.42	51.85	63.89	70.37	
L.S.D ($P \leq 0.05$)		Time= 4.858, extract= 3.073, concentration= 3.073, Interaction= 9.717					

concentration recorded a significantly lower hatching rate of 3.33 for both extracts. Although the hatching rate increased after 6 days of treatment, the effect of the treatments remained clear, particularly in the lemongrass treatment at concentrations of 2.5% and 5%, with hatching rates that did not exceed 36.67% and did not fall below 20%, compared to significantly higher hatching rates in the 90% control treatment and the 2.5% and 5% lantana extract treatments, which recorded hatching rates of 83% and 73%, respectively.

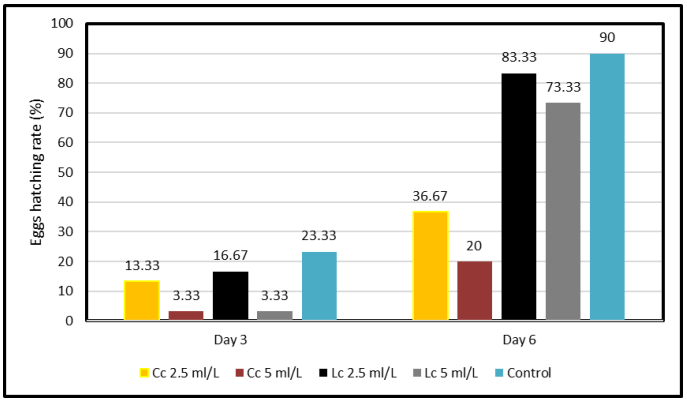

Figure 1: *Effect of Alcohol Extract of Lemongrass C. citratus (Cc) and common lantana L. camara (Lc) on T. urticae egg hatching. Where, LSD(P≤0.05): for time (days)/extracts= 3.543, concentration= 3.339, and interaction= 8.678*

As for the effect of essential oil on the red spider mite eggs hatching, the results showed an effect different from that recorded by the plant extract of the same plant (Figure 2). The lowest hatching percentage after 3 days of treatment was recorded in the 5% lemongrass oil treatment, with a significant difference from all treatments regardless of concentration or type of plant oil. The same effect context was recorded after 6 days of treatment with a highly significant effect for lemongrass oil at concentrations of 5% and 2.5, with a hatching percentage of 6.7% and 26.7%, respectively which significantly differed from the hatching percentage recorded in the control (86.7%) and the 2.5 and 5% treatments of Lantana oil resulting in hatching of 80% and 60%, respectively (Figure 2).

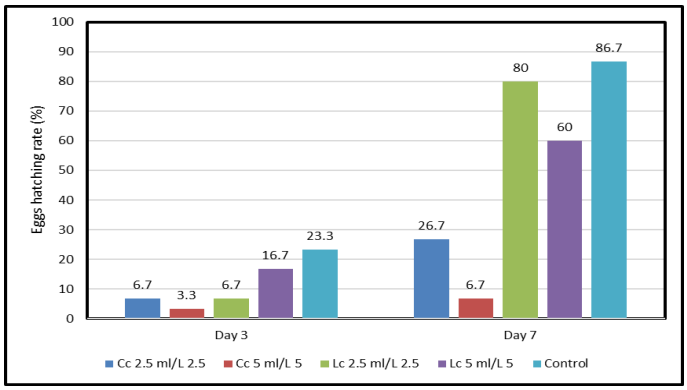

Figure 2: *Effect of essential oil of lemongrass C. citratus (Cc) and common lantana L. camara (Lc) on T. urticae egg hatching. Where, LSD(P≤0.05): for time (days)/extracts= 4.45, concentration= 5.45, and interaction= 10.90*

The results of the study indicate the effectiveness of plant extracts, particularly lemongrass, in affecting red spider mite adults and egg hatching as well. Studies have indicated that plant extracts act as direct toxicants that inhibit feeding or egg laying, cause sterility, or act as growth regulators or behavioral modifiers (Prabuscnivasa, 2004; Heinz-Castro, 2021). Srimongkolchai *et al.* (2013) have found that the alcoholic extract of lantana leaves was highly effective in repelling the two-spotted red mite (T. articae) adults from mulberry leaves and reduced the number of eggs by varying degrees depending on the concentrations used. It was also observed that the aqueous extracts of ginger (*Zingiber officinale*) and cumin (*Cuminum cyminum*) resulted in 100% mortality of the two-spotted red mite larvae, nymphs, and adults when each was used at a concentration of 100% (Fahid

2020). Saqr and Shiban (2019) also indicated that Melia azedarach seed extract led to high mortality in nymphs and adults of the two-spotted red mite. Lemon oil at concentrations of 5% and 2.5%, with hatching rates of 6.7% and 26.7%, respectively, which differed significantly from the hatching rates recorded in the control group (86.7%) and the two treatments of Lantana oil at concentrations of 2.5 and 5%, where hatching rates reached 80% and 60%, respectively. The variability in the effectiveness of plant extracts on pests is often attributed to the plant part used and also to the quantity and quality of active ingredients that affect the pest (Aydin *et al*., 2017; Premalatha *et al*., 2018).

Several studies have demonstrated the potential of using botanical oils as an alternative to chemicals for controlling agricultural pests, including the two-spotted red mite (*T. urticae*). Different concentrations of clove essential oil (*S. aromaticum*) were found to significantly reduce the *T. urticae* population density (Kheradmand, 2018). Clove oil was also effective in reducing *T. urticae* fertility and, consequently, the population density of the mite (Ataíde, 2020). Teng *et al*. (2024) found that lemongrass oil has a lethal and repellent effect on the brown grain mite (*Aleuroglyphus ovatus*), particularly as a contact effect (Mahmoud, 2020). The common lantana oil resulted in high adult mortality of dust mites in laboratory experiments when sprayed directly, resulting in mortality of 50% after 72 hours (Chouikhi *et al*., 2023). The effect was attributed to the oil's content of active compounds such as caryophyllene, humulene, and morulene in varying proportions. Ahmed and Abdelwines (2024) also found that lemongrass and peppermint essential oils produced significant results in the mortality of adult red mites on *O. mangiferus* plants and also affected the pest's life cycle and fertility. Exposure of the pest to these oils significantly increased the enzymes peroxidase and catalase but inhibited the detoxification process. Noha (2019) indicated that cinnamon oil and castor oil significantly affected all stages of the two-spotted red mite, and that using them together was better than using them alone. Vegetable oils have been found to coat the eggshell and prevent gas exchange. This can also lead to hardening of the eggshell, preventing the embryo from hatching. The effect may also occur through the oil's penetration into the egg, affecting the protoplasm and resulting in embryo death. The effect of vegetable oils on adult two-spotted spider mites is likely due to blocking existing respiratory openings or due to the chemical content of the oil, which leads to the death of treated individuals, due to the effect of natural oil vapors (Golan *et al*., 2019). Saad *et al*. (2025) have found that cumin (*Cuminum cyminum*), clove (*Syzygium aromaticum*), lemongrass (*C. citratus*), and black pepper (*Piper nigrum*) oils demonstrated clear efficacy in reducing adult mite populations, which increased with increasing concentration, exposure time, and the period after treatment.

Conclusions

Findings showed that the two-spotted spider mite *T. urticae* eggs hatching and mobile stages were affected by the plant extracts and oils used in this study. Lemongrass extract essential oil showed higher effectiveness in reducing the two-spotted spider mite eggs' hatchability than common lantana extract or oil, regardless of the concentration used. Low egg hatchability was consistently associated with higher concentrations and longer periods post-treatment. Both red mite adult mortality rates and egg hatchability rates were remarkably reduced by lemongrass extract and its essential oil, even when used at low concentrations. Findings of this study can be useful and encourage farmers and growers to use botanical derivatives as biocontrol agents to reduce the population and damage caused by this pest. The results show high acaricidal activity of lemongrass extract and oil against *T. urticae* with mortality effects on eggs and adults at different concentrations within different periods of exposure. Growers are recommended to use lemongrass-based botanical products as an alternative, eco-friendly synthetic pesticide in integrated pest management (IPM) programs during the early stage of infestation for maximum control efficiency.

Acknowledgments

Zaman and Husham from the Faculty of Agriculture, University of Kufa, deeply appreciated all those who guided them in any way with technical completion or support at the end of this mini-research.

Novelty Statement

The manuscript bears a unique scientific contribution arrived at through independent experimentation and analysis. The results have not been previously

published or considered for publication elsewhere.

Author Contributions

Zaman Malik Abdullah and Husham Romeel Meteab: Involved in all stages of the research, from its conceptualization and methodology to data collection, statistical analysis, and writing. The final version of the paper was approved by both authors.

Generative AI or AI assisted technology statement

The AI AI-assisted plagiarism check showed that the text contains no copied material, giving a zero plagiarism score. No AI tools were used to generate scientific content, results, or conclusions presented in the study; all ideas and writings originate exclusively from the authors.

Conflict of Interest

There are no financial, academic, or personal conflicts of interest that could have affected the results or their interpretation, as clearly stated by the authors.

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