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Response of "Salakhani" Pomegranate Trees to Spraying with Moringa Leaves Extract, Garlic, and Turmeric

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ABSTRACT

The present study during seasons in 2022 to study the extracts effect of moringa (Moringa oleifera) leaves at (2-, 4-, and 6-ml l-1), garlic (Allium sativum) cloves (5, 10, and 15 ml l-1), and turmeric (Curcuma longa) at (5, 10, and 15 ml l-1) sprayers on Salakhani pomegranate. Thirty uniform trees were selected, and each tree was considered as an experimental unit using a randomized complete block design (RCBD) with three replicates. The results showed that spraying pomegranate trees with moringa leaves extract with 2 and 6 ml l-1 and all doses of turmeric extract significantly increased surface area and dry weight of leaf, except 6-ml L-1 and 15 ml l-1 of morenga leaves extract of turmeric extract increased leaf dry weight non-significantly compared to the control. As well as all garlic clove extract levels increased the surface area and dry weight of the leaf significantly compared to the control. Moreover, all plant extract treatments were effective in increasing the number of fruits and yield per tree compared to the control. Additionally, most plant extract treatments improved all chemical parameters including total soluble solids, titratable acidity, pH, total sugar, and anthocyanin content as compared to the control.

Keywords: Chemical parameters, leaves dry weight, moringa leaves extract, garlic extracts, turmeric extracts, yield.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is a major tree widely planted in Kurdistan-Iraq. It belongs to the Lythraceae family and it is native return to Iran (Chater, 2017; Tehranifar *et al*., 2010). The pomegranate tree is extremely distributed in both tropical and subtropical regions (Parvizi et al., 2015). It is considered a tolerant tree to drought, salt, and diseases; thus, it can be cultivated as an alternative plant in countries suffering from plant diseases and climatic issues (Chater *et al.,* 2018).

Previous studies have proven that foliar spraying with moringa leaves extract is very useful for enhancing yield, and fruit quality, and delays fruit aging (Nasir et al., 2016; Phiri & Mbewe, 2010). In addition, it increases the ability of crops to resist antagonistic climatic conditions (Chang *et al*., 2007). Moreover, Taha & Aljabary, (2022) reported that spraying with moringa leaves extract significantly increased the fruit moisture content, total soluble solids, total soluble solids/titratable acidity (TSS/TA) ratio, glucose, fructose, vitamin C, and pH in fig trees.

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Garlic extract contains more than 200 chemical compounds, enzymes, and some important volatiles such as Allicin which gives garlic its antibiotic properties (Al-Hadethi *et al*., 2016). Its high contents of volatile and sulfur compounds put both at the top due to the real and essential roles they play in the fruiting process in different trees (Bruneton, 2001). Garlic also contains minerals, vitamins, ascorbic acid, flavonoids, and iodine (Al-Hadethi *et al*., 2016). Also, garlic contains 17 amino acids, which eight of which are essential. The effect of garlic extract on leaf mineral content has been studied by El-Sharony *et al*. (2015) and Abd El–Hamied and El-Amary (2015), which showed that garlic extract caused an increase in the nutrition status of mango and pear. Additionally, Taha & Aljabary, (2022) reported that fig trees sprayed with garlic clove improved fruit quality.

Turmeric is an herbaceous perennial plant. The turmeric rhizome contains 2 to 9 % of curcuminoids that contain about 60% curcumin that releases vanillin, turmeric extract which is rich in carbohydrates (50 % starch), arabinogalactan, potassium salt, essential oils, and pigments, turmeric is also known for its anti-oxidant, anti-microbial, and anti-inflammatory properties (Al-Hadethi *et al.,* 2016). Curcumin has a free radical scavenger activity namely hydroxyl radical that is responsible for protecting DNA from damage and inhibiting lipid peroxidation (Srimal, 1997; Alonso, 2004). Various studies showed that the foliar spraying with turmeric extracts significantly increases leaf N, P, and K contents, in mango (Ahmed *et al.,* 2014) and in peach (Al-Hadethi & Al-Kubaisy, 2015).

In Halabja City, pomegranate cultivation is increased, especially the Salakhani cultivar. This is mainly due to the suitable climate for pomegranate farming and the demand for pomegranate fruits. Pomegranate has many beneficial health characteristics because it is rich in phenolic compounds, involving phenolic acids, flavonoids (anthocyanins), condensed tannins (proanthocyanidins), and hydrolyzable tannins (gallotannins and ellagitannins) (Li *et al*., 2015; Mphahlele *et al*., 2016). Additionally, Halabja is famous for pomegranate concentrated juice production, which is used with salad and most traditional dishes. The previous studies (Abdulrahman *et al.,* 2021; Al-Jabary, 2007) reported that Salakhani pomegranate consists of 50-65% of arils (the edible part) and about 49-54% juice of the total fruit weight with a sour-sweet taste.

The aim of this study is to determine the impact of spraying moringa leaves extract, garlic, and turmeric on the growth, fruit quality, and yield of Salakhani pomegranate.

Materials and Methods

The current study was conducted in 2022 seasons on Salakhani pomegranate grown in a private orchard located in Halabja Governorate, Iraq. The trees were 15 years old and spaced 2.5×3 meters apart. The trees were irrigated with a drip irrigation system. Thirty uniform healthy trees were selected in this study. The selected trees were uniform in vigor and with no visual insufficiency symptoms, Ten different foliar application treatments were used as follows: (i) control (spraying water), (ii) three moringa leaves extract treatments with 2, 4, and 6 ml l^{-1} symbolized MLE1, MLE2, and MLE3, respectively, three garlic cloves extract treatments with 5, 10, and 15 ml l^{-1} symbolized GCE1, GCE2, and GCE3, respectively, and (iv) three turmeric extract treatments with 5, 10, and 15 ml l^{-1} symbolized TE1, TE2, and TE3, respectively.

Preparation of plant extracts.

Preparation of moringa leaves and turmeric extract

Two hundred and fifty grams of moringa leaves or turmeric powder individually were prepared and dissolved in 1 L of distilled water and mixed well from time to time to obtain the homogenized solution. The solutions were placed in a dark place for 24 h, and then the solutions were filtered with cheesecloth as mentioned by AL-Jabary & Fadil (2017) and Sura & Al-Hilfy (2022). The required concentrations were prepared from prepared solutions. The solutions were diluted to obtain the 2, 4, and 6 ml l^{-1} from moringa solution and 5, 10, and 15 ml l^{-1} from turmeric solution.

Preparation of garlic clove extract

About 1000 g of garlic cloves were prepared and dissolved in 1 L of distilled water. The solution was mixed well by an electric mixer. The solution was then filtered by a cheesecloth (Aljabary, 2017), and the required concentrations were diluted to obtain 5, 10, and 15 ml l^{-1} concentrations. The pomegranate trees were sprayed three times to pre-prepared solutions: (i) at the fruit set (i.e. 2nd week of Jun), (ii) after the month from the first spraying (i.e. 2nd week of July), and (iii) one month later (i.e. 2nd week of August).

At harvesting time, the following growth and yield parameters were recorded: (i) leaf area (cm^2): ten leaves from each replicate were randomly collected to estimate leaf area using (Image J software, Glozer, 2008), (ii) leaf dry weight (%): 10 leaves per replicate were randomly collected. Then leaves were oven-dried at 72 °C until the leaves reached a stable weight (Aljabary, 2018), (iii) fruit number: which was calculated for each replicate, and (iv) yield per tree (kg $tree^{-1}$) by weighing the total number of fruits per tree. In addition, the following chemical parameters were recorded: (i) total soluble solids (TSS%) using the hand refractometer (Atago-Japan), (ii) total acidity (TA%) which was expressed as citric acid content as the predominant acid, (iii) pH which estimated using a pH meter (Eu tech – Singapore), and (iv) total sugar (%) which determined by using phenol 5% and H2SO4 (97%). Then, total sugar contents were estimated by spectrophotometer (Spectrophotometer UV-1700 – Shimadzu – Japan) at 490 nm (Aljabary *et al.,* 2021). In addition, anthocyanin content (mg 100 ml^{-1} juice) was estimated according to Ranganna (2015) by using 95% ethanol and 1.5 N hydrochloric acid (HCl) at 85:15 ratios.

Experiment design and statistical analysis:

Randomized Complete Block Design (RCBD) was used with three replications. Each replication represented an experimental unit. Duncan's multiple range test was utilized at level 5% to compare the means using SAS 9.1 software.

Results and Discussion

Vegetative parameters:

Leaf Area (cm^2)

Results indicate that spraying pomegranate trees with MLE1, MLE3, and all doses of turmeric extract significantly increased the leaf area as compared with the control (Figure 1). The GCE treatments did not increase the leaf area compared with the control treatment.

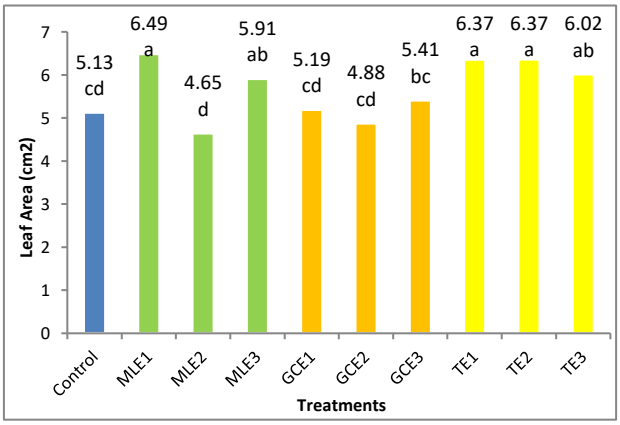

Figure 1: Effect of the spraying with plant extracts on the leaf area of pomegranate trees. (MLE1, MLE2, and MLE3) = 2, 4, and 6ml l^{-1} of moringa leaves extract, respectively, (GCE1, GCE2, and GCE3) = 5, 10, and 15 ml l^{-1} of garlic cloves extract, respectively, and (TE1, TE2, and TE3) = 5, 10, and 15 ml l^{-1} turmeric extract, respectively.

Leaf dry weight (%)

Spraying pomegranate trees with MLE1, TE1, and TE2 significantly increased the leaf dry weight as compared with the control (Figure 2). Generally, all extract concentrations increased the leaf dry weight as compared with the control except MLE2, which displayed the leaf dry weight. The highest leaf dry weight was recorded in TE2.

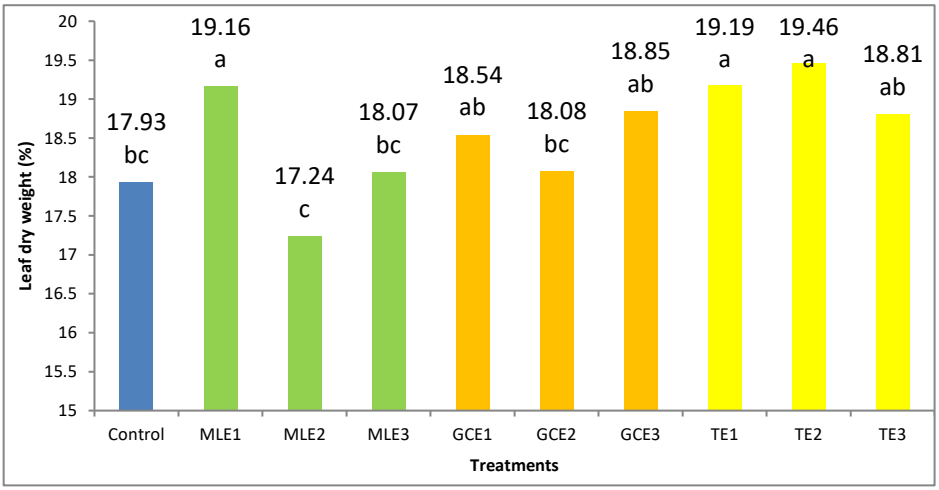

Figure 2: Effect of the spraying with plant extracts on Leaf dry weight of pomegranate trees. (MLE1, MLE2, and MLE3) = 2, 4, and 6ml l^{-1} of moringa leaves extract, respectively, (GCE1, GCE2, and GCE3) = 5, 10, and 15 ml l^{-1} of garlic cloves extract, respectively, and (TE1, TE2, and TE3) = 5, 10, and 15 ml l^{-1} turmeric extract, respectively.

The positive effects of moringa leaves extract may be attributed to its rich in zeatin, phenolic compounds, protein, amino acids, sugars, beta-carotene, flavonoid pigments, vitamins (A, B_1, B_2, B_3, C, and E), and minerals (sodium, calcium, potassium, iron, phosphorous and magnesium) (Anwar *et al.,* 2005). Similarly, previous studies showed that moringa leaves extract plays an important role in stimulating plant growth, and the reason related that moringa extract is rich in natural and natural antioxidants is stimulants (Anwar *et al.,* 2007; Jacob & Shenbagaraman, 2011). The results obtained in this study agree with the results of Akl *et al.* (2017), who found that spraying Flame Seedless grapes with 5% moringa leaves extract caused significant increases in the leaf area and average leaf dry weight. Moringa leaves extract is also a rich source of amino acids including the amino acid especially tryptophan, which plays an important role in the biosynthesis of the auxin (IAA), which improves and strengthens vegetative and cell divisions. These results are also similar to other studies carried out on orange seedlings (Abd Al Rhman *et al.,* 2018), olive trees (Hassan *et al.,* 2019), grapevines (Alsalhy & Aljabary, 2020), and fig (Taha & Aljabary, 2024).

The stimulating influence of turmeric extract is returned to its rich antioxidant effect on cell division, also, the enhancing effects of turmeric extract may be attributed to its stimulating effects on carbohydrate biosynthesis and plant pigments (Pons, 2003; Prakash & Majeed, 2006). These results are agreed with a previous study which showed an improvement in leaf area using 0.05 to 0.8 % of turmeric extract when Taimour mango trees sprayed one to four times (El-Masry & Abd El-Rahman, 2012).

Yield parameters

Fruits number

Increasing the level of plant extracts significantly increased pomegranate fruits number when sprayed with MLE2, MLE3, GCE2, GCE3, and TE3 as compared with the control (Figure 3).

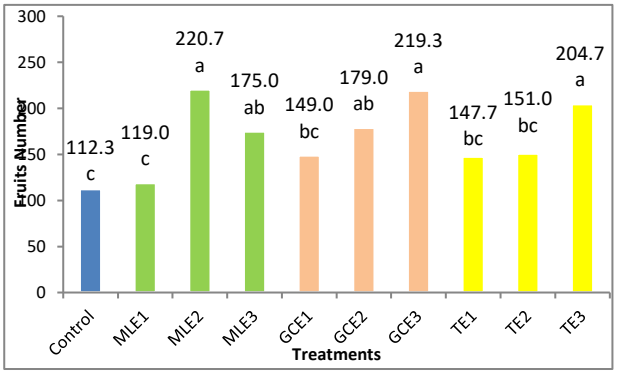

Figure 3: Effect of the spraying with plant extracts on fruit number of pomegranate trees. (MLE1, MLE2, and MLE3)= 2, 4, and 6ml l^{-1} of moringa leaves extract, respectively, (GCE1, GCE2, and GCE3) = 5, 10, and 15 ml l^{-1} of garlic cloves extract, respectively, and (TE1, TE2, and TE3) = 5, 10, and 15 ml l^{-1} turmeric extract, respectively.

Yield per tree (kg tree^{-1})

Using all plant extracts under study significantly increased the yield per tree as compared with the control (Figure 4). The highest yield was obtained with MLE2, GCE3, and TE3 (values = 56.67, 58.25, and 51.91 kg.tree^{-1} respectively).

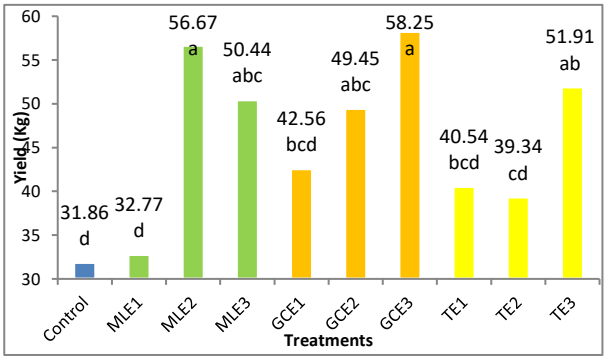

Figure 4: Effect of the spraying with plant extracts on the yield of pomegranate trees. (MLE1, MLE2, and MLE3) = 2, 4, and 6ml l^{-1} of moringa leaves extract, respectively, (GCE1, GCE2, and GCE3) = 5, 10, and 15 ml l^{-1} of garlic cloves extract, respectively, and (TE1, TE2, and TE3) = 5, 10, and 15 ml l^{-1} turmeric extract, respectively

Increasing yield and fruit number per tree of pomegranate are mainly attributed to enhancement of the nutritional status and growth. Moreover, it might be attributed to the higher pigments, nutrients, and antioxidant contents of plant extracts, which might be reflected in encouraging organic compounds biosynthesis and cell division (Srimal, 1997; Bruneton, 2001).

The effects of moringa leaf extract may be attributed to its rich endogenous cytokinins (zeatin, dihydrozeatin, and isopentyladenine) contents. Zeatin plays a significant role in cell division and cell elongation. The rich antioxidant contents of plant extract promote plant growth, and they act as anti-aging effects (Fuglie, 1999; Siddhuraju & Becker, 2003; Anwar *et al*., 2007). Moringa leaves extract is also rich in proteins (25%), it contains the necessary essential minerals such as calcium, magnesium, potassium, iron, zinc, and phosphorus (Sodamade *et al*., 2017). Increasing yield by using plant extracts might be due to a significant increase in the leaf area (Figure 1), which in turn increases the photosynthesis assimilates and essential substances produced in the leaves that move to the different plant parts, including fruits. Nasir *et al.* (2016) reported that spraying Kinnow mandarin trees with 3% moringa leaves extract significantly increased yield per tree. These results are in agreement with other studies performed on pear (Abd El-Hamied and El-Amary 2015), Navel orange trees (Abo El-Enien *et al.* 2015), 'Kinnow' mandarin (Nasir *et al*. 2020), and a grapevine (Alsalhy and Aljabary 2020).

These positive effects of spraying with garlic cloves extract may be related to its rich macro and micronutrients which increase metabolic and vital activities, and its rich contents in carbohydrates, proteins, and vitamins (Al-Hadethi *et al.,* 2016). Garlic clove extract secretes auxin, which encourages growth and cell division (Păcurar & Krejci, 2010).

Chemical parameters

Total soluble solids (TSS %):

The highest TSS content in fresh pomegranate fruit juice was 16.0%, which was recorded in MLE1 (Figure 5), which was significantly higher than the control. Other plant extract treatments increased TSS content but they were non-significant compared to the control.

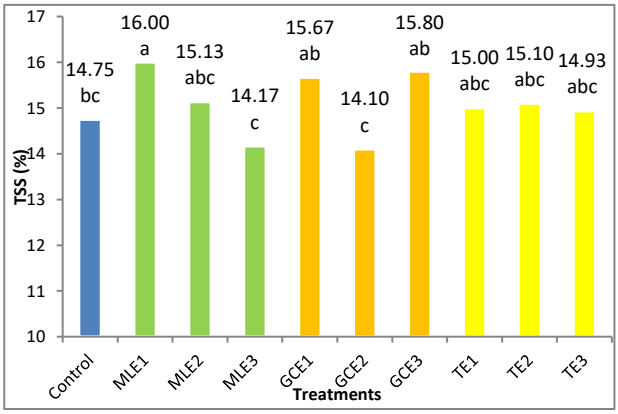

Figure 5: Effect of the spraying with plant extracts on TSS (%) in pomegranate fruit juice. (MLE1, MLE2, and MLE3)= 2, 4, and 6ml l-1 of moringa leaves extract, respectively, (GCE1, GCE2, and GCE3) = 5, 10, and 15 ml l-1 of garlic cloves extract, respectively, and (TE1, TE2, and TE3) = 5, 10, and 15 ml l-1 turmeric extract, respectively

Titratable Acidity (TA%)

Results in Figure (6) indicated that non-significant difference between the plant extracts concentrations and the control in total acidity content in the fruit juice except in fruit were sprayed with MLE1 which obtained the highest value and MLE2 which obtained the lowest value.

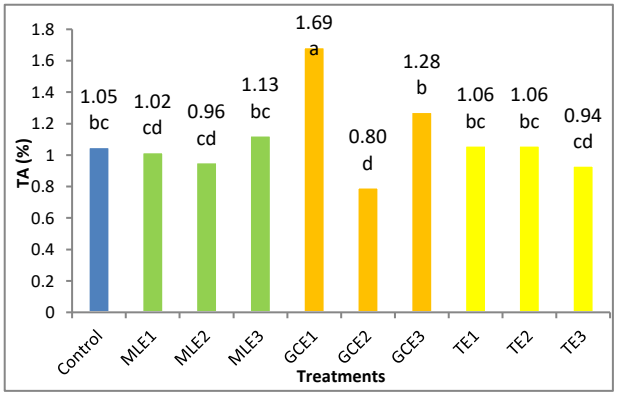

Figure 6: Effect of the spraying with plant extracts on TA (%) in pomegranate fruit juice. (MLE1, MLE2, and MLE3) = 2, 4, and 6ml l^{-1} of moringa leaves extract, respectively, (GCE1, GCE2, and GCE3) = 5, 10, and 15 ml l^{-1} of garlic cloves extract, respectively, and (TE1, TE2, and TE3) = 5, 10, and 15 ml l^{-1} turmeric extract, respectively.

pH

The foliar application of all plant extracts significantly increased the pH of pomegranate fruit juice compared to control, except MLE1 which significantly reduced the pH (Figure 7).

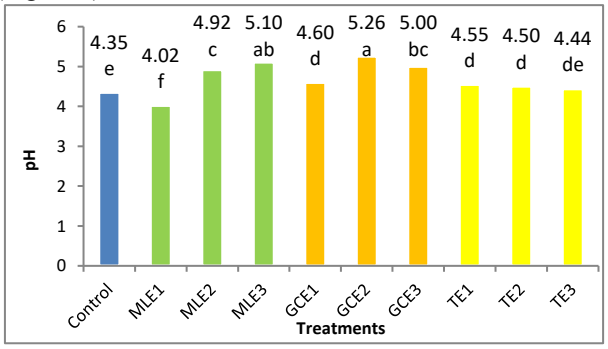

Figure 7: Effect of the spraying with plant extracts on the pH of pomegranate fruit juice. (MLE1, MLE2, and MLE3) = 2, 4, and 6ml l^{-1} of moringa leaves extract, respectively, (GCE1, GCE2, and GCE3) = 5, 10, and 15 ml l^{-1} of garlic cloves extract, respectively, and (TE1, TE2, and TE3) = 5, 10, and 15 ml l^{-1} turmeric extract, respectively.

Total Sugar (%)

Plant extracts did not significantly increase total sugar content (%) as compared to control (Figure 8), except GCE3 and TE3 which significantly decreased the total sugar content (%).

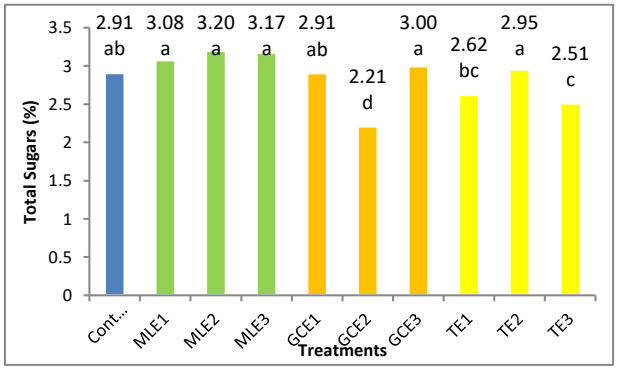

Figure 8: Effect of the spraying with plant extracts on total sugar (%) in pomegranate fruit juice. (MLE1, MLE2, and MLE3) = 2, 4, and 6ml l^{-1} of moringa leaves extract, respectively, (GCE1, GCE2, and GCE3) = 5, 10, and 15 ml l^{-1} of garlic cloves extract, respectively, and (TE1, TE2, and TE3) = 5, 10, and 15 ml l^{-1} turmeric extract, respectively.

Anthocyanin content (mg 100 ml^{-1})

Plant extracts significantly increased anthocyanin content in pomegranate fruits compared to control (Figure 9), except MLE1, GCE2, and TE3, which were significantly reduced fruits anthocyanin content.

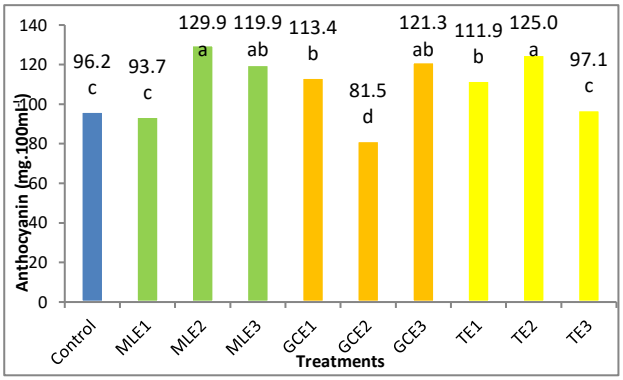

Figure 9: Effect of the spraying with plant extracts on anthocyanin content in pomegranate fruit juice. (MLE1, MLE2, and MLE3) = 2, 4, and 6ml l^{-1} of moringa leaves extract, respectively, (GCE1, GCE2, and GCE3) = 5, 10, and 15 ml l^{-1} of garlic cloves extract, respectively, and (TE1, TE2, and TE3) = 5, 10, and 15 ml l^{-1} turmeric extract, respectively.

The positive effects of moringa plant extracts on pomegranate chemical parameters might be due to the enhancement of plant growth hormones (i.e. zeatin) and necessary nutrients that increase growth and yield (Iqbal, 2014). High calcium and potassium contents in moringa extract have a major role in plant growth and development on enzyme activation, regulation of osmotic pressure, and improvement of photosynthesis and physiological processes (Hasegawa et al., 2000; Epstein & Bloom, 2005). Increases in leaf area might also enhance net photosynthesis assimilates and thus increase fruit growth and development that transported to growing plant parts and fruits. This in consequence increases the total soluble solids, total sugars, and fruit juice pH. Moringa extract decreases the total acidity, which might increase the total soluble solids and the total sugars in fruits. This might enhance the respiration process, which leads to early fruit ripening. In a study, of spraying pear trees Le-Conte cultivar with 2 and 4% moringa leaves extract conducted by Abd El–Hamied & El-Amary, (2015) reported that spraying with 4% caused a significant increase in the total soluble solids and the percentage of total sugars. It also caused a significant decrease in total acidity. Additionally, our results are consistent with the results reported (Alsalhy & Aljabary 2020). They studied spraying MLE at 45 g L^{-1} on the Halawani grapevines which caused a significant increase in the total soluble solids and total sugars. Moreover, Khan et al. (2020) reported that spraying with 3% moringa leaf extract for 5 cultivars of grapevines significantly affected the total soluble solids, total acidity, total sugars, and pH value compared to control. The positive results obtained in the chemical characteristics studied because of spraying the pomegranate trees with garlic cloves extract could be attributed to this extract's role in increasing the vital and metabolic activities in the plant and consequently increasing the absorption of the nutrients by the plant. In addition, the existence of the auxin increases cell division and elongation, which causes an increase in the leaf area and the dry matter percentage in the leaves (Figures, 1 and 2), which increases the outputs of photosynthesis and produced substances in the leaves and moves from their formation sources to their areas of attraction (fruits) in the plant. consequently, causing improvement in the qualitative and chemical characteristics of the treated fruits. A study carried out by El-Sharony *et al*., (2015) on "Fagri Kalan" mango trees reported that spraying with garlic clove extract at 5% significantly increased the fruit content of TSS and total sugars. These results were consistent with results reported by Elamary *et al.,* (2018). They studied spraying the grapevines at 3 and 5% of garlic clove extract, which significantly increased the TSS and total sugars and reduced the TA compared to the non-spray treatment, especially level 5%. A study conducted by Abd El-Hamied & El-Amary (2015) found that spraying "Le-Conte" pear trees with garlic clove extract level 2 and 4% significantly increased the TSS and total sugars in the fruits, while decreasing the TA significantly, especially at level 4% compared to control.

Regarding with the positive impact of turmeric extracts could be attributed to the substantial role of this

extract that contains a potassium salt, carbohydrates, arabinogalactan, (50 % starch), pigments, and essential oils (Srimal, 1997; Alonso, 2004) which plays a significant role in improving fruit quality. Our results are similar to the findings of Ahmed *et al.,* (2015). They studied spraying the Balady mandarin trees at level 0.05 and 5% of turmeric extract, which caused a significant increase in the TSS, TSS/TA, and total sugars and reduced the TA compared to the control.

Conclusion

We can conclude from our results that the MLE1, MLE3, and all doses of turmeric extract significantly increased the leaf area and leaf dry weight except MLE3 and TE3 increased leaf dry weight non-significantly as compared to the control. Moreover, all plant extract treatments were effective in increasing the fruit number and yield per tree compared to the control. Additionally, most plant extract treatments influenced the improvement of all chemical characteristics that were studied compared to the control.

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Conflict of Interest

We have no conflicts of interest to disclose.

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استجابة أشجار الرمان "صاله خانى" للرش بمستخلص أوراق المورينجا والثوم والكركم

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ملخص

أجريت الدراسة الحالية خلال مواسم 2022 لدراسة تأثير الرش بمستخلص أوراق المورينجا عند (2، 4 و6 مل.لتر-1) ومستخلص فصوص الثوم (5، 10 و15 مل لتر-1) ومستخلص الكركم بتركيز (5، 10 و15 مل لتر-1) بالإضافة إلى معاملة المقارنة على اشجار الرمان "صالة خانى" المزروع في بستان خاص في محافظة حلبجة، العراق. ولذلك تم اختيار ثلاثين شجرة سليمة وخالية من أعراض نقص الظاهرية ومتشابهة في قوة نموها، كل شجرة كوحدة تجريبية، واستخدمت تصميم القطاعات العشوائية الكاملة ضمن التجارب البسيطة وبثلاثة مكررات. أوضحت النتائج أن الرش بمستخلص أوراق المورينجا بمعدل 2 و6 مل.لتر-1 وجميع تراكيز مستخلص الكركم أدى إلى زيادة معنوية في مساحة الورقة ووزن الجاف للورقة ما عدا الرش بمستخلص أوراق المورينجا عند 6 مل لتر-1 و15 مل لتر-1 من مستخلص الكركم زاد من الوزن الجاف للأوراق بشكل غير معنوي قياسا بمعاملة المقارنة. وكذلك أدت جميع جرعات مستخلص فصوص الثوم إلى زيادة مساحة الأوراق والوزن الأوراق الجافة بشكل غير معنوي مقارنة بمعاملة المقارنة. علاوة على ذلك، كانت جميع معاملات المستخلصات النباتية فعالة في زيادة عدد الثمار والحاصل لكل شجرة قياسا بمعاملة المقارنة. بالإضافة إلى ذلك، أثرت معظم معاملات المستخلصات النباتية في تحسين جميع الخصائص الكيميائية التي تمت دراستها (المواد الصلبة الذائبة الكلية والحموضة القابلة للمعايرة والرقم الهيدروجيني والسكر الكلي ومحتوى الأنثوسيانين) قياسا بمعاملة المقارنة.

الكلمات الدالة: المؤشرات الكيميائية، وزن الاوراق الجاف، مستخلص أوراق المورينجا، مستخلص الثوم، مستخلص الكركم، الإنتاجية.

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