IMPROVING THE GROWTH AND PRODUCTIVITY OF FIG TREES BY SPRAYING WITH MORINGA LEAVES EXTRACTS AND GARLIC CLOVES

Sara K. H. Taha[1] **Ali M. A. O. Aljabary[2]**
Researcher **Assist. Prof.**
[1]**Dept. Horticulture -Coll. Agric. Engin. Sci. University of Kirkuk**
[2]**Technical Coll. of App. Sci. - Sulaimani Polytechnic University**
akghm003@uokirkuk.edu.iq **ali.omar@spu.edu.iq**

ABSTRACT

This experiment was conducted in a private orchard at Aldaraman, Kirkuk Governorate on "Khalobaziani" local fig trees. This study aimed to investigate the effect of spraying with Moringa leaf extract (MLE) at (0, 2, and 4 ml.l^{-1}) and Garlic cloves extract (GCE) at (0, 10, and 20 ml.l^{-1}) on growth and productivity of fig trees. Results showed that trees sprayed with MLE 4 ml.l-1 led to a significant increase in the leaf area, total chlorophyll content, average leaf dry weight, minerals (NPK) content in leaves, average fruit weight and size, and average yield per tree, while significantly decreased fruit cracking percentage compared to control. Furthermore, significant increase in the leaf area, total chlorophyll content, average leaf dry weight, minerals (NPK) content in leaves, and average fruit weight and size in the trees sprayed with GCE 20 ml.l^{-1} compared to control. The interaction between MLE 4 ml.l^{-1} and GCE 20 ml.l^{-1} showed a significant increase in the leaf area, total chlorophyll content, average leaf dry weight, and minerals (NPK) content in leaves, also significantly decreased fruit cracking percentage compared to most of the other treatments.

Keywords: elements content in leaves, leaf area, yield per tree, fruit weight and size.
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تحسين النمو والإنتاجية لأشجار التين بالرش بمستخلصي أوراق المورينكا وفصوص الثوم

سارة خالد حميد طه [1] علي محي الدين عمر الجباري[2]
باحث أستاذ مساعد
[1]قسم البستنة – كلية علوم الهندسة الزراعية – جامعة كركوك، [2]الكلية التقنية للعلوم التطبيقية – جامعة السليمانية التقنية

المستخلص

أجريت هذه الدراسة في بستان خاص في منطقة الدرمان في محافظة كركوك على أشجار التين المحلية صنف "خالوبازياني". هدفت هذه الدراسة إلى معرفة تأثير الرش بمستخلص أوراق المورينجا (MLE) بتراكيز (0، 2 و 4 مل.لتر$^{-1}$) ومستخلص فصوص الثوم (GCE) بتراكيز (0، 10 و 20 مل.لتر$^{-1}$) على نمو وإنتاجية أشجار التين. أظهرت النتائج أن رش الأشجار بتراكيز 4 مل.لتر$^{-1}$ من MLE أدى إلى زيادة معنوية في مساحة الورقة ومحتوى الكلوروفيل الكلي ومتوسط الوزن الجاف للأوراق ومحتوى المعادن (NPK) في الأوراق ومتوسط وزن وحجم الثمرة ومتوسط الحاصل الشجرة الواحدة، بينما قللت معنويا من نسبة تشقق الثمار مقارنة بالمقارنة. علاوة على ذلك، حدثت زيادة معنوية في مساحة الأوراق ومحتوى الكلوروفيل الكلي ومتوسط الوزن الجاف للأوراق ومحتوى المعادن (NPK) في الأوراق ومتوسط وزن وحجم الثمرة في الأشجار التي تم رشها بتراكيز 20 مل.لتر$^{-1}$ من GCE مقارنةً بالمقارنة. كما أظهر التفاعل بين بتراكيز 4 مل.لتر$^{-1}$ من MLE و 20 مل.لتر$^{-1}$ من GCE زيادة معنوية في مساحة الأوراق ومحتوى معادن الكلوروفيل الكلي ومتوسط الوزن الجاف للأوراق ومحتوى (NPK) في الأوراق وكذلك سبب في تقليل معنوي في نسبة تشقق الثمار مقارنة بمعظم المعاملات الأخرى.

الكلمات المفتاحية: محتوى العناصر في الأوراق، مساحة الأوراق، المحصول لكل شجرة، وزن وحجم الثمرة.
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INTRODUCTION

Fig belongs to the Moraceae and the genus Ficus, which includes more than 800 species of plants, most of which are evergreen, and a limited part of these trees and shrubs' fruits are edible, and a lot of them are classified as ornamental plants (27, 29). Fertilization is considered one of the important operations in fig orchards to obtain high productivity and quality (30). Foliar application is the best technique for fertilization due to the more benefits of nutrients, the lowest economic cost, and reduced environmental pollution (8, 13, 14), this method is more efficient than the ground feeding of the plant in terms of the treating speed of the lack of nutrients that appear clearly on the leaves and since the leaf is the main reason for the photosynthesis process (15, 34, 49). Studies have proven that foliar spraying of the extract of Moringa leaves is very useful for increasing the vigor of growth (23) because the Moringa leaves contain high percentages of zeatin (26). It has high nutritional value compared to other food crops because it contains a high percentage of carbohydrates (22) and the moringa plant is also rich in protein, as it reaches about (25%) whereas the moringa leaves contain all kinds of vitamins and is a source of amino acids as well as rich in minerals such as calcium, magnesium, potassium, iron, zinc and phosphorous (48). It also improves the quality of the quantitative and qualitative produce, delays fruit aging, and improves vegetative growth characteristics (43). And it increases the ability of crops to withstand adverse climatic conditions (23), in addition to that, it increases the resistance of plants treated with moringa leaves extract to diseases and pests (33). As for the garlic cloves extract, it is characterized by containing active substances such as Alcinine, Inuline, Aliina and Alina, and these substances are active antibiotics. It also contains vitamins and yeasts, as well as mineral salts such as phosphorous, sulfur, manganese, calcium, potassium, iodine, and sodium, in addition to fats, cellulose fibers, and sugars (21). It also improves vegetative growth characteristics and yield quality for apples (7). At present, many studies have proven that adding chemical fertilizers in large quantities plays a major role in increasing environmental pollution and health damage to humans and animals (50). Human and public health and environmental protection have also become more important, and for this, the use of organic fertilizer is increasing. Therefore, recent researchers have been interested in using plant extracts in the agriculture field, either as alternatives to pesticides, plant growth regulators, or chemical fertilizers in plant nutrition, because they are natural materials that do not leave any impact on human health and the environment. Few studies on the use of moringa leaf extract on fruit trees, especially on fig trees, have not been used so far, so we chose to use it with garlic clove extract in this study. Therefore, the main objectives of this study are to investigate the effectiveness of both extracts and their interactions in improving the growth and productivity of fig trees.

MATERIALS AND METHODS

This investigation was carried out on "Khalobaziani" local fig trees, nine years old, planted at 2x3m, 27 trees were selected as homogeneous as possible in terms of size and growth strength, to study the effect of spraying with Moringa leaves extract at (0, 2, and 4 $ml.L^{-1}$) concentrations and garlic cloves extract at (0, 10 and 20 $ml.L^{-1}$) concentrations until complete wetness. The control trees were sprayed with distilled water. The spraying process was carried out in the evening and both extracts were sprayed in three batches during the growing season (2021) the first spray was on (10/6/2021), the second spray was on (30/6/2021), and the third spray was on (10/7/2021).

Preparation of Moringa leaf extract: (250 g) of Moringa leaves powder was prepared and a liter of distilled water was added to it and mixed well from time to time and placed in a dark place for 24 hours, after which the resulting solution was filtered well with a piece of cheesecloth. The required concentrations were prepared from it, which are (2 and 4 $ml.l^{-1}$) according to what was mentioned (11).

Prepare garlic clove extract

(1000 g) of garlic cloves were prepared and a liter of distilled water was added to it and mixed well using an electric mixer. After that, the resulting solution was filtered by a piece of

cheesecloth, and the required concentrations were prepared, which are (10 and 20 ml.l^{-1}) according to what was mentioned (10). The following growth and yield parameters were measured:

leaf area (cm^2): Ten leaves from each replicate were randomly collected to estimate leaf area using Image J software (19),

Total chlorophyll content in leaves (CCI): by using a Chlorophyll Content Meter (CCM-200 Plus),

leaf dry weight (%): Ten full-sized leaves were randomly taken from the middle of the branches at the different orientations of trees in August for each experimental unit. Then leaves were oven-dried at 72 °C until the leaves reached a stable weight (9).

Fruit cracking (%): Cracked fruits were calculated using the equation: (Fruits cracking (%) = (Cracked fruits number/ Total fruits number) ×100),

Fruits number per tree (fruit.tree^{-1}): which was calculated for each replicate,

Average fruit weight (g.fruit^{-1}): Ten fruits randomly selected were weighed for each experimental unit,

Average fruit size (cm^3): The size of 10 fruits randomly selected for each experimental unit was measured, using the volume of displacement water, **and Average yield per tree (kg.tree^{-1}):** by weighing the total number of fruits per tree.

Leaves metallic content estimation: Mature leaves were collected 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. The 0.5g of samples were subjected to digestion using a mixture of H_2SO_4 and $HClO_4$. Microkjeldahl was used for the total nitrogen estimation, as reported by (22). UV-Spectrophotometer was used for the phosphorus measurement, as mentioned by Bhargava and Raghupathi (20). A Flame Photometer was used for the potassium and calcium measurement, according to Rowell (44).

Experiment design and statistical analysis

A factorial experiment within a Randomized Complete Block Design (RCBD) was used with three blocks. One tree for the experimental unit. The means were compared using (Duncan's multiple range test) at level 5%, by utilizing (SAS 9.1 software).

RESULTS AND DISCUSSION

Leaf area (cm²), Total chlorophyll content in leaves (CCI), and Leaf dry weight (g.leaf^{-1}): Significant differences in the leaf area, total chlorophyll content, and average leaf dry weight were observed (Table 1), as spraying with 2 and 4 ml.L-1 of moringa leaves extract distinguished in the average leaf area (138.747 and 142.815 cm²), in the total chlorophyll content (32.333 and 36.467 CCI), and the average dry weight per leaf amounted to (44.629 and 51.558 g.leaf^{-1}) sequentially, on the control treatment that recorded the lowest leaf area, total chlorophyll content, and average leaf dry weight with values of 126,460 cm², 27.191 CCI and 39.796 g.leaf^{-1} respectively. The results also showed that spraying with two concentrations (10 and 20 ml.L^{-1}) of garlic clove extract had a significant effect on the leaf area, total chlorophyll content in the leaves, and average leaf dry weight, which showed the highest values (138.934 and 139.095 cm²), (30.903 and 35.087 CCI), and (46.874 and 48.017 g.leaf^{-1}) respectively, and significantly outperformed the control treatment, which recorded the lowest values 129.994 cm² in leaf area, 30.001 CCI in total chlorophyll content and 41.092 g.leaf^{-1} in average leaf dry weight. Significant differences in the leaf area, total chlorophyll content, and average leaf dry weight were found in the interactions among the concentrations of extracts of moringa leaves and garlic cloves (Table 2), the results show the interaction between 4 ml.L^{-1} of moringa leaves and 20 ml.L^{-1} of garlic clove significantly outperformed all other interaction treatments in the leaf area (147.409 cm²), total chlorophyll content in the leaves (39.061 CCI) and average leaf dry weight (57.374 g.leaf^{-1}), while the spraying with the comparison treatment of both extracts of moringa leaves and garlic cloves achieved the lowest values 120.104 cm² in leaf area, 23.755 CCI in the total chlorophyll content and 38.025 gm.leaf^{-1} in average leaf dry weight. We conclude from the positive results obtained in Table (1) that spraying fig trees with moringa leaves extract in the vegetative characteristics (leaf area, total chlorophyll content in leaves, leaf dry weight),

to the important role of this extract because it contains amino acids, protein, beta-carotene, sugars, some phenolic compounds, rich in zeatin, vitamins (A, B1, B2, B3, C, and E), and some minerals (calcium, sodium, iron, potassium, magnesium and phosphorous), and flavonoid pigments. Moreover, moringa leaves extract plays an important role in stimulating plant growth, and therefore it is used as a natural plant growth stimulant, also it's a good source of natural antioxidants (18, 31). This is consistent with what Akl et al. (6) found that spraying Flame Seedless grapes with Moringa leaves extract at a concentration of (5%) caused a significant increase in the characteristics of (leaf area and the average leaf dry weight). Additionally, could be due to reason for this is that the moringa leaves extract contains: A large number of amino acids including the amino acid (Tryptophan), which plays an important role in the biosynthesis of the auxin (IAA), thus it improves and strengthens vegetative characteristics, as well as its, has an important role in increasing divisions and its reflection on growth. The increases in the total chlorophyll content in the leaves (Table 1) could be because the extract of moringa leaves contains good amounts of some micro-nutrients, including iron, which increases the construction of chlorophyll and reduces its oxidation (35, 41). These results are consistent with what was found by Abd Al-Rhman et al. (1) on orange seedlings, Hassan et al. (28) on olive trees, Alsalhy and Aljabary (17) on grapevines and Mohammed and Majeed on strawberry (36, 37). The positive results shown in Table (1) could explain that the effect of spraying garlic clove extract on vegetative characteristics (leaf area, total chlorophyll content in leaves, and average leaf dry weight), may be due to its positive role in increasing metabolic and vital activities and that because it contains auxins, that encourage apical dominance, in addition to its containing some macro and micronutrients that encourage the process of cell division and cause an increase in the elongation of plant branches (42). These results are in agreement with what was found by Leouel et al. (32) on fig trees, Al-Hadethi et al. (7) on apple trees, and Salih et al. (45) on fig trees.

Elements (NPK) content in the leaves

The nitrogen, phosphorous, and potassium elements (%) leaf content: The results in Table (1) show that the highest leaf's nitrogen, phosphorous, and potassium content as a result of spraying with 20 $ml.l^{-1}$ moringa leaves extract, which amounted to (1.793, 0.392 and 0.926%) respectively, and they outperformed significantly over the control treatment which gave the lowest percentages (1.526, 0.332 and 0.822%) of nitrogen, phosphorous and potassium content in the leaves respectively. Related to the impact of spraying with garlic clove extract, the results showed that the spraying with 20 $ml.l^{-1}$ outperformed significantly the control treatment in the leaf's nitrogen, phosphorous, and potassium content, by giving the highest percentages (1.778, 0.400, and 0.991%) respectively. While the lowest percentage (1.567, 0.327, and 0.769%) of nitrogen, phosphorous, and potassium content in the leaves of the control treatment (Table 1). The interaction between the extracts of moringa leaves and garlic cloves in Table (2) shows the significant superiority when trees sprayed with high concentrations of Moringa leaves extract (4 ml. l^{-1}) and garlic clove extract (20 ml. l^{-1}) by giving it the highest percentage in the nitrogen content (1.940%), phosphorous (0.437%), and potassium (1.17%) in the leaves, while the non-sprayed trees with extracts of moringa leaves and garlic clove gave the lowest nitrogen (1.367%), phosphorous (0.283%), and potassium (0.750%) content in the leaves. The results in Table (1) indicate that the effect of spraying with moringa leaves extract has a significant role in increasing the leaves' mineral content from (NPK) for fig trees and that this increase could be because this extract contains major nutrients, especially phosphorous and potassium, as well as other elements such as zinc, calcium, and magnesium. These results are in harmony with what was mentioned by Abd Al-Rhman et al. (1) on orange seedlings, Nasir et al. (39) on tangerine trees, and Al-Sabbagh (16) on Navel orange seedlings. Also, spraying with moringa leaves extract greatly contributed to improving and strengthening the vegetative growth as in Tables (1, 2, and 3), thus, having an important role in increasing the leaves' mineral content

especially from (NPK). The results were in agreement with those of El-Alakmy and El-Bolok (24) they found that foliar application with M. oleifera of olive trees increased the content of, N, P and K in leaves. These results are in agreement with the results reported by Abo El-Enien et al. (3) on Navel orange trees, and Bassiony and Ibrahim (19) on grapevines. From the same Table, it was found that the effect of spraying garlic clove extract also contributed to an increase in the leaves' mineral content (nitrogen, phosphorous, and potassium) for fig trees. These results could be due to the role of garlic extract as in the study conducted by Sivakumar and Ponnusami, (47), who reported that organic fertilization causes the accumulation and uptake of some minerals such as Na, K, Mg, and Ca. Ahmed et al. (4) observed in their study that the nitrogen, phosphorous, and potassium elements were significantly increased when spraying the Superior grapevine with 5% garlic clove extract. The effect of spraying with garlic clove extract has an important role in increasing the vital activities of the plant and thus increasing the absorption of mineral elements by the plant, which leads to an increase in the vegetative growth of trees as in Tables (1, 2, and 3). These results agree with what was found by Abd-El-Hamied and Al-Amary (2) on pear trees, Al-Hadethi et al. (7) on apple trees.

Table 1. Effect of spraying with MLE and GCE concentrations on leaf area, total chlorophyll content, average leaf dry weight, and elements (NPK) content in the leaves

Treatments	Leaf area (cm^2)	Total chlorophyll (CCI)	Leaf dry weight ($g.leaf^{-1}$)	N (%)	P (%)	K (%)
MLE 0 $ml.l^{-1}$	126.460 c	27.191 c	39.796 c	1.526 b	0.332 b	0.822 b
MLE 2 $ml.l^{-1}$	138.747 b	32.333 b	44.629 b	1.737 a	0.362 ab	0.860 ab
MLE 4 $ml.l^{-1}$	142.815 a	36.467 a	51.558 a	1.793 a	0.392 a	0.926 a
GCE 0 $ml.l^{-1}$	129.994 b	30.001 c	41.092 b	1.567 b	0.327 b	0.769 b
GCE 10 $ml.l^{-1}$	138.934 a	30.903 b	46.874 a	1.711 a	0.360 b	0.848 b
GCE 20 $ml.l^{-1}$	139.095 a	35.087 a	48.017 a	1.778 a	0.400 a	0.991 a

Values with different letters in one column are statistically different at 0.05

Table 2. Effect of the interaction between MLE and GCE concentrations on leaf area, total chlorophyll content, average leaf dry weight, and elements (NPK) content in the leaves

Treatments		Leaf area (cm^2)	Total chlorophyll (CCI)	Leaf dry weight ($g.leaf^{-1}$)	N (%)	P (%)	K (%)
MLE 0 $ml.l^{-1}$	GCE 0 $ml.l^{-1}$	120.104 h	23.755 f	38.025 f	1.367 c	0.283 c	0.750 c
	GCE 10 $ml.l^{-1}$	131.245 f	29.103 d	40.970 e	1.617 b	0.333 bc	0.827 bc
	GCE 20 $ml.l^{-1}$	128.032 g	28.714 d	40.393 e	1.593 b	0.380 ab	0.890 bc
MLE 2 $ml.l^{-1}$	GCE 0 $ml.l^{-1}$	133.547 e	33.337 c	40.068 ef	1.657 b	0.350 bc	0.773 c
	GCE 10 $ml.l^{-1}$	140.851 c	26.177 e	47.535 c	1.753 ab	0.353 bc	0.840 bc
	GCE 20 $ml.l^{-1}$	141.843 c	37.486 b	46.284 cd	1.800 ab	0.383 ab	0.967 ab
MLE 4 $ml.l^{-1}$	GCE 0 $ml.l^{-1}$	136.332 d	32.910 c	45.183 d	1.677 b	0.347 bc	0.783 c
	GCE 10 $ml.l^{-1}$	144.706 b	37.429 b	52.116 b	1.763 ab	0.393 ab	0.877 bc
	GCE 20 $ml.l^{-1}$	147.409 a	39.061 a	57.374 a	1.940 a	0.437 a	1.117 a

Values with different letters in one column are statistically different at 0.05

Yield characteristics

Fruit cracking (%): The results of Table (3) indicate that there is a significant decrease in the percentage of fruits cracking with increasing the moringa leaves extract concentration. The lowest percentage of cracked fruits (11.634%) was observed when trees were sprayed with 4 ml.l^{-1} of moringa leaves extract, while the highest percentage was 18.539% which was recorded in the control treatment. As for the effect of spraying garlic clove extract on fruit cracking, the results show that there was a non-significant effect between the concentrations used from garlic clove extract and the comparison treatment. As for the interaction treatments between the extracts of moringa leaves and garlic cloves, the results of Table (4) indicate that the lowest percentage of cracked fruits was observed at the interaction between spraying 4 ml.l^{-1} of moringa leaves extract and the 0 or 20 ml.l-1 of garlic cloves extract (10.341% and 11.539%) respectively, while the highest percent (19.507%) was observed at the interaction between 2 ml.l^{-1} of moringa leaves extract and 20 ml.l-1 of garlic cloves.

Fruits number per tree (fruit.tree^{-1}):

The results show that spraying with 4 ml.l^{-1} of moringa leaves extract had a significant effect on increasing the fruits number per tree, which gave the highest number of 560,889 fruits.tree^{-1} compared to other treatments (Table 3). On the other hand, spraying with both concentrations of garlic cloves extract significantly decreased the fruit number per tree compared to the control tree. The interaction between the extracts of moringa leaves and garlic cloves. The results in Table (4) indicate the significant superiority of the interaction between 4 ml.l^{-1} of moringa leaves extract and 0 ml.l-1 of garlic clove extract by giving it the highest fruits number per tree (597.667 fruits.tree^{-1}), while spraying with 2 ml.l^{-1} of moringa leaves extract and 10 ml.l^{-1} of garlic clove extract gave the least fruits number per tree (511.000 fruits. tree^{-1}).

Average fruit weight (g.fruit^{-1}), Average fruit size (cm^3), and Average yield per tree (kg.tree^{-1}): Significant differences in the average fruit weight, average fruit size, and average yield per tree were observed (Table 3), as spraying with 2 and 4 ml.L^{-1} of moringa leaves extract significantly increased the average fruit weight (23.687 and 23.233 g.fruit^{-1}), average fruit size (37.889 and 36.889 cm3), and average yield per tree (12.731 and 13.075 kg.tree^{-1}) sequentially, compared to the control treatment that recorded the lowest average fruit weight, average fruit size, and average yield per tree (21.796 g.fruit^{-1}, 31.611 cm3, and 11.839 kg.tree^{-1}) sequentially. Related to the effect of spraying with garlic clove extract, the results showed that the spraying with 10 and 20 ml.l^{-1} was significantly superior to the control treatment by giving it the highest percentage in the average fruit weight (23.347 and 23.104 g.fruit^{-1}) respectively, and average fruit size (35.778 and 36.611 cm3) respectively. At the same time, the lowest percentage of the average fruit weight and average fruit size was obtained in the control treatment (22.264 and 34.000 g.fruit^{-1}) respectively. Moreover, a non-significant effect was found due to spraying with garlic cloves extract on average yield per tree (Table 3). The interaction treatments between the extracts of moringa leaves and garlic cloves, the results in Table (4) indicate the interaction between 2 ml.l^{-1} of moringa leaves extract and 20 ml.l^{-1} of garlic clove extract is superior in the average fruit weight (24.232 g.fruit^{-1}), average fruit size (40.667 cm3), and average yield per tree (13.786 kg.tree^{-1}) on the unsprayed trees with both extracts in the average fruit weight (21.196 g.fruit^{-1}), and average fruit size (29.667 cm3). We conclude from the results of data analysis in Tables (3 and 4) that spraying with Moringa leaves extract contributed to obtaining a significant increase in the characteristics of the average fruit weight, the average fruit size, and the average tree yield, and also contributed to reducing the percentage of cracked fruits, and this could be attributed to this extract contained high levels of zeatin, isopentyladenine and dihydrozeatin these are endogenous cytokinins, in addition, zeatin plays an important role in cell division and elongation. It is an antioxidant in plants and has anti-aging effects and promotes plant growth (26, 46). This, in turn, causes a reduction in the fruit cracking percentage as a result of containing this hormone, which causes an increase in the flexibility, and

plasticity of the cell walls and thus reduces the rate of fruit cracking. Moringa leaves extract is also rich in proteins about 25%, in addition to containing the necessary mineral elements such as calcium, magnesium, potassium, iron, zinc, and phosphorous. Or it could be due to its role in obtaining a significant increase in the leaf area and the total chlorophyll content in the leaves as in Table (1), which in turn increases the outputs of the photosynthesis process, as the substances manufactured in the leaves move to the different parts of the plants, including to the fruits, which causes an increase in most of the quantitative characteristics of the yield. Nasir et al. (40) reported in their study that spraying Kinnow mandarin trees with 3% of moringa leaves extract had a significant effect on the average weight and size of the fruit and the average yield of the tree compared to the comparison treatment. These results are in agreement with what was mentioned by Abd El-Hamied and El-Amary (2) on pear trees, Abo El-Enien et al. (3) on Navel orange trees, and Nasir et al. (39, 40) on trees Tangerine, Alsalhy and Aljabary (17) on a grapevine.

Table 3. Effect of the spaying with MLE and GCE concentrations on fruit cracking, fruit number per tree, average fruit weight, average fruit size, and average yield per tree

Treatments	Fruit cracking (%)	Fruits number per tree (fruit.tree^{-1})	Average fruit weight (g. fruit^{-1})	Average fruit size (cm^3)	Average yield per tree (kg.tree^{-1})
MLE 0 ml.l^{-1}	18.539 a	543.556 ab	21.796 b	31.611 b	11.839 b
MLE 2 ml.l^{-1}	15.159 b	538.000 b	23.687 a	37.889 a	12.731 a
MLE 4 ml.l^{-1}	11.634 c	560.889 a	23.233 a	36.889 a	13.075 a
GCE 0 ml.l^{-1}	14.640 a	565.556 a	22.264 b	34.000 b	12.574 a
GCE 10 ml.l^{-1}	14.432 a	530.556 b	23.347 a	35.778 ab	12.426 a
GCE 20 ml.l^{-1}	16.440 a	546.333 b	23.104 a	36.611 a	12.645 a

Values with different letters in one column are statistically different at 0.05

Table 4. Effect of the interaction between MLE and GCE concentrations on fruit cracking, fruit number per tree, average fruit weight, average fruit size, and average yield per tree

Treatments		Fruit cracking (%)	Fruits number per tree (fruit. tree^{-1})	Average fruit weight (g. fruit^{-1})	Average fruit size (cm^3)	Average yield per tree (kg. tree^{-1})
MLE 0 ml.l^{-1}	GCE 0 ml.l^{-1}	564.667 ab	19.419 a	21.196 d	29.667 d	11.943 b
	GCE 10 ml.l^{-1}	515.000 d	17.924 abc	21.782 cd	31.000 cd	11.229 b
	GCE 20 ml.l^{-1}	551.000 bc	18.275 ab	22.409 bc	34.167 bc	12.346 ab
MLE 2 ml.l^{-1}	GCE 0 ml.l^{-1}	534.333 bcd	13.621 bcd	22.518 bc	34.667 bc	11.989 b
	GCE 10 ml.l^{-1}	511.000 d	12.348 cd	24.310 a	38.333 ab	12.420 ab
	GCE 20 ml.l^{-1}	568.667 ab	19.507 a	24.232 a	40.667 a	13.786 a
MLE 4 ml.l^{-1}	GCE 0 ml.l^{-1}	597.667 a	10.341 d	23.077 b	37.667 ab	13.792 a
	GCE 10 ml.l^{-1}	565.667 ab	13.023 bcd	23.949 a	38.000 ab	13.631 a
	GCE 20 ml.l^{-1}	519.333 cd	11.539 d	22.672 bc	35.000 bc	11.802 b

Values with different letters in one column are statistically different at 0.05

It was noted through the results in Table (2) that spraying with garlic cloves extract on the fig trees has contributed to improving the quantitative characteristics of yield, as it led to a significant increase in the characteristics of the average weight and size of fruit, and this could be due to this extract contain macro and micronutrients that increase metabolic and vital activities, in addition to containing many compounds such as carbohydrates, proteins and vitamins that are transmitted to the fruits and work to increase their weight and size. Moreover, garlic clove extract secretes the auxin hormone, which works to encourage plant growth and the process of cell division (42), and the increase in the leaf area and the total chlorophyll content as in Table (1) has a positive effect on increasing the processed materials and thus increasing most of the quantitative characteristics of yield. These results are in agreement with El- Sharony et al. (25) on mango trees, and Mostafa et al. (38) on "Flame Seedless" grapevines. As spraying trees with garlic cloves extract at both concentrations (10 and 20 $ml.l^{-1}$) reduced the fruit number per tree. This could be due to its role in increasing the average fruit weight and size, which caused the depletion of processed nutrients from the photosynthesis process. These results are consistent with the findings of Ahmed et al., (5) where it was found that when spraying peach trees with garlic extract at (0, 1, 2 and 4)%, all concentrations caused a significant decrease in the fruit number per tree compared to the comparison treatment.

CONCLUSION

According to the results, we can conclude that spraying with 2 and 4 $ml.l^{-1}$ MLE led to a significant increase in all the characteristics studied in the fig trees, and also significantly decreased fruit cracking percentage. Furthermore, a significant increase in most of the characteristics studied in the fig trees was observed as a result of spraying with 10 and 20 $ml.l^{-1}$ GCE compared to control. The positive effect was obtained in most interaction treatments, especially in the interaction between MLE 4 $ml.l^{-1}$ and GCE 20 $ml.l^{-1}$ cause to a significant increase in most of the characteristics studied in the fig trees, as well as significantly decreased fruit cracking percentage. It could be concluded and recommended that spraying with MLE or GCE improves the growth and productivity of fig trees.

REFERENCES

1. Abd Al Rhman, A., H.S. Ahmed and S.A. Mohamed. 2018. Effect of moringa extracts and diatoms foliar applications on Washington navel orange and murcott tangor transplant performance. Journal of Horticultural Science & Ornamental Plants, 10(1): 28-40

2. Abd El–Hamied, S.A. and E.I. El-Amary. 2015. Improving growth and productivity of "pear" trees using some natural plants extracts under north sinai conditions. Journal of Agriculture and veterinary Science, 8(1): 1-9

3. Abo El-Enien, M., A. El-Azazy and F. El-Sayed. 2015. Effect of moringa leaves extract as a natural product compared with other synthetic compounds on yield production and fruit quality of navel orange trees. Egypt J Hortic, 42: 899-911.
DOI: 10.21608/ejoh.2015.1339

4. Ahmed, F., H.I.M. Ibrahim, M.A.M. Abada and M.M.M. Osman. 2014. Using plant extracts and chemical rest breakages for breaking bud dormancy and improving productivity of superior grapevines growing under hot climates. World Rural Observations, 6(3): 8-18

5. Ahmed, M., A. Eman, and M. Abd El-Migeed. 2009. Effect of garlic extract and mineral oil spray on flowering, harvesting time, yield and fruit quality of peach (*Prunus persica*) trees cv.'Florida prince'. Middle Eastern and Russian Journal of Plant Science and Biotechnology 3 (special issue 1): 53-57

6. Akl, A., F. Gadalla and M. Abada. 2017. Effect of some plant extracts on growth and nutritional status of flame seedless grapevine transplants. Journal of Productivity and Development, 22(2): 323-337.
DOI: 10.21608/jpd.2017.41900

7. Al-Hadethi, M.E.A., M.H.S. Al-Hamdany, and A.T. AL-Dulaimi. 2016. Role of garlic and turmeric extract in the leaves mineral Contents of Apple Trees. IOSR Journal of Agriculture and Veterinary Science, 9(10): p. 07-09.

8. Al-Hassan, M. F. H., H. A. Baqir and J. W. Mahmoud.2024. The role of chlorophyll spraying according to the evolutionary standard zadoks in the growth characteristics

of two cultivars of bread wheat. Iraqi Journal of Agricultural Sciences,55(1):470-478. https://doi.org/10.36103/w1877d96
9. Aljabary, A. M. A. O. (2018). Effects of foliar application of urea and potassium chloride on some physicochemical properties of "Damson" plum fruits. nd Int. Conference of Agricultural Sciences. College of Agriculture, Sulaimani University. Journal of Zankoy Sulaimani Part-A-(Pure and Applied Sciences), 351-360.
10. Aljabary, A.M. 2017. Effect of immersion in Garlic and Dill seed extract on some storability parameters of potato tubers. Tikrit Journal for Agricultural Sciences 17(4): 79-87
11. AL-Jabary, A.M. and N.N. Fadil. 2017. Effect of immersion in calcium chloride and neem extract on storability of plum fruits (*Prunus domestica*) cv. Damson. Journal Of Kirkuk University For Agricultural Sciences, 8(3): 48-54
12. Aljabary, A.M.A.O., A. J. Ali, Z. J. Salih, A. N. Jamal and A. R. Kareem. 2024. Response of" Salakhani" Pomegranate Trees to Spraying with Moringa Leaves Extract, Garlic, and Turmeric. Jordan Journal of Agricultural Sciences, 20(1), 14-25. https://doi.org/10.35516/jjas.v20i1.696
13. Al-Khafaji, A. M. H. H. and K. D. H. Al-jubouri. 2022. Influence of aqueous extract of barley sprouts, trehalose, and calcium on growth, quality and yield of carrot. Iraqi Journal of Agricultural Sciences, 53(1): 133-140. https://doi.org/10.36103/ijas.v53i1.1517
14. Al-Khafaji, A. M. H. H. and K. D. H. Al-jubouri. 2022. Maximization carrot minerals preserve and antioxidant capacity by foliar application of aqueous barley sprouts extract, trehalose, and calcium. Iraqi Journal of Agricultural Sciences, 53(1):122-132. https://doi.org/10.36103/ijas.v53i1.1515
15. Al-Khafaji, A. M. H. H., and K. D. H. Al-Jubouri. 2023. Upgrading growth, yield, and folate levels of lettuce via salicylic acid and spirulina, vermicompost aqueous extracts, Iraqi Journal of Agricultural Sciences 54(1):235-241. https://doi.org/10.36103/ijas.v54i1.1696
16. Al-Sabbagh, M.N.A. 2020. Effect of some Natural Extracts and Nutrients on Growth and Natural Status of Washington Navel Orange Transplants. Benha University, Egypt. faculty of Agriculture. MSc. Thesis, Horti. Dept.
17. Alsalhy, B.F.J. and A.M.A.O. Aljabary. 2020. Effect of moringa leaves extracts and licorice roots on some growth characteristics and yield of grape (*Vitis vinifera* L.) cv. Halawany. Plant Archives, 20(2): 2616-2623
18. Anwar, F., S. Latif, M. Ashraf and A. H. Gilani. 2007. Moringa oleifera: a food plant with multiple medicinal uses. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 21(1): 17-25. https://doi.org/10.1002/ptr.2023
19. Bassiony, S. and M.G. Ibrahim. 2016. Effect of silicon foliar sprays combined with moringa leaves extract on yield and fruit quality of "Flame Seedless" Grape (*Vitis vinifera* L.). Journal of Plant Production, 7(10):1127-1135. DOI: 10.21608/jpp.2016.46946
20. Bhargava, B.S. and H.B. Raghupathi (1999). Analysis of Plant Materials for Macro and Micronutrients. p: 49-82. In Tandon, H.L.S. (eds.). Methods of Analysis of Soils, Plants, Water and Fertilizers. Binng Printers L-14, Lajpat Nagor, New Delhi, 110024
21. Bruneton, J. 2001. Farmacognosia, Fitoquímica plantas medicinales. Zaragoza, España,: 477-566
22. Burham, B. 2017. Phytochemical, proximate composition and minerals contents of Moringa oleifera. Chemistry Research Journal, 2(2): 78-83
23. Chang, E.-H., R.-S. Chung and Y. H. Tsai. 2007. Effect of different application rates of organic fertilizer on soil enzyme activity and microbial population. Soil Science and Plant Nutrition, 53(2): 132-140. https://doi.org/10.1111/j.1747-0765.2007.00122.x
24. El-Alakmy, H. and D.M. El-Bolok. 2017. Effect of foliar application of some plant extracts and amino acids on "Picual" Olive Production and Oil Quality. Journal of Plant Production, 8(11): 1229-1239. DOI: 10.21608/jpp.2017.41296
25. El-Sharony, T., S. El-Gioushy and O. Amin. 2015. Effect of foliar application with algae and plant extracts on growth, yield and fruit quality of fruitful mango trees cv. Fagri Kalan. Journal of Horticulture, 2(4): 1-6. http://dx.doi.org/10.4172/2376-0354.1000162

26. Fuglie, L.J. 1999. The miracle tree: Moringa oleifera, natural nutrition for the tropics.: The multiple Attributes of Moringa. 17.
27. Harrison, R.D. 2005. Figs and the diversity of tropical rainforests. Bioscience, 55(12): 1053-1064. https://doi.org/10.1641/0006-3568(2005)055[1053:FATDOT]2.0.CO;2
28. Hassan, A., N, Abd-Alhamid; Rawheya B.M.A. Aly; H.S.A, Hassan and Laila F. Hagagg. 2019. Effect of foliar application with algae and moringa leaves extracts on vegetative growth, leaf mineral contents, yield and chemical fruit quality of picual olive trees. Arab Universities Journal of Agricultural Sciences, 27(1): 659-671.
DOI: 10.21608/AJS.2019.43679
29. Herre, E.A., K.C. Jan eler, and C.A. Machado. 2008. Evolutionary Ecology of Fig leaves extra; Recent pro grass and out staneling Puzzles. Ann.Per. Evol. Syst., 37: 438- 456.
30. İrget, M.E., U. Aksoy, B. Okur, A. R. Ongun and M. Tepecik. 2008. Effect of calcium based fertilization on dried fig (*Ficus carica* L. cv. Sarılop) yield and quality. Scientia Horticulturae, 118(4): 308-313. https://doi.org/10.1016/j.scienta.2008.06.024
31. Jacob, S.J.P. and S. Shenbagaraman. 2011. Evaluation of antioxidant and antimicrobial activities of the selected green leafy vegetables. Int. J. Pharm. Tech. Res, 3(1): 148-152.
32. Leonel, S., M.A. Tecchio and G.M.D.A.G. Cóser. 2015. Dormancy breaking of the fig tree with hydrogen cyanamide and garlic extrate. British Journal of Applied Science and Technology, 10(1): 1-10. https://doi.org/10.9734/BJAST/2015/18194
33. Makkar, H.A. and K. Becker. 1996. Nutrional value and antinutritional components of whole and ethanol extracted Moringa oleifera leaves. Animal feed science and technology, 63(1-4): 211-228. https://doi.org/10.1016/S0377-8401(96)01023-1
34. Mallarino, A.P. 2003. Foliar and starter fertilization. Are they needed to supplement primary fertilization? In The Integrated Crop Management Conf. Proceedings. Dec. 3- 4, Ames, IA. Iowa State Univ. Extension.,: 113-120
35. Meireles, D., J. Gomes, L. Lopes, M. Hinzmann and J. Machado. 2020. A review of properties, nutritional and pharmaceutical applications of Moringa oleifera: integrative approach on conventional and traditional Asian medicine. Advances in Traditional Medicine, 20(4): 495-515
36. Mohammed, R. R. and B. H. Majeed. 2023. Effect of moringa leaves extract, calcium, and potassium silicate on the growth, yield, and quality of strawberry fruits. Iraqi Journal of Agricultural Sciences,54(6):1703-1715. https://doi.org/10.36103/ijas.v54i6.1869
37. Mohammed, R. R. and B. H., Majeed, 2024. Response of strawberry growth, yield and marketable fruit quality to spraying with moringa leaf extract, calcium and potassium silicate. Iraqi Journal of Agricultural Sciences, 55(1):440-452. https://doi.org/10.36103/yf9f0c65
38. Mostafa, F., A.K.A. Mohamed1, Mervat A. Aly and M.K. Rizkallaz. 2015. Effect of garlic and camphor oils on bud fertility and yield components of Flame Seedless grape cultivar. Assiut J. Agric. Sci, 46(3): 100-119
39. Nasir, M., A. S. Khan, S. M. A. Basra and A. U. Malik. 2016. Foliar application of moringa leaf extract, potassium and zinc influence yield and fruit quality of 'Kinnow'mandarin. Scientia horticulturae, 210: 227-235. https://doi.org/10.1016/j.scienta.2016.07.032
40. Nasir, M., A. S. Khan, S. M. A. Basra and A. U. Malik. 2020. Improvement in growth, productivity and quality of 'Kinnow'mandarin fruit after exogenous application of Moringa olifera leaf extract. South African Journal of Botany, 129: 263-271. https://doi.org/10.1016/j.sajb.2019.07.042
41. Nouman, W., M.T. Siddiqui and S.M.A. Basra. 2012. Moringa oleifera leaf extract: An innovative priming tool for rangeland grasses. Turkish Journal of Agriculture and Forestry, 36(1): p. 65-75. https://doi.org/10.3906/tar-1009-1261
42. Pacurar, M. and G. Krejci. 2010. Garlic Consumption and Health.: Nova Science Publishers, 1ne. New York
43. Phiri, C. and D. Mbewe. 2010. Influence of Moringa oleifera leaf extracts on germination and seedling survival of three common legumes. International Journal of Agri. and

Bio., 12(2): 315-317
44. Rowell D.L. 1996. Soil science: Methods & applications. Longman Group Limited, UK.: Routledge
45. Salih, M.M., J.M. kalaf and K.A. Hasan. 2020. Effect of spraying with licorice-garlic and marine algae extracts Sea force on some vegetative growth characteristics of fig trees (*Ficus carica* L.) cv. Aswod Diala. Journal Of Kirkuk University For Agricultural Sciences, 11(3): 37-46
46. Siddhuraju, P. and K. Becker. 2003. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringa oleifera* Lam.) leaves. Journal of agricultural and food chemistry, 51(8): 2144-2155. https://doi.org/10.1021/jf020444+
47. Sivakumar, V. and V. Ponnusami. 2011. Influence of spacing and organics on plant nutrient uptake of black nightshade (*Solanum nigrum*). Journal of Horticulture and Forestry, 3(11): 333-335
48. Sodamade, A., A. Owonikoko and D. Owoyemi. 2017. Nutrient contents and mineral composition of Moringa oleifera Seed. International Journal of Communication Systems, 5(2): 205-207
49. Salih, A.Y., A.Q. Hamdan, , and S. M. Tarkan, 2024. Effect of spraying ba and zn at vegetative and root system growth of plum saplings. Iraqi Journal of Agricultural Sciences, 55(1): 453-458. https://doi.org/10.36103/pc2j7e81
50. Taiz, L. and E. Zeiger. 2006. Plant Physiology 4th Ed. Sinauer Associates Incorporated Publishers Sunderland, Massachusetts.