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ORIGINAL ARTICLE

RESPONSE OF THE GROWTH OF ORANGE SEEDLINGS GRAFTED ON CITRUS ROOTSTOCK TO SPRAYING WITH ZINC AND THE ADDITION OF ORGANIC MATTER

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Abstract: The study was conducted at the Indian Horticultural Station (Karbala province), which is affiliated with the General Company for Horticulture and Forests - Ministry of Agriculture for the period from September 2019 to May 2020. In order to study the effect of adding organic matter and spraying zinc on the vegetative growth indicators of orange seedlings, the local cultivar and previously grafted, on the origin of sour orange. In the study, decomposed animal waste was used as a source of organic matter with four levels (0, 1, 2, 4 kg.seedlings^{-1}) and three levels of zinc element (0, 10, 20 mg Zn.L^{-1}) and zinc sulfate salt was used as a source for zinc. A factorial experiment was conducted in a completely randomized design with three replications, and the averages of traits were compared with the least significant difference test. The results indicated that: The treatment of adding organic fertilizers to the growth medium of seedlings at a level (2 kg.seedling^{-1}) significantly excelled in increasing the average vegetative growth indicators of seedlings and gave the highest values, which were 99.00 cm for the length of the seedling, 1.43 cm for the stem diameter, 104.50 leaves for the total number of leaves for the seedling, 25.03 dm^2 for leaf area of seedlings, 45.17 for chlorophyll content of spad leaves, 125.93 g for dry weight of seedlings, 6.17 secondary branches, 66.87 secondary roots, While the level of zinc element spray (20 mg.L^{-1}) was significantly excelled in increasing the averages of the above traits, and the averages values were 97.20 cm, 1.38 cm, 100.58 leaves, 25.83 dm^2, 43.28 spad, 122.83 g, 5.88 branches, 66.53 secondary roots respectively. In terms of the best combination, the combination (2 kg.seedling^{-1} + 20 mg.L^{-1}) excelled in giving the highest averages for the above traits.

***Key words*:** Organic matter, Zinc, Orange seedlings, Citrus fruit.

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1. Introduction

The orange, *Citrus Sinensis* L., belongs to the Rutaceae family and belongs to the genus Citrus. It is important because it constitutes two-thirds of citrus production in the world and because its fruits are free of bitterness, have good taste and are suitable for human consumption [Agha and Daoud (1991)]. The method of its propagation is by grafting on the seed roots. Citrus aurantium was used as a root because it is commonly used in most citrus growing areas and is most suitable for the conditions of Iraq because it is resistant to many diseases such as gum disease and root rot. [Salman (1988)]. Organic manure has been used for a long time in order to improve soil qualities, increase its fertility and ease its preparation of nutrients necessary for plant growth, and this fertilizer can be added in the form of decomposing plant or animal waste (organic compost) [Mansour and Shaaban (2007), Abd Al-Hseen and Manea (2020)], showed the addition of decomposing organic matter to the growth medium of citrus plants at a ratio of 1:1 led to an increase in the leaf area and dry matter of the vegetative total of apple seedlings and

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their chlorophyll content while confirmed. When humic acid was used as a spray on the vegetative part of olive seedlings, significant differences were found in the increase in the average length of the main stem, the number of leaves, and leaf content of nitrogen, phosphorous, potassium and carbohydrates compared to the control treatment [Al-Bayati (2019)]. Using poultry manure in the middle of the growth of Anna apple trees, led to a significant increase in the potassium content of leaves and an increase in yield and leaf area of the plant [Al-Ahbabi (2011), Altaee and Alsawaf (2019)]. Al-Hamdani and Al-Bayati (2015) explained that the spraying of zinc on orange trees led to a significant increase in the number of leaves, leaf area, chlorophyll content of leaves, and an increase in the length, diameter and weight of fruits, and this was reflected in the total yield of trees treated with zinc. The study aims to know the response of local orange seedlings grafted to the roots of Citrus aurantium to the addition of organic matter to the growth medium of seedlings and foliar spraying to the element zinc.

2. Materials and Methods

The research was conducted at the Indian Horticultural Station (Karbala province) affiliated with the General Company for Horticulture and Forests - Ministry of Agriculture for the period from September 2019 to May 2020, In order to study the effect of adding organic matter and spraying zinc on the vegetative growth indicators of orange seedlings, the local variety and previously grafted, on the origin of the sour orange. In the study, decomposed animal waste was used as a source of organic matter with four levels (0, 1, 2, 4 kg. seedlings^{-1}) and three levels of zinc element (0, 10, 20 mg Zn.L-1) and zinc sulfate salt was used as a source for zinc. A factorial experiment was conducted in a completely randomized design (CRD) with three replicates, and the averages of traits were compared with the least significant difference test at a significance level of 0.05, according to the methods mentioned in Al-Rawi and Khalaf Allah (1980) and the application of the SAS program. 180 homogeneous one-year-age seedlings were selected for the purpose of carrying out the study, provided that every 5 seedlings represented one experimental treatment. The seedlings were planted in plastic bags of 10 kg. Organic fertilizers were added before planting the seedlings, mixing with the soil, while the zinc element was sprayed on the vegetative part by 6 sprays that started on 15/11/2019. The period between one spray and another is 30 days. The seedlings were sprayed using a manual sprayer with a capacity of (2 liters) and added with each concentration (1 cm^3) of the cleaning agent as a diffuser for the purpose of increasing the surface tension of water [Al-Jumaili and Al-Dujaili (1989)]. The spraying process was conducted in the morning until the seedlings were completely wet, preceded by irrigation of the seedlings one day before, as irrigation before spraying reduces the concentration of solutes in the leaf cells due to the entry of water and increase their swelling and then opening the stomata, which increases the penetration of the spray solution ions into the leaf cells. The control treatment was also sprayed with distilled water only. The mineral fertilizer was added in the form of dab fertilizer at an average of 25 g per seedling, and the process of irrigating the seedlings and cleaning the growth medium was as needed. Random samples were taken from the seedling growth medium and analyzed for the purpose of determining some of their physicochemical traits (Table 1), while Table 2 shows the components of the organic fertilizer used in the experiment.

2.1 Seedlings were selected for the purpose of studying the average of the following traits from each experimental unit

1. **The seedling length (cm):** It is measured from the area of contact of the stem with the soil to the growing top of the seedling by means of the metric tape.
2. **Stem diameter (cm):** It is measured from the location of the fifth true leaf on the main

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

Traits	Units	Values
soil texture		loamy
clay	g.kg^{-1}	236.3
silt	g.kg^{-1}	308.4
sand	g.kg^{-1}	455.3
Soil reaction level (pH)		7.6
Electrical connection (Ece)	Ds.m^{-1}	2.87
bulk density	Mg.cm^3	1.42
cation exchange capacity	cmolc/kg	17.4
Organic matter	g.kg^{-1}	7.7
Calcium Carbonate	g.kg^{-1}	198.2
total nitrogen	mg.kg^{-1}	12.5
available phosphorus	mg.kg^{-1}	5.1
available potassium	mg.kg^{-1}	24.1

Table 2: Laboratory analysis of organic matter used in the experiment

pH	Salinity	Organic matter	Organic Carbon C:N	C:N	Total Nitrogen	Total Phosphorous	Total Potassium
	$dS.m^{-1}$	$g.kg^{-1}$	$g.kg^{-1}$		$g.kg^{-1}$	$g.kg^{-1}$	$g.kg^{-1}$
6.78	5.07	443.1	337.1	18.5	15.4	0.28	2.7

stem of the seedling.

3. **The total no. of leaves/seedlings:** according to the number of total leaves on the seedling and as an average of the experimental unit.
4. **The leaf area of seedlings (dm^2):** The leaf area of seedlings determined for each experimental unit was measured by calculating, an area of 3 fully-grown leaves taken from the top, middle and bottom of the seedling, using a measuring device Planimeter, as the leaves were reproduced with a cloning device and then the average area of one leaf was multiplied by a number sapling leaves.
5. **The number of side branches:** The number of side branches were calculated for each seedling as an average number of seedlings for the experimental unit.
6. **Chlorophyll content (SPAD unit):** It was estimated by a SPAD chlorophyll meter, both on-site and on Leaves seedlings directly by taking an average of three readings for each leaf.
7. **Percentage of dry matter for seedlings:** 3 seedlings were dried from each treatment with a known fresh weight at Heat 65-70°C in an electric oven, until the weight is stable, then measure the dry weight by means of a sensitive scale.
8. **The average number of secondary roots:** It was calculated as the average of the seedlings identified in the experimental unit.

3. Results and Discussion

3.1 The average seedling length (cm) and the diameter of the seedling stem (cm)

It is noticed from Table 3 that there are significant differences between the levels of organic matter added in the effect on the characteristic of the average seedling length and the diameter of the stem of the seedling. The treatment of adding organic matter at a level of 2 $kg.seedling^{-1}$ gave the highest value for the length of the seedling and the diameter of the stem, which were 99.00 cm and 1.43 cm respectively, compared to the control treatment (without addition) which gave the lowest values of 80.43 cm and 0.90 cm respectively. The same table indicates that spraying with zinc led to a significant increase in the traits of the seedling length and the stem diameter. The spray level 20 mg $Zn.L^{-1}$ excelled, the highest values were 97.20 cm and 1.38 cm respectively, While the control treatment (without spraying) gave the lowest values of 81.30 cm and 0.95 cm, respectively. The results of data analysis showed that the interaction between the two factors had a significant effect in increasing the average length of the seedling and the stem diameter. The treatment with a combination of adding organic matter and spraying zinc (2 $kg.seedlings^{-1}$ + 20 mg $Zn.L^{-1}$) gave the highest values of 104.4 cm and 1.7 cm respectively, on the other hand, the lowest average of these two traits was when no organic matter was added and no Spraying with zinc.

3.2 The average total number of leaves per seedling and the leaf area dm^{-2}

Table 3: Effect of adding organic matter and spraying zinc and their interaction on an average seedling length and stem diameter.

Organic matter $kg.seedlings^{-1}$	Seedling Length cm				Stem Diameter (cm)			
	Zinc $mg.L^{-1}$			Average	Zinc $mg.L^{-1}$			Average
	0	10	20		0	10	20	
0	71.3	80.7	89.3	80.43	0.7	0.9	1.1	0.9
1	76.6	83.9	92.5	84.33	0.8	1	1.3	1.03
2	93.9	98.7	104.4	99	1.2	1.4	1.7	1.43
4	83.4	95.6	102.6	93.87	1.1	1.1	1.4	1.2
Average	81.3	89.73	97.2		0.95	1.1	1.38	
LSD *.05*	O.M: 3.92	Zn : 3.28	Interaction: 5.65		O.M: 0.12	Zn : 0.07	Interaction: 0.17	

Table 4: Effect of adding organic matter and spraying zinc and their interaction on the average number of leaves and leaf area.

Organic matter kg.seedlings^{-1}	Total number of leaves.seedling^{-1}				Leave area.seedlings^{-1} dm^2			
	Zinc mg.L^{-1}			Average	Zinc mg.L^{-1}			Average
	0	10	20		0	10	20	
0	73.2	81.1	87.5	80.6	20.2	24.4	26.1	23.57
1	92.1	97.2	98.4	95.9	21.8	23.4	24.8	23.33
2	95.7	108.1	109.7	104.5	21.9	25.6	27.6	25.03
4	93.8	101.3	106.7	100.6	20.1	23.2	24.8	22.7
Average	88.7	96.93	100.58		21	24.15	25.83	
LSD *.05*	O.M: 3.61	Zn : 3.38	Interaction: 6.48		O.M: 2.12	Zn : 1.64	Interaction: 3.25	

Table 4 showed that there are significant differences between the levels of organic matter added in the effect on the traits of the average number of leaves of a seedling and its leaf area. The treatment of adding organic matter at a level of 2 kg.seedling^{-1} gave the highest value for the two traits, which reached 104.50 leaves and 25.03 dm^{-2} respectively, compared to the control treatment (without addition), the lowest values amounted to 80.60 leaves and 23.57 dm^{-2} respectively. The same table indicates that spraying with zinc elements led to a significant increase in the average of the two traits. The level of spraying was excelled by 20 mg Zn.L^{-1}, the highest values were 100.58 leaves and 25.83 dm^{-2} respectively, while the control treatment (without spray) gave the lowest values amounting to 88.70 leaves and 21.00 dm^{-2} respectively. The results of data analysis showed that the interaction between the two factors had a significant effect on increasing the average seedling length and the diameter of the seedling stem. The treatment with a combination of adding organic matter and spraying zinc (2 kg.seedlings^{-1} + 20 mg Zn. L^{-1}) gave the highest values of 109.7 leaves and 27.6 dm^{-2} respectively, on the other hand, the lowest average of these two traits was when the substance was not added. Organic and not sprayed with zinc.

3.3 The average content of the leaves of chlorophyll and the dry weight of the seedling (g)

Table 5 shows that there are substantial differences between the amounts of organic matter provided in terms of how they affect the trait of the average chlorophyll content in leaves and the dry weight of the seedling. The treatment of adding organic matter at a level of 2 kg.seedling^{-1} gave the highest value for the two traits above, which amounted to 45.17 spad and 125.93 gm, respectively, compared to the control treatment (without addition), which gave the lowest values, which amounted to 35.37 spad and 102.90 gm respectively, The same table indicates that spraying with zinc led to a significant increase in the average of the two traits. The level of spraying excelled by 20 mg Zn.L-1 and gave the highest values of 43.28 spad and 122.83 gm respectively, while the control treatment (without spray) gave the lowest values of 37.78 spad and 105.80 gm respectively. The results of data analysis showed that the interaction between the two factors had a significant effect on increasing the average of the two traits. The treatment with a combination of adding organic matter and spraying zinc element (2 kg.seedlings^{-1} + 20 mg Zn.L^{-1}) gave the highest values of 48.2 spad and 135.8 g respectively, on the other hand, the lowest average of these two traits was when no

Table 5: Effect of adding organic matter and spraying zinc and their interaction on average chlorophyll and dry content of seedlings.

Organic matter kg.seedlings^{-1}	Chlorophyll content spad				The dry weight of seedling (g)			
	Zinc mg.L^{-1}			Average	Zinc mg.L^{-1}			Average
	0	10	20		0	10	20	
0	31.5	36.4	38.2	35.37	95.6	103.4	109.7	102.90
1	36.4	39.3	41.1	38.93	101.8	109.2	117.3	109.43
2	42.5	44.8	48.2	45.17	113.6	128.4	135.8	125.93
4	40.7	42.2	45.6	42.83	112.2	121.4	128.5	120.70
Average	37.78	40.68	43.28		105.80	115.60	122.83	
LSD *.05*	O.M: 2.42	Zn : 2.18	Interaction: 4.05		O.M: 5.06	Zn : 4.67	Interaction: 8.82	

Table 6: Effect of adding organic matter and spraying zinc and their interaction on the average number of branches and secondary roots.

Organic matter kg.seedlings^{-1}	Number of secondary branches.seedling^{-1}				Number of secondary roots.seedling^{-1}			
	Zinc mg.L^{-1}			Average	Zinc mg.L^{-1}			Average
	0	10	20		0	10	20	
0	3.6	4.5	4.9	4.33	46.2	52.9	58.1	52.4
1	4.7	4.9	5.4	5	54.2	61.1	66.7	60.67
2	5.4	6.2	6.9	6.17	61.4	65.3	73.9	66.87
4	5.1	5.8	6.3	5.73	57.9	61.8	67.4	62.37
Average	4.7	5.35	5.88		54.93	60.28	66.53	
LSD *.05*	O.M: 0.37	Zn : 0.28	Interaction: 0.57		O.M: 3.85	Zn : 3.54	Interaction: 6.75	

organic matter was added and not sprayed with zinc.

3.4 The average number of branches and the number of secondary roots of the seedling

It is noticed from Table 6 that there are significant differences between the levels of organic matter added in the effect on the average traits of the number of branches and the number of secondary roots of the seedling, as the treatment of adding the organic matter at the level of 2 kg.Seedling^{-1} sequentially compared to the control treatment (without addition) which gave the lowest values of 5.40 seedling.branch^{-1} and 24.60 seedling.root^{-1} respectively. 20 mg Zn.L^{-1} gave the highest values of 5.88 seedling.branch^{-1} and 66.53 seedling.root^{-1} respectively, while the control treatment (without spraying) gave the lowest values amounted to 4.70 seedling.branch^{-1} and 54.93 seedling.root^{-1} respectively. The results of data analysis showed that the interaction between the two factors had a significant effect on increasing the average of the two traits above. The treatment with a combination of adding organic matter and spraying zinc element (2 kg. seedlings^{-1} + 20 mg Zn.l^{-1}) gave the highest values of 6.9 seedlings.branch^{-1} and 73.9 seedling.root^{-1} respectively. On the other hand, the lowest average of these two traits was when no organic matter was added and no zinc was sprayed.

The results in Tables 3, 4, 5 and 6 showed that the levels of the two study factors (adding organic matter and spraying with zinc) had a significant effect on increasing the average growth indicators of orange seedlings, the local variety grafted on the citrus rootstock, where the level of adding organic matter to the growth medium excelled the seedlings (2 kg.seedling^{-1}) significantly increased the length of the seedling, its disc diameter, the number of leaves in the seedling, the leaf area of the seedling, the dry weight of the vegetative total of the seedling, the number of secondary branches of the seedling, the number of secondary roots and the content of the leaves from chlorophyll. They contain organic acids and their role in increasing the permeability of cell membranes and the transfer of elements within the plant, which contributes to increasing the size, elongation and division of cells, which was positively reflected in the increase in vegetative growth indicators or, the reason could be due to the organic fertilizer containing humic and fulvic acids, which contain a high percentage of nitrogen, which increases the stored carbohydrates that help to increase the strength of vegetative growth and increase the efficiency of photosynthesis, which is positively reflected on the indicators of plant growth [Keller and Kolet (1995)]. It can also be attributed to the positive role of humate in the absorption of nutrients by the plant, where it works on the availability of nutrients in the soil and its transfer, especially the smaller ones, and the amine group in humic acids can adsorb the negative phosphate ion and improve its readiness for the plant [Tatini *et al*. (1991)]. Also, humic acids inhibit the activity of the enzyme (IAA oxidase), which leads to an increase in the activity of auxin (IAA), which plays a role in stimulating plant and root growth, and humic acids improve the holding capacity of elements in the soil. It is useful that adding humic acids to the soil or plant leads to enriching it with nutrients and increasing the plant's resistance to drought and high temperature to a large extent as well as leading to increased growth and improvement of the root group, as well as the role of potassium, which is one of the necessary elements as it works to regulate and stimulate cells and contributes to Regulating osmotic effort, respiratory process, protein metabolism, enzyme stimulation, and controlling the osmotic pressure of the guard cells, thus regulating the processes of stomata closing and opening [Barakat *et al*. (2012)]. The level

of spraying with zinc (20 mg $Zn.L^{-1}$) significantly increased the averages of the above traits. The reason could be due to the element's role in building chlorophyll and stimulating enzymes of the photosynthesis process in the leaves, which lead to the activation of the biosynthesis of photosynthesis products in the leaves, which are used in building the vegetative total and increasing its indicators. Zinc also activates the enzyme Carbonic Anhydrase in chloroplasts, which works to protect proteins from decomposition, and all of this leads to an increase in vegetative growth indicators and an increase in the accumulation of carbohydrates in plant leaves [Abdulrahman (2010)].

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