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EFFECT OF FOLIAR SPRAY WITH SEAWEEDS EXTRACT AND CHITOZAN ON EARLINESS AND PRODUCTIVITY OF GLOBE ARTICHOKE.

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ABSTRACT

Two field experiments were carried out during the two successive seasons of 2012/2013 and 2013/2014 at the Horticulture Research Farm of El-Bramoon, El-Dakahlia Governorate,, to investigate the response of globe artichoke plants cv. French, to foliar spray with seaweeds extract, chitozan levels and their combination on growth, earliness, quality, and productivity.

The main results can be summarized as follows:

1). The results indicated that increasing seaweeds extract and chitozan levels individual or in combination were accompanied with significant increases in vegetative growth characters (plant height, number and dry weight of leaves/ plant) and yield distribution (early, medium and late yields) compared with control.

2). Application of seaweeds extract, chitozan levels and their combination improved most head quality characteristics (head weight, diameter, receptacle fresh and dry weight as well as TSS). However, there were no significant differences in terms of head length in the two seasons.

3) Dry receptacle N, P, K, protein and total sugars contents were positively and significantly responded to application of seaweeds extract, chitozan levels and their combination in the two seasons, while inulin was affected in the second season only.

The combination between chitozan 2ml/Land seaweeds 2g/L as foliar application, seemed to be the most effective treatment, which gave a balanced vegetative growth, a higher early and total yield as well as a good quality. Moreover, this particular treatment combination was more beneficial compared to all other treatments.

Keywords: globe artichoke, seaweeds extract**,** chitozan

INTRODUCTION

Globe artichoke *(Cynara scolymus L*.) belongs to composite family. It is one of the most important vegetable crops grown in Egypt for local markets and exportation. Great attention is giving recently by the Egyptian government to promote globe artichoke production to satisfy the increased demands for local and foreign markets. The period from December to February is the best time for exportation to European countries, this represents a vital importance since production is low and prices are high which affects the net income of globe artichoke production (Okàsha *et al.,* 1997). Thus, factors affecting the early production during this period are of major importance for promoting exportation to European markets since the peak of production occurs usually during March to May. Among these factors seaweeds extract and chitozan, have received the most attention for stimulate and enhance growth and productivity of many vegetable crops.

The application of seaweeds extract for different crops is a great importance due to its contents of high levels of organic matter, essential macro and micro nutrients and vitamins (Crouch and Van-staden, 1992).

Additionally, they contain growth promoting substances, i.e. cytokinins, auxin and abscisic acid which stimulate plant growth and yield and enhance plant tolerance to environmental stress (Zhang *et al.,* 2003), increase nutrient acquisition (Turan and Kose, 2004) and enhance antioxidant Properties (Vernieri, 2005). The beneficial effect of seaweeds extract application is as a result of many components that may work synergistically at different concentrations, although the mode of action still unknown (Fornes *et al.,* 2002 and Shehata *et al.,* 2011). The simulative effects of seaweed products on the plants are well documented. The using of seaweed products improve seeds germination, seedlings development, increase plant tolerance to environmental stresses (Zhang and Ervin, 2004 and 2008), and enhance plant growth and yield (Hong *et al,* 2007; Zodape et al, 2008; Khan *et al.,* 2009; Kumar *et al,* 2012; Craigie, 2011). More over seaweeds are used as soil amendment (Gandhiyappan and Perumal, 2001), in pests control (Hong *et al,* 2007) and plant diseases management (Jayaraj *et al,* 2008).Seaweeds have been also reported to produce beneficial effects on cereals, pulses and flowering plants (Sekar *et al.,* 1995) as well as some vegetable crops (Fawzy *et al.,* 2012) on garlic and (Shehata *et al.,* 2012) on cucumber.

Chitosan is the second abundant polysaccharide next to cellulose, it is a natural biodegradable compound derived from crustaceous shells such as crabs and shrimps, whose main attributes corresponds to its polycationic nature (Bautista-Baños *et al.,* 2006). It has received much attention as a functional biopolymer with applications in agriculture, pharmaceuticals, food, cosmetics and medicines. Agricultural applications of chitosan can reduce environmental stress due to drought and soil deficiencies, increase yields, improve quality, and improve storability of postharvest fruits and vegetables (El Ghaouth *et al.,* 1991 and Linden and Stoner, 2007).

Also, chitosan increases photosynthesis, promotes and enhances plant growth, stimulates nutrient uptake, increases germination (Kim *et al.,* 2005). Many investigators reported that using chitosan as foliar spray increased vegetative growth, yield and quality of some vegetable crops (Abdel-Mawgoud *et al.,* 2010; Kamal and Ghanem 2011 and Fawzy *et al.,* 2012).

The present study aims to investigate the effect of foliar application with seaweeds extract and chitosan levels individual or in combination on Vegetative growth, inducing earliness, improving yield and quality of globe artichoke heads, for both export and local consumption.

MATERIALS AND METHODS

Two field experiments were conducted at the Baramoon Research Station, Mansoura, Dakahlia Governorate, Egypt (+ 7m altitude, 30^{o} 11^{-} latitude and 28^{o} 26^{-} longitude), during seasons of 2012/13 and 2013/14, to study the effect of foliar spray with seaweeds extract and chitozan levels individual or in combination on earliness and productivity of Globe artichoke (*Cynara scolymus* L.).

Table 1 shows some physical and chemical properties of the experiment soil before planting, according to the methods described by Black (1982).

Table 1:Some physical and chemical properties of the experimental soil.

Physical properties	Value		Chemical Properties	Value	
	1st season	2nd season		1st season	2nd season
Sand (%)	27.2	27.5	pH value	8.1	7.9
Silt (%)	31.5	31.4	EC dSm^{-1} in soil paste	0.9	0.8
Clay (%)	41.3	41.1	Total N (%)	0.03	0.04
Texture class	**Clay-loam**	**Clay-loam**	Available P (ppm)	11.3	11.5
$CaCO_3$	3.1	3.2	Available K (ppm)	306	298
Organic matter (%)	1.4	1.2			

Experimental design was randomized complete block with three replicates. The planting dates were 15 and 19 of August in the 1st and 2nd seasons, respectively. the old grown pieces (stumps) were treated pre-planting with fungicides for 30 minutes and hand planted at 1m apart between each two plants on the ride and 1m between the ridges, plot area was $25m^2$(5 lines × 5 m long × 1 m width). Pest control and other agriculture practices were applied as commonly recommended for commercial Globe artichoke production by Ministry of Agriculture.

The experiment included the treatments as follows:

1-control (tap water)
2-chitozan 1ml/L
3- chitozan 2ml/L
4- seaweeds 1g/L
5- seaweeds 2g/L
6- chitozan 1ml/L+ seaweeds 1g/L
7- chitozan 1ml/L+ seaweeds 2g/L
8- chitozan 2ml/L+ seaweeds 1g/L
9- chitozan 2ml/L+ seaweeds 2g/L

A commercial seaweeds extract product was used. Seaweeds extract contains N (1%), K (2.5%), Ca (0.17%), Mg (0.43%), Fe (0.06%), S (2.2%), Zn 0.99 ppm, Boron 3.87 ppm alganic acids (10-12%) and plant hormones (500 ppm).

Chitosan (2-Amino-2-deoxy-beta-D-glucosasmine) solution was prepared by dissolving a proper amount of Chito–Care®, (an Egyptian commercial product of chitosan), in 1% acetic acid solution.

Spraying treatments were applied four times started after 45 days from planting date and repeated every 15 days through the growth season.

Studied Characteristics

Plant growth parameters:

A randomly chosen sample of 5 plants / plot was picked up after 120 days from planting date to determine plant height, weight of dry leaves /plant and to count number of leaves per plant.

Yield distribution:

All flower heads of plants in each plot were harvested and counted during the periods from November-February and March-May, to study yield distribution and to determine early, medium and late yields. Yield was calculated as ton/fed.

Heads quality characteristics:

At the peak of harvesting period (March), head quality characters were considered and the following measurements and determinations were achieved; average head weight, length and diameter, receptacle fresh and dry weight as well as total soluble solids (TSS) in the edible portions, using a hand refractometer.

Chemical constituents:

At 120 days after planting, dry matter of receptacle, were finely ground and wet digested for N, P and K determination;

- Nitrogen concentration was determined by Nesslar method according to AOAC (1960).
- Phosphorus was estimated calorimetrically using the reduced molybdophosphoric blue color method according to Jackson (1973).
- Potassium was determined using the flame photometer (CORNING, M 410).
- Total sugars and inuline in head receptacles were determined according to the methods described by Forsec (1938) and Winton and Winton (1958).
- Total protein was determined by multiplying nitrogen content by 6.25 according to AOAC (1960).

Collected data were statistically analyzed by Analysis of Variance using program (SAS, 1985) with means separated by Least Significant Difference (LSD) test according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Vegetative growth:

The results presented in the Table (2) clearly revealed that, foliar spraying of chitosan, seaweeds extract levels and their combinations significantly affected all growth characters (plant length, number of leaves and dry weight of leaves) in both seasons of study except for leaves number in the first season only. The highest vegetative growth characters were recorded by foliar sprayed with chitosan 2ml/L+ seaweeds 2g/L. Meanwhile, the lowest vegetative growth characters were recorded by control treatment (foliar spraying with tap water). These results may be due to that chitosan or seaweeds extract contains more amino acids, vitamins as well as some trace elements. However, the previous studies have been proved that seaweeds and/or chitosan can, directly or indirectly, influence the physiological activities of the plants (Kamal, and Ghanem 2011 and Shehata *et al.,* 2012). In this regard, Crouch and Van Staden (1992) revealed that seaweed concentrate (SWC) significantly improved growth of tomato seedlings. Also, Abou El-Yazied *et al.* (2012) mentioned that foliar application of seaweeds extract enhanced snap bean growth. Moreover, Kim *et al.,* 2005 and Mondal *et al*., (2012) reported that chitosan has been shown to stimulate growth of sweet basil plants.

Yield distribution:

The effect of chitosan levels, seaweeds extract and their combinations on early, medium and late yields is illustrated in Table (2). Results proved that spraying globe artichoke plants with chitosan or seaweeds extract at different tested concentrations resulted in a highly significant improvement in

yield distribution in both seasons, compared with control. The highest concentration of chitosan 2ml/L+ seaweeds 2g/L resulted in highest yield distribution in the first and second seasons, respectively. The combinations of chitosan 2 ml/L+ seaweeds 1g/L had a similar effect to that of Chitosan2ml/L+ seaweeds 2g/L on most characters of study. It's clearly that all treatments resulted in increasing the early yield compared with control and these increments represents, in diminished order, 8, 12.8, 27.5, 32.4, 43.5, 61.5 60, 71.9 and 6.2, 10.3, 14.1, 22.8, 30.1, 39.8, 49.2 and 55.1%as for chitosan 1ml/L, chitosan 2ml/L, seaweeds 1gm/L, seaweeds 2gm/L, chitosan 1ml+seaweeds 1gm/L, chitosan 1ml+seaweeds 2gm/L, chitosan 2ml+seaweeds 1mg/L and chitosan 2ml+seaweeds 2gm/L in both seasons respectively. Such foundation may be due to the role of both seaweeds extract and chitosan in, exhibition different regulatory and defensive roles through elicitation and signaling of different physiological and metabolically processes. Seaweed extracts have been shown to induce resistance to frost, fungal and insects attach, reduce red spider, aphid and nematode infestation and increase nutrients uptake from soil (Mooney and Van Staden, 1986). Also, Crouch and Van Staden (1992) revealed that seaweed concentrate (SWC) significantly exhibited early fruit ripening and total fruit fresh weight, the number of harvested fruits was also increased. Moreover, Pieta and Pastucha (2002) reported that yield increases in soybean following foliar application of chitosan at the initial stages of flowering.

Heads quality characteristics:

Data recorded in Table (3) showed that, foliar spraying with chitosan and seaweeds extract at different levels individual or in combination were responsible for significant improvements on head quality characteristics, expressed as head's weight, diameter, and receptacle fresh and dry weight as well as total soluble solids (TSS) compared to the control. Meanwhile, length of head was not significantly affected in both seasons. The highest heads quality characteristics were recorded by foliar sprayed with chitosan 2ml/L+ seaweeds 2g/L followed by, chitosan 2mlL+ seaweeds 1g L. Meanwhile, the lowest were recorded by control treatment. These increments may be explained on the bases that all used treatments had favorable stimulatory effects on vegetative growth characters and enhanced photosynthetic apparatus, and consequently reproductive growth triggers a switch in partitioning from vegetative growth sinks to reproductive sinks. In this respect, it was mentioned that foliar application of seaweed extract increased harvestable bean (Phaseolus vulgaris L.) yields (Temple and Bomke, 1989). Also, Abdulraheem, (2009) reveared that fruits diameter and length, early and total yield and firmness were enhanced by seaweeds applications.

Chemical constituents:

Data in Table (4) illustrate that receptacle contents of N,P,K, total sugars % and protein percent contents were greatly affected by all treatments compared with the control, in the two seasons except for Inulin % in the second season only.

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combination between chitosan 2mlL+ seaweeds 2gL treatments were superior in their effects on all mentioned characters followed by chitosan 2mlL+ seaweeds1gL treatments. The significant increments in the obtained characters over control may be attributed to its effects on enhancing ion uptake (Marschner 2013). Exogenous applications of elicitor compounds as chitosan (i.e., deacylated chitin), promote accumulation of isoflavone in soybean seeds (Al-Tawaha *et al.* 2005). Pise and Sabale (2010) showed that carbohydrate, proteins, free amino acids, polyphenols and nitrogen content increased in seaweed treated plants. In the same direction, there was significant effect due to seaweed extract (sea force1) on chlorophyll, carbohydrates, total soluble solids and vitamin C contents, in fruits and nitrogen, phosphorous and potassium in leaves of cucumber plants (Abdulraheem, 2009).

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تـأثير الـرش بمسـتخلص الأعشـاب البحريـة والشـيتوزان علـي الانتـاج المبكـر والمحصول الكلى وجودة الخرشوف.

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أجرى هذا البحث بالمزرعة البحثية بالبرامون التابعة لمعهد بحوث البساتين خلال موسمى الزراعة الشتوى ٢٠١٢/٢٠١٣ و٢٠١٣/٢٠١٤ لدراسة تأثير الرش بمستويات مختلفة من مستخلص الأعشاب البحرية والشيتوزان علي الانتاج المبكر والمحصول الكلى وجودة الخرشوف صنف فرنسى.

أظهرت النتائج أن الرش بمختلف التركيزات من مستخلص الاعشاب البحرية وكذلك الشيتوزان أدى إلى زيادة معنوية فى صفات النمو الحضرى (ارتفاع النبات، عدد أوراق النبات، والوزن الجاف لأوراق النبات) والمحصول الكلى (المبكر، والمتوسط، والمتاخر) وذلك بالمقارنة بالكنترول، ولوحظ أن الزيادة فى الصفات المذكورة كان متزامنا مع زيادة مستويات مستخلص الأعشاب والشيتوزان كل على حده أو خليطا من كل منهما.

أدت المعاملات السابقة إلي تحسين فى معظم صفات رؤس الخرشوف (وزن وقطر الرأس، الوزن الطازج والجاف للتخت، بالاضافة إلى المواد الذائبة الكلية)، بينما لم تصل الزيادة إلى المعنوية بالنسبة لطول الرأس، كان ذلك خلال موسمى التجربة.

استجاب محتوى التخت من النتروجين والفوسفور والبوتاسيوم والانيولين والسكريات الكلية والبروتين معنويا لمعاملات الرش المذكورة خلال موسمى البحث فيما عدا محتوى الانيولين فى الموسم الأول لم تصل الزيادة الى المعنوية.

حققت المعاملة بخليط الأعشاب البحرية (٢جم/لتر) والشيتوزان (٢مل/لتر) أفضل النتائج فى الحصول على نمو خضرى جيد وكذلك أعلى محصول كلى ومبكر ذو جودة مرتفعة.

Table 2: Vegetative growth and yield distribution of globe artichoke as affected by foliar spray with seaweeds extract and chitozan during 2012 / 2013 and 2013 / 2014 seasons.

	Vegetative growth						Yield distribution Ton/fed.					
Characters	**Plant height (cm)**		**NO. leaves /plant**		**Dry weight of leaves/plant (gm)**		**Early**		**Medium**		**late**	
Treatments	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**
Control (tap water)	62.7	66.2	40.6	51.0	140.14	131.72	0.749	0.851	1.917	1.695	3.501	3.66
Chitosan 1ml/L	66.7	70.1	45.1	55.5	148.14	135.22	0.812	0.904	2.005	1.819	3.577	3.792
Chitosan 2m/lL	69.7	75.9	50.4	58.4	159.93	141.16	0.845	0.939	2.069	1.914	3.614	3.982
Seaweeds 1g/L	78.8	82.2	56.7	62.6	167.73	150.16	0.955	0.971	2.199	1.985	3.696	4.115
Seaweeds 2g/L	80.4	86.2	60.8	65.9	174.94	154.42	0.992	1.045	2.251	1.669	3.819	4.223
Chitosan 1ml/L+ seaweeds 1g/L	83.5	87.7	63.1	70.0	177.68	161.74	1.075	1.108	2.305	1.718	3.995	4.317
Chitosan 1ml/L+ seaweeds 2g/L	89.2	90.5	67.3	70.6	188.16	169.15	1.210	1.190	2.379	1.818	4.152	4.389
Chitosan 2ml/L+ seaweeds 1g/L	88.8	99.9	76.0	72.3	191.06	176.93	1.205	1.270	2.411	1.900	4.209	4.435
Chitosan 2ml/L+ seaweeds 2g/L	92.4	102.4	78.8	73.5	195.66	180.38	1.288	1.320	2.515	1.977	4.289	4.505
LSD	4.2	6.9	5.8	N.S	6.49	8.83	0.041	0.051	0.081	0.099	0.061	0.159

Table 3: Heads quality characteristics of globe artichoke as affected by foliar spray with seaweeds extract and chitozan during 2012 / 2013 and 2013 / 2014 seasons.

	Head						Receptacle					
Characters	**Weight (gm)**		**Length (cm)**		**Diameter(cm)**		**Fresh Weight(gm)**		**dry Weight (gm)**		**T.SS(%)**	
Treatments	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**
Control (tap water)	190.2	210.65	9.7	10.2	6.85	8.24	50.20	59.72	3.72	4.09	8.2	8.8
Chitosan 1ml/L	195.93	222.14	10.1	10.9	7.15	8.53f	52.92	64.72	3.88	4.28	8.5	8.9
Chitosan 2m/lL	204.64	231.56	10.3	11.2	7.45	8.96e	55.49	66.32	4.03	4.68	8.7	9.3
Seaweeds 1g/L	215.36	242.92	10.5	11.4	7.92	9.22d	59.62	70.19	4.32	4.82	8.8	9.5
Seaweeds 2g/L	219.95	251.71	10.9	11.8	8.19	9.65	61.69	74.21	4.49	4.97	8.9	9.7
Chitosan 1ml/L+ seaweeds 1g/L	228.42	259.73	11.1	12.1	8.52	9.87	64.12	75.25	4.63	5.17	9.1	10.0
Chitosan 1ml/L+ seaweeds 2g/L	240.17	266.16	11.3	12.4	8.97	10.14	66.95	78.85	4.92	5.26	9.2	10.3
Chitosan 2ml/L+ seaweeds 1g/L	249.68	270.35	11.6	12.6	9.24	10.52	70.15	82.39	5.04	5.37	9.5	10.6
Chitosan 2ml/L+ seaweeds 2g/L	258.92	277.11	11.7	12.8	9.36	10.77	72.15	83.95	5.22	5.52	9.6	10.7
LSD	9.33	9.49	N.S	N.S	0.34	0.54	3.78	2.33	0.13	0.13	0.22	0.24

Table 4: Chemical composition of globe receptacles as affected by foliar spray with seaweeds extract and chitozan during 2012 / 2013 and 2013 / 2014 seasons.

caracters	**N %**		**P %**		**K%**		**Total sugars %**		**Inulin %**		**Protein%**	
Treatments	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**	**S_1**	**S_2**
Control (tap water)	2.01	2.08	0.237	0.252	2.68	2.82	3.20	3.36	1.19	1.22	12.562	13.00
Chitosan 1ml/L	2.03	2.17	0.298	0.291	2.76e	2.95	3.31	3.45	1.26	1.29	12.687	13.562
Chitosan 2m/lL	2.09	2.26	0.317	0.312	2.88d	3.03	3.39	3.57	1.26	1.33	13.062	13.458
Seaweeds 1g/L	2.15	2.39	0.328	0.339	3.01	3.19	3.46	3.63	1.31	1.35	13.437	14.937
Seaweeds 2g/L	2.22	2.45	0.352	0.378	3.16	3.27	3.52	3.69	1.34	1.35	13.875	15.312
Chitosan 1ml/L+ seaweeds 1g/L	2.29	2.56	0.373	0.398	3.23b	3.30	3.64	3.76	1.38	1.40	14.312	15.99
Chitosan 1ml/L+ seaweeds 2g/L	2.36	2.68	0.396	0.412	3.33	3.43	3.38	3.82	1.40	1.43	14.749	16.74
Chitosan 2ml/L+ seaweeds 1g/L	2.44	2.80	0.402	0.445	3.47	3.58	3.80	3.97	1.40	1.49	15.25	17.50
Chitosan 2ml/L+ seaweeds 2g/L	2.48	2.88	0.419	0.466	3.53	3.62	3.91	4.10	1.42	1.51	15.50	17.99
LSD	**0.13**	**0.14**	**0.027**	**0.020**	**0.13**	**0.17**	**0.35**	**0.15**	**N.S**	**0.09**	**0.83**	**1.07**