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Effect of Spraying Urea and Addition of Potassium on Growth Parameters of Local Citrus Seedling (*Citrus sinensis* L.) Grafted on Sour Orange Rootstock

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Abstract: The effects of different levels of urea spray (0, 0.5, 1, 2%) with a total number of five spraying. The interval between each spray was one month. The second-factor addition of potassium fertilizer (potassium sulfate) applied of partitioning for five batches, the concentration of potassium sulfate was 50 g per seedling. The results revealed that a significant association of the concentration of the urea and growth indicators of the seedlings, by giving the highest averages for seedling length, stem diameter, total leaves number, leaf area, dry weight, the leaves content of chlorophyll, nitrogen, phosphorus, and potassium. Similarly, the potassium fertilizer application was significantly correlated to the growth indicators for a citrus seedling. However, the urea alone or combined with the addition of potassium at the early stages of growth could be useful in improving seedling quality.

Keywords: Urea, Potassium, Foliar spraying, Orange seedling, Sour orange

Orange (*Citrus sinensis* L.; Rutaceae) is an important fruit plant producing two-thirds of the world's citrus demands with a good taste (Vita et al 2019, Li et al 2019). Its' propagation method is grafting on seed rootstocks. Sour orange has been used as a rootstock because it is common to most areas of citrus cultivation and more suitable for the conditions of Iraq because it is resistant to many diseases such as gummosis and rotting roots and it has a root system with many branches, it reaches to high depths of soil and it has good compatibility with most citrus cultivars grafted on it (Albrigo et al 2019). Hazarika and Aheibam (2019) observed that spraying urea on orange trees led to improving the vegetative growth and increasing leaf area indicators and the leaves content of chlorophyll due to increasing the photosynthesis efficiency, thus improving their fruits. Al-Araji et al (2006) reported that fertilizing the seedlings of citrus rootstocks (Troyer citrange) with urea (1 g kg^{-1} soil) led to a significant increase in the traits of the length and diameter of seedling stem, number of their leaves and the leaves content of nitrogen and phosphorus. Al-Jubouri and Al-Hamidawi (2013) indicated when spraying the grow more nutrient solution containing 20% nitrogen on the total vegetative for the local orange seedlings led to a significant increase in seedling height and their diameter, the number, and length of their branches and the number of their leaves and leaf area and the leaves content from the chlorophyll. Karuna et al (2019) and Khankahdani et al (2019) confirmed that spraying the urea solution to 1% concentration on the total vegetative for sour orange seedlings led to a significant increase in plant height, number of branches, the average of their length, number of leaves, leaf area, percentage of dry matter percentage and the leaves content of chlorophyll and nitrogen. Hashim (2014) showed that spraying the nitrogen element within the liquid fertilizer components (LiQ Humus) on the total vegetative for the local orange seedlings led to a significant increase in the height of the seedlings and the leaf area and the leaves content of chlorophyll, nitrogen, phosphorus and potassium compared to the treatment of the seedlings spraying with distilled water only. Al-Hamdani and Al-Bayati (2015) indicated when spraying urea with a concentration of 0.05% on orange trees to existing a significant increase in the percentage of the fruit set and the percentage of fruit remaining on the plant and increasing the percentage of fruit juice and percentage of sugar in it. As well as increase the leaf area for the trees as well as the leaves content of chlorophyll. Brar et al (2011) and Padhan et al (2019) show that added potassium improves nitrogen absorption, thus helps to increase the efficiency of nitrogen use. The synthesis of proteins requires a high level of potassium, which is very important in the photosynthesis process and transferring the photosynthesis products from leaves to the rest of the plant, increases the resistance to diseases, and helps to transfer nitrates in the form of KNO3 from roots to leaves in the plant (Johnston 2010, Munson 2018). Zhang et al (2010) indicated that the interaction between nitrogen and potassium is considered an interesting subject in many studies that focused on nutritious potassium under different nitrogen systems. The addition of potassium

has been neglected in many developing countries, therefore led to the depletion of potassium from the Agricultural Ecosystems and this prevented the increase in the traits of the cultivated plant's yield. This study aims to identify the response of local orange seedlings grafted on sour orange rootstocks to spraying urea solution on the total vegetative and adding potassium fertilizer to the growth media of seedlings.

MATERIAL AND METHODS

The study was conducted in Al-Handia Horticulture Station (Karbala province) Ministry of Agriculture for the period from September 2017 to June2018. Four spraying levels of urea solution (0, 0.5, 1 and 2%) were used with sprayings five times at an interval of. The second factor represented five periods of partitioning addition of potassium fertilizer (Potassium sulfate), the period between them is 30 days, with a concentration of 50 g per Seedling. The factorial experiment was conducted according to the Completely Randomized Design (CRD), with three replicates. The seedlings were sown in 10 Kg plastic bags. The first spraying and the first addition for fertilizer on 10 November /2017 The spraying was done using a 2 L hand spray and it was added with each concentration (1 cm^3) of Dishwashing solution as a spreading material (Chhetri and Ghoniem 2019, Pérez-Pastor et al 2019). The spraying was done in the morning and until the complete wetness for the seedlings which it preceded by irrigation of the seedlings before one day. The irrigation prior to spraying reduces the concentration of the solutes in the leaves cells due to the water entering and increasing the swelling, thus opening the stoma, which increases the permeability of the spraying solution ions to the leaf cells (Schjoerring et al 2019). The control treatment was sprayed with water only. The mineral fertilizer was added as DAP at a rate of 30 g per seedlings. The process of irrigation seedlings and cleaning the growth media done as needed. Random samples were taken from the growth media of the seedlings and analyzed for the purpose of determining some of their physicochemical traits (Table 1) estimated according to standard methods (Jackson 1958, Black 1965). After completion of the experiment, three seedlings were selected for the purpose of studying the following average traits from each experimental unit.

The seedling length was measured from the contact area for the stem with soil to the apical meristem of the seedling. The stem diameter was measured from the location of the fifth real leaf on the main stem for the seedlings. The total number of leaves per seedling was calculated. The leaf area for the seedlings identified was measured by calculating the area of 3 full-grown leaves taken from the top, middle and bottom of the seedling using a planimeter, where the leaf was scanned with a scanning device and the average area of the on leaf was multiplied by the number of leaves for seedling. The total number of leaves and number of lateral branches were calculated form 3 plants in each replication. Chlorophyll content (SPAD Unit was estimated by the chlorophyll meter (SPAD) y on the leaves of the seedlings directly by taking the average of three readings per leaf. Five leaves of each known fresh weight seedling were dried at 70-65°C in an electric oven and until the weight is stable, and the dry weight was then measured for estimation of dry matter in leaves.

Table 1. Physical and chemical traits of the nursery soil used in the experiment

Type of analysis	Value	Units
Soil texture	Clay Loam	-
Clay	228.4	g kg^{-1}
Silt	374.3	
Sand	397.3	
pH	7.6	-
Electrical conductivity (Ec)	2.08	dSm^{-1}
Apparent density	1.36	Mg cm^{-3}
Cation exchange capacity	18.2	cmol charge kg^{-1}
Organic matter	7.3	g kg^{-1}
Calcium carbonate	181.2	
Total nitrogen	13.6	Mg kg^{-1}
Phosphorus availability	6.2	
Potassium availability	18.4	

For estimating NPK content of leaves the samples were taken randomly from all parts of the seedling and then washed with distilled water to get rid of the dust and impurities and it was placed in perforated paper bags, and then dried in an electric oven at a temperature of 70 m and until the dry weight is stable, The samples were then milled and a 0.2 g sample was taken and digested by adding 4 mL of sulfuric acid and 2 ml of concentrated pyrochloric acid according to the method in Jones and Steyn (1973). The nitrogen elements were estimated using a modified Kjeldahl method using a micro-Kjeldahl device (Haynes1980)and phosphorus was estimated using Ammonium molybdate and ascorbic acid in the Spectrophotometer device (John 1970) and potassium by using a Flame photometer according to the method in (Hesse 1971).

RESULTS AND DISCUSSION

Length of the seedling and stem diameter of the seedling: The differences were significant between the spraying levels for the urea solution in for average length of the seedling and the stem diameter of the seedling, where the

spraying treatment at a concentration of 2% gave the highest average length of seedling and stem diameter amounted to (94.83, 1.28 cm, respectively) compared to the control, 76.05, 0.80 cm, respectively (Table 2). The addition of potassium fertilizer at different levels of partitioning led to a significant increase in of seedling length and stem diameter (102.50, 1.43 cm, respectively) in 4 batches, and there is no difference between them and the method of the partitioning addition for 5 batches.

There was no significant difference between the interaction treatments. The interaction treatment (spraying with urea at a level of 2% and the addition of potassium fertilizer on 4 batches) gave the highest average seedling length and stem diameter (108.3, 1.60 cm), respectively. The lowest average of these two traits was in treatment with no spraying urea and adding potassium fertilizer at one batch.

Number of leaves in the seedling and the leaf area: There were significant differences between the spraying levels for the urea solution on average number of leaves in the seedling and the leaf area, where the spraying at a concentration of 2% gave the highest average number of leaves in the seedling and the leaf area amounted to (102.13 leaves, 22.13 dm^2, respectively) compared to the control treatment (spraying with add water) which gave the lowest averages of 85.60 leaves, 18.93 dm^2, respectively (Table 3). The adding potassium fertilizer at different levels of partitioning led to a significant increase in number of leaves in the seedling and the leaf area (106.35 leaves, 23.60 dm^2), and there is no difference between them. The method of the partitioning addition for 5 batches.

The interaction between the two factors had a significant effect on the increase in the average number of leaves in the seedling and the leaf area. The interaction of (spraying with urea at a level of 2% and the addition of potassium fertilizer on 4 batches gave the high number of leaves in the seedling and the leaf area (114.10 leaves and 25.6 dm^2, respectively).

Chlorophyll (spad) and dry weight of seedling (g): There were significant differences between the spraying levels for the urea solution in chlorophyll (spad) in leaf and dry weight of seedling being higher in the spraying t at a concentration of 2% (46.23 spad, 110.18 g compared to the control treatment (37.98 spad, 96 g, respectively). The adding potassium fertilizer at different levels of partitioning led to a significant higher content chlorophyll in leaves and dry weight of seedling and there is no difference between them and the method of the partitioning addition for 5 batches. The

Table 2. Effect of urea spraying and the partitioning addition of potassium fertilizer on seedlinglength and stem diameter

Potassium fertilizer	Seedling length (cm)					Stem diameter of seedling (cm)				
	Spraying urea solution (%)				Average	Spraying urea solution (%)				Average
	0	0.5	1	2		0	0.5	1	2	
One batch	58.2	67.4	76.2	84.5	71.58	0.5	0.6	0.8	1	0.73
Two batches	68.6	74.7	87.3	89.8	80.1	0.7	0.8	0.9	1.2	0.9
Three batches	82.6	85.4	94.1	96.7	89.7	0.8	0.9	1.2	1.3	1.05
Four batches	94.8	98.1	108.8	108.3	102.5	1.2	1.4	1.5	1.6	1.43
Five batches	95.1	98.3	107.9	108.1	102.35	1.2	1.4	1.5	1.5	1.4
Average	76.05	81.4	91.6	94.83		0.8	0.93	1.1	1.28	
LSD 0.05	Urea = 2.73, Potassium = 3.05, interaction = 5.11					Urea = 0.15, Potassium = 0.17, interaction = NS				

Table 3. Effect of urea spraying and the partitioning addition of potassium fertilizer on number of leaves in the seedling and the leaf area

Potassium fertilizer	Total number of leaves (leaves)				Average	Leaf area (dm^2)				Average
	Spraying urea solution (%)					Spraying urea solution (%)				
	0	0.5	1	2		0	0.5	1	2	
One batch	75.4	78.9	84.7	93.6	83.15	15.2	16.4	16.9	18.2	16.68
Two	79.8	84.6	88.7	95.4	87.13	19.5	20.8	21.1	21.8	20.8
Three	90.4	94.2	100.1	105.4	97.53	20.1	21.4	21.8	22.9	21.55
Four	96.8	105.2	109.3	114.1	106.35	20.9	22.6	25.3	25.6	23.6
Five	96.9	105.6	108.3	112.9	105.93	21.3	22.8	24.8	25.1	23.5
Average	85.6	90.73	95.7	102.13		18.93	20.3	21.28	22.13	
LSD 0.05	Urea = 2.54, Potassium = 2.85, interaction = 5.03					Urea = 1.51, Potassium = 1.68, interaction = 1.83				

interaction between the two factors had a significant effect on the increase in the average of leaves content from chlorophyll and dry weight of seedling. The interaction treatment (spraying with urea at a level of 2% and the addition of potassium fertilizer on 4 batches) gave the highest average.

The average number of branches (branches) and the leaves content from nitrogen (%): There were significant differences between the spraying levels for the urea solution in the average's trait number of branches (branches) and the leaves content from nitrogen (%), where the spraying treatment at a concentration of 2% gave the highest average number of branches and the leaves content from nitrogen amounted to (5.40 branches, 2.15%), respectively compared to the control, 4.38 branches, 1.34%, respectively (Table 5). The addition of potassium fertilizer at different levels of partitioning led to a significant increase the highest averages number of branches and the leaves content from nitrogen amounted to (5.68 branches, 1.97%, respectively)in four batches, interaction treatment had a significant difference. The interaction treatment (number of branches and the leaves content from nitrogen) gave the highest average (6.2 branches, 2.25%, respectively).

Percentage of phosphorus and potassium in the leaves: The differences were significant between the spraying levels for the urea solution in for the percentage of phosphorus and potassium in the leaves (%), where the spraying treatment at two gave the highest average phosphorus and potassium in the leaves amounted to (0.39, 1.94%, respectively) compared to the control (0.24, 1.54%, respectively) in (Table 6). The addition of potassium fertilizer at different levels of partitioning led to a significant increase in the percentage of phosphorus and potassium in the leaves (0.39, 1.92%, respectively) in 4 batches, and there is no difference between them and the method of the partitioning addition for 5 batches.The interaction between the two factors had a significant effect on the increase in the average leaves content from the phosphorus and potassium. The interaction of spraying with urea at a level of 2% and the addition of potassium fertilizer on 4 batches gave the highest average of leaves content from the phosphorus and potassium (0.51, 2.15%, respectively).

These factors (spraying with urea fertilizer solution and

Table 4. Effect of urea spraying and the partitioning addition of potassium fertilizer on chlorophyll content in leaves from and dry weight of seedling

Potassium fertilizer	The leaves content from chlorophyll (spad)					The dry weight of seedling (g)				
	Spraying urea solution (%)				Average	Spraying urea solution (%)				Average
	0	0.5	1	2		0	0.5	1	2	
One batch	31.4	32.8	33.9	36.2	33.58	76.8	80.2	81.8	85.6	81.1
Two batches	36.9	44.3	46.1	48.2	43.88	93.5	95.4	98.7	104.1	97.93
Three batches	38.7	44.2	46.1	48.7	44.43	104.3	115.4	116.9	122.7	114.83
Four batches	44.9	47.7	49.1	51.8	48.38	109.4	119.4	124.6	128.3	120.43
Five batches	44.8	48.1	49.6	50.9	48.35	109.6	120.6	124.1	127.1	120.35
Average	37.98	42.25	43.8	46.23		96	102.6	105.5	110.18	
LSD 0.05	Urea = 2.17, Potassium = 2.43, interaction = 3.86					Urea = 2.24, Potassium = 2.50, interaction = 4.09				

Table 5. Effect of urea spraying and the partitioning addition of potassium fertilizer on number of branches and the nitrogen content in leaves from nitrogen

Potassium fertilizer	Number of branches				Average	Nitrogen in leaves (%)				Average
	Spraying urea solution(%)					Spraying urea solution(%)				
	0	0.5	1	2		0	0.5	1	2	
One batch	3.2	3.6	3.8	3.9	3.63	0.9	1.6	1.7	2.1	1.57
Two batches	4.3	4.8	5.6	5.8	5.13	1.39	1.44	1.98	2.09	1.73
Three batches	4.7	5.1	5.3	5.7	5.2	1.48	1.48	2.07	2.18	1.8
Four batches	5.3	5.3	5.9	6.2	5.68	1.59	1.89	2.14	2.25	1.97
Five batches	5.4	5.2	5.9	6.1	5.65	1.61	1.92	2.11	2.21	1.96
Average	4.38	4.7	5.15	5.4		1.34	1.6	1.97	2.15	
LSD 0.05	Urea = 0.41, Potassium = 0.46, interaction = 0.68					Urea = 0.13, Potassium = 0.14, interaction = 0.23				

Table 6. Effect of urea spraying and the partitioning addition of potassium fertilizer on phosphorus and potassium in the leaves (%)

Potassium fertilizer	Percentage of phosphorus in the leaves (%)					Percentage of potassium in the leaves (%)				
	Spraying urea solution (%)				Average	Spraying urea solution (%)				Average
	0	0.5	1	2		0	0.5	1	2	
One batch	0.17	0.21	0.26	0.29	0.23	1.36	1.49	1.55	1.63	1.51
Two batches	0.22	0.27	0.32	0.36	0.29	1.41	1.53	1.72	1.98	1.66
Three batches	0.27	0.31	0.36	0.39	0.33	1.68	1.71	1.83	1.99	1.8
Four batches	0.31	0.35	0.38	0.51	0.39	1.72	1.85	1.95	2.15	1.92
Five batches	0.32	0.35	0.36	0.5	0.38	1.73	1.84	1.92	2.13	1.91
Average	0.24	0.29	0.33	0.39		1.54	1.65	1.76	1.94	
LSD 0.05	Urea = 0.03, Potassium = 0.04, interaction = 0.05					Urea = 0.11, Potassium = 0.13, interaction = 0.17				

the addition of potassium fertilizer in a partitioning manner) affected significantly in increasing the averages of growth indicators for orange seedlings the local cultivar grafted on the sour orange rootstocks. The level of spraying with urea fertilizer solution at 2% concentration on seedling leaves was significantly excelled in increasing the seedling length, stem diameter, number of leaves in the seedling, leaf area of the seedling and dry weight of the total vegetative for the seedlings, number of secondary branches for seedlings and leaves content of chlorophyll, nitrogen, phosphorus. The reason may be due to the role of nitrogen in increasing cell size, its elongation, and division, which was positively reflected in the increase in vegetative growth indicators or it can be due to the role of the nitrogen element, which increases the stored carbohydrates, vegetative growth and photosynthetic efficiency are positively reflected on plant growth indicators. These results agree with Al-Hamdani (2015) and Khankahdani et al 92019).

The level of adding potassium fertilizer in a partitioning manner and with four batches increases the average of the above traits. The reason may be due to the role of the element in the construction of chlorophyll and the stimulating enzymes in the photosynthesis process in the leaves, which activate the bio-metabolism for photosynthesis products which are used to build the total vegetative and increase its indicators (Abdulrahma 2010, Al-Kahattab 2017). The role of potassium element in the regulation and stimulation of cells and contributes to the regulation of the osmotic potential and the respiration process and the protein metabolizing and the stimulation of enzymes and controlling the osmotic pressure for the guard cells, thus regulates the processes of closing and opening the stomas (Barakat et al 2012). The increase in the averages growth indicators for seedlings due to the addition of potassium fertilizer in batches is due to the availability of this element in different stages of seedling growth, especially the elongation stage, leaf formation stage, chlorophyll concentration, and nutrient elements. This leads to an increase in photosynthesis (Jones 2019).

CONCLUSION

This study unraveled the factors affecting the response of citrus seedling to foliar application of urea, and periods of partitioning addition of potassium (Potassium sulfate). Our findings showed that urea concentration at two percent is good growth indicators of the seedlings control. Potassium at different batches was more effective for the growth indicators for citrus seedling. Foliar spray of urea and partitioning addition of potassium significantly increase the percentage of phosphorus and potassium in the citrus leaves.However, the urea alone or combined with the addition of potassium at the early stages of growth could be useful in improving seedling quality.

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