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EFFECT OF CULTIVAR AND SOME GROWTH STIMULANTS ON YIELD, TUBER QUALITY AND STORABILITY OF JERUSALEM ARTICHOKE

M. E. Ragab[1], M. E.M. Ahmed[2], A. A. Alaraby[2], Rehab M. Mahddy[2]
[1] Horticulture Department, Faculty of Agriculture, Ain Shams University
[2] Horticulture Department, Faculty of Agriculture, Tanta University
Dr.memahmed@yahoo.com

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ABSTRACT: *In order to study the effect of cultivars and foliar application of some growth stimulants as well as their interaction on the production, quality and storability of Jerusalem artichoke; a split plot experiment was conducted with three replicates. El-Balady and Fuseau were assigned to main plots and 7 various stimulants were assigned to sub plots. Data was collected on some vegetative, yield, tuber physical characteristics, chemical components of leaves and tubers as well as storability. The results indicated in some characters, that there are significant differences between both cultivars with the superiority of Fuseau cultivar. Either seaweed extract and yeast extract treatments were the most effective treatments for yield, tuber physical characteristics, while chitosan treatment gave the lowest values for storage losses percentage. Also the interactions between Fuseau and seaweed extract, yeast, or chitosan gave the most desirable values according to the studied character.*

Key words: *Jerusalem artichoke; chitosan; seaweed; amino acids, potassium, humic acid, yeast.*

INTRODUCTION

Jerusalem artichoke {Helianthus tuberosus L.) is one of the very important non-traditional vegetable crops because of its high sugars content, primarily inulin, productivity and possibilities of cultivation on marginal land. Also, it is a good source of fructose, useful in food industry and for Pharmaceuticals (Ben-Chekroun *et al.,* 1994). Tubers contain 20.4 - 31.9% of dry matter, from which carbohydrates are the main component. Most of carbohydrates consist of water-soluble inulin. Concentration of inulin reaches 50 - 56% of dry matter or 11.3 - 14.2 g 100 g'' of fresh mass of tubers (Ben-Chekroun *et al.,* 1997).

The agricultural and horticultural uses for chitosan, primarily for plant defense and yield increase, are based on how this glucosamine polymer influences the biochemistry and molecular biology of the plant cell. The cellular targets are the plasma membrane and nuclear chromatin. Subsequent changes occur in cell membranes, chromatin, DNA, calcium, MAP Kinase, oxidative burst, reactive oxygen species and phytoalexins (Hadwiger, Lee A 2013).

Humic acid is particularly used for increasing the nutrient availability (Stevenson, 1994). Moreover, humic substances can chelate most metals present in the soil thereby; increasing their availability to the plants (Stevenson, 1994). Humic substances also have an effect on the growth of roots and root hairs (Pinton *et al.,* 1999).The increase of the root surface caused by humic substances promotes the uptake of elements such as potassium, phosphorus and Iron (Marschner, 1995). The increase of the root surface caused by humic substances promotes the uptake of elements such as potassium, phosphorus and Iron (Marschner, 1995 and Cesco *et al*., 2002).

Potassium nutrition is one of the major factors that affect growth, yield and quality of plant. It plays an important role in promotion of enzymes activity and enhancing the translocation of assimilation sugar, starch and protein synthesis (Marschner, 1995). Low levels of nutrients such as K is considered one of the major productions constrains of all types of soil. Furthermore, potassium forms are the third most important nutrient limiting plant growth and consequently bulb yield. (Marschner, 1995), Ali and Taalab (2008) found that the application of potassium sulfate gave the best values of P,K and Zn content.

The application of seaweed extract fertilizer on different crops was of great importance to substitute the commercial chemical fertilizers and to reduce the cost of production. Liquid fertilizers derived from seaweeds are found to be superior to chemical fertilizers due to high level of organic matter, micro and macro elements, vitamins and fatty acids as well as being rich in growth regulators**,** (Crouch and Van Staden 1993).

Yeast - as a natural source of cytokinins, enzymes, amino acids, vitamins and minerals (Khedr and Farid, 2002; Mahmoud, 2001). yeast extract was suggested to participate in a beneficial role during vegetative and reproductive growths through improving flower formation and their set in some plants due to its high auxin and cytokinins content and enhancement of carbohydrates accumulation. Ghoname *et al.,* (2010) found in sweet pepper that the foliar applied yeast had positive effects on phosphorus and potassium contents in the leaves.

Amino acids are biologically important organic compounds. The requirement of amino acids in essential quantities is well known as a means to increase yield and overall quality of crops. The foliar application of amino acids is based on its requirement by plants in general and at critical stages of growth in particular. Plants absorb amino acids through stomas and are proportionate to environment temperature (Kowalczyk and Zielony, 2008). Amino acids are fundamental ingredients in the process of protein synthesis. About 20 important amino acids are involved in the process of each function. Studies have proved that amino acids can directly or indirectly influence the physiological activities of the plant Qualls and Haines 1991 and Yu *et al.,* 2002).

In order to enhance the production of Jerusalem artichoke under Egyptian condition, the present study was conducted to investigate the effect of some growth stimulants viz., Chitosan, humic acid, potassium, seaweed extract, yeast extract and amino acids, on two cultivars of Jerusalem artichoke for growth, yield, tuber quality and storability.

MATERIALS AND METHODS

This study was carried out at the private farm in Meit Yazeid village, El-Santa center, El-Gharbia Governorate, Egypt during two successive seasons of 2012 and 2013. In order to investigate the effect of cultivar and foliar applications of some growth stimulants on yield, tuber quality and storability of Jerusalem artichoke the growth stimulants consisted of six treatments Viz.,, chitosan, seaweed extract, humic acid, amino acids, yeast extract and potassium, in addition to foliar spray with tap water as control treatment. Each of chitosan and seaweed extract was used with concentration of 1ml/l., each of humic acid, amino acids and potassium was used with a concentration of 2ml/l, whereas yeast extract was used with 5 g/l. El-Balady and Fuseau cultivars of Jerusalum artichoke were kindly provided by Horticulture Research Institute, and used as plant materials. The source of chitosan was the Company Kimia Egypt and chitosan was follows:

N	1000 ppm	P	500 ppm
K	500 ppm	Fe	100 ppm
cu	50 ppm	Mn	50 ppm
B	50 ppm.		

The source of seaweed extract was the LELLI- company and the analysis of seaweed was:

Component	Con.	Component	Con.
Soluble dry matter	350 g / LS		12%
Organic matter	20 g / L	Boron	0.001%
Aliginic acid	4 g / L	Mo	0.13 %
N	6 %	Natural plant horm0ns	
Mg	3 %		

The source of humic acid was the company of Union Agricultural Development in Cairo, Egypt. The analysis of humic acid was humic acid 86 %, folvic acid 17 %, K_2o 6 %.

Amino acids as powder form of different amino acid were follows:
Alanine = 6.90 % Arginie = 5.22 %
Aspartic acid = 9.93 % Cystine = 2.25 %
Glycine = 4.06 % Glutaminc acid = 7.25%
Histidine = 6.34 % Isoleucine = 0.15%
Leucine = 10.99% Lysine = 7.19 %
Metionine = 0.71 % phenylalanine = 5.93%
Serine = 3.88 % Threonine = 2.47 %
Tryptophan = 0.68 % Tyrosine = 1.92 %
Valine = 6.79 % proline = 2.84 %
Total amino acids = 85.5 %
Free L- α amino acid = 16 %
Organic Nitrogen = 12 %
Potassium oxide = 2.5%

The chemical composition of the commercial potassium were N 10, P2o2 5, K_2o 40 w /w

The physical and chemical properties of the soil of the experimental area are presented in Table 1.

The planting dates were 12^{th} and 8^{th} April in both growing seasons, respectively. All cultural practices of cultivation, irrigation, fertilization…etc. were performed according to the recommendations of the Egyptian Ministry of Agriculture.

Data recorded

Vegetative growth characters: A random sample of three plants from each experimental plot was taken at flower initiation stage (120 days after planting) and vegetative data recorded were number of main shoots per plant, number of lateral shoots per plant and total chlorophyll content on leaves.

Tuber yield and tuber physical characteristics: At the harvest time of both seasons, after 254 days from planting, all tubers were harvested and collected per plot and total number of tubers per plant as well as weight of tubers per plant was calculated. Three random tubers were weighed and average tuber weight was calculated, also tuber volume was determined by using displacement method and average tuber volume was then calculated. Consequently, Specific gravity was determined by dividing tuber weight by its volume, Specific gravity = Weight in air / (Weight in air - Weight in water) (Edgar, 1951).

Table (1): The physical and chemical properties of the experiments soil

	Ec ds/cm	0.33
	PH	7.19
Soluble cations (meq/l)	Mg	0.1
	Na	1.002
	K	0.2774
Soluble anions (meq/l)	cl^{-1}	2.337
	Hco_3^{-1}	1.886
Mechanical analysis	Sand	23.8
	Silt	41.7
	Clay	34.5
	N	66.11 ppm
	P	17.586 ppm
	K	284.18 ppm
$Caco_3$		3.703%

Chemical Components:

The fifth top fully expanded leaf blade was collected from six plants within each treatment as a sample for determining Mg and K concentrations in leaves. In addition, ten uniform tubers were randomly chosen from each sub plot at harvesting time. Samples of peeled, sliced tubers were used after oven-dried at 60-75 ^{o}c in an air forced ventilated oven until constant weight for determination of the chemical constituents of tubers. i.e., potassium and magnesium were determined in dry matter of the plant as well as in tubers. Potassium percentage was determined by using flame photometer according to Brown and lilliland (1946) while, Magnesium content was determined by using atomic absorption spectrometer as the method described by Rawe (1973) and expressed as ppm. Chlorophyll measuremed by A.O.A.C (1995), Total carbohydrates of tubers were determined colorimetrically according to anthirone method. Reducing sugars were determined in dry matter of random tuber samples from each experimental plot at harvest in the end of season by di nitro salicylic acid Inulin content was determined in tubers according to the method of winton and winton (1958).

Storability:

Jerusalem artichoke tubers were harvested and weighted, then they were divided into two parts, one of them were stored at the field, while the other one were kept at refrigerator at 4 °c and 85 -95 % RH , both parts were stored for 45, and 90 days. Tubers were weighted again after each of these two periods and the decrease of weight according to storage loss were calculated.

The experimental design and statistical analysis

A split plot design with two factors was used and because of more sensitivity in stimulants effect and its interaction with cultivars was required compared to single cultivar effect, therefore, the main plots were assigned to the cultivars and the split plots were assigned to various stimulants treatments. All treatments either main or sub ones were randomly distributed and the area of experimental unit was 15m^2 divided into 5 ridges. Each ridge was 60 cm in width and 5 m in length. Data analysis was carried out using Mstatc software. Analysis of variance (ANOVA) was performed and when significant differences existed ($p < 0.05$), the least significant difference (LSD; a=0.05) test was used as a means separation procedure between cultivars while duncan's multiple range test was used as a mean separation procedure between stimulants as well as the interaction between two factors.

RESULTS AND DISCUSSION

Vegetative characters:

It is clear from Table (2), that there is no significant difference between El-Balady and Fuseau cultivars for all studied vegetative characters in both seasons, except number of lateral shoots in the first season and total chlorophyll content in the second season since they gave significant values with the superiority of Fuseasu cultivars which exceeded El-Balady cultivar. In This concern Ragab *et al.* (2003) reported that there were no significant differences between El-Balady and Fuseau cultivar for number of main shoots per plant. On the contrary, he found that El-Balady cultivar had significant increment in lateral shoots per plant compared with Fuseau cultivar.

Concerning the effect of growth stimulants, the application of either seaweed extract or yeast extract gave the highest values for all characters and they are not statistically different.

Regarding the interaction between cultivars and growth stimulants, it is clear from Table (3), that the combination of Fuseau + seaweed, Fuseau + yeast extract and El-Balady + seaweed extract gave the highest significant values wheres the control treatment El-Balady cv. Spraying with tap water gave the lawest values of all the above mentioned characters..

The positive effects of dry yeast application were reflected its significance as a natural source of cytokinins, enzymes, amino acids, vitamins and minerals (Khedr and Farid, 2002; Mahmoud, 2001). It was reported that, dry yeast has stimulatory effects on cell division and enlargement, nucleic acid synthesis, protein and chlorophyll formation (Kraig and Haber, 1980; Castelfranco and Beale, 1983).

The promoting effect of seaweed application on vegetative growth bulbs may be due to the seaweed extract contains growth promoting hormones (IAA and IB A), cytokinins, trace elements (Fe, Cu, Zn, Co, Mo, Mn, Ni) ,vitamins and amino acids . (Challen, and Hemingway,1965). The enhanced plant growth effects in seawed extract-treated plants may be affected by auxins, gibberellins, cytokinins, precursors of ethylene and betaine and cytokinins which are present and potentially involved in enhancing plant growth responses (Stephen *et al.,* 1985). In the present study, enhancement of foliage plant growth could be the result of the hormonal activity of the seaweed extract (Crouch and Staden, 1993).These results are in agreement with.Abdel-Mawgoud, *et al.* (2010), on watermelon and Ghoname *et al*., (2010) on sweet pepper, who reported significant effect of either seaweed or yeast in the enhancement of vegetative growth characters.

Table (2). Effect of cultivar and growth stimulants on vegetative growth characters of Jerusalem artichoke during 2011/2012 and 2012/2013 seasons.

	Main shoots No./plant		**Lateral shoots No./plant**		**Total Chlorophyll Mg/gm f.w**	
	1st season	**2nd season**	**1st season**	**2nd season**	**2nd season**	**1st season**
Cultivars						
El-Balady	5.85 A	3.88 A	74.01 B	68.06 A	1.70 A	1.64 B
Fuseau	6.66 A	3.98 A	82.14 A	69.11 A	1.77 A	1.78 A
Growth stimulants						
Chitosan	6.43 A	4.13 AB	78.01 B	70.77 AB	1.73 B	1.69 CD
Humic acid	6.24 A	3.99 ABC	82.53 AB	69.71 AB	1.74 B	1.67 CD
Potassium	6.56 A	3.69 CD	78.59 AB	66.45 B	1.70 B	1.62 DE
Seaweed	6.40 A	4.17 A	85.46 A	76.00 A	1.90 A	1.84 AB
Yeast	6.43 A	4.11 AB	85.52 A	72.84 AB	1.79 AB	1.86 A
Amino acids	6.54 A	3.80 BCD	79.97 AB	68.24 AB	1.77 AB	1.75 BC
Tap water (control)	5.20 B	3.63 D	56.46 C	56.06 C	1.52 C	1.54 E

Means followed by the same letter (s) are not significantly different at 5% level (Duncan's Multiple Range Test).

Table (3). Effect of interaction between cultivars and growth stimulants on vegetative growth characters of Jerusalem artichoke during 2011/2012 and 2012/2013 seasons

		Main shoots No /plant		Lateral shoots No/plant		al chlorophyll (mg/g)	
Cultivars	Stimulants	1st season	2nd season	1st season	2nd season	1st season	2nd season
El-Balady	Chitosan	5.637 CDE	4.083 A	75.32 BC	70.73 ABC	1.657 BCDE	1.533 EF
	Humic acid	5.553 DE	4.047 AB	78.87 ABC	72.30 AB	1.720 ABCD	1.567 EF
	Potassium	6.333 ABCD	3.547 B	69.81 CD	62.38 BCD	1.610 CDE	1.490 F
	Seaweed	6.060 BCD	4.193 A	82.98 AB	79.28 A	1.883 A	1.747 BCD
	Yeast	6.297 ABCD	4.077 A	85.18 AB	72.55 AB	1.760 ABCD	1.843 AB
	Amino acids	6.107 BCD	3.697 AB	75.35 BC	65.41 BCD	1.803 ABC	1.843 AB
	Tap water	4.977 E	3.540 B	50.54 E	53.76 D	1.480 E	1.487 F
Fuseau	Chitosan	7.223 A	4.180 A	80.69 AB	70.80 ABC	1.803 ABC	1.843 AB
	Humic acid	6.920 AB	3.933 AB	86.18 A	67.12 ABC	1.760 ABCD	1.773 ABC
	Potassium	6.793 AB	3.840 AB	87.37 A	70.53 ABC	1.797 + ABC	1.760 BC
	Seaweed	6.743 AB	4.153 A	87.94 A	72.72 AB	1.913 A	1.940 A
	Yeast	6.563 ABC	4.147 A	85.85 A	73.12 AB	1.827 AB	1.887 AB
	Amino acids	6.967 AB	3.903 AB	84.58 AB	71.07 ABC	1.747 ABCD	1.657 CDE
	Tap water	5.423 DE	3.727 AB	62.38 D	58.37 CD	1.560 DE	1.590 DEF

Means followed by the same letter (s) are not significantly different at 5% level (Duncan's Multiple Range Test

Yield and tuber physical characteristics:

According to data presented in Table (4), it is clear that the effect of cultivar had insignificant values for all yield and tubers physical characteristics in both seasons except in two cases Viz., the weight of tubers per plant where it exhibited significant values in both seasons and average tuber volume in the first season, furthermore, the two characters had greater values of Fuseau cultivar than El-Balady cultivar with values of 1.908 and 1.815 kg/plant for tubers weight per plant and 85.43 for average tuber volume in the first season. These results do not coincide with Ragab *et al* (2003), who found that El-Balady cultivar exceeded Fuseau cultivar for tuber yied and tuber physical characteristics.

Yield and tuber physical characteristics were significantly influenced by growth stimulants applications. It could be generally concluded that, the application of either seaweed or yeast gave highest significant values for all characters expect specific gravity and weight of tubers per plant. Specific gravity was increased by applied of potassium in both seasons and they are not statistically different in most cases. On the other hand, the application of tap water (control treatment) gave the lowest values for all characters.

From Table (5), it could be generally concluded that the interaction effect between cultivars and growth stimulants indicated that the application of Fuseau + seaweed, Fuseau + yeast had the maximum significant values for all studied characters in both seasons. And they did not differ significantly from the combination of chitosan with Fuseau cultivar in most cases, on the contrary the control treatment had the lowest values for all characters.

Table (4): Effect of cultivar and growth stimulants on tuber yield and tuber physical characteristics of Jerusalem artichoke during 2011/2012 and 2012/2013 seasons.

	No of tubers/plant		Weight of tubers/plant (kg)		Average tuber weight (g)		Average tuber volume (cm^3)		Specific gravity	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cultivars										
El-Balady	83.04 A	71.26 A	1.482 B	1.480 B	58.24 A	55.38 A	62.51 B	58.40 A	0.904 A	0.9043 A
Fuseau	86.67 A	70.16 A	1.908 A	1.815 A	63.94 A	57.95 A	85.43 A	65.08 A	0.901 A	0.9014 A
Growth stimulants										
Chitosan	83.19 B	76.57 AB	1.737 AB	1.650 A	61.03 B	58.24 AB	81.07 A	63.55 ABC	0.903 AB	0.9000 A
Humic acid	83.00 B	71.69 BCD	1.688 B	1.658 A	62.30 AB	55.35 B	74.76 B	64.56 ABC	0.928 AB	0.9117 A
Potassium	83.18 B	69.69 CD	1.722 AB	1.675 A	58.43 B	52.86 BC	71.67 BC	60.58 BC	0.948 A	0.9617 A
Seaweed	90.28 A	75.54 ABC	1.753 AB	1.765 A	67.60 A	63.44 A	75.95 AB	64.97 AB	0.918 AB	0.9150 A
Yeast	91.76 A	79.08 A	1.817 A	1.732 A	67.83 A	63.15 A	74.05 BC	65.71 A	0.880 AB	0.9183 A
Amino acids	86.50 AB	67.82 D	1.650 B	1.593 A	58.89 B	54.62 B	72.37 BC	59.79 C	0.913 AB	0.9100 A
Tap water (control)	76.07 C	54.57 E	1.498 C	1.457 A	51.57 C	48.98 C	67.92 C	53.03 D	0.828 B	0.8033 B

Means followed by the same letter (s) are not significantly different at 5% level (Duncan's Multiple Range Test).

Table (5). Effect of interaction between cultivars and growth stimulants on tuber yield and tuber physical characteristics of Jerusalem artichoke during 2011/2012 and 2012/2013 seasons.

		No of tubers/plant		Weight of tubers/plant (kg)		Average tuber weight		Average tuber volume		Specific gravity	
Cultivars	Stimulants	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
El-Balady	Chitosan	79.62 CD	75.43 AB	1.423 EF	1.527 ABC	56.14 CDE	51.50 DE	68.80 C	60.48 BC	0.993 A	0.913 ABC
	Humic acid	83.35 BCD	75.50 AB	1.423 EF	1.463 ABC	60.20 BCD	55.37 BCD	68.53 CD	62.74 ABC	0.893 AB	0.907 ABCD
	Potassium	80.04 CD	70.94 BC	1.557 DE	1.463 ABC	55.09 DE	51.62 DE	60.97 CDE	56.14 C	0.967 AB	0.900 ABCD
	Seaweed	85.26 BC	73.81 ABC	1.540 DE	1.603 ABC	66.71 AB	65.25 A	63.50 CDE	62.62 ABC	0.893 AB	0.917 ABC
	Yeast	91.17 AB	77.28 AB	1.623 D	1.567 ABC	65.59 AB	63.98 A	61.10 CDE	61.88 BC	0.847 AB	0.920 ABC
	Amino acids	87.08 ABC	70.72 BC	1.470 EF	1.437BC	56.04 CDE	53.74 CDE	59.63 DE	55.60 CD	0.920 AB	0.957 AB
	Tap water	74.79 D	55.15 D	1.337 F	1.297 C	47.93 E	46.18 E	55.07 E	49.33 D	0.817 B	0.817 CD
Fuseau	Chitosan	86.77 ABC	77.72 AB	2.050 A	1.773 AB	65.92 AB	64.97 A	93.34 A	66.62 AB	0.813 B	0.887 BCD
	Humic acid	82.65 BCD	67.87 BC	1.953 ABC	1.853 AB	64.39 ABC	55.33 BCD	81.00 B	66.38 AB	0.963 AB	0.917 ABC
	Potassium	86.32 ABC	68.44 BC	1.887 BC	1.887 AB	61.76 ABCD	54.10 BCDE	82.37 B	65.02 AB	0.930 AB	1.023 A
	Seaweed	95.31 A	77.28 AB	1.967 ABC	1.927 A	68.48 AB	61.62 ABC	88.40 AB	67.32 AB	0.943 AB	0.913 ABC
	Yeast	92.34 AB	80.88 A	2.010 AB	1.897 AB	70.07 A	62.31 AB	87.00 AB	69.54 A	0.913 AB	0.917 ABC
	Amino acids	85.92 ABC	64.91 C	1.830 C	1.750 ABC	61.73 ABCD	55.51 BCD	85.11 AB	63.98 AB	0.907 AB	0.863 BCD
	Tap water	77.34 CD	54.00 D	1.660D	1.617 ABC	55.21 DE	51.78 DE	80.78 B	56.74 C	0.840 AB	0.790 D

Means followed by the same letter (s) are not significantly different at 5% level (Duncan's Multiple Range Test).

The positive effects of applying active yeast extract and seaweed extract were attributed to its own contents of different nutrients, high percentage of protein, large amounts of vitamin B and natural plant growth regulators such as cytokinins (Glick, 1995 and Fathy and Farid, 1996); physiological roles of vitamins and amino acids in the yeast and seaweed extract which increased the metabolic processes role and levels of endogenous hormones, i.e., IAA and GA_3 (Chaliakhyan, 1957 and Sarhan and Abdullah, 2010) which may promoted the vegetative growth characters which in turn reflected on increasing the tubers yield and enhancing the tubers quality. These results coincide with those obtained by Crouch and Van Staden (1993)., (Ghoname *et al*., 2010), El-Tohamy (2008), who found significant positive effect of either seaweed or yeast on various crops.

Chemical components:

Data illustrated in Table (6), show that the effect of cultivars was insignificant for all chemical components in both seasons, except the percentage of leaves content of potassium in both season, tubers content of magnesium in the second season, carbohydrates percentage in the second season which showed significant values with the superiority of Fuseau cultivar over El-Balady cultivar. In this concern, Ragab *et. al*., (2003), reported that there were no significant differences between El-Balady cultivar and Fuseau cultivar for Inulin content, carbohydrates percentage, or reducing sugars percentage.

Table (6). Effect of cultivar and growth stimulants on chemical components characters of Jerusalem artichoke during 2011/2012 and 2012/2013 seasons

	K % (Leaves)		K % (tubers)		Mg leaves (ppm)		Mg tubers (ppm)		Inulin (g /100 g) tuber f.w		Carbohydrates (%)in tuber		Reducing sugars (%) In tuber	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cultivars														
El-Balady	2.563 B	2.372 B	1.718 A	1.379 A	2.961 A	1.909 A	1.405 A	1.115 B	9.011 A	8.505 A	29.38 A	23.17 B	0.6571 A	0.755 A
Fuseau	2.750 A	2.708 A	1.778 A	1.464 A	2.995 A	1.887 A	1.391 A	1.181 A	9.201 A	8.895 A	29.48 A	24.57 A	0.6229 A	0.764 A
Growth stimulants														
Chitosan	2.562 C	2.493 BC	1.707 B	1.493 B	3.233 A	1.917 A	1.518 A	1.163 A	9.467 AB	9.167 AB	30.33 AB	24.96 AB	0.6833 A	0.783 AB
Humic acid	2.597 C	2.397 C	1.733 B	1.348 C	3.202 A	1.915 A	1.488 AB	1.182 A	8.733 BC	8.283 C	28.37 BC	24.17 AB	0.6083 AB	0.692 CD
Potassium	2.945 A	2.755 A	2.135 A	1.685 A	2.785 A	1.937 A	1.362 BC	1.217 A	8.617 BC	8.700 BC	28.67 BC	23.40 B	0.6567 A	0.750 BC
Seaweed	2.737 BC	2.553 BC	1.700 B	1.413 BC	2.935 A	1.988 A	1.438 ABC	1.217 A	10.35 A	9.633 A	30.91 AB	25.59 A	0.6850 A	0.825 A
Yeast	2.818 AB	2.595 AB	1.858 B	1.478 BC	3.040 A	1.997 A	1.468 ABC	1.138 A	10.57 A	9.600 A	31.68 A	24.64 AB	0.6917 A	0.847 A
Amino acids	2.670 BC	2.585 AB	1.753 B	1.402 BC	2.843 A	1.907 A	1.332 C	1.138 A	8.267 BC	8.133 CD	28.63 BC	23.87 AB	0.6017 AB	0.743 BCD
Tap water (control)	2.267 D	2.402 C	1.350 C	1.128 D	2.810 A	1.623 B	1.178 D	0.9833 B	7.740 C	7.383 D	27.43 C	20.49 C	0.5533 B	0.675 D

Means followed by the same letter (s) are not significantly different at 5% level (Duncan's Multiple Range Test).

Generally, It could be also concluded that, the application of either foliar spray with potassium or yeast extract gave the highest significant values for both potassium content and magnesium content in either leaves or in tubers in both seasons. For the rest of chemical components characters, the foliar application of seaweed as well as yeast extract gave the highest values for inulin, carbohydrate content, reducing sugars contents. On the contrary, control treatment (tab water) had the lowest values for all studied characters

Concerning Interaction effect from Table (7), it is clear that the application of Fuseau + potassium, Fuseau + seaweed, and Fuseau + yeast gave the highest values for all chemical components characters and they did not differ significantly. Also, they are did not differ significantly from the application of El-Balady + potassium, El-Balady + seaweed, and El-Balady + yeast in some characters. Indicating the superiority of combination of Fuseau cultivar with any of potassium, seaweed, or yeast treatments, as found in previous results, the application of tab water, gave the lowest values.

Table (7). Effect of interaction between cultivars and growth stimulants chemical components characters of Jerusalem artichoke during 2011/2012 and 2012/2013 seasons.

		K % (Leaves)		K % (tubers)		Mg leaves (ppm)		Mg tubers (ppm)	
Cultivars	Stimulants	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
El-Balady	Chitosan	2.330 EF	2.260 F	1.680 B	1.437 BC	3.050 A	1.817 CD	1.577 AB	1.103 ABC
	Humic acid	2.453 DEF	2.310 EF	1.687 B	1.350 C	3.317 A	1.980 ABC	1.580 A	1.130 ABC
	Potassium	2.887 AB	2.627 BCD	2.127 A	1.597 B	2.473 A	1.943 ABCD	1.367 BCDE	1.207 A
	Seaweed	2.580 CDE	2.243 F	1.663 B	1.353 C	3.060 A	1.987 ABC	1.447 ABCD	1.223 A
	Yeast	2.760 ABC	2.283 EF	1.823 B	1.420 BC	3.067 A	2.027 A	1.373 ABCDE	1.070 ABC
	Amino acids	2.680 BCD	2.533 CDE	1.693 B	1.363 C	2.993 A	2.017 AB	1.357 CDE	1.100 ABC
	Tap water	2.253 F	2.347 EF	1.353 C	1.130 D	2.770 A	1.590 F	1.133 F	0.9733 C
Fuseau	Chitosan	2.793 ABC	2.727 ABC	1.733 B	1.550 BC	3.417 A	2.017 AB	1.460 ABCD	1.223 A
	Humic acid	2.740 ABC	2.483 CDEF	1.780 B	1.347 C	3.087 A	1.850 BCD	1.397 ABCDE	1.233 A
	Potassium	3.003 A	2.883 AB	2.143 A	1.773 A	3.097 A	1.930 ABCD	1.357 CDE	1.227 A
	Seaweed	2.893 AB	2.863 AB	1.737 B	1.473 BC	2.810 A	1.990 AB	1.430 ABCDE	1.210 A
	Yeast	2.877 AB	2.907 A	1.893 B	1.537 BC	3.013 A	1.967 ABC	1.563 ABC	1.207 A
	Amino acids	2.660 BCD	2.637 BCD	1.813 B	1.440 BC	2.693 A	1.797 DE	1.307 DEF	1.177 AB
	Tap water	2.280 F	2.457 DEF	1.347 C	1.127 D	2.850 A	1.657 EF	1.223 EF	0.9933 BC

Means followed by the same letter (s) are not significantly different at 5% level (Duncan's Multiple Range Test).

Table (7): Cont.

		Inulin (g/100g) tuber f.w		Carbohydrates (%)in tubers		Reducing sugars (%) in tubers	
Cultivars	Stimulants	1st season	2nd season	1st season	2nd season	1st season	2nd season
El-Balady	Chitosan	9.833 ABC	9.067 ABC	29.76 ABC	24.54 ABCD	0.740 AB	0.793 ABCD
	Humic acid	8.800 BCD	7.733 DEF	28.39 BC	24.54 ABCD	0.603 BCD	0.690 DE
	Potassium	8.233 CD	8.667 BCDE	28.09 BC	22.07 DEF	0.6200 BCD	0.757 CDE
	Seaweed	10.50 AB	9.567 AB	30.76 AB	24.37 ABCD	0.710 ABC	0.777 BCD
	Yeast	10.37 AB	9.167 ABC	32.22 A	22.99 CDEF	0.780 A	0.887 A
	Amino acids	7.800 D	8.133 CDEF	29.52 ABC	23.45 BCDE	0.627 BCD	0.720 CDE
	Tap water	7.547 D	7.200 F	26.93 C	20.26 F	0.520 D	0.660 E
Fuseau	Chitosan	9.100 ABCD	9.267 ABC	30.90 AB	25.38 ABC	0.627 BCD	0.773 BCD
	Humic acid	8.667 BCD	8.833 ABCD	28.35 BC	23.80 BCD	0.613 BCD	0.693 DE
	Potassium	9.000 ABCD	8.733 BCDE	29.25 ABC	24.73 ABCD	0.693 ABC	0.743 CDE
	Seaweed	10.21 AB	9.700 AB	31.06 AB	26.81 A	0.660 ABC	0.873 AB
	Yeast	10.77 A	10.03 A	31.14 AB	26.29 AB	0.603 BCD	0.807 ABC
	Amino acids	8.733 BCD	8.133 CDEF	27.74 BC	24.30 ABCD	0.577 CD	0.767 CD
	Tap water	7.933 CD	7.567 EF	27.93 BC	20.71 EF	0.587 CD	0.690 DE

Means followed by the same letter (s) are not significantly different at 5% level (Duncan's Multiple Range Test).

These results may be due to the seaweed extract may be due to presence of some growth promoting substance (IAA, IBA, Gibberellins, Cytokinins, Vitamins and Amino acid).Also, Beneficial effects of yeast may be due to it is a natural source of cytokinins, enzymes, amino acids, vitamins and minerals (Khedr and Farid, 2002; Mahmoud, 2001).

The previous results are coincide with those obtained by Ali and Taalab (2008), and Abdel-Mawgoud, *et al.* (2010), found positive effect of seaweed on chemical components of watermelon plants. Also Ghoname *et al.,* (2010) found in sweet pepper that the foliar application of yeast had positive effects on phosphorus and potassium contents in the leaves. These results are in disagreement with Fawzy *et al.,* (2012) showed that foliar spraying of seaweed extract on Chinese garlic failed to reach of significant in K%.

Stroability:

Figures (1), shows that the difference between both cultivars was significant only in two characters Viz., the weight losses percentage after 45 days in fridge storage and the weight losses percentage after 90 days in field storage. With the superiority of Fuseau cultivars for the weight losses percentage of tubers after 90 days of storage in the fridge in the first season, where it showed less significant value, while

El-Balady cultivar was gave lowest value for the weight losses percentage of tubers after 90 days after storage in the field in the first season.

Figure (2), indicates that chitosan application was the most effective treatment for reducing the losses percentage of tubers during either fridge storage or field storage since it gave the lowest values for the two seasons of experiment.

It is clear from Figure (3), that the most desirable lower values of the weight losses percentage of tubers occurred during either storage in the filed or in the fridge were obtained by chitosan application accompanied with either E-Balady or Fuseau cultivars.

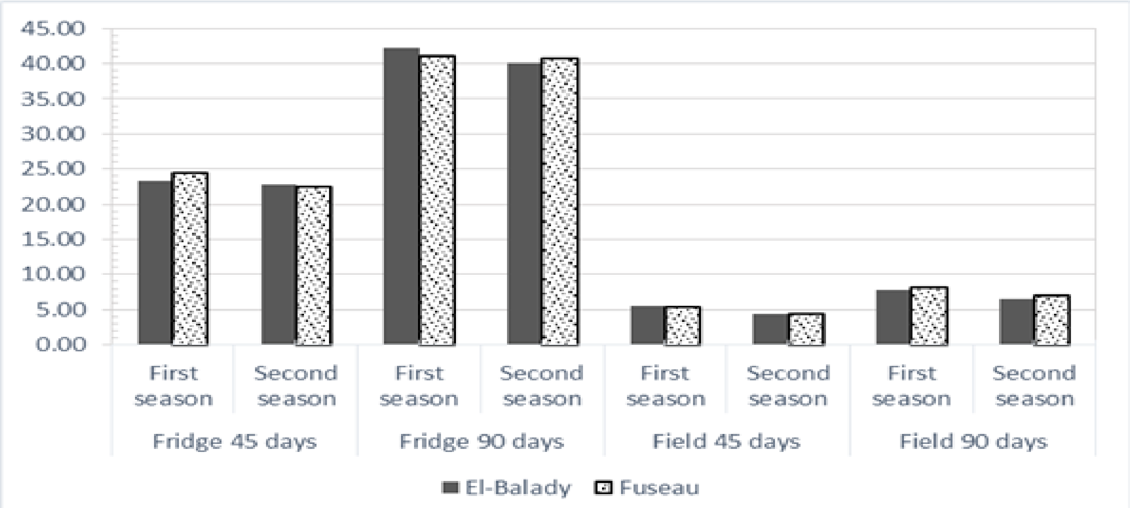

Figure 1: Effect of Cultivars on weight loos percentage of Jerusaem artichoke plants in 2011/2012 and 2012/2013 seasons.

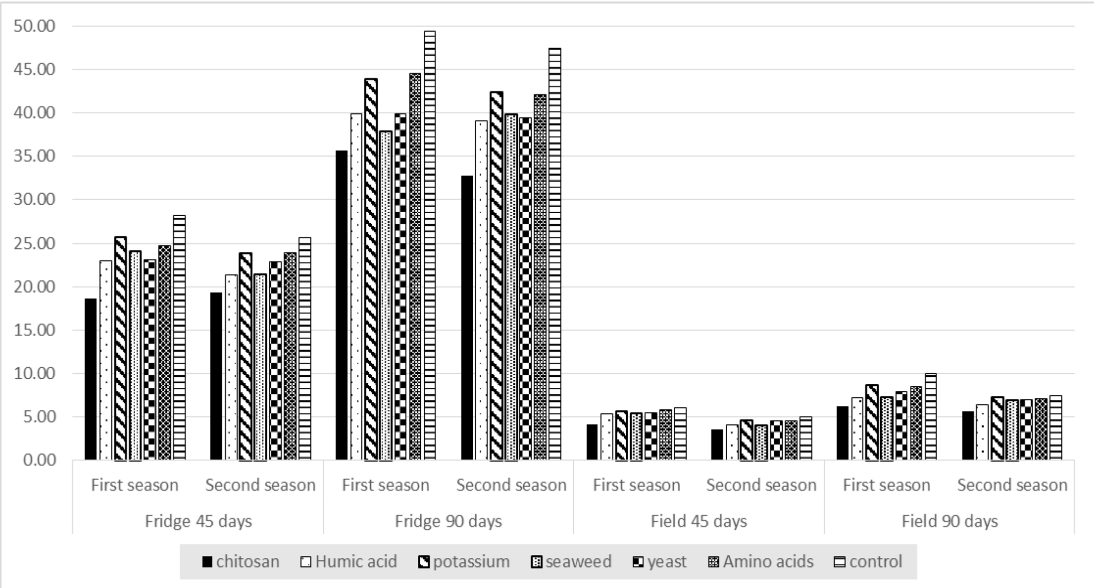

Figure 2: Effect of growth stimulants on weight loos percentage of Jerusaem artichoke plants in 2011/2012 and 2012/2013 seasons

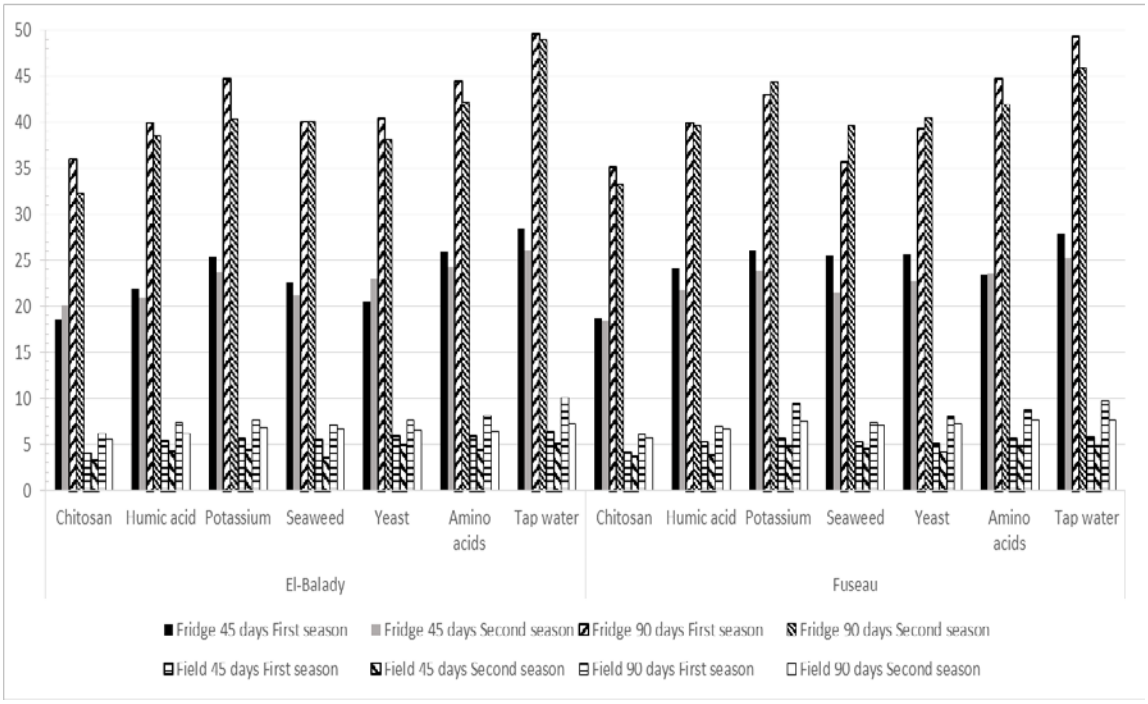

Figure 3: Effect of Interaction between cultivars and growth stimulants on weight loos percentage of Jerusaem artichoke plants in 2011/2012 and 2012/2013 seasons.

These results may be due to the beneficial effects of chitosan on plant storability of garlic bulbs may come to the positive effect of chitosan coatings is related to its ability to extend the storage life of fruits and vegetables. Chitosan forms a semipermeable film that regulates the gas exchange and reduces transpiration loses and fruit ripening is slowed down. Because chitosan is applied as a coating, generally respiration rate and hence water loss is reduced (Shehata *et al*. 2012).

CONCLUSIONS

In general, foliar application of yeast at 5 g/l and seaweed extract at can be recommended for improving growth, yield, and quality of Jerusalem artichoke. Also, foliar application of chitosan extract at 1ml/l can be used for improving storability of Jerusalem artichoke under the conditions of the experiment, as indicated in this work.

REFERENCES

Abdel-Mawgoud, A. M.R., A. S Tantawy, M. A. EL-Nemr and Y. N. Sassine (2010). Growth and yield responses of strawberry plants to chitosan application. European Journal of Scientific Research,39(1):161-168.

Ali, A. H. and A. S. Taalab (2008). Effect of natural and /or chemical potassium fertilizers on growth, bulbs yield and some physical and chemical constituents of onion (*Allium cepa*, L.). Res.J.Agric.&biology. Sci.,4(3):228 237.

A.O.A.C. (1995). Official method of analysis 16th Ed., Association of Official Analytical Chemists International, Arlington Virginia, USA.

Ben-Chekroun, M., J. Amzile and M. El Yachioui (1994). Qualitative and quantitative development of carbohydrate reserves diu-ing the biological cycle of jerusalem artichoke *(Helianthus tuherosus* L.) tubers. New Zealand, J. of Crop and Hort. Sci. 22, 31-37.

Ben-Chekroun, M., J. Amzile, A. Mokhtari, N.E. El Haloui and J. Prevost (1997). Qualitative change of carbohydrate content of two varieties of jerusalem artichoke tubers *(Helianthus tuherosus* L.) during cold storage conditions (4^0C). J. Agronomy & Crop Sci., 179, 129-133.

Brown, J. D. and O. Lilliland (1946). Rapid determination of potassium and sodium in plant material and soil extracts by flame photometry. Proc.Amer. Soc. Horticulture. Sci., 48:341-346.

Castelfranco, P.A. and S.I. Beale (1983). Chlorophyll biosynthesis recent advances and areas of current interest. Ann. Rev. Plant Physio,34:241-278.

Chaliakhyan, M.K. (1957). Effect of vitamins on growth and development of plants.DoklyAkad.Nauk. SSSK, III: 894-897.

Crouch, I.J. and J. Van Staden (1993). Effect of seaweed concentrate from Ecklonia maxima [Osbeck] paenfess on Melodogyre incognita infestation on tomato. J. Applied Phycol., 5: 37-43.

Fawzy, Z. F., Z. S. El-Shal, Li Yunsheng, Ouy.ang Zhu and Omaima M. Sawan (2012). Response of Garlic (*Allium Sativum,* L.) Plants To Foliar Spraying of Some Bio-Stimulants Under Sandy Soil Condition. Journal of Applied Sciences Research, 8(2): 770-776, 2012.

Challen, S. B. and J .C. Hemingway (1965). Growth of Higher plants in response t0 feeding with seaweed extracts.Proc.5^{th} Ind.Seaweed Symp.

Crouch, I.J. and van J. Staden (1993). Evidence for the presence of plant growth regulators in commercial seaweed products. Plant Growth Regul., 13:21–29.

Edgar, A.D. (1951). Determining the specific gravity of individual potatoes. American Potato Journal, 28: 229-231.

Fathy, E.S.L. and S. Farid (1996). The possibility of using vitamin B and yeast to delay senescence and improve growth and yield of common beans (Phaseolus vulgarisL) J. Agric. Sci. Mansoura Univ., 21(4): 1415-1423.

Ghoname, A. A., M.A. El-Nemr, A.M.R Abdel-Mawgoud and W. A. El-Tohamy (2010). Enhancement of Sweet Pepper Crop Growth and Production by Application ofBiological, Organic and Nutritional Solutions . Australian Journal of Basic and Applied Sciences, 5(5): 670-677, 2011

Glick. B.R. (1995). the enhancement of plant growth by free living bacteria. Canad. J. Microbiology, 41: 109-117.

Hadwiger, L.A., S.J. Klosterman and J.J. Choi (2002). The mode of action of chitosan and its oligomers in inducation plant ptomoters and developing disease resistance in plants, In: K.Suchiva, S.Chandrkrachang, P.Methacanon and M.G. Peter (eds.), Advances in chitin science, vol. Bangkok, pp.452-457

Kowalczyk, K. and T. Zielony (2008). Effect of aminoplant and asahi on yield and quality of lettuce grown on rockwool. Proc. Conf. of Biostimulators in Modern Agriculture, 7-8 Febuary, Warsaw, Poland

El-Tohamy, W.A., H.M. El-Abagy and H.M. El-Greadly (2008). Studies on the effect of putrescine, yeast and vitamin C on growth, yield and physiological responses of eggplant (Solanum melongena L.) under sandy soil conditions. Aust J Basic Appl Sci. 2 (2): 296-300.

Khedr, Z.M.A. and S. Farid (2002). Response of naturally virus infected tomato plants to yeast extract and phosphoric acid application. Annals of Agric. Sci. Moshtohor. Egypt, 38(2): 927-939.

Kraig, E. and J.E. Haber (1980). Messenger ribonucleic acid and protein metabolism during sporulation of Saccharomyces cerevisiae. J. Bacterial., 144: 1098-1112.

Mahmoud, T.R. (2001). Botanical studies on growth and germination of Magnolia (Magnolia grandifloraL.) Plants. M.Sc. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., 103 pp.

Marschner, H. (1995). Mineral nutrition of higher plants. London, England :Academic press.

Pinton, R., S. Cesco, S. Santi, F. Agnolon and Z. Varanini (1999). Waterextractable humic substances enhace iron deficiency responses by Fe deficient cucumber plants. Plant and Soil 210:145-157.

Qualls, R. and B.L. Haines (1991). Geochemistry of dissolved organic nutrients in water percolating through a forest ecosystem. Soil Sci. Soc. Am. J., 55: 1112-1123

Ragab, M.E., K.A. Okasha, I.I. El-Oksh and N.M. Ibrahim (2003). Effect of cultivar and location on yield, tuber quality, and storability of Jerusalem artichoke (*Helianthus tuberosus* L.) I. growth, yield, and tuber characteristics. Acta Hort. (ISHS) 620: 103-111.

Rawe, G. J. (1973). Food Analysis by Atomic Absorption Spectroscopy, Varian Techtorm. Australia, USA switzerl 1 and Pp: 89.

Sarhan, T. and O.K. Abdullah (2010). Effect of Azotobacterinoculation, dry bread yeast suspension and varying levels of urea on growth of potato Cv. Desiree. html/www.tropentage.de/2010/abstracts/full/628

Shehata, S.A., Z.F. Fawzy and H.R. El-Ramady (2012). Response of cucumber plants to foliar application of chitosan and yeast under greenhouse. Australian Journal of Basic and Applied Sci., 6(4): 63-71.

Sadasivam S. and Amanickam (1991). Biochemical methods for agricultural sciences pp 6-8.

Stephen, A. B. Tay, John K. Macleod, Lok Man S. Palnia and David S. Lethama (1985). Detection of cytokinins in a seaweed extract. Phytochemistry 24(1 1): 2 611-2 614.

Stevenson, F.J. (1994). Humic chemistry:Genesis, composition, reactions. New Yorc:John Wiley and Sons Univ., 29 (3): 1407-1422

Winton, A. L. and K. B. Winton (1958). The analysis of foods. John Wiley and Sons, Inc. London. 357 .

تأثير الصنف وبعض محفزات النمو على المحصول وجودة الدرنات والقدرة التخزينية لنبات الطرطوفه

محمد امام رجب[١] ، محمد السيد محمد أحمد[٢] ، عاصم عبد المجيد العربي[٢] ، رحاب محمد محضى[٢]

[١] قسم البساتين – كلية الزراعة –جامعة عين شمس

[٢] قسم البساتين – كلية الزراعة – جامعة طنطا

الملخص العربى

تم دراسة تأثير كلا من الصنف والرش الورقى ببعض محفزات النمو وكذلك التفاعل بين كلا من الصنف ومحفزات النمو على نمو وانتاجية وجودة الدرنات والقدرة التخزينية لنبات الطرطوفة ومن أجل تحقيق ذلك تم تصميم تجربة بنظام القطع المنشقة واستخدم فى التجربة صنفين هما البلدى وفيوزو تم توزيعهم على القطع الرئيسية بينما تم

استخدام ستة محفزات للنمو هى الشيتوسان ، حمض الهيوميك، مستخلص الطحالب البحرية، البوتاسيوم، الخميرة، الأحماض الأمينية بالاضافة الى الرش بماء الصنبور كمعاملة كنترول وتم توزيع معاملات محفزات النمو على القطع المنشقة ثم أخذت بعض القياسات الخضرية ، قياسات على محصول الدرنات ، الصفات الفيزيائية للدرنات وبعض المكونات الكيميائية لكل من الأوراق والدرنات. وحللت النتائج احصائيا باستخدام البرنامج الاحصائى Mstatc وعند وجود فروق معنوية بين متوسطات المعاملات تمت المقارنة بين المتوسطات باستخدام طريقة Duncan's Multiple Range Test

وأظهرت النتائج وجود فروق معنوية بين كلا من الصنفين البلدى وفيوزو فى عدد محدود من الصفات وكان التفوق واضحا للصنف فيوزو فى معظم هذه الصفات . كانت معاملات مستخلصات الطحالب البحرية والخميرة والشيتوسان هى أفضل المعاملات فى تحقيق أفضل نتائج وذلك على حسب الصفة. بينما كان تفوق الشيتوسان واضحا فيما يخص صفات الفقد فى الوزن اثناء التخزين حيث قلل من الفقد الناتج عن تخزين المحصول.

وكانت معاملات التفاعل انعكاسا لكلا من عاملى الأصناف ومحفزات النمو فبصورة عامة حققت التوليفات بين كلا من الصنف فيوزو وأيا من مستخلصات الطحالب البحرية، الخميرة أو الشيتوسان أفضل النتائج واختلفت أفضلية هذه المركبات باختلاف الصفات موضع الدراسة وان لم توجد فروق معنوية بينها فى معظم الحالات.