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Role of Spraying by Moringa Leaf, Garlic, and Turmeric Extracts in Pomegranate Leaves Mineral Content

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ABSTRACT

The current study was done in 2022 seasons to study the influence of foliar application by moringa leaf extract at (2, 4, and 6 ml.l^{-1}), garlic cloves extract (5, 10, and 15 ml.l^{-1}), and turmeric extract at (5, 10, and 15 ml.l^{-1}) plus the control treatment on some minerals content in the "Salakhani" pomegranate leaves grown in a private orchard situated in Halabja Governorate, Iraq. Thirty healthy trees, uniform in their vigor and with no visual insufficiency symptoms, were selected, each tree as an experimental unit by utilizing a simple randomized complete block design. The results revealed that the spraying with the most doses of moringa leaf extract, garlic cloves, and turmeric significantly increased the N, K, Mg, Ca, Zn, Fe, and B in the leaves content of pomegranate compared to the control. The effect of the studied plant extracts regarding the P content in pomegranate leaves compared to the control expressed insignificant differences. Generally, the leaf content of N, K, Mg, Ca, Zn, Fe, and B increased with increasing concentrations of moringa leaf extract, garlic cloves, and turmeric. The highest concentration of them gave the highest value of studied minerals content. Thus, it can be recommended to use these plant extracts as an alternative to chemical fertilizers.

Keywords: Moringa leaf extract, garlic, turmeric, pomegranate.

1. Introduction

The pomegranate (*Punica granatum* L.) tree is extremely distributed in tropical and subtropical regions. It is considered a tolerant crop to drought, salt, and diseases, thus, as an alternative crop can be planted pomegranate trees in countries suffering from plant diseases and climactic issues[1].

Moringa leaves are a good source of calcium. The calcium content can vary depending on factors such as the soil in which the plant is grown. On average, dried Moringa leaves contain about 2,003 mg/kg of calcium and are rich in potassium. The potassium content can range from 1,324 to 1,974 mg/kg in dried leaves. Moringa leaves are a good source of iron content ranging from 7 to 28 mg/kg in dried leaves and are also a good source of magnesium content ranging from 368 to 870 mg/kg in dried leaves[2].

Numerous studies have confirmed that Moringa leaves extract spraying is highly useful for improving the properties of the qualitative and quantitative products and retards fruit senescence[3]. Moreover, Alsalhy and Aljabary,[4] indicated that spraying with moringa leaf extract significantly enhanced the leaf chlorophyll content, leaf area, total yield, average cluster weight, and berries quality. Taha and Aljabary,[5] noticed that sprayed with moringa leaf extract significantly enhanced the fig fruits' quality over the control treatment. Furthermore, it increases the crop's capability to resist adverse climatic conditions[6].

Garlic is not particularly high in calcium. It contains about 246 mg/kg of calcium. Garlic is a source of potassium. The potassium content in dried garlic can range from 1,672 to 1,942 mg/kg[7]. Garlic contains a moderate amount of iron. The iron content in garlic is approximately 1.7 mg/kg. The magnesium content in garlic is relatively low, at about 37 mg/kg[8]. Garlic clove contains flavonoids, minerals, vitamins, sulfur, ascorbic acid, and a trace of iodine. As well, garlic contains 17 amino acids. The garlic extract's impact on leaf elements content has been reported by[9,10], which showed that garlic extract caused a substantial impact on the nutrition condition of mango and pear respectively.

Turmeric is not a significant source of calcium. It contains about 183 mg/kg of calcium, also it is not a significant source of iron. It contains about 41 mg/kg of iron[11]. Turmeric contains a moderate amount of potassium. The potassium content in dried turmeric is approximately 2,525 mg/kg. It contains a small amount of magnesium. The magnesium content in dried turmeric is approximately 60 mg/kg[12]. The composition of turmeric extract comprises a significant carbohydrate content, primarily consisting of 50% starch, arabinogalactan, essential oils,

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potassium salt, pigments, and curcumin. Curcumin's capacity to scavenge free radicals, especially the hydroxyl radical, and act as an antioxidant is one of its noteworthy qualities. This specific antioxidant action is crucial in safeguarding DNA from damage and restraining lipid peroxidation[13, 14]. Numerous studies have shown that the spraying extract of turmeric substantially increases leaf N, P, and K contents, in mango[15] and peach[16]. Additionally, El-Masry and Abd El-Rahman's research[17] demonstrated that the application of turmeric extracts through spraying led to an enhancement in the levels of nitrogen (N), phosphorus (P), and potassium (K) within mango leaves. In a separate study by Ahmed et al.[18], it was observed that the foliar application of turmeric extract at a concentration of 0.1% resulted in an elevation of nitrogen (N), phosphorus (P), potassium (K), and magnesium (Mg) content in Valencia Orange leaves.

The pomegranate tree is widely cultivated in Iraq, especially in Halabja Governorate. Halabja governorate is famous for Salakhani pomegranate cultivation and production significantly. Several studies showed it has good quality, especially for export[19, 20]. The pomegranate tree displays extensive adaptability and low cost-effective cultivation, drought resistance, and favorable economic returns, making it a potential candidate for exports. Consequently, its cultivation area has been on the rise in recent times. Given this, formulating approaches to maintain pomegranate productivity is of utmost importance. Among various agricultural practices, the application, accessibility, uptake, and assimilation of nutrients by pomegranate play a pivotal role in shaping its productivity. To raise and maintain pomegranate yields, a well-balanced nutrient application becomes critical. This demonstrates that recommendations for nutrients must be based on in-depth analyses of the soil and plants. Nutrient deficits have also increased due to the ongoing use of high-analysis fertilizers with low organic content. Pomegranate production and quality are significantly influenced by mineral nutrition. Among the essential nutrients, micronutrients hold particular importance in determining the productivity and quality of pomegranates. Various studies have established that diagnosing soil and plant nutrition forms the foundation for optimizing yield and quality across several crops. This approach identifies nutrient imbalances, deficiencies, or excesses in both soil and crops but also aids in formulating strategies to enhance nutrient application for improved yield and quality[21]. due to the high importance of the minerals, leaf content to get better fruit quality, and the content of plant extract on the minerals and rich in secondary metabolism compounds. Therefore, the goal of this study is to investigate the role of foliar application of moringa leaf extract, garlic, and turmeric in Salakhani pomegranate leaf minerals content.

2. Materials and Methods

This investigation was carried out on the pomegranate cv. Salakhani has grown in a special orchard in Halabja Governorate, Iraq, on trees 15 years old with (2.5 x 3m) distances. The irrigation system followed is drip. Thirty trees symmetric in their growth were selected and then sprayed with the following treatments: Control (comparison treatment). Spraying with (2, 4, and 6ml.l^{-1}) of moringa leaf extract, symbolized (M1, M2, and M3) respectively. Spraying with (5, 10, and 15 ml.l^{-1}) of garlic cloves extract, symbolized (G1, G2, and G3) respectively. Spraying with (5, 10, and 15 ml.l^{-1}) of turmeric extract, symbolized (T1, T2, and T3) respectively. Each treatment was sprayed three times (the second week of Jun (fruit set), the second week of July, and the second week of August).

2.1 Plant extracts preparation

2.1.1 Moringa leaves and turmeric extract preparation

The levels (2, 4, and 6 ml.l^{-1}) of moringa leaves powder or (5, 10, and 15 ml.l^{-1}) of turmeric powder were prepared from the stock solution by soaking (250g) of each extract in a liter of distilled water and mixing well from time to time for 24 hours in a dark place, after that filtered well by cheesecloth the resulting solution considered as stock solution as reported by Taha and Aljabary,[5].

2.1.2 Preparation of garlic cloves extract

The levels (5, 10, and 15 ml.l^{-1}) of garlic cloves were prepared from the stock solution by mixing (1000g) of garlic cloves with (1L) distilled water and mixing well with an electric mixer. After that, filtered well by cheesecloth, the resulting solution is considered a stock solution, as reported by Aljabary[22] and Omer et. al.[23].

2.1.3 Leaves metallic content estimation

Mature leaves were gathered from variance sections of the tree. The samples were taken two weeks after the third spraying and subsequently cleansed and rinsed using tap water followed by distilled water. Afterward, the leaves were air-dried put into perforated paper bags, then introduced into an oven, and subjected to temperatures of 65-70°C until a consistent weight was achieved. Each sample, weighing 0.5g, was finely processed using an electric grinder. The resulting material was subjected to digestion using a mixture of H2SO4 and HClO4 until colorless extracts were derived, rendering them suitable for subsequent elemental analysis. Microkjeldahl was used for the total nitrogen estimation, as reported by[24]. UV-Spectrophotometer was used for the phosphorus measurement, as mentioned by Bhargava and Raghupathi[25]. A Flame Photometer was used for the potassium and calcium measurement, according to Rowell[26]. Whereas, an Atomic Absorption apparatus was utilized to estimate the amounts of zinc, iron, magnesium, and boron, as mentioned by Gupta[27].

3. Experiment design and statistical analysis

A simple Randomized Complete Block Design was utilized involving three repetitions, with every tree serving as an individual experimental entity. For mean comparison, Duncan's multiple range test was applied at a significance level of 5%, employing the (SAS 9.1 software).

4. Results and Discussion

4.1. Nitrogen, Potassium, Phosphor, and Calcium in Leaf (%)

Significant differences between plant extract levels (moringa leaves extract, garlic cloves, and turmeric) have been noticed for N, K, and Ca in the leaves content than the control. While there were no significant variances in P leaf content between plant

extract levels and control. Generally, increased the N, K, P, and Ca content with increasing levels of moringa leaf extract, garlic cloves, and turmeric. The lowest value of N, K, and Ca content was recorded in untreated tree leaves, whereas the maximum value was noticed in treated tree leaves with high levels of all plant extract. Additionally, the highest values of N and Ca were noticed in leaves collected from treated trees with the highest concentration of moringa leaf extract and garlic cloves (Figure 1 A, B, C, D).

Numerous studies have highlighted the significant importance of leaf mineral content in plant development, yield, and fruit quality. Nitrogen is a critical constituent of plant proteins, enzymes, chlorophyll, and nucleic acids, playing a vital part in overall plant growth and photosynthesis[28]. Similarly, phosphorus is essential for energy transfer and storage in plants, serving as a key component of adenosine triphosphate and participating in vital processes such as photosynthesis, respiration, and cell division[29]. On the other hand, potassium is involved in enzyme activation, osmoregulation, and cell turgor maintenance, impacting water uptake and nutrient transport in the plant. Sufficient potassium levels enhance fruit quality attributes such as size, color, and taste[28].

Additionally, calcium plays a crucial role in forming cell walls and stability, cell division, and signal transduction within the plant. Adequate calcium levels contribute to reduced risk of fruit disorders and improvements in fruit quality attributes like firmness and shelf life[30]. Al-Jabary[20] reported that the K and Ca reduced the pomegranate fruit cracking and enhanced its quality. Furthermore, Rashid et al.,[31] found that calcium and zinc sulfate improved the fruit quality of “Rubygem and Sweet Charlie” strawberry.

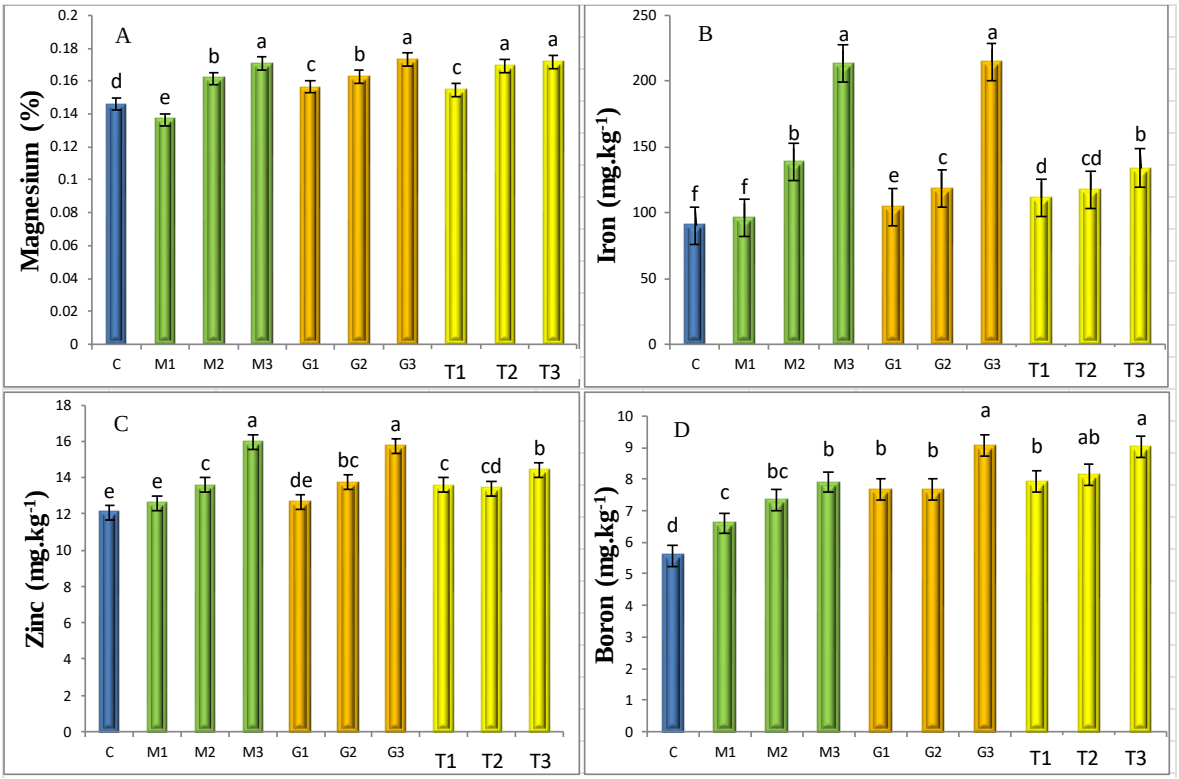

Figure 1: Effect of the spraying with plant extracts on the Magnesium (%), Zinc (mg.kg-1), Iron (mg.kg-1), and Boron (mg.kg-1) in pomegranate leaves. The similar letters on the columns mean that there are no significant differences between means at 0.05 level of probability.
(M1, M2, and M3) = 2, 4, and 6ml l-1 of moringa leaves extract, respectively, (G1, G2, and G3) = 5, 10, and 15 ml l-1 of garlic cloves extract, respectively, and (T1, T2, and T3) = 5, 10, and 15 ml l-1 turmeric extract, respectively.

4.2. Magnesium, Iron, Zinc, and Boron in Leaf

Data in Figures (2A, B, C, and D) detected significant differences in levels of moringa leaf extract, garlic cloves, and turmeric for Mg, Fe, Zn, and Boron content in the leaves than the control. Overall, the leaf content of Mg, Fe, Zn, and B increased by increasing levels of all used plant extracts; the minimum value of these elements content was obtained in untreated leaves trees except Mg the minimum value was obtained in leaves trees treated with 2 ml.l^{-1}, while the maximum value was obtained in leaves trees treated with high levels of each plant extract.

The productivity of pomegranates is significantly influenced by the availability, uptake, and utilization of nutrients during various cultural practices. Magnesium plays a vital role in photosynthesis as it is a central component of chlorophyll, essential for this process. Additionally, it participates in enzyme activation and DNA synthesis[32]. Similarly, iron is critical for chlorophyll synthesis and is involved in the electron transport process during photosynthesis[20]. Also, zinc is crucial for amino acid (tryptophan) production. It is a component of enzymes and transcription factors, participating in diverse metabolic processes.

Adequate zinc levels further promote flowering, fruit set, and fruit maturation, improving yields and better fruit quality[33]. Boron is involved in cell wall formation, membrane integrity, and cell division, which are critical for overall plant growth and development. It influences the stiffness and structure of plants by being essential for the synthesis and stability of specific structural elements in the cell wall[18]. Boron plays a vital role in reproductive functions like the initiation of pollen germination, elongation of pollen tubes, and successful fertilization[34].

The significant effects of these plant extracts on the leaves' mineral content were mostly brought about by their favorable impact on enhancing nutrient status and tree growth in favor of generating more fruits, this may be attributed to the higher concentration of plant extracts (Moringa leaves, garlic cloves, and turmeric) from pigments, nutrients, and antioxidants, reflected in encouraging organic compounds biosynthesis and cell division[14, 35], this results in an increase in the leaves' mineral content due to an increase in the soil's mineral absorption.

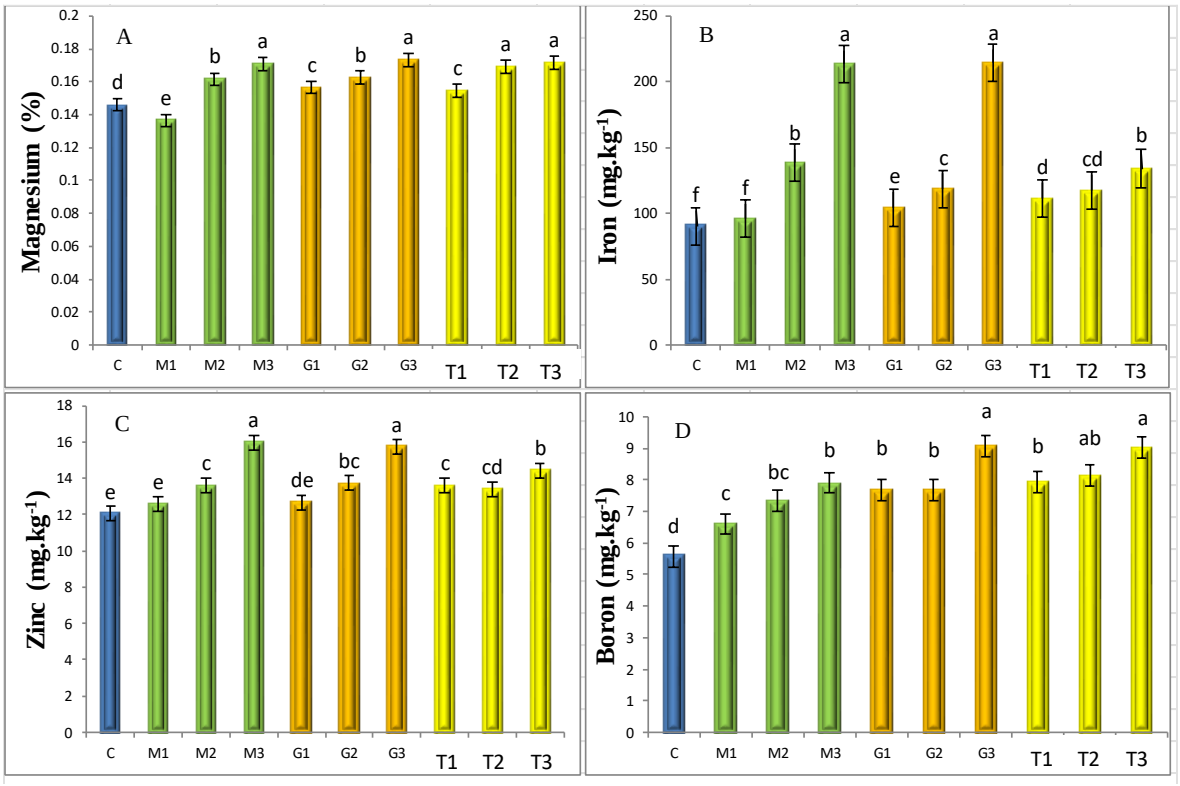

Figure 2: Effect of the spraying with plant extracts on the Magnesium (%), Zinc (mg.kg-1), Iron (mg.kg-1), and Boron (mg.kg-1) in pomegranate leaves. The similar letters on the columns mean that there are no significant differences between means at 0.05 level of probability.
(M1, M2, and M3) = 2, 4, and 6ml l-1 of moringa leaves extract, respectively, (G1, G2, and G3) = 5, 10, and 15 ml l- of garlic cloves extract, respectively, and (T1, T2, and T3) = 5, 10, and 15 ml l-1 turmeric extract, respectively.

These favorable influences of moringa leaf extract may be the reason for its contains zeatin, phenolic compounds, protein, amino acids, sugars, beta-carotene, flavonoid pigments, vitamins, and minerals (potassium, sodium, calcium, iron, phosphorous, zinc, and magnesium), may be the reason for these beneficial effects. The moringa leaf extract is also utilized as a natural promotion of plant growth since it aids in promoting plant development and is a strong source of antioxidants[36-38]. However, the moringa leaf extract may cause this because it contains a variety of amino acids involving tryptophan, which is crucial for the biosynthesis of auxin, improving and strengthening vegetative characteristics. Moreover, Aljabary et al.[39] discovered that foliar spraying pomegranate trees with moringa leaf extract at 2 ml.l^{-1} caused a substantial rise in the properties of leaf area and the average leaf dry weight. It also plays an important role in promoting divisions and the root's ability to absorb minerals, which increases the leaves' mineral content. Our results agreed with those of[40] who found that foliar application with *M. oleifera* of olive trees raised the N, P, and K in leaves content. Harhash et al.[41] indicated that the foliar spraying with moringa extracts on “Kalamata” olive trees raised the content of N, P, K, Zn, and B in the leaves. Also, Abd El-Hamied and El-Amary[9] explained that moringa leaf extract, when sprayed on pear trees of the cultivar Le-Conte at rates of 2 and 4%, increased the visible mineral content of the leaves, particularly in the areas of nitrogen, phosphorus, and potassium.

Additionally, spraying 0.50 ml/L of moringa leaf extract on the orange "Washington and Murcott Tangor" cultivars considerably boosted the leaf's mineral levels from nitrogen, potassium, phosphorus, iron, zinc, and manganese than the control[42]. According to Hassan et al.[43], treating olive trees at 2 and 4% of moringa extract enhanced the leaf's chemical composition of potassium, phosphorus, and nitrogen compared to the control.

These positive effects of spraying with garlic cloves extract may be related to its containing macro and micronutrients that increase metabolic and vital activities, in addition to containing many compounds such as carbohydrates, proteins, and vitamins that are transported to the leaves which increase leaves mineral content. Moreover, garlic clove extract contains the auxin hormone, which works to encourage plant growth and the process of cell division[44]. Furthermore, these results could be due to the garlic extract role as in the study conducted by Sivakumar and Ponnusami[45], who reported that organic fertilization causes the accumulation and uptake of some minerals such as Na, K, Mg, and Ca. Ahmed et al.[46] observed that the nitrogen, phosphorous, and potassium elements were significantly increased when spraying the Superior grapevine with 5% garlic clove extract. On the other hand, this could be attributed to its involvement in raising the leaves' dry matter percentage and the leaf area compared to the control treatment (data not shown), which, by speeding up the stomata's opening and closing processes, plays a crucial part in the elements' attraction to the leaves and absorption from the soil. These findings are consistent with those of Jamali[47], who discovered that garlic extract spraying on olive transplants at a rate of 50 mg.l^{-1} boosted the amount of N and K in the leaves. According to Abd El-Hamied and El-Amary[9], spraying pear grafts with 4% rates of garlic extract may increase the leaf content of the N and K. These findings generally concur with those of[15], who discovered that the N, P, and K content were boosted in the mango trees' leaves when sprayed with turmeric extract. Also, Shakir & Al-Rawi[48] reported that spraying pear transplants with garlic extract at 20 ml.l-1 gave a maximum content of leaves nitrogen, iron, potassium, and zinc for two seasons.

These positive influences of spraying with turmeric extract may be attributed to its substantial role that contains a potassium salt, arabinogalactan, carbohydrates (50 % starch), pigments, and essential oils[13, 14], which plays a substantial role in improving plant growth. Turmeric is a good source of phosphorous, calcium, iron, potassium, sodium, ascorbic acid, thiamin, niacin, riboflavin, sugars, total carbohydrates, protein, and dietary fiber[49]. Additionally, Hasegawa et al.[50] and Epstein & Bloom[51] found that Ca and K in turmeric extract have a significant function in plant growth and development through the activation of enzymes, control of osmotic pressure, enhancement of photosynthesis, and enhancement of other physiological processes, thus increasing the required nutrients for plant development and growth and that the increases created substances in the leaves, thus cause to increase leaves minerals content. Additionally, this could be due to its role in raising the leaves dry matter and the leaf area than control (data not shown), which has a substantial role in elements absorption from the soil, which caused to increase in mineral content in the leaves. These findings generally concur with those of Ahmed et al.[16], who discovered that the leaf content of mango trees increased from N, P, and K when sprayed with turmeric extract. Thompson Seedless grapevines are sprayed with turmeric extract by Armanious [52]. Additionally, Al-Hadethi and Al-Kubaisy[16] that foliar spray Peento peach trees with turmeric extract at two g.l^{-1} interacted with 12 g.l^{-1} licorice roots extract got significant maximum leaf N and K content for both seasons.

Conclusion

We can conclude from our findings that the most doses of turmeric, garlic cloves, and moringa leaf extract considerably raised the leaf content of N, K, Mg, Ca, Zn, Fe, and B relative to the control. Additionally, the leaf content of N, Ca, K, Fe, Mg, Zn, and B was raised with increasing concentrations of extract from moringa leaves, garlic cloves, and turmeric. Thus, it can be recommended to use these plant extracts as an alternative to chemical fertilizers, which are eco-friendly and safe for humans.

Conflict of interests

None

Author contribution

All parts of this article were conducted by the author.

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Data Availability

The datasets generated during and/or analyzed during the current study are available from the author upon reasonable request.

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