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EFFECT OF SEWAGE AND SILICON FERTILIZATION ON THE GROWTH OF PEACH TREES

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ABSTRACT

This experiment was carried out at University of Baghdad – College of Agricultural Engineering Sciences – Research station in order to evaluate the effect of four concentrations of sewage (O_0=0, O_2=2, O_4=4, and O_8=8 kg L^{-1}) and three concentrations of Silicon (Si_0=0, Si_{25}=25, and Si_{50}=50 ml L^{-1}) on the vegetative growth characteristics of peach saplings cv. Red June according to randomized complete block design (RCBD). Results revealed that the application of Sewage has significantly increased the plant's height, leaves area, secondary shoots number, leaves dry weight, chlorophyll, and carbohydrates content. Also the application of Silicon has significantly increased the plant's height, leaves area, secondary shoots number, leaves dry weight, chlorophyll, and carbohydrates content. While the interaction treatment of O_8S5_0 gave the most significant values of all studied parameters.

***Keywords*:** Sewage, Silicon, Fertilization, Peach trees.

Introduction

Peach (*Prunus persica* L.) is a deciduous fruit that belongs to Rosaceae family; is revered as a delicious and healthy summer fruit and a major fruit crop of commerce and high productivity; however, it's cultivation and productivity in Iraq has been decreased on account of lake of fertilization, irrigation, .. Etc. Sewage or sludge, (the final product of the wastewater treatment process) is considered as a prime source of organic matter and nutrients for plants that make a great economic return for its role in improving the soil qualities, nutrients availability, and increasing the fruits production and quality (Staf and Buryan, 2016); nevertheless, it also has risks as it contains heavy nutrients in high concentrations. López *et al*. (2014) indicated that the sludge contains important nutrients for the plant, such as nitrogen; which increases the cells division and elongation in the leaves and consequently increases the leaf area; also, the high concentrations of sludge fertilizer increases vegetative growth and nitrogen accumulation in stems and leaves, which is form 50% of the nitrogen required for the growth; consequently, all the vegetative growth characteristics influences by increasing the concentrations of organic fertilizer; it has an important role on enzymes efficiency that work to decompose complex compounds that lead to the release of nutrients and enhance their availability, and consequently increases growth rates.

Silicon is a semi-essential nutrient for plants; it improves the defensive mechanisms of plants against environmental and biological influences and thus reflects positively on the yield quantity and quality; while the lack of Silicon causes an imbalance in the growth, development and reproduction of plants (Epestein and Bloom, 2005),it also regulating the nutrients absorption, transpiration and flow of water within the plant; consequently, the accumulation of nutrients, then increasing the vegetative characteristics of the plant, such as plant height and leaf area (Guntzer *et al*., 2012). Kong and Kong (2012) indicated that the application of Silicon on apple trees has increased the leaves content of chlorophyll and the photosynthesis efficiency. Saleem and Joody (2019) mentioned that the foliar application of K2sio3 potassium silicate has increased the stem diameter, leaf area and secondary branches. In addition, Wang and Galletta (1998) found that the application of Silicon on Strawberry (*Fragaria ananassa*) has increased the plant height, dry weight and leaves content of chlorophyll.

Materials and Methods

A factorial experiment was carried out according to Randomized complete block design (R.C.B.D) with two factors; the first was four concentrations of sewage (O_0=0, O_2=2, O_4=4, and O_8=8 kg L^{-1}) and three concentrations of Silicon (Si_0=0, Si_{25}=25, and Si_{50}=50 ml L^{-1}). The application of sewage was applied once during March, while the Silicon was applied in the middle of April, May, and June, and the fall season fertilization was applied in the first and middle of September. All parameters were measured and subjected to computerized statistical analysis of variance (ANOVA) according to Genstat software and means of treatments were compared using L.S.D at 0.05 (Alrawi and Khalaf Allah, 2000).

Measured Parameters

1. Plant height (cm) Measured by the metric tape
2. Leaves area (cm^2): According to Dvornic (1965) method
3. Branches number (tree $branch^{-1}$)
4. Leaves dry weight percent (%): according to the following equation

(Dry weight / wet weight) x 100.

5. Leaves content of chlorophyll (mg 100 gm^{-1} wet weight): Measured and calculated according to Goodwin 1976 method.
6. Branches carbohydrates content (%) according to Joslyn (1970).

Results and Discussions

Plant Height (cm)

Results in Table1 revealed that the application of sludge had a significant effect on plant height; the concentration of 8 kg $Tree^{-1}$ gave the highest value reached 151.8 cm compared to the control treatment that gave the lowest values reached 82.4 cm. Silicon also had a significant effect on the studied parameter by giving the highest values under the concentration of 50 ml^{-1} L reached 130.2 cm compared to the control treatment which gave 113.7 cm. Also, the interaction treatment between sewage and Silicon at the concentrations of sludge 8 kg $Tree^{-1}$ and silicon 50 ml. L^{-1} gave the most significant values of plant height reached 160.7 cm compared to the control treatment which gave the lowest value reached 72.3 cm.

Table 1 : Effect of sewage and silicon fertilization on the plant height of peach trees.

Average (Si)	Sewage (Kg.tree^{-1})				Si (ml.L^{-1})
	8	4	2	0	
113.7	144.7	129.3	108.3	72.3	0
120.7	150.0	137.3	113.3	82.3	25
130.2	160.7	143.7	123.7	92.7	50
5.27	10.54				L.S.D 5%
	151.8	136.8	115.1	82.4	(Sewage) Average
	6.08				L.S.D 5%

Table 2 : Effect of sewage and silicon fertilization on the leaves area of peach trees.

Average (Si)	Sewage (Kg.tree^{-1})				Si(ml.L^{-1})
	8	4	2	0	
35.75	45.62	39.00	32.00	26.33	0
39.83	49.33	44.33	35.67	30.00	25
42.67	54.00	46.33	36.67	33.67	50
1.10	2.20				L.S.D 5%
	49.67	43.22	34.78	30.00	Average(Sewage)
	1.10				L.S.D 5%

Table 3 : Effect of sewage and silicon fertilization on the branches number of peach trees.

Average (Si)	Sewage (Kg.tree^{-1})				Si(ml.L^{-1})
	8	4	2	0	
12.58	16	15.67	10.33	8.33	0
13.75	16.67	16.67	12	9.67	25
15.75	20	18.67	13.33	11	50
0.9	1.88				L.S.D 5%
	17.56	17	11.89	9.67	(Sewage) Average
	1.08				L.S.D 5%

Table4. Effect of sewage and silicon fertilization on the leaves dry weight of peach trees.

Average (Si)	Sewage (Kg.tree^{-1})				Si(ml.L^{-1})
	8	4	2	0	
42.42	45.00	51.67	40.00	33.00	0
43.33	46.33	52.67	41.00	33.33	25
44.50	48.33	54.33	41.33	34.00	50
2.38	4.76				L.S.D 5%
	46.56	52.89	40.78	33.44	(Sewage) Average
	2.74				L.S.D 5%

Table 5 : Effect of sewage and silicon fertilization on the leaves content of chlorophyll of peach trees.

(Si) Average	Sewage (Kg.tree^{-1})				Si(ml.L^{-1})
	8	4	2	0	
242.8	291.0	262.0	227.0	191.3	0
251.6	296.0	267.0	234.3	208.7	25
260.5	309.7	272.3	240.3	219.7	50
5.93	11.86				L.S.D 5%
	299.0	267.1	233.9	206.6	Average (Sewage)
	6.85				L.S.D 5%

Table 6 : Effect of sewage and silicon fertilization on branches carbohydrates content of peach trees.

Average (Si)	Sewage (Kg.tree^{-1})				Si(ml.L^{-1})
	8	4	2	0	
15.25	19.33	17.67	13.33	10.67	0
16.83	20.33	19.67	14.67	12.67	25
18.17	21.33	15.33	15.33	14.00	50
1.20	2.41				L.S.D 5%
	20.33	19.78	14.44	12.44	Average (Sewage)
	1.39				L.S.D 5%

Leaves Area (cm^2)

Results in Table 2 revealed that the application of sludge had a significant effect on leaves area; the concentration of 8 kg Tree^{-1} gave the highest value reached 49.67 cm^2 compared to the control treatment that gave the lowest values reached 30.00 cm^2. Silicon also had a significant effect on the studied parameter by giving the highest values under the concentration of 50 ml^{-1} L reached 42.67 cm^2 compared to the control treatment which gave 35.75 cm^2. Also, the interaction treatment between sewage and Silicon at the concentrations of sludge 8 kg Tree^{-1} and silicon 50 ml. L^{-1} gave the most significant values of leaves area reached 54.00 cm^2 compared to the control treatment which gave the lowest value reached 26.33 cm^2.

Branches Number (branch plant^{-1})

Results in Table 3 revealed that the application of sludge had a significant effect on Branches number; the concentration of 8 kg Tree^{-1} gave the highest value reached 17.56 branch plant^{-1} compared to the control treatment that gave the lowest values reached 9.67 branch plant^{-1}. Silicon also had a significant effect on the studied parameter by giving the highest values under the concentration of 50 ml^{-1} L reached 15.56 branch plant^{-1} compared to the control treatment that gave 12.58 branch plant^{-1}. Also, the interaction treatment between sewage and Silicon at the concentrations of sludge 8 kg Tree^{-1} and silicon 50 ml. L^{-1} gave the most significant values of Branches number reached 20 branch plant^{-1} compared to the control treatment which gave the lowest value reached 8.33 branch plant^{-1}.

Leaves dry weight (%)

Results in Table4 revealed that the application of sludge had a significant effect on Leaves dry weight; the concentration of 8 kg Tree^{-1} gave the highest value reached 46.56 % compared to the control treatment that gave the lowest values reached 33.44 %. Silicon also had a significant effect on the studied parameter by giving the highest values under the concentration of 50 ml^{-1} L reached44 .50 % compared to the control treatment that gave 42.42 %. Also, the interaction treatment between sewage and Silicon at the concentrations of sludge 8 kg Tree^{-1} and silicon 50 ml. L^{-1} gave the most significant values of Leaves dry weight reached 48.33 % compared to the control treatment which gave the lowest value reached 33.00 %.

Leaves content of chlorophyll (mg 100 gm^{-1} wet weight)

Results in Table5 revealed that the application of sludge had a significant effect on Leaves content of chlorophyll; the concentration of 8 kg Tree^{-1} gave the highest value reached 299 mg 100 gm^{-1} wet weight compared to the control treatment that gave the lowest values reached 206.6 mg 100 gm^{-1} wet weight. Silicon also had a significant effect on the studied parameter by giving the highest values under the concentration of 50 ml^{-1} L reached 260.5 mg 100 gm^{-1} wet weight compared to the control treatment that gave 242.8 mg 100 gm^{-1} wet weight. Also, the interaction treatment between sewage and Silicon at the concentrations of sludge 8 kg Tree^{-1} and silicon 50 ml. L^{-1} gave the most significant values of Leaves content of chlorophyll reached 309.7 mg 100 gm^{-1} wet weight, compared to the control treatment which gave the lowest value reached 191.3 mg 100 gm^{-1} wet weight.

Branches carbohydrates content (%)

Results in Table6 revealed that the application of sludge had a significant effect on Branches carbohydrates content; the concentration of 8 kg Tree^{-1} gave the highest value reached 20.33% compared to the control treatment that gave the lowest values reached 12.44 %. Silicon also had a significant effect on the studied parameter by giving the highest values under the concentration of 50 ml^{-1} L reached 18.17% compared to the control treatment that gave 15.25 %. Also, the interaction treatment between sewage and Silicon at the concentrations of sludge 8 kg Tree^{-1} and silicon 50 ml. L^{-1} gave the most significant values of Branches carbohydrates content reached 21.33% compared to the control treatment which gave the lowest value reached 10.67%.

The increment of the studied vegetative characteristics can be due to the high content of organic matter that contains nutrients, including nitrogen, which is the most important nutrient in the formation of amino acids, which works to increase the formation of secondary compounds, stimulate the plant's enzymatic system, increase the cells division and elongation, increase the efficiency of photosynthesis and the accumulation carbohydrates and proteins, which Contributes to increased shoots growth (Barker, 2015). The application of silicon has a positive role in increasing plant height and leaves area, and branches number; this is reflected on the branches content of carbohydrate, increase the leaf content of chlorophyll and the efficiency of photosynthesis; additionally, silicon has a role in increasing the absorption of nitrogen, phosphorous and potassium nutrients that were the macro and essential nutrients for plants growth (Saleem and Joody, 2019).

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