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Research Article
Attempts to Improve the Growth and Fruiting of Barhi Date-palms under Salinity Stress

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Abstract

Background and Objectives: Minia governorate in Egypt as an arid land area suffers from high salinity in both soil and water used for irrigation, which causes an obstacle to the growth of date palm which is one of the promising crops. The objective of this study was to alleviate the adverse effect of salinity on growth and fruiting of Barhi cultivar by using humic acid as a soil addition at rate 50 mL per palm with foliar application of selenium and silicon both of them at 25 and 50 ppm single or combined. **Materials and Methods:** This study was carried out during two successive seasons (2018 and 2019) by choosing of 21 palms seven treatments each treatment replicated 3 replicates, the cultivation space was 8 by 8 m apart and the age of palms was about 8 years, in private orchard located in desert of west Samalout district, Minia governorate, Egypt. **Results:** The using of humic with application of selenium and silicon at high concentrate was very effective in enhancing the vegetative growth characters like total chlorophylls and nutritional statute of leaves (N, P, K, Ca and Mg) compare to control (untreated trees). The application of silicon at 50 ppm with humic acid was better than the using of selenium at 50 ppm with humic acid and also better of using both of them individual at 25 ppm and very near to use both of elements at 25 ppm with humic. **Conclusion:** Application of both selenium and silicon at 50 ppm with Humic was the superior treatment in yield, bunch weight, fruit physical and chemical characters.

Key words: Date palm, barhi, salinity, humic acid, silicon, selenium, growth, fruiting

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Soil salinity and water stress are becoming major problems in various widespread areas of the cultivated land in Egypt. Newly reclaimed sandy soil may also be affected at various degrees by some sorts of salinity. It is well known that salt can impair the performance of production and growth of many horticultural plants especially fruit trees. Growth, fruit production and quality parameters are seriously limited by soil salinity[1].

Reclamation and improvements of new lands in Egypt is an absolute must to face the ever-increasing demands of the growing population. The majority of the new lands in Egypt are sandy and calcareous soils. The main problems of these soils are their poor structure, low availability of water and nutrients, low fertility and higher salinity and calcium carbonate and the possibility of forming a surface crust and indurate layers at shallow depths.

Soil salinization is expanding relentlessly in numerous regions of the world under worldwide environmental change. This circumstance is exasperated by the improvement of concentrated plantation practice and flooded grounds utilizing poor water quality. Saltiness makes significant issues plant development and dietary status which thus reflected contrarily to yield and organic product quality in most natural product crops[2].

The deleterious effects of salinity on plant growth are associated with low osmotic potential of the soil solution (water stress), nutritional imbalance, specific ion effects (salt stress) or a combination of these factors[3].

Recently, many attempts were accompanied for counteracting the adverse effects of salinity stress on yield and fruit quality by using non-traditional methods. These methods were the application of humic acid, silicon and selenium.

Fekry[4] found that using of humic acid, Effective Microorganisms (EM), selenium, silicon and amino acids alleviates the adverse effects of soil and irrigation water salinity on growth, tree nutritional status, yield and fruit quality of Picual olive trees.

Humic substances have numerous significant roles in plant nourishment and fertility of soil. Plants cultivated in soils which contain sufficient humic substances are less liable to stress and are more advantageous status[5].

Humic extracts with distinct chemical and physical-chemical characteristics obtained various extracts and from different sources were used to know their biological activity. Humic substances play a vital role in soil fertility and plant nutrition. Plants grown on soils which contain adequate humin, Humic Acids (HAs) and Fulvic Acids (FAs) are less subject to stress are healthier, produce higher yields and the nutritional quality of harvested foods and feeds are superior[6]

Application of silicon was found by previous studies[7-10] as well as selenium as reported to enhance the tolerance of fruit crops to biotic and abiotic stresses[11], the biosynthesis of most organic foods, uptake of water and nutrients and the formation of natural hormones. Their impact as antioxidants in reducing Reactive Oxygen Species (ROS) surely reflected in protecting plant cells from death.

Previous studies confirmed that using silicon[5,12-17] and selenium[18,19] had an announced promotion on yield and fruit quality in different crop fruits.

This study was processing to solve the problem of salinity and its effects on date palm production under the salty soils.

MATERIALS AND METHODS

This study was conducted during 2018 and 2019 seasons on date palm Barhi. The palms were about 8 years old, in a private orchard located at desert of west Samalout district, Minia governorate.

The palms were planted at 8×8 m apart in sandy soil under drip irrigation system with the same amount of water. Each selected palm received the common horticultural practices that are already applied in the orchard except those dealing with using humic, selenium and silicon and soil was washed at the end of year to ensure the stability of soil salinity. Salinity of soil was 2600 ppm and salinity of water was 1700 ppm.

Soil analysis was done according to previously described methods[20-22].

Experimental work: This experiment included seven treatments:

- Spraying water (control)
- Addition of humic at rate 50 mL+spraying selenium at 25 ppm
- Addition of humic at rate 50 mL+spraying selenium at 50 ppm
- Addition of humic at rate 50 mL+spraying silicon at 25 ppm
- Addition of humic at rate 50 mL+spraying silicon at 50 ppm
- Addition of humic at rate 50 mL+spraying selenium at 25 ppm+spraying silicon at 25 ppm
- Addition of humic at rate 50 mL+spraying selenium at 50 ppm+spraying silicon at 50 ppm

Each treatment was replicated three times, one palm per each. The statistical design was Randomized Complete Block Design (RCBD). Humic acid was added once at growth start, silicon and selenium were sprayed in the forms of potassium silicate (25% Si+10% K_2O) and sodium selenite (20% Se) (Na_2SeO_3, $5H_2O$), respectively. Each palm received three sprays at growth start, just after fruit setting and at one month interval. Triton B as a wetting agent was added to all sprayed materials at 0.05%. Spraying was done till runoff.

The following parameters were recorded in both seasons:

- Total chlorophylls (a+b) as mg g^{-1} F.W[23]
- Percentages of N, P, K, Ca and Mg in dried leaves according to previous methods[20,24,25]
- Bunch weight (kg)
- Yield/palm (kg)
- Some physical and chemical characteristics of the fruits namely fruit weight (g) and dimensions (length and width in cm), total soluble solids (%), total sugars (%), reduced sugar (%), total acidity (%) (as g malic acid/100 g pulp) obtained according to previous method[26]

All the obtained data were tabulated and subjected to the proper statistical analysis using new L.S.D at 5% according to a previous study[27].

RESULTS

According to data shown in Table 1, the soli salinity is too high that means adverse effect on all aspects of growths and fruiting of date palm.

Content of total chlorophylls and percentages of N, P, K, Ca and Mg in dried leaves: It is clear from the obtained data in Table 2 that using of both of selenium and silicon in foliar application at high concentration (50 ppm) with the humic as a soil addition was high significant compare control in improve the contents of leaves pigments such as; total chlorophyll tincture as an indicator of the efficiency of vegetative growth and photosynthesis. Palms which treated by using of them individual or together (selenium and silicon) at low concentration were lower than the using of them in high concentration. The contents of dried leaves of N, P, K, Ca and Mg in relative to the control treatment were superior in the promising treatment compare to control and also with other treatments.

Bunch weight and yield per palm: According to the data showed in Table 3 the both of the bunch weight and the yield are significant compare to the control, where the using of humic acid with selenium and silicon in 50 ppm increase the bunch weight from 11.65 and 11.13 kg, respectably in the two seasons to 18.66 and 18.72 kg by this promised treatment. It is evident from the data in Table 3 that the yield was significantly improved in response to the addition of humic with the foliar application of the two materials more than using of humic with selenium or silicon individual and using humic with them together in 25 ppm and that means using

Table 1: Analysis of the tested soil

Contents	Value
Sand (%)	92.0
Silt (%)	5.5
Clay	2.5
Texture grade	Sandy
pH (1: 2.5 extract)	7.89
EC (1: 2.5 extract) (dsm^{-1})	4
Calcium carbonate (%)	2.5
Total N (%)	0.08
Available P (Olsen, ppm)	1.9
Available K (ammonium acetate, ppm)	92.0
Available micronutrient (ppm)	-
Zn	0.8
Fe	0.5
Mn	0.7
Cu	0.1

Table 2: Effects of foliar application of silicon and selenium with humic acid on total chlorophylls and N%, P%, K%, Ca% and Mg% contents of Barhi date palms during 2018 and 2019 seasons

	Total chlorophylls (mg/ g F.W)		Leaf N%		Leaf P%		Leaf K%		Leaf Ca%		Leaf Mg%	
Treatments	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Control	47.76	48.29	1.31	1.27	0.14	0.16	1.41	1.44	1.81	1.80	0.40	0.38
H at 50 mL+Se at 25 ppm	51.18	52.22	1.61	1.46	0.25	0.25	1.45	1.46	1.98	1.85	0.42	0.40
H at 50 mL+Se at 50 ppm	53.37	52.93	1.67	1.62	0.34	0.31	1.48	1.49	1.99	1.96	0.42	0.41
H at 50 mL+Si at 25 ppm	53.65	54.73	1.69	1.77	0.40	0.41	1.52	1.54	2.11	2.09	0.43	0.43
H at 50 mL+Si at 50 ppm	54.36	55.25	1.75	1.80	0.43	0.44	1.58	1.58	2.18	2.22	0.44	0.44
H at 50 mL+Se and Si at 25 ppm	55.73	56.16	1.84	1.83	0.45	0.45	1.64	1.67	2.31	2.28	0.45	0.45
H at 50 mL+Se and Si at 50 ppm	57.05	57.72	1.91	1.96	0.47	0.45	1.73	1.75	2.43	2.39	0.46	0.46
New L.S.D at 5%	1.55	1.41	0.20	0.10	0.03	0.03	0.02	0.03	0.04	0.10	0.01	0.01

H: Humic, Se: Selenium, Si: Silicon

Table 3: Effects of foliar application of silicon and selenium with humic acid on bunch weight yield and fruit physical characterized of Barhi date palms during 2018 and 2019 seasons

	Bunch weight (kg)		Yield/palm (kg)		Fruit weight (g)		Fruit length (cm)		Fruit width (cm)	
Treatments	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Control	11.65	11.13	78.57	81.73	17.08	17.08	3.08	3.05	2.52	11.65
H at 50 mL+Se at 25 ppm	12.38	12.58	82.82	84.96	17.34	17.34	3.12	3.12	2.58	12.38
H at 50 mL+Se at 50 ppm	13.01	13.07	88.09	88.82	17.57	17.53	3.23	3.26	2.59	13.01
H at 50 mL+Si at 25 ppm	14.43	14.71	93.27	94.75	17.63	17.62	3.34	3.34	2.62	14.43
H at 50 mL+Si at 50 ppm	15.39	15.85	96.12	97.34	17.77	17.74	3.37	3.41	2.73	15.39
H at 50 mL+Se and Si at 25 ppm	16.89	17.33	98.53	98.53	18.24	18.25	3.44	3.47	2.84	16.89
H at 50 mL+Se and Si at 50 ppm	18.66	18.72	101.07	103.18	18.83	18.89	3.53	3.56	2.89	18.66
New L.S.D at 5%	0.58	0.44	2.78	2.35	0.13	0.09	0.05	0.04	0.03	0.04

H: Humic, Se: Selenium, Si: Silicon

Table 4: Effects of foliar application of silicon and selenium with humic acid on fruit chemical characterized of Barhi date palms during 2018 and 2019 seasons

	TSS (%)		Total sugars (%)		Reducing sugars (%)		Total acidity (%)	
Treatments	2018	2019	2018	2019	2018	2019	2018	2019
Control	27.8	27.69	25.52	26.33	20.11	20.20	0.33	0.34
H at 50 mL+Se at 25 ppm	29.35	29.36	27.13	27.16	20.13	20.55	0.33	0.31
H at 50 mL+Se at 50 ppm	29.85	30.43	28.32	28.48	21.17	21.13	0.28	0.29
H at 50 mL+Si at 25 ppm	31.58	31.19	29.47	29.75	21.36	21.41	0.25	0.23
H at 50 mL+Si at 50 ppm	31.99	32.55	30.33	30.76	21.84	21.91	0.22	0.23
H at 50 mL+Se and Si at 25 ppm	33.25	33.55	31.57	31.84	22.27	22.54	0.21	0.20
H at 50 mL+Se and Si at 50 ppm	34.34	34.69	32.41	32.72	22.87	22.93	0.19	0.20
New L.S.D at 5%	0.75	0.77	0.67	0.73	0.19	0.33	0.02	0.02

H: Humic, Se: Selenium, Si: Silicon

selenium incorporated with silicon with Humic significantly enhanced bunch weight and yield per palm in relative to using each nutrient alone with the humic acid. Yield per palm reached 101.07 and 103.18 kg while in the control treatment reached 78.57 and 81.73 kg during both seasons, respectively. The percentage of yield increase due to application of the promised treatment over the control treatment reached 22.26 and 20.78% during the two seasons, respectively.

Fruit physical and chemical characterized: The data in Table 3 and 4 showed that the promising treatment which using of humic acid with selenium and silicon at 50 ppm was better than other treatments and also improves fruits physical and chemical characterized where it was very significant in increase fruit weight, dimensions, total soluble salts, total sugars and reducing sugars while decrease total acidity compare to untreated palms fruit which produced low quality fruits in the both of seasons.

DISCUSSION

This study was found that the using of selenium with silicon as foliar application plus soil addition of humic acid under salinity stress improve growth, yield, bunch weight, fruit physical and chemical characters of Barhi date palm. Whereas, this study carried out to handle adverse effects of salinity on plant production of Barhi date palm. Salinity is the major problem which face reclamation and cultivation in arid and dry lands and consider the reason of big problem with the low osmotic potential of the soil solution (water stress), nutritional imbalance, specific ion effects (salt stress) or a combination of these factors[28].

During data obtained from this experimental work it is clear that addition of humic at rate 50 mL via soil addition with spraying of selenium and silicon both of them at 50 ppm was very high significant compare to all other treatments and control, this enhancement was in all parameters which examined as shown in Table 2-4.

Previous studies was agreed with the results which obtained via using of humic acid as fertilizer enhance the fruit trees growth[29-31].

The essential roles of selenium has been reported to help plants cope with stress by stimulating the plant cell antioxidant capacity through the enhancement of the activity of antioxidant enzymes and the synthesis of ascorbate, proline, flavonoids, alkaloids and carotenoids, this improved plant production under salinity[32,33] as this study results mentioned. Silicon seems to benefit certain plants when they are under stress. It has been found to improve drought tolerance and delay wilting in certain crops where irrigation is with held and may enhance the plant's ability to resist

micronutrient and other metal toxicities that means good growth reached[34] like this experimental work had. The effect of both of selenium and silicon promote growth and fruiting of Barhi date palm might be attributed to the effect of selenium in increasing activates of enzymes such as; glutathione-peroxidase, antioxidant activities, protections plants from abiotic and biotic stresses, biosynthesis of carbohydrates as well as it reduces reactive oxygen species. As well as the effect of silicon in enhancing the tolerance of the trees to all stresses, uptake and transport of water and different nutrients, root development and antioxidant defense systems.

These results also corroborated with the findings of Gissel-Neilson *et al.*[9] and Gupta and Gupta[35] on selenium also according to Ferrara *et al.*[36] and Al-Wasfy [5,37].

CONCLUSION

The results concluded that use of humic as soil additive at the rate of 50 mL per palm with selenium and silicon enhance the growth, yield and fruit quality. The additive should be sprayed at 50 ppm concentration three times at growth start, just after fruit setting and at one month interval.

SIGNIFICANCE STATEMENT

This study discovered the effect of using of humic with foliar application of both of selenium and silicon that can be beneficial for alleviating adverse effects of salinity on growth and fruiting of date palm and this study will help the researchers to uncover the critical areas of date palm Barhi cultivar that many researchers were not able to explore. Thus, a new theory on alleviating salinity stresses may be arrived at.

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