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Effect of Fertilizing With K-Amino Acid and Nutrient Solution on Some Growth Parameters of *Citrus Reticulata* Saplings

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ABSTRACT

The experiment was conducted in a certified citrus nursery belonging to the General Directorate of Horticulture and Forests in Karbala Governorate/Al-Hindiyah District for the growing season 2019, to study the effect of fertilizing with K-amino acid and nutrient solution on plant vegetative growth and nutritional contents of *Citrus reticulata* saplings grafted onto the original *Citrus aurantium* at age of six months old, after grafting. Fertilization with K-amino acid or spraying with nutrient solution was at three levels (0, 1, 2 $ml.L^{-1}$). Saplings were sprays six times on the 15th of March, April, Mays, then in August, September, and October. The results showed that fertilizing with K+amino acid at $2ml.L^{-1}$ led to the highest rate shoot and root fresh and dry weight, leaf content of chlorophyll and the total carbohydrates. The interaction treatment of 1 $ml.L^{-1}$ of both K+ amino acid and the nutrient solution had the highest values in shoot FW. While, nutrient solution and the K+amino acid at $2ml.L^{-1}$ recorded the highest rates of shoot DW, root FW and DW, and leaf content of total carbohydrates. The interaction of 2 $ml.L^{-1}$ K+amino acid and $1ml.L^{-1}$ nutrient solution was the highest value in case of leaf content of total chlorophyll.

Keywords: Organic compost, mandarin, plant nutrition, NPK, Kerbala

INTRODUCTION

Foliar fertilization is one of the important composting processes and techniques in plant nutrition. It helps in the high utilization of nutrients and reduced environmental pollution. Foliar feeding is an effective method that increases the movement of nutrients more broadly within plant parts, increases plant growth, and covers a large part of its nutrient requirements (Naseem et al., 2019).

Studies have shown that feeding plants with foliar fertilization is one of the most important matters under conditions of determinants of absorption from the roots, especially when conditions of drought, change in the degree of soil interaction pH, fluctuation of soil temperature, and the competitive effect between positive and negative ions of nutrients. Nitrogen, phosphorous and potassium are among the major elements that plants need in large quantities. Foliar fertilization with these elements is also preferred to reduce the cost of fertilizers compared to ground fertilization and to avoid excessive fertilization and the loss of large quantities of it by washing operations that lead to contamination of groundwater, especially with nitrogen (Lovatt, 2013).

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Compost and Latin Compostium are things that are placed together. It is the result of the biological decomposition of organic matter of plant or animal origin by the action of bacteria and other microorganisms under certain environmental conditions of warmth, humidity and good ventilation (Al-Eid, 2013). The use of fertilizing naturally or formally to the plant to ensure the provision of the nutrients necessary for the growth of the plants (Ali, 2012). Adding fertilizers is one of the usual methods and practices, especially for seedlings, to increase the absorption of nutrients (Jacobs and Timmer, 2005). The importance of compost comes as an organic fertilizer, as it is one of the most important sources of nitrogen in organic agriculture, improving the soil's physical, chemical and biological properties, as well as improving soil fertility, as it is easy to handle and store (Gharial et al., 2008).

Vieira (2010) showed that fertilizers are one of the most important applications in agriculture and the addition of fertilizers plays a major role in increasing the growth of citrus fruits and improving their quality and nutritional value. To fully benefit, the appropriate form of fertilizer must be used and added at the appropriate time and in the best way and in the economical amount that gives the highest yield without over application.

Amino acids are among the nitrogenous organic compounds and are the main building blocks for the formation of proteins, as well as an important part in the synthesis of hormones, enzymes and vitamins (Kamar 1987; Frederick et al. 2007; Abd el Aziz et al., 20102). Amino acids are mainly important for plant growth, they are added by spraying the leaves according to the need of the plant and the stage of growth, and they are absorbed through the stomata and the absorption process is affected by the surrounding environment conditions, especially the temperature (Stino et al., 2010).

The basic unit for building proteins is amino acids, and spraying plants with amino acids is an effective way to provide a ready-made formula of protein building blocks as it directly or indirectly affects the stimulation of physiological activities carried out by plants. Abd El-Samad et al. (2010), proved by Shafeek et al. (2012) (EL-Ghamry et al. 2009) Davies (1002) (Souri, 2016). (Bano et al., 2016). Also, treating plants with amino acid, is one of the important treatments in cases of stress in harsh and unsuitable environmental conditions for plants (Rai, 2002). (Kobayashi and others, 1995; Mano and Nemoto, 2012).

Potassium is one of the important elements for plants, including citrus, as it is included in the synthesis of some chemicals that are the basis and essential for the respiration and photosynthesis process in plants (Abdoul 1988). And potassium plays an important role in regulating the osmotic effort of the plant cell and controls the processes of opening and closing the stomata of the plant cells. There is an important role for trachomium, by directly or indirectly affecting the activation of a large number of important enzymes responsible for energy use, nitrogen metabolism and respiration. The lack of potassium causes the accumulation of toxic amines such as Agmatine and Putrescine, weakening the root system of the plant and thus weakening the plant in general (Havlin et al., 2005). Therefore, this study aimed to evaluate the effect of fertilizing with K-amino acid chelated potassium and/or the nutrient solution

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on vegetative growth plant nutritional contents of mandarin *Citrus reticulata* saplings grafted onto the *Citrus aurantium* rootstocks.

MATERIALS AND METHODS

Two factors were used in the experiment. The first factor was fertilization with K+amino acid at 0, 1 or 2 $ml.L^{-1}$ and the second factor was the foliar spray with the nutrient solution in three levels 0, 1 or 2 $ml.L^{-1}$ mandarin seedlings, which were chosen as homogeneous as possible. All saplings were six months old after grafting. Saplings were sprayed at a rate of six sprays per year. The trial parameters were distributed according to a randomized complete design (R.C.B.D) trial. The experiment included (16) treatments and three replications, and it was distributed randomly to (48) experimental units, and each experimental unit contained (4) saplings with a total saplings number of 256.

At the end of the experiment data were collected including shoot and root fresh and dry weight, leaf content of total chlorophyll ($mg.100g^{-1}FW$) and leaf content of total carbohydrates (%). Samples were taken from the fourth leaf below the growing apex (Kamble et al., 2015), Leaf content of total chlorophyll ($mg.100g^{-1}FW$) and dissolved carbohydrates (mg.100g-1 DW) were measured according to the method by Duboies et al. (1956). Data were analyzed statistically by using analysis of variance ANOVA and means were compared among treatments using computing statistical program GenStat, 2012 operated for Windose7 system. Means were compared according to Least significant difference (L.S.D) at a probability level of 0.05.

RESULTS AND DISCUSSION

The results (Table1) showed that fertilizing with K-amino acid led to a significant increase in plant shoot fresh weight. The 1 $ml.L^{-1}$ K-amino acid resulted in the highest shoot fresh weight average 82.443g with a significant difference compared to the control treatment 66.826g. The treatment of foliar fertilization with the nutrient solution had significant increase in shoot fresh weight of *Citrus reticulata* saplings. 1 ml. Liter -1) of the nutrient solution had the highest rate of shoot fresh weight of 85.773g compared to the control treatment of 70.233g. The interaction treatment of 1 $ml.L^{-1}$ K-amino acid and 1ml. $ml.L^{-1}$ nutrient solution resulted in the highest shoot FW of 91.63g with significant differences from most other treatments.

With regard to shoot dry weight (Table2), the fertilization treatment with 2 ml. L-1 K + amino acid recorded the highest value, 31.21g, compared to the control treatment, 24.68g. As for the nutrient solution, the treatment 2 ml. L-1 led to the highest rate of dry weight of 30.04g, compared to 21.48g in the control treatment. Generally, the highest average of shoot dry weight was in the interaction treatment with 2 ml. L-1 of both K-amino acid and the nutrient solution recording 38.26g, with a significant difference from the control and other interference parameters.

The results (Table 3) showed that fertilization with K + amino acid significantly affected the average of plant root fresh weight. The treatment 1 $ml.L^{-1}$ K-amino acid resulted in the highest rate compared to the other concentrations. Whereas, the highest

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Table1. Effect of fertilizing with K-amino acid and nutrient solution on shoot fresh weight of mandarin *Citrus reticulat* saplings

K-amino acid (ml.L^{-1})	Nutrient solution (ml.L^{-1})			Average
	Control (0)	1	2	
0	64.01	75.15	61.32	66.826
1	76.37	91.63	79.33	82.443
2	70.32	90.54	82.09	80.983
Average	70.233	85.773	74.246	
L.S.D.(P≤0.05)	K-amino acid		2.081	
	Nutrient solution		1.838	
	Interaction		4.570	

Table2. Effect of fertilizing with K-amino acid and nutrient solution on shoot dry weight of mandarin *Citrus reticulat* saplings

K-amino acid (ml.L^{-1})	Nutrient solution (ml.L^{-1})			Average
	Control (0)	1	2	
0	20.97	24.98	28.11	24.68
1	19.83	22.30	23.76	21.96
2	23.64	31.75	38.26	31.21
Average	21.48	26.34	30.04	
L.S.D.(P≤0.05)	K-amino acid		2.452	
	Nutrient solution		2.181	
	Interaction		5.572	

Table3. Effect of fertilizing with K-amino acid and nutrient solution on root fresh weight of mandarin *Citrus reticulat* saplings

K-amino acid (ml.L^{-1})	Nutrient solution (ml.L^{-1})			Average
	Control (0)	1	2	
0	53.73	55.31	60.49	56.51
1	82.81	77.19	75.89	78.63
2	71.33	81.79	83.36	78.82
Average	69.29	71.43	73.24	
	K-amino acid		2.63	

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L.S.D.(P≤0.05)	Nutrient solution	1.87
	Interaction	3.86

rates of foliar fertilization with nutrient solution were at concentration 2 ml.L-1. However, the highest rate of root fresh weight was in the interaction treatment 2 ml.L^{-1} K-amino acid and the nutrient solution which was significantly higher compared to the other interactions.

Similarly, the treatment of 2 ml.L^{-1} K-amino acid resulted in the highest values of plant root dry weight compared to the control and other concentrations (Table4). However, the concentration 1 ml.L^{-1} did not differ from the 2 ml.L^{-1} in the treatment of foliar fertilization with nutrient solution, but they differed from the control treatment. The interaction treatment of 2ml.L^{-1} K-amino acid and 2 ml.L^{-1} of the nutrient solution resulted in the highest average (38.30 g) of root dry weight compared with the other interaction treatments.

The results (Table 5) showed that fertilization with K + amino acid 2 ml.L -1 resulted in the highest rate of leaf content of chlorophyll compared to other concentrations. The nutrient solution at 1 ml.L^{-1} recorded the highest value compared to the other concentrations. The interaction of 2 ml.L^{-1} K+amino acid and 1ml.L^{-1} nutrient solution was the highest value in case of leaf content of total chlorophyll.

As for the leaf content of total carbohydrates in mandarin saplings, the highest rate was at a concentration of 2 ml.L^{-1} K-amino acid and at the same concentration of the nutrient solution with a significant difference from the control and the concentration 1ml / liter. Similarly, at the same concentration (2 ml.L^{-1}) K-amino acid interacted with the nutrient solution led to the highest value in the leaf content of carbohydrates (20.268%) and was significantly different from the control and the other treatments (Table6).

Table4. Effect of fertilizing with K-amino acid and nutrient solution on root dry weight of mandarin *Citrus reticulat* saplings

K-amino acid (ml.L^{-1})	Nutrient solution (ml.L^{-1})			Average
	Control (0)	1	2	
0	20.21	27.13	33.27	26.87
1	22.64	35.70	26.86	28.40
2	25.71	32.38	38.30	32.13
Average	22.85	31.74	32.81	
L.S.D.(P≤0.05)	K-amino acid		1.45	
	Nutrient solution		1.22	
	Interaction		2.78	

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Table5. Effect of fertilizing with K-amino acid and nutrient solution on mandarin saplings leaf content of total chlorophyll mg.100g FW^{-1}

K-amino acid (ml.L^{-1})	Nutrient solution (ml.L^{-1})			Average
	Control (0)	1	2	
0	33.04	36.21	36.79	35.346
1	36.15	47.13	46.50	43.260
2	49.70	50.03	42.21	47.313
Average	39.630	44.456	41.833	
L.S.D.(P≤0.05)	K-amino acid		1.268	
	Nutrient solution		1.380	
	Interaction		2.471	

Table6. Effect of fertilizing with K-amino acid and nutrient solution on mandarin saplings leaf content of total carbohydrates (%)

K-amino acid (ml.L^{-1})	Nutrient solution (ml.L^{-1})			Average
	Control (0)	1	2	
0	6.843	9.602	12.441	9.628
1	12.173	11.753	12.786	12.237
2	16.159	19.942	20.268	18.789
Average	11.725	13.765	15.165	
L.S.D.(P≤0.05)	K-amino acid		0.234	
	Nutrient solution		0.198	
	Interaction		0.378	

Myint et al. (2010) indicated that chlorophyll has a direct relationship to the nitrogen content of plants. It was also reported by Peter and Rosen (2005), the possibility of estimating the nitrogen content in plant leaves by estimating their chlorophyll content since most plant nitrogen is concentrated in the leaves. Nitrogen helps build large leaves that are rich in chlorophyll, and that the color of the leaves is light or yellowish indicates a lack of nitrogen (Al-Douri and Al-Rawi, 2000) Al-Zuhairi (2017).

The effect of treatments with organic fertilizer and nutrient solution was observed to increase the percentage of carbohydrates in the plant. This is logical because some of these carbohydrates are used to grow roots and prepare the energy required for the absorption of nutrients from the soil (Al-Araji et al., 2006). This efficiency increases with the presence of foliar fertilization and the ease with which nutrients are absorbed by plant leaves. The percentage of utilization by foliar fertilization reaches 85% with a comparison with fertilization through the roots, as the nutrients are absorbed by the stomata and the stalk of the leaf, as well as through the cracks in the cuticle layer and the cytoplasmic strands running through it, and this increases the efficiency of the photosynthesis process and the production of carbohydrates (Naseem et al., 2019). Organic fertilizers have a significant effect in increasing and improving the absorption of important nutrients, and this may be attributed to the increase and efficiency of the carbon assimilation process in plant leaves and the increase in carbohydrate build-up (Al-Jryan, 2011).

Organic fertilizer is a mixture of macro and micronutrients such as potassium, phosphorous, nitrogen, iron and others, which are the basis for growth and that increasing their percentage to a certain extent leads to an increase in their absorption by the plant and thus increase the content of leaves From foodstuffs (Osman et al., 2010). Studies have shown that foliar fertilization with materials containing nutrients leads to an increase in the internal content of plant tissue from these materials (Barker and Pilbeam, 2007).

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