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Hassooni & Khalil

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EFFECT OF FOLIAR SPRAY WITH ALPHA-TOCOPHEROL AND ORGANIC FERTILIZATION WITH MUSHROOM COMPOST ON GROWTH OF ASWAD DIALA FIG TRANSPLANTS

***Zainab M. Hassooni* [1 *], *Nazik H. Khalil* [2]**
[1]Department of Horticulture and Landscape Engineering, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq Zainab.Majid2205m@coagri.uobaghdad.edu.iq
[2]Assist. Prof, Department of Horticulture and Landscape Engineering, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq, Nazik.khalil@coagri.uobaghdad.edu.iq

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ABSTRACT

This study was conducted at Research Station of College of Agricultural Engineering Sciences, University of Baghdad, during 2023 growing season to investigate the effect of alpha-tocopherol and levels of organic fertilization with spent mushroom compost (SMC) on some vegetative growth traits of two-year-old Aswad Diala fig transplants planted in 30 cm plastic pots. The experiment included spraying alpha-tocopherol at four concentrations (0, 100, 200, 300 mg L^{-1}) and fertilizing transplants with three levels of spent mushroom compost (0, 1, 2 kg per transplants). The experiment was designed under a randomized complete block design with three replicates. The results showed significant increases in all studied traits. Spraying alpha-tocopherol at concentrations of 300 and 200 mg L^{-1} significantly exceeded the control in leaf elemental content (mg), chlorophyll a and b, dry weight, and leaf fresh weight. Meanwhile, transplants fertilized with spent mushroom compost at ratios of 3:1 and 2:1 excelled in mentioned traits.

Keywords: spent mushroom compost, Black Dialy fig, chlorophyll a, chlorophyll b.

تأثير الرش الورقي بالالفا توكوفيرول والتسميد العضوي بمخلفات الفطر في نمو شتلات التين أسود ديالى

***زينب ماجد حسوني* [1] *نازك حقي خليل* [2]**
1. قسم البستنة وهندسة حدائق، كلية علوم الهندسة الزراعية، جامعة بغداد، بغداد، العراق، Zainab.Majid2205m@coagri.uobaghdad.edu.iq
2. استاذ، قسم البستنة وهندسة حدائق، كلية علوم الهندسة الزراعية، جامعة بغداد، بغداد، العراق ، Nazik.khalil@coagri.uobaghdad.edu.iq

الخلاصة

اجريت هذه الدراسة في محطة الابحاث في كلية علوم الهندسة الزراعية– جامعة بغداد خلال موسم النمو 2023 للتحقق من تأثير الالفا توكوفيرول ومستويات التسميد العضوي بمخلفات الفطر (SMC) في بعض صفات النمو الخضري لشتلات التين صنف (اسود ديالى) بعمر سنتين، مزروعة في سنادين بلاستيكية بقطر 30سم، تضمنت الرش بالالفاتوكوفيرول بأربع تراكيز (0،100،200،300 ملغم لتر-1)، وتسميد الشتلات بثلاث مستويات من مخلفات الفطرSpent mushroom compost (0،1، 2كغم شتلة -1). صممت التجربة وفق نظام القطاعات العشوائية وبواقع ثلاث مكررات. اظهرت النتائج زيادة معنوية لجميع الصفات المدروسة، اذ تفوق الرش بالالفاتوكوفيرول بتركيز (300,200) ملغم لتر -1 بتركيز عناصر mg,Ca، الكلوروفيل a,b, وزن جاف, وزن رطب في الاوراق، في حين تفوقت الشتلات التي تم تسميدها بمخلفات الفطربنسبة اضافة(3:1,2:1)بالصفات المذكورة انفا .

الكلمات المفتاحية: مخلفات الفطر، تين اسود ديالى كلوروفيل a,b.

[*]This article is taken from the first researcher's master's thesis.

INTRODUCTION

Fig (Ficus carica L.) belongs to the Moraceae family and is one of approximately 1000 species within genus Ficus. Researchers believe that the original habitat of the fig tree is the southern Arabian Peninsula (**Al-Hajami, 2019**), and from there, it spread to regions of Asia Minor. Currently, fig cultivation is concentrated in the Mediterranean Basin, where 80% of the world's production occurs. Global fig production reached 1,242,449.04 tons in 2022 (**FAO, 2023**). Mitra (1997) emphasized that figs are among the most nutritious fruits, containing per 100 grams of fresh fruit approximately 78% water, 1.3% protein, 0.3% fat, 17% carbohydrates, 2% fiber, 48 mg of carotene, and 50 mg of vitamin B. Figs also contain essential minerals such as calcium, phosphorus, potassium, zinc, and iron (**Jumaa, 2006**).

Fig trees are classified as semi-tropical trees, often with multiple trunks, and their branches are not densely intertwined like those of other trees. Fig trees are characterized by their Latex and distinctive aroma. The fig fruit is technically a false fruit, known botanically as a syconium, which is a fleshy receptacle enclosing a cavity. This cavity is connected to the outside by a small opening called the eye (**Sarkhosh *et al.*, 2022**).

Alpha-tocopherol (Vitamin E) is a natural compound found in living organisms with a molecular formula of $C_{29}H_{50}O_2$ and a molecular weight of 430.71 g/mol. It is a fundamental antioxidant crucial for combating oxidative stress in plants (**Dellapenna, & Menesaffrane, 2011**). This compound is considered the most biologically active form of vitamin E compared to other forms, possibly due to its unique structural characteristics.
Alpha-tocopherol plays several important physiological roles in plants. One significant role is its ability to reduce free radicals in chloroplast membranes, thereby minimizing lipid oxidation (**Faisal & Abdullah, 2020; Al-Rubaie, 2022**).

Organic fertilization is preferred in fruit orchards to achieve healthier and environmental production. The key to the success of agricultural production is using fertilizers from organic and biological sources (**Khalil, 2023**)

Organic matter consists of plant and animal residues along with soil microorganisms. Under suitable conditions, these materials decompose to form organic acids and humic substances. Organic matter plays a vital role in improving soil physical and chemical properties and enhances nutrient availability, especially in soils deficient in organic materials and with high calcium content (**Aba Al-Meikh *et al.*, 2018; Alkhafaji & Khalil, 2019**).

Plant development and growth is controlled by several factors, Fertilization plays a crucial function in controlling plant growth and development as well as improving fruit features, which favorably impacts yield and farmer revenue. Several factors influence productivity improvement (**Al-Hadethi *et al.*, 2020; Al-Halfi & Al-Azzawi, 2022**), Spent mushroom compost (SMC) is a type of organic residue from mushroom farms that can be used as an alternative organic fertilizer, reducing or replacing the need for chemical fertilizers (**Danny, 2017**). SMC is rich in essential nutrients such as nitrogen, phosphorus, potassium, calcium, magnesium, and trace elements.

The application of SMC improves soil chemical, physical, and biological properties of soil by enhancing soil structure, increasing water retention capacity, and biological activity due to the increased organic matter content (**Verma *et al*., 2020**). Organic fertilization helps mitigate the negative impact of environmental pollutants and reduces associated problems of chemical fertilization (**Al-mashari *et al*., 2017; Soni *et al*., 2022**).

The study aimed to investigate effects of organic fertilization using spent mushroom compost (SMC) and foliar spray of alpha-tocopherol on growth and productivity of Aswad Diala fig transplants, in line with global trend towards reducing chemical fertilizers and adopting sustainable agricultural practices.

MATERIALS AND METHODS

The research was conducted in shade of Station B, Department of Horticulture and Landscape Engineering, College of Agricultural Engineering Sciences, University of Baghdad, for 2023-2024 season. on two-year-old Aswad Diala fig trans plant.

The transplants were pruned to standardize height (140-145 cm) and number of lateral branches (2-3) as much as possible. They were then transplanted into pots with a diameter of 30 cm (12 L), filled with a soil mixture containing spent mushroom compost (SMC) at ratios of 0 (S0), 1:3 (S1), and 1:2 (S2), as first factor. The electrical conductivity (EC) of the compost was 1.21 dS/m, and the pH was 8.

The second factor, alpha-tocopherol, was applied as foliar spray at concentrations of 300, 200, 100, and 0 mg L-1, labeled as E3, E2, E1, and E0 respectively, with a 20-day interval between sprays.

The study was conducted as a factorial experiment using a randomized complete block design (RCBD). The concentrations of elements (Mg, Ca), chlorophyll (a, b), and leaf dry and fresh weights were estimated as indicators to study the factors.

RESULTS AND DISCUSSION

Effect of foliar spraying with alpha-tocopherol and fertilization with spent mushroom compost (SMC) on leaf Mg and Ca (%) content:

results presented in Table 1. The interaction treatment of foliar spraying with alpha-tocopherol and SMC fertilization showed a significant effect in increasing .the leaves mg and Ca content . Especially, E3S1 treatment outperformed others by increasing the percentage of magnesium and calcium in the leaves to 0.70% and 0.85%, respectively. This was compared to the lowest concentration recorded in E0S0 treatment, which showed values of 0.28% for magnesium and 0.24% for calcium.

The foliar application of alpha-tocopherol had a significant effect in leaves magnesium and calcium content. E3Treatment (with a concentration of 300 mg L-1) showed highest percentage increase in magnesium (0.56%) and calcium (0.69%). lowest concentrations of magnesium and calcium in leaf plants were recorded in E0 treatment, reaching 0.49% and 0.61%, respectively. Treatment S2 recorded the highest concentration of magnesium in the leaves, reaching 0.58%. Additionally, S1 treatment exhibited the highest concentration of calcium in the leaves, measuring 0.74%. On other hand, lowest concentrations of these elements in leaves were recorded in seedlings from S0 treatment, with values of 0.42% for magnesium and 0.54% for calcium, respectively.

Effect of foliar spray with alpha-tocopherol and fertilization with spent mushroom compost (SMC) on leaf chlorophyll a, b content (mg g^-1 fresh weight):

The research results in Table 2 indicate that foliar spraying with alpha-tocopherol and organic fertilization led to increased growth of seedlings, as evidenced by higher chlorophyll a and b content in the leaves. E2S2 Treatment exhibited the highest leaf chlorophyll a and b content, measuring 19.11 mg g-1 and 12.53 mg g-1, respectively, while the lowest values were observed in seedlings from E0S0 treatment, with chlorophyll a content of 7.82 mg g-1 and chlorophyll b content of 4.83 mg g-1.

Seedlings treated with alpha-tocopherol at 300 mg L-1 (E3) showed the highest chlorophyll a and b content, measuring 15.11 mg g-1 and 10.23 mg g-1, respectively. Conversely, the lowest chlorophyll a and b content was recorded in seedlings from E0 treatment, with values of 11.97 mg g-1 and 8.74 mg g-1, respectively.

Significant effects of SMC fertilization on chlorophyll a and b content were observed, with S2 treatment showing the highest chlorophyll a and b content at 17.08 mg g-1 and 11.44 mg g-1, respectively. The lowest values were recorded in seedlings from S0 treatment, with chlorophyll a and b content of 10.17 mg g-1 and 6.87 mg g-1, respectively.

The effect of foliar spray with alpha-tocopherol and fertilization with spent mushroom compost (SMC) on leaf dry weight and fresh weight:

The results presented in Table 3 demonstrate that the combined treatment of foliar spraying with alpha-tocopherol and SMC fertilization had a significant impact on both leaf dry weight and fresh weight. E3S1 Treatment showed the highest increases in leaf dry weight and fresh weight, reaching 10.15 g-1 and 23.32 g-1, respectively. In contrast, the lowest values for leaf dry weight and fresh weight were recorded in E0S0 treatment, measuring 5.52 g-1 and 11.36 g-1, respectively.

The foliar spray treatment with alpha-tocopherol had a significant effect on both leaf dry weight and fresh weight of fig transplants. E3 Treatment (at a concentration of 300 mg/L) exhibited higher leaf dry weight and fresh weight, measuring 8.78 g-1 and 38.73 g-1, respectively. Conversely, the lowest values for leaf dry weight and fresh weight were observed in plants from E0 treatment, recording 7.46 g-1 and 16.07 g-1, respectively.

Furthermore, organic fertilization of fig transplants with spent mushroom compost (SMC) demonstrated positive results in growth and development. S2Treatment showed the highest average leaf dry weight and fresh weight, reaching 8.91 g-1 and 20.34 g-1, respectively. On the other hand, the lowest values for leaf dry weight and fresh weight were recorded in seedlings from S0 treatment, measuring 6.53 g-1 and 14.03 g-1, respectively.

Table (1): Effect of Alpha-Tocopherol Foliar Spray and Mushroom Compost Fertilization on Leaf Magnesium and Calcium Percentage and Chlorophyll a,b Content (mg/g Fresh Weight).

	Mg%					**Ca%**				
S	E					E				
	E_0	E_1	E_2	E_3	Mean	E_0	E_1	E_2	E_3	Mean
S_0	0.58	0.48	0.36	0.42	0.42	0.24	0.78	0.65	0.52	0.54
S_1	0.51	0.51	0.70	0.57	0.57	0.81	0.74	0.57	0.85	0.74
S_2	0.41	0.68	0.62	0.58	0.58	0.78	0.57	0.77	0.70	0.69
Mean	0.49	0.50	0.55	0.56		0.61	0.67	0.66	0.69	
	S	E	Lnt.			S	E	Lnt.		
LSD 5%	0.0067	0.0078	0.0135			0.0098	0.0113	0.0197		
Chlorophyll a Content (mg/g Fresh Weight)						Chlorophyll b Content(mg/g Fresh Weight)				
S_0	7.82	11.21	10.51	11.16	10.17	4.83	8.62	7.51	6.55	6.87
S_1	13.18	12.06	12.91	15.97	13.53	10.43	9.31	8.67	11.74	10.03
S_2	14.91	16.12	19.11	18.21	17.08	10.98	9.87	12.53	12.41	11.44
Mean	11.97	13.13	14.17	15.11		8.74	9.27	9.57	10.23	
	S	E	Lnt.			S	E	Lnt.		
LSD 5%	0.0140	0.0162	0.0281			0.118	0.126	0.234		

Table (3): Effect of Alpha-Tocopherol Foliar Spray and Mushroom Compost Fertilization on Leaf Dry Weight and Fresh Weight (g).

S	Leaf Dry Weight(g)					Leaf Fresh Weight (g)				
	E					E				
	E_0	E_1	E_2	E_3	Mean	E_0	E_1	E_2	E_3	Mean
S_0	5.52	7.02	9.47	7.14	6.53	11.36	15.89	14.61	14.23	14.03
S_1	8.86	7.78	7.02	10.15	8.45	17.72	15.00	16.04	23.32	18.02
S_2	8.02	9.03	9.53	9.07	8.91	19.12	20.07	21.61	20.55	20.34
Mean	7.46	7.94	7.67	8.78		16.07	16.99	17.42	19.37	
LSD 5%	S	E	Lnt.			S	E	Lnt.		
	0.008	0.009	0.017			0.009	0.010	0.018		

DISCUSSION

The results indicate that foliar spray with alpha-tocopherol (vitamin E) and organic fertilization using spent mushroom compost (SMC) improved the growth of fig seedlings. The foliar application of vitamin E contributed to an increase in leaf chlorophyll content by enhancing the activity of certain enzymes that protect chloroplasts from oxidative stress. Alpha-tocopherol interacts with unsaturated fatty acids, stabilizing cellular membranes and enhancing enzymatic activity, including chlorophyll content in plants. Additionally, vitamin E plays a crucial role in the function of photosynthetic enzymes, acting as a cofactor to enhance pigmentation and provide an optimal environment for photosynthesis (**Al-Tameemi, 2017**).

Additionally, vitamin E improves the overall condition of plants by increasing enzyme activity and nutrient accumulation, resulting in higher chlorophyll content. This enhances the plant's ability for photosynthetic construction, explaining the role of vitamin E in reducing the effectiveness of enzymatic antioxidants and improving the vegetative, flowering, and root growth of plants (**Abdul Latif *et al.,* 2016**). Vitamin E also protects chloroplastic membranes from photodamage, thus providing an optimal environment for photosynthesis (**Hamadi & Najah, 2024**). This protection leads to increased dry and wet weights, nutrient content, and consequently, enhanced photosynthetic processes, resulting in nutrient and carbohydrate accumulation, along with higher nutrient percentage.

The increased *concentration of magnesium and calcium in the leaves (Table 1) due to organic fertilization with SMC* may *be attributed to the rich mineral content in SMC, providing essential* nutrients *readily available for plant growth, along with organic acids that facilitate nutrient absorption by regulating* soil pH levels **(Saloom, & Alsahaf, 2016)**, magnesium it participates in process of sugars forming and transporting carbohydrates. It also contributes to process of regulating osmotic potential in plants, in addition to its role in stimulating formation of plant hormones. Because of movement of its diffusible part and its rapid transfer from old parts of plant to new growth, so symptoms of its deficiency appear on lower leaves of plant first, as it produces yellowing between leaves veins as a result of failure to build chlorophyll **(Ahmed & salih, 2023)**

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Perhaps the reason for this lies in vitamin E's role in promoting cell growth and elongation through the activation of certain enzymes, including those involved in photosynthetic processes (**Faisal & Abdul Samad, 2020**). Additionally, alpha-tocopherol activates enzymes that protect chloroplasts by acting as antioxidants, thereby enhancing the biological activities of plants and subsequently increasing the absorption and assimilation of nutrients, including major elements. This aligns with findings by **Sadek**.**(2014)**

he significant increase in dry and wet leaf weights (Table 3) and chlorophyll content in leaves (Table 2) may be attributed to the optimal concentrations of elements in the leaves

(Table 1), possibly caused by organic fertilization. The increase in chlorophyll led to enhanced elemental content due to the fundamental physiological and vital role of plant components through the activity of various enzymes and protein synthesis, which positively influences growth factors (**Hameed & Nazik, 2023; Azawi & Salih, 2019**). Consequently, this activates the photosynthetic process by enhancing vegetative growth characteristics (**Awad & Nazik, 2022**).

The positive effect of fertilization with spent mushroom compost in treatment E2S2 increasing the chlorophyll a,b content in the leaves may be attributed to their combined impact on improving carbon metabolism by increasing leaf chlorophyll content(**Al-Mashhadani, *et al* 2019 ; al silmawy & abdulratha, 2023**) ,as shown in Table 2. This led to enhanced nutrient accumulation. Furthermore, the increased availability of nutrients in the soil resulting from organic fertilization with spent mushroom compost reflects positively on their proportion in the plant, which directly and indirectly contributes to chlorophyll synthesis and activates numerous photosynthetic enzymes that promote vegetative growth in plants (**hameed & khalil, 2023**).

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CONCLUSIONS

The impact of spraying with α-Tocopherol and organic fertilization with spent mushroom on all studied traits was observed, which showed significant impact on all vegetative characteristics. Meanwhile, foliar spraying with α-Tocopherol showed an effect on quantity and quality yield traits due to its increase in chlorophyll content and enhancement of nutrient levels in the leaves.

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