EFFECT OF SOME SOIL AMENDMENTS AND PROLINE ON JERUSALEM ARTICHOKE (*HELIANTHUS TUBEROSUS* L.) PRODUCTIVITY IN FAYOUM GOVERNORATE.

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ABSTRACT

Jerusalem artichoke (*Helianthus tuberosus* L.) is considered as one of non-comparatively new traditional vegetable crop introduced in Egypt. It is considered as one of the primary sources for inulin in higher plants. The scope of the current study was to assess the main and interaction effects of two natural and safety materials; potassium humate as soil application and proline as foliar spraying on growth and productivity of Jerusalem artichoke plants cv. Balady. Therefore, two field experiments were conducted during the summer seasons of 2015 and 2016 in Demo Experimental Farm, Faculty of Agriculture, Fayoum University. The experimental layout was a split- plot system in a Randomized Complete Blocks Design with three replications.Three Potassium humate levels (0, 20, 40 kg fed^{-1}) were randomly distributed in the main plots whilst, Three proline concentrations (0, 5, 10 mM) were allocated in the sub-plots. Gained results displayed that tubers weight $plant^{-1}$, number of tubers $plant^{-1}$, dry weight of tuber $plant^{-1}$ and yield fed^{-1} were positively responded to either soil application of potassium humate or foliar spraying of proline. The impact of foliar application with proline on average weight of tuber was not significant in both seasons. Generally treating Jerusalem artichoke plants with potassium humate or proline gave significantly higher leaves and tubers N, P, K and proline contents in both seasons. On the other side, Leaf and tuber Na contents were, truly depressed owe to application of potassium humate or proline. In addition, the interaction of the two studied factors on leaf and tuber Na contents was intrinsic. Finally, the soil application of potassium humate at 20 and/or 40 kg fed^{-1} integration with foliar application of proline at 5 and/or 10 mM enhanced Yield and yield components and Chemical composition of Jerusalem artichoke under newly reclaimed soil conditions of Fayoum Governorate.

Key Words: Jerusalem artichoke (*Helianthus tuberosus* L.), saline soil, Potassium humate, Proline, Vegetative growth, Yield and yield components, Chemical composition.

INTRODUCTION

Jerusalem artichoke is considered as one of the comparatively new traditional vegetable crops introduced in Egypt. It is grown in the clay and the sandy soils but high tuber yield was obtained from the sandy soil. The tuber flesh of this plant is a rich source for fructo oligosaccharides (inulin), which act as sweeteners that not affect blood sugar level after ingestion **(Seljasen and Slimestad, 2007)**. Jerusalem artichoke accumulates high levels of fructans in their stems and tubers. Fructans and the fructose resulting from fructans hydrolysis can be used in human diet or in medical and industrial applications **(Schittenhelm, 1999 and Monti *et al*., 2005)**.

Humic acid is a commercial product contains many elements, which improve soil fertility and increase the availability of nutrient elements and consequently affect plant growth and yield. Humic acid particularly is used to remove or decrease the negative effects of chemical fertilizers and some chemicals in the soil. The major effect of humic acid on plant growth has long been reported. There is basic agreement on the benefits of humus, but there is quite a controversy on the benefit of application of applied humate (the deposits containing the humic acids). Humic substance supply growing plants with nutrition makes soil more fertile and productive increasing the water holding capacity of soil; therefore, it helps plants resist droughts and stimulates seed germination. Humic acid reduces other fertilizer requirements, increases yield in crops, improved drainage, increases aeration of the soil, increases the protein and mineral contents of most crops and establishes a desirable environment for microorganism development **(Salman *et al*., 2005)**

Proline plays a very important role in cell osmotic potential, stability of membrane and detoxification of toxic ions in plants under saline conditions **(Ashraf and Foolad, 2007)**. It plays a highly beneficial role in plants exposed to various stress conditions. Besides acting as an excellent osmolyte, proline plays three major roles during stress as a metal chelator, an antioxidative defense molecule and a signaling molecule (**Hayat *et al*., 2012; Szabados and Savouré, 2010)**.

The aim of this research is to cultivate Jerusalem artichoke (*Helianthus tuberosus*) plant under saline conditions, using techniques that reduce the effect of salt stress to give the best productivity of the crop from the area unit. Also exploitation of saline soils in the cultivation of nontraditional crops that produce high production, economic and export importance and promising where ethanol is extracted on a commercial scale in addition to the sugar required in a worldwide.

MATERIALS AND METHODS

3.1 Field experiments

Two field experiments were conducted during the summer seasons of 2015 and 2016 at Demo Agriculture Experimental Station, College of Agriculture, Fayoum University to evaluate the response of Jerusalem artichoke plant (*Helianthus tuberosus* L.) to soil application of three rates of potassium humate (85% humic acid); 0, 20 and 40 Kg fed^{-1} and three foliar concentrations of proline; 0, 5 and 10 mM.

Soil samples (0.25 cm depth) were taken just before each experiment. Cores from different replications were bulked and the samples were analyzed. Physical and chemical analyses were performed by the College of Agriculture Soil Testing Laboratory according to the standard procedures **(Wilde *et al.*, 1985)** and the results were presented in Table 1.

3.1 Field experiments.

Tubers of Jerusalem artichoke used in this study were obtained from the Horticulture Research Institute Department of Potato and Vegetable Research, Giza Governorate.

Local tubers of Jerusalem artichoke cv. Balady were hand planted in the field, on 4th of April 2015 and 6th of April 2016 seasons. The experimental layout was a split-plot system in a randomized complete blocks design with three replications. Potassium humate rates were randomly distributed in the main plots whilst, proline concentrations were randomly allocated to the sub-plots. Each experimental unit was planned to cover an area of 15 m^2 including three rows of 5 m long and 1 m wide, with plants spacing averaged 50 cm apart. In order to protect against border effects, each experimental unit was separated from the next unit by 1 m alley.

Different potassium humate rates were applied during tuber sowing while; proline concentrations were foliar sprayed twice, to run off, after 90 and 105 days of tuber sowing. All experimental units received N, P_2O_5 and K_2O at rates of 33, 15 and 24 kg fed^{-1}, respectively. During soil preparation, phosphorus fertilizer as well as organic manure (compost 8 ton fed^{-1}) and sulpher 100 kg fed^{-1} were broadcasted and N and K fertilizers were side banded at two equal portions; 1 and 3 months after planting. Recommended agro-management practices were performed for the commercial production of Jerusalem artichoke.

Table 1: Physical and chemical characteristics of the experimental site during the seasons of 2015 and 2016.

Properties	2015	2016
Physical properties:		
Clay %	14.5	12.6
Silt %	21.7	22.3
Fine sand %	63.8	65.1
Soil texture	Sandy clay loam	Sandy clay loam
Chemical properties		
pH	7.5	8.2
ECe (dS m^{-1})	7.4	10.0
$CaCO_3$ %	11.3	12.8
SAR	12.7	11.9
Soluble ions (m mole L^{-1})		
Ca^{++}	17.8	19.5
Mg^{++}	22.2	20.1
Na^{+}	56.7	60.9
K^{+}	2.17	2.01
CO_3^{--}	4.86	4.66
HCO_3^{-}	5.67	5.59
Cl^{-}	51.0	59.0
SO_4^{--}	34.4	37.6
Available elements(mg kg^{-1} soil):		
N	9.62	7.89
P	24.5	20.3
K	279	251

3.2. Plant sampling.

In each experimental unit, the middle row was chosen to determine tuber yield and its components, while three plants from the two outer rows were randomly chosen for chemical composition.

3.3. Data Recorded.

3.3.1. Yield and yield components.

After the signs of maturity were showed up on the plants, such as yellowing of leaves and the laying of plants, plants were suspended for one month before harvest and the plants were cut on 5 and 6 January in 2015 and 2016, respectively. Tubers weight plant^{-1}, number of tubers plant^{-1}, average weight of tuber, dry weight of tubers plant^{-1} and yield fed^{-1} were recorded

At harvest time, 270 days after tuber sowing, three plants were randomly chosen and the following measurements were performed:

- Tubers weight plant^{-1} (kg).
- Number of tubers plant^{-1}.
- Average weight of tuber (g); calculated by dividing weight of tubers plant^{-1}by number of tubers plant^{-1}.
- Dry weight of tubers plant^{-1}(g).
- Yiled fed^{-1} (ton)**;** recorded as the total weight of tubers from all plants of the middle row, and then converted into tones fed^{-1}.

3.3.2. Chemical Constituents.

After 135 days from tuber sowing, three randomly selected plants from each experimental unit were obtained and dried at 70°C in a forced-air oven till constant weight.

Random tuber samples were harvested after 270 days from tuber sowing, washed with tap water, then cutted and air–dried for two weeks. The cuts were dried at 70°C in a forced-air oven until constant weight.

The dried samples of leaves and tubers were used to measure the following items:

- Leaf and tuber N mg g^{-1} was estimated using colorimetrically determined by using the technique of **Hafez and Mikkelsen (1981)**.
- Leaf and tuber P mg g^{-1} was colourimetrically estimated according to the stannous molybdate chloride method as illustrated in **A.O.A.C. (1995)**.
- Leaf and tuber K and Na mg g^{-1} were photometrically measured using Flam photometer as mentioned by **Wilde *et al.* (1985)**.
- Leaf and tuber free proline (mg g^{-1}) colormetrically determined using ninhydrin reagent as outlined by **Bates *et al.* (1973)**.

3.4. Statistical analysis.

All data were subjected to analysis of variance (ANOVA) for a randomized complete block design, after testing for homogeneity of error variances according to the procedure outlined by **Gomez and Gomez (1984)** using **InfoStat (2016)**. Significant differences between treatments were compared at $P \leq 0.05$ by Duncan's
multiple range test.

RESULTS AND DISCUSSION

1. Yield Characters

Application of potassium humate generally, reflected significant increments in tubers weight plant^{-1}, number of tubers plant^{-1}, average weight of tuber, dry weight of tubers plant^{-1} and yield fed^{-1} in both seasons compared to the control treatment (Table 2).

Spraying the foliage of Jarusalem artichoke plants with proline, irrespective of the concentration used, reflected significant increments in tuber weight plant^{-1}, number of tuber plant^{-1}, dry weight of tubers plant^{-1} and yield fed^{-1} compared to the control treatment in the both seasons, while the impact of foliar application with proline on average weight of tuber was not significant in both seasons.

The dual application of potassium humate and proline together on yield and yield components was significant in 2015 and 2016 seasons.

Muscolo *et al.*, 1993 and **Zhang and Schmidt, 2000** which they reported that yield increment due to potassium humate may resulted from hormone-like activities of the humic acid through their involvement in increasing, photosynthesis, oxidative phosphorylation, protein synthesis, antioxidant and various enzymatic reactions. In addition, humic acid has been claimed to promote plant growth by increasing cell membrane permeability, oxygen uptake and photosynthesis, nutrient uptake, and root cell elongation (**Russo and Berlyn, 1990; Böhme and ThiLua, 1997 and Nardi *et al.*, 2002**).

Increasing yield attributes and economic yields as a result of proline application may be attributed to the increase in plant growth parameters (AboArab, 2018) and decreasing uptake on mineral ions specially Na (Table 3). The promoting effect of spraying proline on yield characters can be explained the active role of proline. It is an amino acid and is one of the most commonly occurring compatible solutes and plays a crucial major role in osmoregulation and osmotolerance (**Rhodes and Hanson, 1993 Hasegawa *et al.*, 2000**). It protects membranes and proteins against the destabilizing effects of dehydration during abiotic stress. In addition, it has some ability to scavenge free radicals generated under stress conditions (**Ashraf and Foolad, 2007**).

Table (2): Effect of potassium humate and proline on tubers weight plant^{-1}, number of tubers plant^{-1}, average weight of tuber, dry weight of tubers plant^{-1} and yield fed^{-1} of Jerusalem artichoke plants during the seasons of 2015 and 2016.

Treatment		Tubers weight plant^{-1} (kg)		No.of tubers plant^{-1}		Average weight of tuber (g)		Dry weight of tubers g plant^{-1}		Yield fed^{-1} (ton)	
Potassium humate (kg fed^{-1})	Proline (mM)	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
0		1.39^{C*}	0.54^{C}	75^{C}	43^{C}	18.3^{B}	12.6^{C}	449^{C}	147^{C}	11.0^{C}	4.5^{C}
20		2.13^{B}	1.47^{B}	99^{B}	108^{B}	22.1^{A}	13.5^{B}	922^{B}	581^{B}	17.0^{B}	11.8^{B}
40		2.32^{A}	1.69^{A}	107^{A}	113^{A}	21.7^{A}	14.9^{A}	1262^{A}	863^{A}	$18. 5^{A}$	13.7^{A}
	0	1.38^{C}	0.91^{C}	67^{C}	66^{C}	20.7^{A}	13.7^{A}	559^{C}	344^{C}	10.7^{C}	7.4^{C}
	5	2.17^{B}	1.32^{B}	105^{B}	93^{B}	20.5^{A}	13.9^{A}	958^{B}	556^{B}	17.0^{B}	10.7^{B}
	10	2.29^{A}	1.47^{A}	110^{A}	106^{A}	20.8^{A}	13.4^{A}	1116^{A}	691^{A}	18.8^{A}	11.9^{A}
0	**0**	0.98^{d}	0.43^{I}	62^{e}	32^{g}	15.9^{e}	13.1^{c}	264^{h}	87^{I}	7.5^{f}	3.6^{I}
	5	1.54^{c}	0.55^{h}	83^{d}	43^{f}	18.6^{d}	13.0^{c}	491^{g}	149^{h}	12.0^{e}	4.7^{h}
	10	1.65^{c}	0.64^{g}	81^{d}	55^{e}	20.3^{cd}	11.6^{d}	592^{f}	205^{g}	13.5^{d}	5.2^{g}
20	**0**	1.51^{c}	1.08^{f}	60^{e}	82^{d}	25.2^{a}	13.1^{c}	597^{f}	387^{f}	11.6^{e}	8.8^{f}
	5	2.34^{b}	1.60^{d}	117^{bc}	117^{c}	20.0^{cd}	13.7^{bc}	990^{d}	631^{d}	18.4^{c}	12.8^{d}
	10	2.54^{a}	1.73^{c}	121^{ab}	125^{b}	21.0^{bc}	13.8^{bc}	1178^{c}	724^{c}	21.0^{b}	13.7^{c}
40	**0**	1.66^{c}	1.22^{e}	79^{d}	83^{d}	20.9^{bc}	14.7^{ab}	815^{e}	559^{e}	12.9^{d}	9.9^{e}
	5	2.63^{a}	1.81^{b}	115^{c}	119^{c}	22.9^{b}	15.1^{a}	1393^{b}	888^{b}	20.7^{b}	14.6^{b}
	10	2.68^{a}	2.03^{a}	126^{a}	137^{a}	21.6^{bc}	14.8^{ab}	1577^{a}	1143^{a}	21.8^{a}	16.7^{a}

*Values marked with the same letter(s) within the main and interaction effects are statistically similar using Duncan's multiple range test at P = 0.05. Uppercase letter(s) indicate differences between main effects, and lowercase letter(s) indicate differences within interaction of each character.

2. Chemical Composition

Treating the Jarusalem artichoke plants with potassium humate gave significantly higher leaves and tubers N, P, K and proline contents in both seasons. On the other side, the highest value of leaves and tubers Na content were obtained at 0 kg fed^{-1} potassium humate through, the two experimental seasons. (Table3, 4)

Nitrogen, phosphorus, potassium and proline contents in leaves and tubers were increased significantly by spraying proline at the concentrations up to 10 mM. While, the highest value of leaves and tubers Na content were obtained at 0 mM with proline in 2015 and 2016 seasons.

The interaction between potassium humate levels by proline concentrations on N, P, K and proline contents in leaves and tubers were significant in both years. Wherease, the highest value of leaves and tubers Na content was found at 0 kg fed^{-1} potassium humate with 0 mM proline in the two experimental seasons.

In conclusion soil application of potassium humate increased leaf and tuber contents of N, P, K and free proline and decreased Na (Table 3, 4) Hence, it could be concluded that the beneficial effect of humic acid on of Jerusalem artichoke plants has been related to role in accumulation of free proline. In addition, humic acid similarly as a good fertilizer state creating more accessibility for the nutrients **(Osman and Ewees, 2008; Osman and Rady, 2012 and Hemida *et al.*, 2017)** by reducing soil pH value as well as increasing the action of soil organisms. Plants overcome this difficulty by increasing the concentration of proline accumulation in plants exposed to salt; water stress has been correlated in many species with their adaptation to osmotic stress. Complex atomic reactions including the accumulation of perfect solutes, the generation of stress proteins, and the expression of different sets of genes are part of the plant indicating also defense system against salinity **(Hasegawa *et al.,* 2000 and Sairam and Tyagi, 2004).** It is well known that, one of the most common reactions to saline situations is the generation of proline which acts as a perfect solute, an osmoprotectant, and a protective agent for cytosolic enzymes and cell division organelles (**Turan and Aydın, 2005 and Jiménez-Bremont *et al.,* 2006).** According to many researchers, humic substances might upgrade the uptake of portion nutrients; diminish the uptake for toxic components **(Khaled and Fawy, 2011). Rady *et al.* (2016)** reported that soil application of potassium humate led to significant reductions in the leaf concentrations of Na of cotton. In this connection, **Taha and Osman (2017)** suggested that the positive effect of potassium humate on N, P and K leaf content of bean plants might be due to their effect on relative water content, membrane stability index, DPPH radical scavenging activity and increased of accumulation of compatible osmolytes such as TSS, free proline, total flavonoids, total phenolics, carotenoids, and reduce electrolyte leakage.

Proline application may elevate the uptake of beneficial macro-nutrients to maintain the osmotic balance by reducing the concentration of toxic ions (Na^+ and Cl^-) which assist normal growth and development of crops **(Hoque *et al*., 2007; Ashraf and Foolad, 2007 and Nawaz *et al*., 2010).** The exclusion of Na^+ ions, and higher K^+/Na^+ ratios in bean plants grown under saline conditions have been confirmed as important selection criteria for salt tolerance **(Abdelhamid *et al.,* 2010).** Tables show that exogenous applications of proline significantly increased concentrations of P and K and decreased Na ion levels in salt-affected plants. The ability of the plant to limit the transport of Na into its shoot is important to maintain a high growth rate and to protect metabolic processes from the toxic effects of Na **(Razmjoo *et al*., 2008)**. This could be attributed to the ability of roots to exclude Na+ from the xylem sap flowing to the shoot, which implies better growth of the shoot than the root **(Kaya *et al*., 2007)**. The results here demonstrate that exogenous applications of proline under saline stress conditions resulted in increased P and K levels, but lower concentrations of Na (Tables 3and 4). Thus, proline caused a reduction in Na absorption and toxicity. This could explain the mitigating effects of proline on the growth of Jerusalem artichoke plants in saline soils. The antagonistic relationship between Na^+ and K^+ ions, as a result of proline treatment, indicates that proline could play a role in modifying K^+: Na^+ ratios under salt stress, which is reflected in reduced membrane damage and higher water contents under salinity stress (**AbdElHamid *et al.,* 2013)**.

Table (3): Effect of potassium humate and proline on N and P content in leaves and tubers of Jerusalem artichoke plants during the seasons of 2015 and 2016.

Treatment		Leaves N mg g^{-1} DW		Tubers N mg g^{-1} DW		Leaves P mg g^{-1} DW		Tubers P mg g^{-1} DW	
Potassium humate (kg fed^{-1})	Proline (mM)	2015	2016	2015	2016	2015	2016	2015	2016
0		2.94^{B*}	2.82^{B}	2.92^{B}	2.76^{B}	0.233^{C}	0.311^{C}	0.229^{C}	0.299^{C}
20		3.17^{A}	3.56^{A}	3.68^{A}	3.47^{A}	0.317^{B}	0.384^{B}	0.313^{B}	0.372^{B}
40		3.15^{A}	3.52^{A}	3.61^{A}	3.34^{A}	0.331^{A}	0.400^{A}	0.349^{A}	0.392^{A}
	0	2.40^{C}	2.69^{C}	2.75^{C}	2.51^{C}	0.232^{C}	0.300^{C}	0.202^{C}	0.278^{C}
	5	3.24^{B}	3.49^{B}	3.35^{B}	3.25^{B}	0.314^{B}	0.379^{B}	0.337^{B}	0.357^{B}
	10	3.62^{A}	3.72^{A}	4.12^{A}	3.81^{A}	0.335^{A}	0.416^{A}	0.353^{A}	0.428^{A}
0	0	2.45^{d}	2.06^{e}	2.34^{d}	2.32^{g}	0.192^{e}	0.231^{f}	0.158^{g}	0.236^{h}
	5	3.12^{c}	3.14^{cd}	3.05^{c}	2.80^{e}	0.265^{d}	0.347^{de}	0.228^{e}	0.304^{f}
	10	3.24^{bc}	3.26^{c}	3.38^{b}	3.15^{d}	0.243^{d}	0.354^{d}	0.302^{d}	0.357^{e}
20	0	2.36^{d}	3.01^{d}	2.98^{c}	2.68^{ef}	0.248^{d}	0.329^{e}	0.200^{f}	0.293^{g}
	5	3.29^{b}	3.67^{b}	3.54^{b}	3.55^{b}	0.323^{c}	0.390^{c}	0.378^{bc}	0.372^{d}
	10	3.87^{a}	4.01^{a}	4.53^{a}	4.17^{a}	0.379^{a}	0.433^{b}	0.362^{c}	0.453^{b}
40	0	2.39^{d}	3.00^{d}	2.94^{c}	2.54^{f}	0.256^{d}	0.340^{de}	0.247^{e}	0.306^{f}
	5	3.31^{b}	3.65^{b}	3.46^{b}	3.39^{c}	0.355^{b}	0.401^{c}	0.405^{a}	0.397^{c}
	10	3.74^{a}	3.91^{a}	4.44^{a}	4.11^{a}	0.383^{a}	0.460^{a}	0.395^{ab}	0.473^{a}

*Values marked with the same letter(s) within the main and interaction effects are statistically similar using Duncan's multiple range test at P = 0.05. Uppercase letter(s) indicate differences between main effects, and lowercase letter(s) indicate differences within interaction of each character.

Table (4): Effect of potassium humate and proline on K^+ , Na^+ and proline content in leaves and tubers of Jerusalem artichoke plants during the seasons of 2015 and 2016.

Treatment		Leaves K^+ mg g^{-1} DW		Tubers K^+ mg g^{-1} DW		Leaves Na^+ mg g^{-1} DW		Tubers Na^+ mg g^{-1} DW		Leaves proline mg g^{-1}DW		Tubers proline mg g^{-1}DW	
Potassium humate (kg fed^{-1})	Proline (mM)	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
0		2.92^{C*}	3.14^{C}	3.06^{C}	3.22^{C}	0.168^{A}	0.165^{A}	18.3^{B}	12.6^{C}	2.31^{C*}	1.80^{C}	2.29^{C}	2.74^{C}
20		3.50^{B}	3.73^{B}	3.93^{B}	3.88^{B}	0.148^{B}	0.151^{B}	22.1^{A}	13.5^{B}	3.10^{B}	2.73^{B}	3.05^{B}	3.10^{B}
40		3.61^{A}	4.02^{A}	4.10^{A}	4.05^{A}	0.134^{C}	0.133^{C}	21.7^{A}	14.9^{A}	3.71^{A}	3.06^{A}	3.35^{A}	3.33^{A}
	0	2.78^{C}	3.22^{C}	3.03^{C}	2.93^{C}	0.179^{A}	0.183^{A}	20.7^{A}	13.7^{A}	1.87^{C}	1.24^{C}	1.93^{C}	2.01^{C}
	5	3.29^{B}	3.57^{B}	3.74^{B}	3.77^{B}	0.149^{B}	0.149^{B}	20.5^{A}	13.9^{A}	3.36^{B}	3.04^{B}	3.01^{B}	3.27^{B}
	10	3.96^{A}	4.10^{A}	4.33^{A}	4.46^{A}	0.123^{C}	0.117^{C}	20.8^{A}	13.4^{A}	3.89^{A}	3.31^{A}	3.75^{A}	3.89^{A}
0	0	2.12^{g}	2.59^{e}	2.13^{h}	2.58^{f}	0.200^{a}	0.204^{a}	15.9^{e}	13.1^{c}	1.22^{I}	0.75^{I}	1.74^{g}	2.01^{h}
	5	3.24^{de}	3.33^{d}	3.15^{g}	3.11^{de}	0.167^{b}	0.168^{c}	18.6^{d}	13.0^{c}	2.41^{g}	2.13^{f}	2.02^{f}	2.59^{f}
	10	3.38^{c}	3.50^{cd}	3.89^{d}	3.98^{c}	0.138^{cd}	0.123^{g}	20.3^{cd}	11.6^{d}	3.30^{e}	2.52^{e}	3.11^{e}	3.60^{d}
20	0	3.07^{f}	3.52^{cd}	3.39^{f}	3.00^{e}	0.170^{b}	0.192^{b}	25.2^{a}	13.1^{c}	1.52^{h}	1.12^{h}	2.03^{f}	1.95^{I}
	5	3.27^{cde}	3.65^{c}	3.96^{cd}	4.09^{c}	0.145^{c}	0.143^{e}	20.0^{cd}	13.7^{bc}	3.65^{d}	3.41^{d}	3.45^{d}	3.52^{e}
	10	4.15^{b}	4.01^{b}	4.45^{b}	4.56^{b}	0.129^{d}	0.118^{h}	21.0^{bc}	13.8^{bc}	4.13^{b}	3.66^{b}	3.67^{b}	3.83^{b}
40	0	3.16^{ef}	3.54^{cd}	3.57^{e}	3.20^{d}	0.167^{b}	0.153^{d}	20.9^{bc}	14.7^{ab}	2.86^{f}	1.87^{g}	2.03^{f}	2.07^{g}
	5	3.34^{cd}	3.74^{c}	4.09^{c}	4.12^{c}	0.134^{d}	0.136^{f}	22.9^{b}	15.1^{a}	4.03^{c}	3.57^{c}	3.56^{c}	3.68^{c}
	10	4.33^{a}	4.78^{a}	4.65^{a}	4.84^{a}	0.102^{e}	0.109^{I}	21.6^{bc}	14.8^{ab}	4.23^{a}	3.74^{a}	4.47^{a}	4.25^{a}

*Values marked with the same letter(s) within the main and interaction effects are statistically similar using Duncan's multiple range test at P = 0.05. Uppercase letter(s) indicate differences between main effects, and lowercase letter(s) indicate differences within interaction of each character.

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تأثير إضافة بعض محسنات التربة و البرولين على الإنتاجية لنباتات الطرطوفة النامية في محافظة الفيوم

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الخلاصة

نباتات الطرطوفة من محاصيل الخضر غير التقليدية التي تم إدخالها في مصر وتعتبر أحد المصادر الرئيسية للإنيولين في النباتات. وفى محاولة للتخفيف من الآثار الضارة للملوحة بإستخدام مواد أمنه لا تسبب أى تأثير ضار على النظام البيئي الأرضي وبالتالي علي صحة الإنسان. وبناء عليه كان الهدف من هذه الدراسة هو توضيح التأثيرات الرئيسية والمتداخلة لهيومات البوتاسيوم كإضافة أرضيه والبرولين كرش هوائي على الصفات المورفولوجية والمحصول والمحتوى الكيميائي لنباتات الطرطوفة صنف البلدي النامية تحت ظروف ارض مستصلحة حديثا. ولإنجاز هذة الدراسه أجريت تجربتان حقليتان بمزرعة دمو التجريبية بكلية الزراعة جامعة الفيوم خلال الموسم الصيفى لعامى ٢٠١٥ ، ٢٠١٦ حيث تم إستخدام التصميم الإحصائي فى نظام القطع المنشقة مرة واحدة في ثلاثة مكررات وقسمت المعاملات الي ثلاث مستويات من هيومات البوتاسيوم (صفر ، ٢٠ ، ٤٠ كجم للفدان) في القطع الرئيسية وثلاث تركيزات من البرولين (صفر ، ٥ ، ١٠ ملليمول) في القطع المنشقة وذلك بصورة عشوائيه.

وقد أظهرت النتائج زيادة معنوية فى كلا من وزن وعدد الدرنات للنبات والوزن الجاف للدرنات للنبات والمحصول الكلي للفدان لإضافة كلا من هيومات البوتاسيوم كإضافة أرضية والبرولين رشا على المجموع الخضري وكان تأثير رش البرولين على متوسط وزن الدرنة غير معنويا في كلا الموسمين. وبصفة عامة أوضحت نتائج التحليلات الكيميائية أن معاملة نباتات الطرطوفة بهيومات البوتاسيوم أو البرولين أدت إلى زيادة معنوية لمحتوى النيتروجين والفسفور والبوتاسيوم والبرولين في الأوراق والدرنات مقارنة بالنباتات غير المعاملة في كلا الموسمين . وعلى الجانب الآخر عدم اضافة هيومات البوتاسيوم أو البرولين أعطت أعلى القيم من محتوى الصوديوم في الأوراق والدرنات في كلا موسمي الدراسة وكان هناك تأثيراً معنويا واضحاً فى التفاعل بين العوامل المدروسة المختلفة.

وأخيراً ، فإن إضافة هيومات البوتاسيوم بمعدل ٢٠ أو ٤٠ كجم للفدان كإضافة أرضية مع الرش الورقي للبرولين بتركيزات ٥ أو ١٠ مليمول أدى الي تحسين كلا من الصفات الخضرية والمحصول ومكوناته والتركيب الكيميائى للأوراق والدرنات لنباتات الطرطوفة النامية تحت ظروف الأراضي المستصلحة حديثاً بمحافظة الفيوم.