Iraqi Journal of Market Research and Consumer Protection
(2025) 17(1): 118- 128
DOI:
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المجلة العراقية لبحوث السوق
وحماية المستهلك

PHYSIOLOGICAL RESPONSE OF APRICOT TRANSPLANTS TO AMINO ACIDS ADDITION AND SPRAYING WITH GLUTATHIONE AND KAOLIN

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Received 2/ 8/ 2023, Accepted 12/ 9/ 2023, Published 31/ 3/ 2025

ABSTRACT

This study was conducted in a lath house, Dept. Of Hort. and Landscape, College of Agricultural Engineering Sciences, Univ. Baghdad, Al- Jadriya during 2022 growing season to investigate influence of liquid organic fertilizer (Siapton 10 L) and spraying with glutathione and kaolin on some vegetative growth characteristics and leaf mineral content of two year's old of "Red" apricot transplants. Factors of study experiment included addition of two levels of liquid organic fertilizer (Siapton 10 L) containing a group of amino acids to soil ,without addition (S_0), and 3 ml L^{-1} (S_3), while glutathione spray was sprayed with three levels; without spray (G_0), spraying at 200 mg L^{-1} (G_{200}) and spraying at 400 mg L^{-1} (G_{400}), As for kaolin spray, they were sprayed in three levels (0, 500, and 1000 mg L^{-1}), which are denoted by symbols K_0, K_{500}, and K_{1000}, respectively. The experimental results showed that liquid organic fertilizers at 3 ml L^{-1}(S_3) significantly increased in stem diameter of 9.52 mm, highest leaf potassium content of 1.77%, leaf water content of 70.99 % and decreased in leaf proline content of 4.90 µmol.gm fresh weight^{-1}. Results also showed that glutathione spray especially at 400 mg L^{-1} (G_{400}), showed significant superiority in increased in stem diameter of 10.07 mm, leaf potassium content of 1.76 % and leaf water content of 70.51 %. Kaolin spray also affected, especially spraying at 1000 mg L^{-1} and gave highest increasing of stem diameter of 9.47 mm, highest leaf potassium content of 1.77 %, leaf water content of 71.00 % and decreased in leaf proline content of 4.65 µmol.gm fresh weight^{-1}.

Keywords: apricot, glutathione, kaolin, organic fertilizers, physiological response.

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

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(2025) 17(1): 118-128

الإستجابة الفسيولوجية لشتلات المشمش لإضافة الأحماض الأمينية والرش بالكلوتاثيون و الكاولين

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الخلاصة

نفذت هذه التجربة في الظلة التابعة الى قسم البستنة وهندسة الحدائق ضمن محطة ابحاث (B) الواقعة في كلية علوم الهندسة الزراعية/ جامعة بغداد، كانت الظلة المستخدمة لغرض اجراء هذه الدراسة هي عبارة عن هيكل حديدي لبيت بلاستيكي تمت تغطيته بمادة السارن الأخضر نسبة تظليله 50%، للموسم 2022 لدراسة استجابة شتلات المشمش لإضافة الاحماض الامينية ورش الكلوتاثيون والكاؤولين. العامل الأول هو السماد العضوي السائل Siapton 10L بمستويين هما بدون إضافة (S_0) و الأضافة الأرضية بتركيز 3 مل.لتر$^{-1}$ (S_3)، والعامل الثاني هو رش الكلوتاثيون وكانت بدون رش (G_0) ورش 200 ملغم.لتر-1 (G200) ورش 400 ملغم-1 (G400)، اما العامل الثالث هو رش الكاؤولين وكان بدون رش (K0) ورش 500 ملغم.لتر-1 (K500) ورش 1000ملغم.لتر-1 (K1000) . أظهرت نتائج الدراسة ان اضافة السماد العضوي السائل اثرت معنوياً في زيادة قطر الساق بلغت 9.52 ملم ومحتوى الأوراق البوتاسيوم بلغ1.77 % وأعلى محتوى من الماء النسبي بلغ 70,99%، أقل محتوى من البرولين بلغ 4,90 مايكرومول. غم وزن طري$^{-1}$. اشارت النتائج ايضاً ان رش الكلوتاثيون لاسيما رش (G400) تفوق معنوياً في الزيادة في قطر الساق بلغت 10,07 ملم ، محتوى الأوراق من البوتاسيوم اذ بلغ 1.76 % والماء النسبي للأوراق بلغت 70,51 %. كما ان رش الكاؤولين لاسيما التركيز (K1000) اثر معنوياً و اعطى اعلى زيادة في قطر الساق بلغت 9,47 ملم ، ومحتوى الأوراق البوتاسيوم بلغ 1,77 %، اعلى محتوى للأوراق من الماء النسبي بلغت 71,00 %، واعطى اقل محتوى للأوراق من البرولين بلغت 4,65 مايكرومول.

الكلمات المفتاحية: المشمش، الكلوتاثيون، الكاولين، السماد العضوي، الإستجابة الفسيولوجية.

INTRODUCTION

Prunus armeniaca L. is scientific name for apricot trees, which are members of Rosaceae family. The history of the apricot tree extends back to 5000 years in China relating to Emperor Yu's era. Other accounts claim that it is native to northern China, where it was cultivated 4,000 years ago, there are wild types of apricots cultivated from Japan to Afghanistan, and Romans dubbed it Armenian apple, therefore some scholars believed that apricots originated in Armenia and were thus given this name (**Janick, 2005; Alwan, 2017**). On 2018, global apricot output was approximately (3,838,523) tons, with cultivated areas totaling (548,730) hectares. Turkey ranks first on list of apricot-producing countries, with production reaching (750,000) tons, accounting for nearly a quarter of global production. Uzbekistan is ranked second, followed by Iran, Algeria, and Italy (**FAO, 2019**). Number of apricot fruit trees in Iraq is projected to be 1,066,429 trees, generating roughly 34,728 tons, with an average yield per tree of approximately 32.56 kg (**PCBS, 2019**).

In addition to having a positive impact on soil properties by improving soil aeration, which enhances root spread and growth, as well as its role in increasing nutrient availability, as well as increasing the various activities of microorganisms and their secretions, which increase plant resistance to drought conditions, organic fertilizers are also often inexpensive and readily available in local markets. Agriculture professionals are well aware of the significance of organic matter and its significant and influential role in the characteristics of vegetative growth as well as the yield and quality of fruits if it is added to soil or sprayed on vegetative systems, which is, it supplies plants with nutrients without harming the environment (**Nardi *et al.*, 2016;**

Al-Hadethi, 2019) .There are many studies and researches that indicated positive effect of organic fertilization containing amino acids on many different vegetative growth characteristics, (**Saleem & Joody, 2015**) in a study, that included three levels of organic fertilizer Com Sol (0, 5, 10 ml.L^{-1}) they found it significantly increased shoot number and leaf area especially at 10 ml.L^{-1}. And in a study to find out effect of adding three levels of Fulvigrow liquid organic fertilizer (0, 2.5 and 5 ml.L^{-1}) on three citrus rootstocks, (**Majeed, 2021**) found that addition at a concentration of 5 ml.L^{-1} had a significant effect on increasing Leaves content of potassium, relative water content, and decrease in leaf proline content, compared to control treatment. (**Alghanim *et al.*, 2023**) found that liquid organic fertilizer (vit –org) at 10 ml.tree^{-1} caused significant increases in leaf area and , leaf chlorophyll contents, leaf dry weight, and shoot length for "Ibrahim" apple trees.

Glutathione its partial formula is C10H17N3O6S, its molar mass is 307.32 g.mol^{-1}, and its melting point is 195 °C. It dissolves easily in water and is insoluble in organic solvents such as methanol. It is from the group of Glutamate Ketogglutarate, which is a tripeptide compound consisting of three amino acids, cysteine, glycine and glutamic, which is one of most important antioxidants to control plant responses to abiotic stresses, it participates in plant defense mechanism against adverse conditions. It is found in roots and leaves, with its presence mainly in mitochondria, followed by peroxisomes nucleus, cytosol and chloroplasts. The interaction of glutathione and its ability to dissolve in water makes it an ideal antibiotic against abiotic stresses, as it participates in many cellular processes, including in which the absorption of heavy elements and removal of toxins and work against types of reactive oxygen in plant cell ROS and there are several functions performed by glutathione in growth and plant development, Glutathione also works in the process of gene expression, protein and DNA building, and also contributes to process of cellular expansion, transmission of cellular signals, production of some plant hormones, including cytokines, and increase in plant resistance to various diseases. It also has a role in removing toxicity of hydrogen peroxide and some heavy elements that cause toxicity. For plants, including mercury, and works to increase plant tolerance to various stresses, including heat stress, salinity stress, and heavy elements (**Al-Khafaji *et al.*, 2022 & Rai *et al.*, 2023**) .Some studies were conducted to find out effect of spraying with glutathione on growth of fruit trees, **(Ahmed *et al.*, 2018**) found in their study on effect of spraying glutathione on growth of grape vines with three concentrations (500 mg, 1 and 2 g.L^{-1}) and compared them to no spraying indicated that spraying led to a significant increase in leaves chlorophyll and potassium contents, and this increase increased with increasing spray concentrations. **Saied (2019)** Also found in his experiment on spraying three levels of glutathione (500 mg, 1 and 2g.L^{-1}) alone or in combination with spraying fish oil on growth of mango trees that there was a significant increase in leaf mineral content, especially when spraying at the level of 2 g.L^{-1}.

As for kaolin clay, it is one of the inert clay minerals and has the chemical formula $Al_2Si_2O_5(OH)_5$. It primarily consists of aluminum silicate. It is typically found in nature either as successive sedimentary layers or flat lentil-shaped formations close to the earth's surface, as well as regular deposits in eroded igneous rocks. In a report on frequently used mineral clays, which includes kaolin clay, a group of international experts at the World Health Organization noted that kaolin is non-toxic and a safe material that can be used in a variety of fields because it was described as an environmentally friendly material, which encouraged many researchers to investigate the effects of their use on various plants (**Brito *et al.*, 2019; Al-Mokadem *et al.*, 2023;Glenn *et al* (2003)** summarized the most important benefits of using kaolin on plants in

its ability to reduce sunburn, increase carbon metabolism, reduce heat and water stress, and improve growth ,fruit quantity, quality and color. Studies were conducted on effect of spraying kaolin on growth of fruit trees. In aresearch conducted by (**Cirillo *et al.*, 2021**) on olive transplants (Salella cultivar) grown in pots in which anti-transpiration (Vapor Gard) and kaolin were used, results showed significant differences in leaves relative water content and their content of chlorophyll, compared with no treatment. (**Mahmoudian *et al.*, 2021**) When spraying four varieties of walnut with kaolin at four levels (0, 2.5, 5 and 7.5%) found that spraying had a significant effect on increasing leaf content of chlorophyll, potassium and relative water, and increased gas exchange, especially when spraying at two levels 5 and 7.5%. Due to lack of studies on role of glutathione and kaolin in growth of fruit trees in general and apricot transplants in particular, so study aimed to know role of these two compounds and addition of amino acids in physiological traits for apricot transplants.

MATERIALS AND METHODS

This study was conducted in a lath house, Dept. Of Hort. and Landscape , College of Agricultural Engineering Sciences, Univ. Baghdad, Al- Jadriya during 2022 growing season to investigate influence of liquid organic fertilizer (Siapton 10 L) and spraying with glutathione and kaolin on some vegetative growth characteristics and leaf mineral content of two year's old of "Red" apricot transplants. Factors of study experiment included addition of two levels of liquid organic fertilizer (Siapton 10 L) containing a group of amino acids to soil ,without addition (S_0), and 3 ml.transplant^{-1} (S_3), while glutathione spray was sprayed with three levels; without spray (G_0), spraying at 200 mg.L^{-1} (G_{200}) and spraying at 400 mg.L^{-1} (G_{400}), As for kaolin spray, they were sprayed in three levels (0, 500, and 1000 mg.L^{-1}), which are denoted by symbols K_0, K_{500}, and K_{1000}, respectively. Treatments were replicated three times (three transplants in experimental unit) at factorial experiment in a RCBD and thus number of transplants used was 162 transplants. The results of study were statistically analyzed and averages were compared according to (L.S.D) at 0.05 according to (**Elsahookie & Wuhaib, 1990**). Date of transplants spraying was at beginning of April, with six sprays, period between one spray and next was one month, addition of liquid organic fertilizer was done with three spring additions, period between one addition and next was a month, as it was at end of March, and it was repeated at end of April and end of May, and at beginning of September and beginning of October. The following parameters were determined in experimental season:

1. Increased in stem diameter (mm): stem diameter were measured using a (Vernier) at beginning (5-3-2022) and end of experiment (1-12-2022), according to difference between them and that such an increase in transplant height.
2. Leaf potassium Content: in 20-11-2022 samples of ten leaves from middle shoots, Leaves were washed with tap water, rinsed with distilled water, and then dried at 70 c^0 until a constant weight, ground and digested according (**Chapman & Pratt, 1978**). Potassium was estimate the chromatic by using spectrophotometer by (**Estefan *et al.*, 2013**).
3. Leaves relative water content (RWC) %: relative water content was measured by weighing leaves after cleaning them from dust (wet weighing), then immersing them in water for 3 hours, weighing them after extracting them from water (saturation weighing), then drying them in oven until the weight stabilized, and measuring their dry weight. The adjective was calculated according to (**Ahmed, 1984**) as follows: RWC = Leaves wet weight - dry weight / weight after saturation - dry weight x 100.

4. Leaves proline content (µmol.gm fresh weight^{-1}) : proline content was estimated according to method of (**Bates *et al.*, 1973**) using the following equation : mg proline x ml toluene / 115.5 / sample weight / 5.

RESULTS AND DISCUSSIONS

Effects of liquid organic fertilizer (Siapton 10 L) and spraying with glutathione and kaolin and their interaction on increased in stem diameter and leaf potassium content in apricot transplants:

Data concerning effect of treatments on increased in stem diameter and leaves potassium content are listed in Tables (1 and 2). The data cleared that, liquid organic fertilizers at 3 ml.L^{-1}(S_3) significantly increased in stem diameter of 9.52 mm and highest leaf potassium content of 1.77 %, while lower values of these traits was in S_0 treatment. Tables (1 and 2) also shows that glutathione spray especially at 400 mg.L^{-1} (G_{400}) , showed significant superiority in increased in stem diameter of 10.07 mm and leaf potassium content of 1.76 %. Kaolin spray also affected in stem diameter and leaf potassium content, especially spraying at 1000 mg.L^{-1} and gave highest increasing of stem diameter of 9.47 mm and highest leaf potassium content of 1.77 %, while lower values of these traits was in K_0 treatment. The interactions between liquid organic fertilizers and glutathione spray significantly affected in stem diameter and leaf potassium content especially interaction treatment ($G_{400}S_3$) of 10.37 mm and 1.86 %, respectively while lower values of these traits was in G_0S_0 treatment. Interactions between glutathione and kaolin spray significantly affected especially when interaction treatment ($G_{400}K_{1000}$) and gave 10.64 mm as increased in stem diameter and 1.86 % as leaf potassium content, while lower values of these traits was in G_0K_0 treatment. Interaction between liquid organic fertilizer treatment and kaolin spray especially interaction treatment (S_3K_{1000}) as it gave highest increased in stem diameter of 9.99 mm and highest leaf potassium content of 1.88 %. Triple interactions between study factors had a significant effect in these traits.

Table (1) Effects of liquid organic fertilizer (Siapton 10 L) and spraying with glutathione and kaolin and their interaction on increased in stem diameter (mm) in apricot transplants.

Glutathione (G)	Liquid fertilizer (S)	Kaolin (K)			G × S
		K_0	K_{500}	K_{1000}	
G_0	S_0	7.11	7.42	7.66	7.40
	S_3	8.67	8.90	9.12	8.90
G_{200}	S_0	8.16	8.53	8.90	8.53
	S_3	8.92	9.17	9.82	9.30
G_{400}	S_0	9.20	9.88	10.25	9.78
	S_3	9.66	10.42	11.03	10.37
L.S.D 0.05		0.81			0.47
G × K					G
G_0		7.89	8.16	8.39	8.15
G_{200}		8.54	8.85	9.36	8.91
G_{400}		9.43	10.15	10.64	10.07
L.S.D 0.05		0.57			0.33
S × K					S
S_0		8.31	8.61	8.94	8.62
S_3		9.09	9.49	9.99	9.52
L.S.D 0.05		0.47			0.27
K		8.70	9.05	9.47	
L.S.D 0.05		0.33			

These results may be due to addition of liquid organic fertilizers, which affect properties of soil, as it increases its ability to retain water and works to improve soil aeration, which improves roots spread and growth, as well as its role in increasing nutrients availability (table 2), as well as increasing various activities of microorganisms and their secretions, which may be rich in important growth regulators, and thus improve stem diameter. These results are consistent with what he found (**Al-Hadethi *et al.*, 2020; Azawi and Salih, 2019**) in olive transplants and consistent with (**Khalil, 2023)** on three citrus species, they showed that addition of organic fertilizers increases stem diameter and leaves potassium content of transplants. The reason for these results is due to role of glutathione and kaolin in their ability to reduce solar burns, increase carbon metabolism, reduce heat and water stress, and thus improve vegetative growth characteristics of plants (**Rai *et al.*, 2023 and Al-Mokadem *et al.*, 2023**).

Table (2) Effect of liquid organic fertilizer (Siapton 10 L) and spraying with glutathione and kaolin and their interaction on leaf potassium content (%) in apricot transplants.

Glutathione (G)	Liquid fertilizer (S)	Kaolin (K)			G × S
		K_0	K_{500}	K_{1000}	
G_0	S_0	1.43	1.48	1.56	1.49
	S_3	1.59	1.68	1.80	1.69
G_{200}	S_0	1.50	1.58	1.61	1.56
	S_3	1.64	1.72	1.95	1.77
G_{400}	S_0	1.54	1.63	1.82	1.66
	S_3	1.78	1.91	1.90	1.86
L.S.D 0.05		0.33			0.19
G × K					G
G_0		1.51	1.58	1.68	1.59
G_{200}		1.57	1.65	1.78	1.67
G_{400}		1.66	1.77	1.86	1.76
L.S.D 0.05		0.23			0.13
S × K					S
S_0		1.49	1.57	1.66	1.57
S_3		1.67	1.77	1.88	1.77
L.S.D 0.05		0.19			0.11
K		1.58	1.67	1.77	
L.S.D 0.05		0.13			

Effects of liquid organic fertilizer (Siapton 10 L) and spraying with glutathione and kaolin and their interaction on Leaves relative water content (RWC) and Leaves proline content in apricot transplants:

Data concerning effect of treatments on leaves relative water and leaves proline content are listed in Tables (3 and 4). The data cleared that, liquid organic fertilizers at 3 $ml.L^{-1}$(S_3) significantly increased in leaf water relative content of 70.99 % and decreased in leaf proline content of 4.90 µmol.gm fresh $weight^{-1}$. Tables (3 and 4) also shows that glutathione spray especially at 400 $mg.L^{-1}$ (G_{400}), showed significant superiority in leaf water content of 70.51 % while glutathione spraying treatments did not affect leaf proline content. kaolin spray was significantly effect in increased leaf water content and decreased leaf proline content especially at 1000 $mg.L^{-1}$ excelled in leaf water content of 71.00 % and decreased leaf proline content of 4.65 µmol.gm fresh $weight^{-1}$. The interactions between liquid organic fertilizers and glutathione spray significantly affected in leaf water content and decreased leaf proline content especially the interaction treatments ($G_{400}S_3$) and ($G_{200}S_3$) of 77.90 % and 4.78 µmol.gm fresh $weight^{-1}$, respectively. The interactions between glutathione and kaolin spray significantly affected especially when interaction treatment ($G_{400}K_{1000}$) and gave 75.96 % as leaf water content. The interaction between liquid organic fertilizer treatment and kaolin spray especially interaction treatment (S_3K_{1000}) as it gave highest leaf water content of 77.70 % and lowest leaf proline content of 4.34 µmol.gm fresh $weight^{-1}$. Triple interactions between study factors had a significant effect in these traits.

Table (3) Effect of liquid organic fertilizer (Siapton 10 L) and spraying with glutathione and kaolin and their interaction on Leaves relative water content (RWC) (%) in apricot transplants.

Glutathione (G)	Liquid fertilizer (S)	Kaolin (K)			G × S
		K_0	K_{500}	K_{1000}	
G_0	S_0	48.77	55.14	60.26	54.84
	S_3	56.89	64.00	68.54	63.14
G_{200}	S_0	50.72	57.55	64.90	57.72
	S_3	61.60	73.87	80.36	71.94
G_{400}	S_0	57.46	64.20	67.73	63.13
	S_3	70.28	79.22	84.19	77.90
L.S.D 0.05		18.42			10.63
G × K					G
G_0		52.83	59.57	64.40	58.93
G_{200}		56.16	65.71	72.63	64.83
G_{400}		63.87	71.71	75.96	70.51
L.S.D 0.05		13.02			7.52
S × K					S
S_0		52.32	58.96	64.30	58.53
S_3		62.92	72.36	77.70	70.99
L.S.D 0.05		10.63			6.14
K		57.62	65.66	71.00	
L.S.D 0.05		7.52			

The results of tables (3 and 4) may be due to effect of adding liquid organic fertilizer, which works to increase soil ability to retain water and improve most of its characteristics, and thus increase absorption of water and nutrients, and this explains increase in leaves relative water content, and given role of liquid organic fertilizer in improving absorption of elements, including potassium table (2), therefore, it regulates opening and closing of stomata, and thus has an effect on increasing leaves relative water content. The reason for decrease in leaves proline content, when adding liquid organic fertilizers, is that this addition works to increase permeability of cellular membranes, absorption of nutrients, and increase of photosynthesis and formation of carbohydrates and proteins, which are basic building of enzymes, and thus it reduces degraded amino acids including proline (**Shilan & Hama,2022) .**These results are consistent with what he found (**Al-Karam & Al-Biaty,2016**) they found a significant increase in leaf water content content when adding or spraying with organic fertilizers. Glutathione spray also reduces heat stress by maintaining or increasing relative water content and activity of antioxidant enzymes (**Ding *et al.*, 2016**).

The reason for this increase in leaves relative water content is attributed to role of kaolin in reducing plant transpiration rates and thus increasing plant ability to retain water. **Khalel (2015)** mentioned that spraying anti-transpiration works to increase leaves relative water content by decreasing transpiration rate, As kaolin works to form a thin white cover on leaf surface that reflects sun rays falling on it, thus lowering leaves temperature (**Brito *et al.*, 2019**). In addition to increase in level of growth-regulating hormones IAA, GA, and CK, and decrease in ABA concentration when spraying kaolin, which stimulates increase in plant vegetative characteristics (Tables 1 and 2) and protein building, and then decrease in plant proline content.

Table (4) Effect of liquid organic fertilizer (Siapton 10 L) and spraying with glutathione and kaolin and their interaction on leaves proline content (µmol.gm fresh weight^{-1}) in apricot transplants.

Glutathione (G)	Liquid fertilizer (S)	Kaolin (K)			G × S
		K_0	K_{500}	K_{1000}	
G_0	S_0	5.84	5.44	5.12	5.47
	S_3	5.62	4.82	4.32	4.92
G_{200}	S_0	5.73	5.50	4.92	5.38
	S_3	5.41	4.88	4.04	4.78
G_{400}	S_0	5.76	5.46	4.80	5.34
	S_3	5.38	4.98	4.66	5.01
L.S.D 0.05		0.51			0.29
G × K					G
G_0		5.73	5.13	4.72	5.19
G_{200}		5.57	5.19	4.48	5.08
G_{400}		5.57	5.22	4.73	5.17
L.S.D 0.05		0.36			N.S
S × K					S
S_0		5.77	5.47	4.96	5.40
S_3		5.47	4.89	4.34	4.90
L.S.D 0.05		0.29			0.17
K		5.62	5.18	4.65	
L.S.D 0.05		0.21			

CONCLUSIONS

Foliar spraying of apricot transplants with glutathione and kaolin at a concentration of 400 mg.L-1 and 1000 mg.L-1, respectively had a positive effect on improving physiological characteristics of transplants. Also, adding liquid organic fertilizer (Siapton 10 L) to pots soil planted with apricot transplants produced positive effects by improving growth characteristics, increasing leaves relative water content, and reducing proline content.

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