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Response of fig seedlings Aswad Diala Variety to spraying with licorice root extract and Moringa leaves on root characteristics

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Abstract
The study was conducted on fig saplings of the Aswad Diyala cultivar in the lath house of the Department of Horticulture and Landscape Engineering, College of Agriculture, University of Karbala, during growing spring season of 2023. The experiment included 54 two-year-old seedlings with uniform vegetative growth, planted in 10 kg plastic pots, to investigate the individual and interaction effects two factors of natural plant extracts. The first factor was licorice root extract at three concentrations (0, 4, and 8 g L^{-1}), while the second factor was Moringa leaf extract at three concentrations (0, 5, and 10 g L^{-1}).The trial was carried out as a factorial experiment within a randomized complete block design (R.C.B.D) with three replicates. Each replicate contained 18 saplings, with two saplings per experimental unit. The results showed that spraying licorice root extract at 8 g L^{-1} and Moringa leaf extract at 10 g L^{-1} significantly increased all studied root traits (length of the longest root, root diameter, root volume, percentage of moisture content, dry weight of the root system) when treating fig saplings of the Aswad cultivar individually and with two-way interaction of study factors, with significant differences compared with the distilled water spray treatment.
Keywords: biostimulants, plant extracts, sustainable development, fruit trees, natural alternatives, moisture content
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Introduction

Ensuring global food security is considered a major challenge for agriculture in recent times, and this challenge is intensified and increased by several factors, including climate change, which reduces the productivity of Fig saplings. On the other hand, attention has been directed to agricultural products and their relationship with the living standard as a consequence of the rising need for agricultural products characterized by high quality in terms of appearance, size, firmness, their medical benefits, and their nutritional value, which reflects the extent of consumers' interest in high-quality plant products (Fróna Szanderak and Harangi-Rakes, 2019).

In addition, the decline of land suitable for use and the intensification of agricultural practices increase the complexity of the situation (Pandey, 2020). With achieving sustainable agriculture, interest is increasing in finding organic materials that are environmentally safe (Durán-Lara and Marican, 2020). Among fruit trees, fig trees *Ficus carica* L. have emerged as one of the most important fruits distinguished by their nutritional and health value (Zhao et al., 2020; Mehmet et al., 2009). Since the decrease in fig tree productivity is among the most prominent challenges facing farmers, researchers and farmers have tended to find promising solutions through the strategic application of nutrients and the utilization of natural plant extracts is one of the alternatives to chemical fertilizers, which are believed to be a promising and effective manner in cost aspect also, they can applied in sustainable applying they can applied in sustainable applying to environmentally sustainable agricultural practices. Accordingly, the present work was aiming to be an attempt for using ecofriendly natural alternatives having no impact on human health and environment. Some of these alternatives are the application of biostimulants or natural extracts for plant nutrition as safe alternatives (Mallarino , 2003; Fallovo et al., 2008; Tirado kulieva et al., 2022; Santini et al., 2021), by foliar fertilization or foliar feeding. Licorice root extract and Moringa leaf extracts are among such the extracts, because they are rich sources of naturally stimulating agents which can replace synthetic growth stimulants, mevalonic acid, vitamins, essential nutrient elements and plant-protective compounds (Yakhin et al., 2017; Mousa et al., 2002; Hossain et al., 2012). This is what was indicated by (Siddhuraju and Becker, 2003), as they showed that Moringa leaves contain various antioxidants, in addition to containing a high percentage of zeatin and cytokinin, known for their ability to maintain plant growth and its vegetative activity. (Taha and Aljabory, 2024) also clarified a significant effect when spraying fig trees with Moringa leaf extract at concentrations of 0, 2, and 4 mL L^{-1} and garlic extract at concentrations of 0, 10, and 20 mL L^{-1} on vegetative and fruit growth traits and improving productivity. Al-Marsoumi and Al-Hadethi (2024) showed that adding two types of bacteria (A4) and buffalo manure at a concentration of 500 gm.soil-1 (B2) and spraying moringa extract at a concentration of 40 gm.l-1 (M2) as interaction treatment A4B2M2 gave best results in plant height, leaves number, leaf area, leaf nitrogen and phosphorus content, It reached (45.33) cm, (230.1) leaves.plant-1, (41.67) cm2, (2.43) % and (0.236)%, respectively, compared to control treatment (without addition and without spraying). Eid et al. (2018) mentioned that licorice extract is among the extracts that can be considered an alternative to growth regulators in the rooting of olive cuttings. Al-Saif et al., (2024) demonstrated that applying licorice extract of root and potassium sorbate to mango tree leaves resulted in a significant enhancement of the total soluble solids percentage in the fruits. , the ratio of total soluble solids to acidity, vitamin K content, an increase in leaf area, and total chlorophyll content. Alghanim et al. (2023) also demonstrated the synergistic effect of Moringa leaf extract and organic fertilizers on the growth of the Ibrahimi apple variety, improving growth characteristics such as leaf area, leaf chlorophyll content, dry weight, and branch length. Many studies have been conducted on the role of biostimulants or natural plant extracts such as yeast extract, willow leaf extract, garlic extract, and other natural extracts in improving agricultural products.

Yousif and Hassan (2023) also pointed to the effective role of plant extracts in plant resistance to diseases because they are rich in phenolic compounds, such as hydroxyl derivatives that contain benzoic acid and cinnamic acid. They indicated that eugenol is the main compound in clove, while gallic acid, as the basic phenol, was found exclusively in thyme. From this, this study investigated the impact of licorice root extract and Moringa leaf extract on the root system properties and moisture content of fig saplings of the Aswad Diyala cultivar.

Materials and Methods

The trial was implemented in the lath, College of Agriculture / University of Karbala, during the spring season (10/3/2023 to 1/7/2023), to investigate how foliar spraying with licorice root extract (LRE)and Moringa leaves extract (MLE) affects the characteristics of the root system of fig saplings of the Aswad Diyala cultivar. The trial implemented as factorial experiment in RCBD with three replications. First factor: LRE at three rates (0, 4, 8) g L^{-1}, and Second factor: MLE at three rates (0, 5, 10) g L^{-1}. Each replicate contain 18 saplings, with 2 saplings for each treatment. The saplings were sprayed to full wetting with LRE and MLE at the studied concentrations twice, and the time between each spray was two weeks each spray starting from 20/3/2023. All service operations of irrigation and hoeing (weed removal) from the pots or between replicates were carried out for all treatments equally whenever needed. Measurements were conducted in late June 2023, during which the following characteristics were evaluated.

- Mean length of the longest root (cm): The above-ground portion was detached from the root system at the crown region, the roots were rinsed with water, and the length of the longest root was measured using a measuring tape.
- Average root volume (cm^3): The volume of the root system of the saplings was estimated using a graduated cylinder with a known volume of water.
- Root diameter rate (cm): It was estimated based on the formula of (Schenk and Barber, 1980).

$$D = 2x\sqrt{\frac{V}{L} * \pi}$$

Where:
D = root diameter (cm)
V = root volume (cm3)
L = root length (cm)
π = constant ratio 22/7

4- Percentage of moisture content (%) according to moisture content, following equation:

$$\text{Moisture content } (\%) = \frac{\text{Fresh leaf weight} - \text{dry leaf weight}}{\text{Dry leaf weight}} x100$$

5- Average dry weight of root system (gm): Cultivated saplings were uprooted from the planted pots and then their vegetative portion was detached from their roots at the crown region, being washed by water and put in perforated paper bags inside electric oven (70 °C) until reaching constant weight, so that each sample was weighed using sensitive electrical balance (Abdul Hussein , 1986). Data were analyzed, at the end of the trial, in a RCBD with three replicates, and submitted to appropriate design for a factorial experiment 2×3 (licorice root extract x Moringa leaf extract). Means were compared using L.S.D at level of 0.05 probability (Al-Rawi and Khalaf Allah, 2000).

Results and Discussion

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1- Mean length of the longest root (cm): The results revealed a significant effect of spray application with LRE on the average root length of fig saplings of the Diyala Black cultivar. The treatment with a rate of 8 g/L resulted in the greatest average length of 49.000 cm, while the saplings in the control treatment showed the lowest average length of 39.000 cm.

Foliar application of MLE also had a clear effect on the mean of this trait. The greatest mean value for this characteristic was expressed by saplings treated with the extract in the rate of 10 g L^{-1}, which was at 47.220 cm (Table 3) and the lowest mean (42.440 cm) in control treatment. Furthermore, a significant interaction was observed for the mean root length where the saplings sprayed with LRE at 8 g L^{-1} and MLE at 10 g L^{-1} had the greatest mean (50.330 cm), while the control treatment had the least mean of (36.000 cm).

2- Root volume: The results revealed that mean root volume was influenced by licorice extraction (Table (2). The rate of 8 g L^{-1} had the largest mean for this characteristic, 96.667 cm3, whereas the control exhibited the lowest one (82.889 cm3). The mean root volume was also markedly affected by the Moringa leaf extract. The maximum average of this characteristic was obtained for the extract at a rate of 10 g L^{-1} (91.667 cm3) and the minimum mean for control saplings (87.000 cm3).

The interaction presented in the same table also showed that the mean of root volume were significantly influenced, since seedlings treated with licorice root extract at 8 g L^{-1} and Moringa leaf extractat 10g L^{-1} provided the means higher than other treatments, which was 99.000 cm3 being lower control treatment (80.667 cm3).

3- Root diameter: Table (2) indicated that foliar spraying with licorice root extract show significant effect on the root diameter characteristic of fig saplings, Aswad Diyala cultivar, and that the concentration 8 gL^{-1} achieved the highest mean value in this characteristic at 5.949 cm compared to comparison treatment which recorded the least level at 4.016 cm. High significant influence of foliar application with MLE was also observed on this trait, and the concentration level 10 g L^{-1} gave the greatest mean value (6.614) as compared to control treatment which were the least (3.459).

A significant effect was also observed for the interaction between licorice root extract and Moringa leaf extract, as the concentration of 8 g L^{-1} and the concentration of 10 g L^{-1} gave the highest mean of 8.153, whereas the control treatment gave the lowest mean of 2.953.

4- Percentage of moisture content %: It could be observed a significant impact for the spraying of licorice extract on the moisture content of Aswad Diyala fig saplings (Table 2), in which 8 g L^{-1} achieved the greatest percentage among treatments with an average of 71.71% when compared with control treatment, which gave the lowest mean value reached 60.75%. Similar result was recorded on the Moringa leaf-based treatment where concentration of 10g/L^{-1} gave the best average (77.560%) and control treatment had the least average value (50.29).

Similarly the interaction was also found to be highly significant for this trait (Table 2), and the saplings that were treated with LRE at a rate of 8 g L^{-1} then MLE at a rate of 10 g L^{-1}, recorded greatest mean value of (82.270%) , while the control achieved the least with (44.530%).

5- Root System Dry Weight (g seedling-1) The results revealed a significant differences on the average root system dry weight due to Foilar application of licorice root extract (Table 2). The treatment T5 (8 g L^{-1}) recorded the highest average of 30.867 g sapling^{-1} and the control had lowest mass 22.344.g sapling^{-1}. The results also indicated that spraying with MLE had a considerable influence on this character. Spraying of saplings with the extract at a rate of 10 g L^{-1} caused significant enhancement ($p \leq 0.05$) in root system dry weight that achieved the value 27.800 g sapling^{-1} compared with untreated one, which was equal to 24.744 g sapling^{-1}. In addition, the interaction also revealed significant effect on root dry weights with 8 g L^{-1} of licorice and 10 g L^{-1} of MLE resulted in the highest rate of this trait reaching 33.400 g saplings, compared with the control treatment, which recorded the lowest mean for this trait 21.367 g sapling^{-1}.

Discussion: he increase observed in the studied traits (mean longest root, root volume, root diameter, percentage of moisture content, and dry weight of the root system) is attributed to the role of LRE, due to its content of mineral elements such as N, Mg, and Fe, which are nutritional elements that aid in the synthesis of chlorophyll molecules, thereby increasing the efficiency of the photosynthesis process. In addition, licorice root extract contains amino acids, sugars, and mineral elements that play a vital role in physiological processes (Al-Ajeeli ,2005, Hammdi and Abbas 2012, Lazim et al. 2013, Al-Rubaie 2014). This is consistent with Mohammed and Majeed (2024), who, in their study on strawberry seedlings, observed a significant positive effect of using licorice root extract on most of the strawberry plants' growth characteristics. Furthermore, auxin plays a role in increasing branching and the formation of lateral roots, which ultimately increases root growth indicators represented by root length, root volume, and the dry weight of the root system (Muhammad, 1985). This aligns with what It also agrees with the study by Abdul Hameed and Al-Amri (2015) on pear trees, and the study by Alghanim et al. (2023) on apple trees.

From the data analysis results in Tables (2), we conclude that spraying with Moringa leaf extract contributed to a significant increase in the characteristics and average volume of the root system. This is attributed to the fact that MLE contains high rate of zeatin, isopentenyl adenine, and dihydrozeatin. In addition to these cytokinins, zeatin effectively contributes to cell division and cell elongation. It is an antioxidant in plants, has anti-aging effects, and promotes plant growth (Siddhuraju and Becker, 2003, and Fuglie, 1999). Furthermore the role of MLE in stimulating plant growth, as it works as a natural stimulant for plant growth, in addition to being a good source of natural antioxidants (Hoque et al., 2020, Santini et al., 2021). This in line with what was found Nasir et al. (2016), or the reason could be attributed to the presence of amino acids in MLE, such as the amino acid tryptophan, which has a great role in the biosynthesis of auxin (IAA). In addition, it improves and strengthens vegetative characteristics, and increases divisions, which is reflected in growth (Meireles et al., 2020; Nouman et al., 2012). These results agree with what Abd Al Rhman et al. (2018) reached on orange saplings, and Hassan et al. (2019).

These results indicate that foliar spraying of licorice root extract and Moringa leaf extract enhances plant growth traits through increasing growth indicators. Our results indicate that foliar feeding with Moringa leaf extract may be one of the best possible methods to enhance growth characteristics. It was previously indicated that applying foliar feeding on leaves increased significantly the growth and productivity of different plant species compared with the control group (Hoque et al., 2020; Makkar et al., 2007; Mvumi, 2013).

Conclusion: The findings from the present study showed that foliar application of licorice root extract and Moringa leaf extract, alone or in combination, produced a stimulatory effect on some fruit plant performance attributes as well as moisture content in fig saplings (Aswad Diyala cultivar). This was manifested in terms of plant growth and yield. These findings in general indicated the significance of the combinatory effect of licorice root extract with Moringa leaf extract towards sustainable agricultural practices. Consequently, in the future due to results seen it is recommended a corresponding integration in orchards should be tested using biostimulants or natural plant extracts in the fruit tree nurseries for nutrient management enhancement and avoiding mineral fertilizer chemicals; which contributes toward sustainable and eco-friendly agricultural practices.

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Authors' Contribution: Manar A. F. Hassan conceived and designed the experiment, conducted the laboratory and field work, analyzed the data, and wrote the manuscript. The author reviewed and approved the final version of the paper.

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Novelty Statement: This study provides the first integrated evaluation of foliar application of licorice root extract and Moringa leaf extract on root system characteristics of fig saplings (Aswad Diala cultivar). It highlights the synergistic bio stimulatory effects of these natural extracts as eco-friendly alternatives to synthetic fertilizers, contributing to sustainable nutrient management and improved root development in fruit saplings

References:

Abd Al Rhman A, Ahmed HS, Mohamed SA. 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.

Abdul Hameed SA, El-Amary EI. 2015. Improving growth and productivity of pear trees using some natural plant extracts under North Sinai conditions. *Journal of Agriculture and Veterinary Science*.8 (1):1–9.

Abdul Hussein MAA. 1986.The effect of some treatments on the rooting of olive cuttings, Ashari and Nepalese varieties, under sprinkler irrigation. [Master's thesis]. Baghdad (Iraq): University of Baghdad, College of Agriculture;

Al-Ajeeli TA. 2005. The effect of gibberellin GA_3 and some nutrients on the production of glycyrrhizin and some other components in licorice plant *Glycyrrhiza glabra*. [PhD thesis]. Baghdad (Iraq): University of Baghdad, College of Agriculture;

Alghanim FSR, Al-Hadethi MEA, Yaviç A. 2023. Response of apple trees performance to moringa extract, humic acid, and liquid organic fertilizers (Vit-Org). *Journal of Plant Production*. doi:10.21608/jpp.2023.213580.1244.

Al-Marsoumi FSH, Al-Hadethi MEA.2024. Effect of Bacterial Biofertilizer, Buffalo's Organic Manure and Moringa Leaves Extract Spray in Vegetative Growth Characteristics of Local Orange Transplants. 5th International Conference of Modern Technologies in Agricultural Sciences. IOP Conf. Series: Earth and Environmental Science 1371.042030. doi:10.1088/1755-1315/1371/4/042030

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Vol. 36 Issue 2, 2026, Pages 225-227

Al-Rawi KM, Khalaf Allah AA. 2000. *Design and Analysis of Agricultural Experiments*. Mosul (Iraq): Ministry of Higher Education and Scientific Research - Mosul University Press;
Al-Rubaie SMK. 2014. Effect of spraying dry yeast suspension and licorice root extraction on vegetative and root growth of sour orange transplants (*Citrus aurantium* L.). *Euphrates Journal of Agricultural Sciences*.6 (2):338–352.
Al-Saif AM, El-Khamissi HA, Elnaggar IA, Farouk MH, Omar MAE, Abd El-Wahed AEN, Hamdy AE, Abdel-Aziz HF. 2024. Licorice-root extract and potassium sorbate spray improved the yield and fruit quality and decreased heat stress of the 'Osteen' mango cultivar. *Peer J.;* 12:e18200. doi:10.7717/peerj.18200. PMID: 39391826; PMCID: PMC11466221.

Durán-Lara EF, Valderrama A, Marican A. 2020. Natural organic compounds for application in organic farming. Agriculture.;10(2):41. doi:10.3390/agriculture10020041.
Eid AAM, Nomier SA, Ibrahim MM, Gad MM. 2018. Effect of some natural extracts, indolbutiric acid and naphthalene acetic acid on rooting of picual olive cuttings. Zagazig J Agric Res.;45(1):119-136.
Fallovo C, Cristofori V, Mendoza de-Gyves E, Rivera CM, Rea R, Fanasca S, et al. 2008. Leaf area estimation model for small fruits from linear measurements. HortScience. 43(7):2263-2267. doi:10.21273/HORTSCI.43.7.2263.
Fróna D, Szenderák J, Harangi-Rákos M. 2019. The challenge of feeding the world. Sustainability. 11(20):5816. doi:10.3390/su11205816.
Fuglie, L.J. 1999. The Miracle Tree: Moringa oleifera: Natural Nutrition for the Tropics. Church World Service, Dakar, 68..
Hammdi MT, Abbass JA. 2012. Effect of spraying zinc and liquorice (Glycyrrhiza glabra) root extract on growth and flower of Spanish iris bulbs (*Iris xiphium*). Jordan J Agric Sci.;8(1):127-137.
Hassan A, Abd-Alhamid N, Aly RBMA, Hassan HSA, Hagagg LF. 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 Univ J Agric Sci.27(1):659-671. doi:10.21608/AJS.2019.43679.
Hoque TS, Rana MS, Jahan SA, Jahan I, Abedin MA. 2020. Moringa leaf extract as a bio-stimulant on growth, yield and nutritional improvement in cabbage. Asian J Med Biol Res. 6:196-203.
Hossain MM, Miah G, Ahamed T, Sarmin NS. 2012. Study on allelopathic effect of Moringa oleifera on the growth and productivity of mungbean. Int J Agric Crop Sci.. (4) 15:1122-1128
Lazim ZS, Jasim SN, Ahmed CA. 2013. The effect of spraying with both extracts of liquorice and fenugreek in vegetative and flowering growth and vase life of Antirrhinum. Euphrates Journal of Agriculture Science 5(1):17- 18.
Makkar HPS, Francis G, Becker K. 2007. Bioactivity of phytochemicals in some lesser-known plants and their effects and potential applications in livestock and aquaculture production systems. Anim Feed Sci Technol.137:1-18. doi:10.1017/S1751731107000298.
Mallarino AP. 2003. Foliar and starter fertilization: are they needed to supplement primary fertilization? In: The Integrated Crop Management Conf Proceedings; Dec 3-4; Ames, IA. Ames (IA): Iowa State Univ Extension; p. 113-120.
Mehmet GM. 2009. Analysis of fatty acids and some lipophilic vitamins found in the fruits of the Ficus carica variety picked from the Adiyaman District. J Biol Sci.413:320-323.
Meireles D, Gomes J, Lopes L, Hinzmann M, Machado J. 2020. A review of properties, nutritional and pharmaceutical applications of Moringa oleifera: integrative approach on conventional and traditional Asian medicine. Adv Tradit Med. 20(4):495-515.
Mohammed RR, Majeed BH. 2024. Response of strawberry growth, yield and marketable fruit quality to spraying with moringa leaf extract, calcium and potassium silicate. Iraqi J Agric Sci. 55(1):440-452.
Muhammad, A-AK. 1985. Plant Physiology, Part 2. 29. Dar Al-Kutub for Printing and Publishing, University of Mosul, Iraq.
Mousa TN, Abdul-Jabbar WA, A Abdul Hameedbdul-Majid NA. 2002; Study of some components of local licorice (Glycyrrhiza glabra L.) root powder. Iraqi J Agric Sci. 34(4):30-38.
Mvumi C, Tagwira F, Chiteka AZ. 2013. Effect of Moringa extracts on growth and yield of maize and common beans. Greener J Agric Sci.3:55-62.
Nasir M, Khan AS, Basra SA, Malik AU. 2016. Foliar application of moringa leaf extract, potassium and zinc influence yield and fruit quality of 'Kinnow' mandarin. Sci Hortic.; 210:227-235.
Nouman W, Siddiqui MT, Basra SMA. 2012. Moringa oleifera leaf extract: an innovative priming tool for rangeland grasses. Turk J Agric For.; 36(1):65-75. doi:10.3906/tar-1009-1261.
Pandey D. 2020. Agricultural sustainability and climate change nexus. In: Singh P, Singh RP, Srivastava V, editors. Contemporary Environmental Issues and Challenges in Era of Climate Change. Singapore: Springer;. p. 77-97. doi:10.1007/978-981-32-9595-7_4.
Santini G, Biondi N, Rodolfi L, Tredici MR. 2021. Plant biostimulants from cyanobacteria: an emerging strategy to improve yields and sustainability in agriculture. Plants (Basel). 10(4):643. doi:10.3390/plants10040643.
Schenk MK, Barber SA. 1980. Potassium and phosphorus uptake by corn genotypes grown in the field as influenced by root characteristics. Plant Soil. 54:65-76.
Siddhuraju P, Becker K. 2003. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agro climatic origins of drumstick tree (Moringa oleifera Lam.) leaves. J Agric Food Chem. 51(8):2144-2155. doi:10.1021/jf020444+.
Taha SKH, Aljabory AMAO. 2024. Improving the growth and productivity of fig trees by spraying with moringa leaves extracts and garlic cloves. Iraqi J Agric Sci. 55(3):1147-1157.
Tirado-Kulieva VA, Gutiérrez-Valverde KS, Villegas-Yarlequé M, Camacho-Orbegoso EW, Villegas-Aguilar GF. 2022. Research trends on mango by-products: a literature review with bibliometric analysis. J Food Meas Charact. 16(4):2760-2771. doi:10.1007/s11694-022-01400-7.
Yakhin OI, Lubyanov AA, Yakhin IA, Brown PH. 2017. Biostimulants in plant science: a global perspective. Front Plant Sci. 7:2049.
Yousif AA, Hassan WA. 2023. HPLC analysis and antifungal activity of some plant extracts against decay apple fruits. Iraqi J Agric Sci. 54(1):291-302.
Zhao GY, Gong LM, Wu LL, She SQ, Liao Y, Zheng H, et al. 2020. Immunomodulatory effect of fermented fig (Ficus carica L.) fruit extracts on cyclophosphamide-treated mice. J Funct Foods. 75:10

Table 1. Some physical and chemical properties of the soil used in the experiment

Soil texture	**Sandy loam**
Sand	956 g kg^{-1}
Silt	29 g kg^{-1}
Clay	15 g kg^{-1}
pH	7.6
EC	2.4 dS m^{-1}

Table 2. Effect of foliar application with LRE and MLE and their interaction on root system traits and moisture content of fig saplings, cultivar Aswad Diyala.

Treatment	Mean length of the longest root (cm)	Root volume (cm^3)	Root diameter (cm)	Percentage of moisture content (%)	Root System Dry Weight (g $sapling^{-1}$)
	Spring 2023	Spring 2023	Spring 2023	Spring 2023	Spring 2023
L0	39.000	82.889	4.016	60.75	22.344
L1	46.780	88.444	5.048	64.70	25.489
L2	49.000	96.667	5.949	71.71	30.867
L.S.D$_{(0.05)}$	**0.535**	**0.263**	**0.400**	**0.687**	**0.192**
M0	42.440	87.000	3.459	50.29	24.744
M1	45.110	89.333	4.939	69.310	26.156
M2	47.220	91.667	6.614	77.560	27.800
L.S.D$_{(0.05)}$	**0.535**	**0.263**	**0.400**	**0.687**	**0.192**
L0M0	36.000	80.667	2.953	44.530	21.367
L0M1	39.000	83.000	3.957	62.99	22.200
L0M2	42.000	85.000	5.137	74.720	23.467
L1M0	44.000	86.333	3.317	46.180	24.467
L1M1	47.000	88.000	5.273	72.250	25.467
L1M2	49.330	91.000	6.553	75.680	26.533
L2M0	47.330	94.000	4.107	60.150	28.400
L2M1	49.330	97.000	5,587	72.690	30.800
L2M2	50.330	99.000	8.153	82.270	33.400
L.S.D$_{(0.05)}$	**0.927**	**0.456**	**0.694**	**1.190**	**0.707**