



Efficacy assessment of garlic extract as a natural aphid control agent on infected tomato plants

Dilawar Hussain^{a*}, Mohsin Iqbal^a, Nabeel Arshad^a, Anayat Ullah^a, Muhammad Yousaf Javed^a, Shakeel Ahmad^a, Noor Fatima^b, Noor Ud Din^c, Ujala Khalid^a, Muhammad Adeel^a

^aDepartment of Plant Pathology, College of Agriculture University of Layyah, Pakistan

^bDepartment of Zoology, University of Agriculture Faisalabad, Pakistan

^c Department of Plant Breeding and genetics, College of Agriculture University of Layyah, Pakistan

Article info

Article history:

Received: 17 July 2023

Accepted: 26 September 2023

Keywords: Aphid; Garlic Extract; Insect and Pest; Tomato; Vegetables.



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*Corresponding author

alig9028252@gmail.com

Conflict of Interest: The authors declare no conflict of interest.

Abstract

This controlled pot experiment aimed to assess the effectiveness of garlic extract as a natural aphid control agent on infected tomato plants (*Solanum lycopersicum*). The study investigated the impact of different doses of garlic extract on plant height, leaf damage, fruit production, and overall yield. The garlic extract was prepared by diluting crushed garlic bulbs with water to achieve the desired concentrations. The experiment employed a randomized complete block design with four treatment groups: a control group (0%), low dose (10%), medium dose (30%), and high dose (50%) of garlic extract. The treatments were applied using a handheld sprayer, and the plants were monitored for aphid populations using visual inspection and sticky traps. Data collected were subjected to statistical analysis, including analysis of variance (ANOVA), to determine significant differences between treatments. The results revealed that higher doses of garlic extract led to increased plant height, decrease in leaf damage caused by aphids, higher fruit production, and improved overall yield. The control group exhibited the lowest values for all parameters, while treatments with garlic extract showed significant improvements. The highest yields were observed in Treatment 50%, where plants treated with the highest dose of garlic extract yielded 41.2 kg per treatment. These findings demonstrate the potential of garlic extract as an effective aphid control agent, capable of enhancing tomato crop yield and economic returns for farmers.

1. INTRODUCTION

The tomato, *Solanum lycopersicum* L., is a widely favored vegetable for home gardens and ranks as the second most commonly consumed vegetable globally, right after potatoes (*Solanum tuberosum* L.). Originally hailing from South America, particularly Peru and Ecuador, the tomato was first cultivated and domesticated in Mexico (Benton, 2007). During the middle of the 16th century, the tomato made its way to Europe. It was mainly showcased in early herbals for its visual appeal, but it wasn't commonly consumed, except in Italy and Spain. In fact, many people believed the fruit to be poisonous, and it took until 1800 for it to be recognized as a valuable vegetable. Fast forward

to today, the tomato is now extensively cultivated across the globe due to its delightful taste, vibrant color, rich flavor, and nutritious qualities. Tomatoes are a versatile food that can be enjoyed in various ways, either straight from the garden or after undergoing processing. Including tomatoes in your diet can be beneficial for maintaining a healthy and balanced eating plan. Not only do they contain very few calories, but they are also packed with essential nutrients like vitamin A, vitamin C, and various minerals. Additionally, tomatoes provide small but valuable amounts of vitamins from the B complex, including thiamin, riboflavin, and niacin, as noted by Sainju and Dris 2006.

Tomatoes are a good source of iron and contain lycopene, an antioxidant that may protect against cancer. Yellow tomatoes have more vitamin A than red ones (Naika et al., 2005). Research indicates that lycopene, a compound found in tomatoes, may lower the chances of prostate cancer (Miller et al., 2002). Additionally, consuming tomatoes can potentially decrease the likelihood of gastroenteric diseases like colon, rectal, and stomach cancer. Moreover, tomatoes are easily digestible and their vibrant color can boost your appetite (Sainju and Dris, 2006).

Plant diseases and pests can cause significant economic losses in agricultural production. A study conducted by Tolman et al. (2004) found that insect damage led to a loss of approximately 30% in tomato yield. Detecting infested plants at an early stage, before visual symptoms appear, is crucial for implementing effective management strategies and pest control measures to prevent the spread of diseases (Zee et al., 2001; Park et al., 2016). Currently, we rely heavily on insecticides to control aphids. However, this has led to some aphid species, like the peach, tomato, and potato aphid, becoming resistant to these chemicals. To address this issue, we need alternative methods of aphid control. One potential solution is using plant extracts that repel aphids or discourage them from feeding. This could help decrease the number of aphids on plants without relying solely on insecticides (Bizzaro et al., 2005; Van Toor et al., 2008; Imbaya et al., 2018).

Allium sativum, commonly known as garlic, has been widely utilized in culinary practices and traditional medicine for more than 4000 years. It possesses various beneficial properties such as antiseptic, anti-inflammatory, antioxidant, cardioprotective, and anticancer effects. The antimicrobial activity of garlic is attributed to its prominent organ sulfur compounds, including ajoenes, allicin, alliin, allyl sulfide, and 1,2-vinyldithiin (Lanzotti 2006; Corzo Martinez et al., 2007; Martins et al., 2016). For instance, Gong et al. (2013) conducted a study on the impact of 2% raw garlic straw extracts on root-knot nematodes (*Meloidogyne incognita*) in tomato plants. The researchers observed that the garlic extracts inhibited the growth of nematodes and led to an increase in tomato yield. Similarly, Jess et al. (2017) explored the potential use of garlic oil in controlling *Megaselia halterata* (a species of phorid fly) in commercial mushroom production. The researchers found that low concentrations (ranging from 0.1% to

20%) of garlic solutions effectively repelled adult female *M. halterata*. A commonly recommended recipe for a garlic solution involves using 25 grams of chopped garlic in 10 liters of water. This solution can be applied to the soil and plants, exhibiting effectiveness against various pathogens such as fungi and bacteria, as well as pests including mites, aphids, larvae of Lepidoptera, and small bedbugs (Ministerio de Agricultura. Servicio Agrícola y Ganadero, 2013). Garlic (*Allium sativum* L.) is a highly effective plant-based bio-pesticide known for its ability to control seed-borne diseases. It contains allicin, a compound that gives garlic its distinctive smell and taste while providing biological properties. Studies have shown that garlic possesses insecticidal and fungicidal properties, making it effective against pests like mites, ticks, nematodes, and worms. These characteristics make garlic a valuable resource for pest management and disease control in agriculture and veterinary applications.

This controlled pot experiment aimed to assess the effectiveness of garlic extract as a natural aphid control agent on infected tomato plants (*Solanum lycopersicum* L.). The study investigated the impact of different doses of garlic extract on plant height, leaf damage, fruit production, and overall yield.

2. MATERIALS AND METHODS

2.1. Material

A controlled pot experiment was conducted at the Department of Pathology, University of Layyah to investigate the effectiveness of garlic extract as a natural aphid control agent on infected tomato plants (*Solanum lycopersicum* L.). The experiment consisted of 24 pots divided into four treatment groups, each replicated three times. Two pots were used for each replication, resulting in a total of six pots per treatment group. The randomization process ensured unbiased distribution of treatments across the pots, following a randomized complete block design (RCBD).

2.2. Garlic extract preparation

The treatments applied to the tomato plants were as follows: Treatment T1 (control): No garlic extract was applied (0%). Treatment T2: Low Dose - A diluted concentration of garlic extract was prepared by mixing 10 (ml) of garlic extract with 90 ml of water (10%). Treatment T3: Medium Dose - A moderately concentrated garlic extract was prepared by mixing 30 ml of garlic extract with 70 ml of water (30%).

Treatment T4: High Dose - The highest concentration of garlic extract was prepared by mixing 50 ml of garlic extract with 50 ml of water (50%) (Table 1). This entire dose aimed to test the effectiveness of a more potent concentration of garlic extract as an aphid control agent. The garlic extract was obtained by crushing fresh garlic bulbs and extracting the juice. It was then diluted with water to achieve the desired concentrations for each treatment. The garlic extract was applied to the tomato plants using a handheld sprayer, ensuring thorough coverage of all plant parts.

2.3. Aphid treatment control

Table 1. Different Doses of Garlic Extract for Various Treatments:

Treatments	Concentration of Garlic Extract %
T1	0%
T2	10%
T3	30%
T4	50%

The pots were placed in a greenhouse with controlled environmental conditions, replicating optimal tomato growth conditions. To create the perfect conditions for healthy tomato growth in a controlled environment, make sure the temperature stays between 20-28°C (68-82°F), maintain humidity at around 70%, provide 12-16 hours of light per day with the right intensity (400-600 μmol/m²/s), and carefully manage nutrient supply while keeping pests and diseases

in check through diligent monitoring and control measures.

Throughout the experiment, regular monitoring of aphid populations was conducted using visual inspection and sticky traps placed in each pot. The number of aphids present on the plants was recorded at regular intervals, such as weekly, to track the effectiveness of the garlic extract in controlling aphid infestation.

2.4. Data analysis

The collected data from the experiment were subjected to statistical analysis using appropriate methods such as analysis of variance (ANOVA). The analysis aimed to determine significant differences between the treatments and evaluate the efficacy of garlic extract as an aphid control agent on tomato plants. In addition to assessing aphid control, the study also considered several parameters as part of the investigation, including plant height, leaf damage caused by aphids, and yield. These parameters provided a comprehensive evaluation of the effects of garlic extract on the tomato plants and their potential as a natural aphid control measure.

3. RESULTS AND DISCUSSION

The results of the efficacy assessment of garlic extract as a natural aphid control agent on infected tomato plants are presented in Table 2. The measurements taken include plant height, damage to leaves per plant, number of fruits per plant, and yield per treatment.

3.1. Plant height

The tomato plants treated with different doses of garlic extract exhibited varying heights. The control group T1 had a plant height of 95.00(cm), while the plants treated with T2, T3, and T4 doses of garlic extract showed heights of 113 cm, 128 cm, and 139 cm,

Table 2. Efficacy Assessment of Garlic Extract as a Natural Aphid Control Agent on Infected Tomato Plants:

Treatments	Plant Height (cm)	Damage leaf per Plant	Fruit per Plant	Yield kg/Treatment
T1 (0%)	95.00 ± 15.35	7.00 ± 0.58	4.00 ± 4.04	18.90 ± 9.98
T2 (10 %)	113.00 ± 12.44	6.00 ± 0.58	6.00 ± 2.00	27.20 ± 8.12
T3 (30%)	128.00 ± 11.07	5.00 ± 0.58	9.00 ± 3.16	34.40 ± 9.16
T4 (50 %)	139 ± 16.77	6 ± 0.58	13 ± 4.36	41.2 ± 10.85

respectively. The highest value was observed in T4, indicating a positive correlation between garlic extract dose and plant height. According to a study reported by Arora et al. (2014), they found that using a combination of garlic is more effective in pest control compared to using only garlic. Garlic acts as a natural pesticide, inhibiting the growth of pests and insects, while also improving plant growth parameters such as height.

3.2. Damage to leaves per plant

The severity of leaf damage caused by aphids was assessed for each treatment. The control group (T1) had the highest damage score, denoted as 7.00. However, all treatments with garlic extract (T2, T3, and T4) exhibited lower damage scores, suggesting the potential of garlic extract in reducing leaf damage caused by aphids. In a study conducted by Gravel et al., 2007, it was demonstrated that diallyl disulphide, a component found in the essential oil of garlic, possesses insecticidal characteristics that exhibit efficacy against various pests, including the *Alternaria Solani* species.

3.3. Number of fruits per plant

The number of fruits per plant increased with increasing doses of garlic extract. The control group (T1) had the lowest number of fruits per plant (4.00), while the plants treated with low (T2), medium (T3), and high (T4) doses of garlic extract yielded 6.00, 9.00, and 13.00 fruits per plant, respectively. This indicates that garlic extract has a positive impact on fruit production. The findings of this study indicate that garlic possesses inherent insecticidal characteristics, as reported by Sigei et al. (2014). Additionally, it has been observed that the application of garlic enhances the overall growth and development of plants. The experimental results revealed that garlic exhibited the most abundant harvest, with a remarkable yield of 55 fruits. It is plausible that the relatively low concentration of the garlic spray employed in this study might not have effectively mitigated the growth of *Alternaria Solani*, as suggested by previous research conducted by Voorrips et al. (2011).

3.4. Yield per treatment

The overall yield per treatment was calculated in kilograms (kg). The control group (T1) had a yield of 18.9 kg, while the treatments with garlic extract (T2, T3, and T4) resulted in higher yields of 27.2 kg, 34.4 kg, and 41.2 kg, respectively. These findings demonstrate the potential of

garlic extract to increase the overall yield of tomato plants. The findings elucidate that the absence of insecticidal intervention leads to a decline in crop productivity. This phenomenon occurs due to the indirect detrimental effects of *Alternaria solani* on the leaves of tomato plants, which disrupt the process of photosynthesis and impede their growth, ultimately causing stunted development (Voorrips et al., 2011; Sigei et al. 2014).

Overall, the results indicate that garlic extract, particularly at higher doses, shows efficacy in controlling aphid infestation on tomato plants. It leads to increased plant height, reduced damage to leaves, higher fruit production, and improved yield. These findings support the potential use of garlic extract as a natural aphid control agent in tomato cultivation.

4. CONCLUSION

In conclusion, the efficacy assessment of garlic extract as a natural aphid control agent on infected tomato plants revealed promising results. The study examined the effects of different doses of garlic extract on various parameters, including plant height, damage to leaves per plant, number of fruits per plant, and overall yield. The treatments with garlic extract exhibited positive effects on most of parameters, with higher doses demonstrating greater efficacy. The results showed the potential of garlic extract in improving tomato crop yield and economic returns for farmers. Based on the findings, it is recommended that further research and field trials be conducted to optimize the dosage and application methods of garlic extract as an aphid control agent.

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