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Influence of foliar spray with seaweed extracts on growth, setting and yield of tomato during summer season

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ABSTRACT

Two field trials were conducted during two successive summer seasons of 2008 and 2009 at the Experimental Farm, El Kassasein Research Station, Ismailia Governorate, to elucidate the effect of foliar spray with seaweed extracts (without, 1g/ l and 2g/ l) and four tomato hybrids (Master R.S., K615, K111 and K 306) as well as their interaction on growth, dry weight, flowering, fruit setting, physical characters, yield and chemical constituents of tomato plants (*Lycopersicon esculentum* Mill.) during summer season under sandy soil conditions.

Tomato hybrid K615 recorded the highest values of leaf area, number of leaves/plant, leaves and total dry weight, and fruit diameter, while the hybrid K306 gave the highest values of plant height, setting percentage, fruit length, number of fruits/plant, yield /plant and total yield /fed. As well as K% content in fruits.

Spraying tomato hybrids with seaweed extracts at a rate of 1g/ l recorded maximum values of plant growth characters, leaves and total dry weight, while spraying the plants with seaweed at 1 or 2g/ l reflected the highest values of setting percentage, number of fruits/plant, yield/plant and total yield /fed. as well as total soluble solids as compared to the control. The interaction treatment between the hybrid K615 and foliar spray with seaweed extracts at 2g/ l gave the highest values of leaves number/plant, number of shoots/plant, leaf area, dry weight, fruit diameter, number of fruits/plant, N% and protein % as well as total soluble solids. On the other side, the combination between tomato hybrid K306 and foliar spray with seaweed extracts at 2g/ l gave the best values of plant height, number of shoots/plant, setting percentage, fruit length, yield/plant and total yield /fed. as well as K% content in fruits.
Keywords: Seaweed, tomato hybrids, growth, flowering, setting and yield.

INTRODUCTION

The tomato (*Lycopersicon esculentum* Mill.) is one of the most important as well as popular vegetables allover the world as well as in Egypt. It is found in the market throughout the year months. In Egypt, it takes first rank among the vegetables. In addition, tomato represents one of the most important vegetable crops for local consumption and exportation.

It is fairly well known that temperature has a marked effect on fruit setting tomato. Fruit set is usually poor when the temperature is either relatively low or relatively high.

Seaweeds are the macroscopic marine algae found attached to the bottom in relatively shallow costal waters. They grow in the intertidal, shallow and deep sea areas up to 180 meter depth and also in estuaries and backwaters on the solid substrate such as rocks, dead corals and pebbles. Seaweed zone is one of the conspicuous and wide-spread biotope in the shallow marine environment. The seaweeds are totally different from higher plants as they neither have true leaves, stems and roots or vascular system none specialized sex organs (Thirumaran *et al.,* 2009a).

The use of seaweeds as manure in farming practice is very ancient and common practice among the Romans and also practiced in Britain, France,

Spain, Japan and China. There are also records of culture of seaweeds for manure in Ireland and South Africa (Thirumaran *et al.,* 2009a). Seaweeds are used either directly or after compositing or burning being made into a meal. Case of seaweed, especially species of *Sargassum* has been used in parts of coastal Kerala as manure for coconut plantation. Experiments on the use of seaweed as manure have been carried out by Thivy (1960) who showed higher rate of growth and higher yield in crop plants. Bhosle *et al.* (1975) prepared a seaweed liquid fertilizer and studied its effects on *Phaeseouls vulgaris.* Seaweed extracts, as foliar nutrient sprays, have been used in horticulture for several decades (Blunden, 1991).

Studies conducted with seaweed sprays under controlled experiments resulted in higher earlier yields and larger fruit size in tomatoes (Verkleij, 1992). Plants treated with 112fl oz/acre seaweed concentrate had a higher marketable yield, elemental concentrations of tomato fruits were not affected by seaweed spray (Csizinszky, 1994).

Temple and Bomke (1989) showed that seaweed application caused an increment in fresh and dry weight of bean leaves. Treating tomato plants with seaweed concentrate exhibited early fruit ripening and total fresh weight of fruits was increased by 17% and number of harvested fruits were improved by about 10% (Crouch and Van Staden, 1992). Hamed (1997) on sweet pepper concluded that seaweed extracts significantly increased total yield, P and K percentage as compared with the control. El-Aidy *et al.* (2002) reported that foliar application of seaweed extracts significantly increased plant height, leaves number, leaf area, dry weight of leaves / plant, TSS% and acidity of sweet pepper. Awad *et al.* (2006) indicated that foliar application of seaweed extracts at dose (2g/l) significantly increased plant height, foliage dry weight, total tuber yield, number of tubers / plant and NPK percentage of potato. Treating seeds of *Abelmoschues esculentus* and *Cyamopsis tetrogonolaba* (L) Taub. of lower concentration (20%) of seaweed liquid fertilizer showed better response in terms of shoot and root length, number of leaves as compared to other concentrations (Thirumaran *et al.*, 2009 a and b).

Regarding tomato hybrids, Marmand cultivar showed significantly higher nitrogen, phosphorus and potassium contents as well as early and total yield than V.F.N.-8 and Pritchard cultivars (Hewedy, 1988). Ben-Oliel *et al.* (2005) reported that fruit TSS and titratable acidity were significantly increased in tomato hybrid R-144; while yield was slightly decreased as compared with other hybrids (R-175, FA 612 and FA 624).Tomato hybrid Avinash-2 produced more fruit than the nonhybrid cv. Pant T3 (Almeselmani *et al.*2010).

MATERIALS AND METHODS

The present work was carried out during two successive summer seasons of 2008 and 2009 at the Experimental Farm, El Kassasein Research Station, Ismailia Governorate, to evaluate the effect of foliar spray with seaweed extracts (without, 1g/l and 2g/l) and four tomato hybrids (Master R.S., K615, K111 and K 306) as well as their interactions on growth, dry weight, yield, flowering, fruit setting and chemical constituents of tomato

(*Lycopersicon esculentum* Mill.) grown under sandy soil conditions using drip irrigation system.

The physical and chemical properties of the experimental soil are given in Table1.

Table1: The physical and chemical properties of the tested soil during 2008 and 2009 seasons

Physical properties			Chemical properties		
	2008	**2009**		**2008**	**2009**
Sand (%)	96.5	95.6	Organic matter	0.03	0.08
Silt (%)	1.7	1.6	Available K (ppm)	52	64
Clay	1.8	2.8	Available P (ppm)	5.5	6.2
Field capacity	6.5	6.8	Available N (ppm)	5.4	6.9
Wilting point	2.4	2.5	Calcium carbonate (%)	0.18	0.26
Available water	4.5	4.5	pH	8.1	8.1
Water holding capacity	13.8	14.5			

This experiment included 12 treatments, which were the combinations between three concentrations of Seaweed extracts (without, 1 and 2g/l) and four tomato hybrids (Master R.S., K615, K111 and K306) seeds of Master R.S. hybrid were obtained from Horticulture Research Institute, Agriculture Research Center,Giza Egypt, while the other hybrids were obtained from Kansouh (2002).

Seaweed extracts (Algifert) as powder from *Ascophyllum nodosum* and biological fertilizer contains appreciable quantities of nutrients, phytohormones, amino acids and vitamins (Table2). It was obtained from Sidasa Egypt Company.

Treatments were arranged in a split plot design with three replicates, tomato hybrids were assigned randomly in the main plots, while sub-plots were devoted to seaweed extracts. The seeds of tomato hybrids were sown in nursery of foam trays on 1st and 4th of March in 2008 and 2009 seasons, respectively, and transplanted on 4th and 7th of April 2008 and 2009 seasons, respectively, the plot area was 15m^2, plants were spaced at 40cm apart . Every plot consisted of 3 dripper lines 4m in length and 1.25m in width with about 30 plants in every plot. One dripper line was left between each two experimental plots without spraying as a guard row to avoid the overlapping (contamination) of spraying solution. One dripper line (5m^2) was earmarked for samples and the other two dripper lines (10m^2) were earmarked for estimating yield and its components.

Seaweed extracts were applied as foliar spray, three times by 10 days intervals, beginning 30 days after transplanting (30, 40 and 50 days from transplanting). The untreated plants (control) were sprayed with tap water. The normal agriculture practices of tomato under drip irrigation system were followed according to the recommendations of Agriculture Ministry. The treatments carried out in this study were as follows:

A. Main plots (tomato hybrids)

1. Master R.S.

2. K615
3. K111
4. K306

B. Sub-plots (foliar application)

1. Control (tab water) .
2. Seaweed extracts 1g/l.
3. Seaweed extracts 1g/l.

Table 2: Chemical analysis of seaweed extracts (Algifret)*

Components (%)			
Appearance	Brownish-black crystals		
Solubility in water	100% soluble		
Typical analysis:-			
Maximum moisture	6.5 %		
Organic matter	44-5%		
Ash (minerals)	44-55%		
Elements:-			
Macro elements (%)		**(ppm) Micro elements**	
Total nitrogen (N)	1.0-2.0	Boron (B)	75-150
Available phosphoric acid (P_2O_5)	2.0-4.0	Iron (Fe)	75-250
Soluble potash(K_2O)	18.0-22.0	Manganese(Mn)	8-12
Sulfur (S)	1.0-2.0	Copper (Cu)	1-10
Magnesium (Mg)	0.2-0.5	Zinc (Zn)	25-75
Calcium (Ca)	0.1-0.2		
Carbohydrates -	**Alginic acid, Mannitol, Laminarin**		
-Naturally occurring growth promoters	**Cytokinins, Auxins , Gibberellins**		
Amino acids (average g of amino acid/ 100 g of protein) : -			
Alanine	3.81	Lysine	1.33
Arginine	0.22	Methionine	1.39
Aspartic	5.44	Phenylalinine	2.82
Cystine	trace	Proline	4.42
Glutamic acid	7.69	Serine	0.14
Glycine	3.16	Threonine	1.27
Histidine	0.42	Tyrosine	1.80
Isoleucine	1.94	Valine	3.46
Leucine	4.84		
Vitamins (ppm) :-			
Provit.	40.0	C	200-400
B1	6.8	D	4.0
B2	6.0	E	70.0
B12	0.04	Niacin	70.0

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Data recorded

1. Growth parameters

A random sample of three plants was taken from every plot at 60 days from transplanting in both seasons of study for evaluating the growth characters of tomato plants expressed as: plant height (cm), number of both leaves and shoots / plant, leaf area and total dry weight (leaves + branches) / plant (g), (the samples were dried in an electric oven at 70^{o}C till constant weight).

2. Flowering characters

A random sample of three plants from each plot (in the second season only) were labeled and the following data were recorded: number of both flowers and fruits on the first four trusses, total number of flowers / plant, total number of fruits / plant and fruit set percentage = (total number of fruits/plant) / (total number of flowers/plant) × 100; that was calculated on different trusses as well as per plant.

3. Physical characters

At each picking time, a representative sample of five fruits from each experimental plot was taken for determining the following characteristics: fruit length (cm), fruit diameter (cm) and fruit index (fruit length / fruit diameter). Total soluble solids (T.S.S.) were determined in fruits samples taken especially for chemical characteristics, the full-ripe fruits were blended and filtrated through muslin cloth and then through filter paper No. 1, the total soluble solids was determined in the filtrate by using Calr Zeis refractometer.

4. Yield and its components

Fruits of each plot were harvested at full-ripe (maturity) stage, and then counted, weighed and the following data were calculated: number of fruits/plant, average fruit weight, individual plant yield and total yield / fed.

5. Fruit chemical constituents

Dried fruits were finely ground separately and digested with sulfuric acid and percholoric acid (3:1). Nitrogen, phosophorus and potassium were determined according to the method described by Kock and Mc-Meekin (1924), Murphy and Riley (1962) and Brown and Lilliland (1946), respectively.

6. Total protein (%)

The previously determined nitrogen of dry fruits was used for calculating total crude protein by multiplying N- values by 6.25 (A.O.A.C. 1980).

7. Statistical analysis

Obtained data were subjected to the analysis of variance according to Snedecor and Cochran (1980). Duncan's multiple range test was used for the comparison among treatments (Duncan, 1955).

RESULTS AND DISCUSSION

Vegetative Characters

Effect of tomato hybrids

Data presented in Table 3 reveal that there was a significant difference between tomato hybrids in plant height, number of leaves / plant and plant leaf area. However, such differences did not reach to the level of significance in plant height during the first season and number of shoots per plant during both seasons of study. In this respect, the highest values of number of leaves were recorded by hybrid Master R. S. while the hybrid K615 recorded the highest values of leaf area and number of shoots / plant. On the other side, the tallest plants were recorded by hybrid K111. Such differences among the tested tomato hybrids in growth parameters may be due to the differences in their genetic potential. These results are in agreement with those reported by Hewedy (1988) and Ben-Oliel *et al.* (2005) on tomato.

Effect of seaweed extracts

Data in Table 3 show also the effect of foliar spray with seaweed extracts on vegetative growth of tomato hybrids. It is obvious from the data that increasing the dose of applied seaweed extracts from 0.0 up to2g/l led to a marked stimulative effect on growth parameters as compared with the control treatment in both seasons, with the exception of number of shoots per plant. These results might be attributed to the beneficial effect of seaweed extracts contain naturally occurring supplying nutrients, plant growth hormones (auxins, cytokines and gibberellins) as well as other plant biostimulants; e.g. amino acids, vitamins that could maintain photosynthetic rates, improve plant resistances, delay plant senescence and control cell division (Kusima,1989 ; Crouch and Van Standen ,1992).These results are in agreement with those obtained by Temple and Bomke (1989) on beans, El-Aidy *et al.* (2002) on sweet pepper and Awad *et al.* (2006) on potato.

Table 3: Effect of tomato hybrid, seaweed extracts and their combinations on vegetative growth of tomato hybrids at 60 days after transplanting during 2008 and 2009 seasons

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test

Treatments		Growth characters / plant							
		2008 Season				2009 Season			
Tomato hybrids	Seaweed extracts	Plant height (cm)	Leaves No.	Shoots No.	Leaf area (cm^2)	Plant height (cm)	Leaves No.	Shoots No.	Leaf area (cm^2)
Master R.S.		52.8a	70.2a	6.9a	1580ab	54.8b	73.4a	7.1a	1628a
K615		53.9a	68.1a	7.3a	1691a	55.5ab	70.4a	7.1a	1701a
K111		56.6a	66.8ab	6.6a	1538b	60.5a	71.3a	7.0a	1615a
K306		56.8a	57.6b	6.0a	1456b	58.9ab	58.7b	5.9a	1492b
	Control	49.7b	59.8b	5.8a	1409b	49.5b	59.4b	5.9a	1418a
	1 gm/l	57.5a	64.6ab	7.2a	1575ab	61.9a	69.3a	7.2a	1642a
	2 gm /l	57.9a	72.7a	7.1a	1714a	60.8a	76.7a	7.3a	1768a
Master R.S.	Control	49.8f	67.3b-d	5.7bc	1421c-e	50.7f	70.3d	6.0bc	1427ef
	1 gm/l	54.2de	69.0bc	7.7a	1579bc	58.0cd	73.7cd	8.0a	1672a-d
	2 gm /l	54.5cd	74.3ab	7.3ab	1737ab	55.7de	76.3bc	7.3ab	1785ab
K615	Control	48.7f	59.7e-g	7.0a-c	1517cd	45.3g	56.0fg	6.3bc	1469d-f
	1 gm/l	56.3b-d	66.0c-e	7.3ab	1731ab	59.8cd	70.3d	7.0a-c	1742a-c
	2 gm /l	56.8b-d	78.7a	7.7a	1824a	61.3bc	85.0a	8.0a	1892a
K111	Control	50.0f	59.3e-g	5.3c	1378de	51.2ef	60.7ef	5.7c	1449d-f
	1 gm/l	61.2a	64.7c-f	7.7a	1492cd	69.0a	72.3cd	8.0a	1623b-e
	2 gm /l	58.7ab	76.3a	6.7a-c	1745ab	61.3bc	81.0ab	7.3ab	1776ab
K306	Control	50.3ef	52.7g	5.3c	1323e	51.0ef	50.7g	5.7c	1327f
	1 gm/l	58.5a-c	58.7fg	6.0a-c	1498cd	60.7bc	61.0ef	5.7c	1530c-f
	2 gm /l	**61.7**a	**61.3**d-f	**6.7**a-c	**1548**c	**65.0**ab	**64.3**e	**6.3**bc	**1620**b-e

Effect of interaction

The results in Table 3 illustrate the effect of the interaction between tomato hybrids and foliar spray with seaweed extracts on vegetative characters. It is obvious from the data that there were significant differences among most of the interaction treatments on all studied vegetative characters. These results are true in both growing seasons. In general, the interaction between tomato hybrid K615 and foliar spray with seaweed extracts at a rate of 2g/l gave the highest values of number of leaves and

shoots as well as leaf area as compared with other interaction treatments which recorded the lowest values in both seasons.

Dry Weight

Effect of tomato hybrids

The results listed in Table 4 clearly show the effect of tomato hybrids on dry weight of different organs of tomato plant at 60 days from transplanting; such results indicate that there were significant differences among the four hybrids in both growing seasons regarding all studied characteristics except shoots dry weight. In general, the hybrid K615 recorded the maximum values of leaves and total dry weight, followed by Master R.S. and K11, while K306 ranked the last one. The effect of tomato hybrids on dry weight might owe much to the increase in vegetative plant growth characters (Table3). These results matched with those reported by Hewedy (1988) and Ben-Oliel *et al.* (2005) on tomato.

Table 4: Effect of tomato hybrid, seaweed extracts and their combinations on dry weight of tomato hybrids at 60 days after transplanting during 2008 and 2009 seasons

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Treatments		Dry weight (g / plant)					
		2008 Season			2009 Season		
Tomato hybrids	Seaweed extracts	Leaves	Shoots	Total	Leaves	Shoots	Total
Master R.S.		37.82ab	19.77a	57.59ab	39.80a	21.03a	60.83ab
K615		40.49a	21.21a	61.70a	41.45a	21.56a	62.97a
K111		36.85b	19.26a	56.11b	39.64a	20.90a	60.54ab
K306		34.88b	18.17a	53.05b	36.31b	19.08a	55.39b
	Control	33.77b	17.59a	51.36b	33.69b	18.01a	51.70b
	1 gm/l	37.72ab	19.73a	57.45ab	40.70ab	21.25a	61.92a
	2 gm /l	41.04a	21.50a	62.54a	43.52a	22.66a	66.19a
	Control	34.05c-e	17.64b-d	51.69de	35.57e-g	19.76bc	55.33fg
Master R.S.	1 gm/l	37.81bc	19.90a-d	57.71bc	40.55b-d	21.12a-c	61.67c-e
	2 gm /l	41.61ab	21.78ab	63.39ab	43.29a-c	22.20ab	65.49b-d
	Control	36.34cd	18.83a-d	55.17cd	33.92fg	17.94cd	51.86gh
K615	1 gm/l	41.45ab	21.70a-c	63.15ab	43.69a-c	22.64ab	66.21a-c
	2 gm /l	43.68a	23.11a	66.79a	46.74a	24.09a	70.83a
	Control	33.00de	17.37cd	50.37de	34.18fg	18.08cd	52.26gh
K111	1 gm/l	35.75c-e	18.52b-d	54.27cd	40.21b-d	21.05a-c	61.26c-e
	2 gm /l	41.80ab	21.89ab	63.69a	44.55ab	23.57a	68.12ab
	Control	31.69e	16.51d	48.20e	31.08g	16.27d	47.35h
K306	1 gm/l	35.88cd	18.79a-d	54.67cd	38.35d-f	20.18bc	58.53ef
	2 gm /l	37.08cd	19.21a-d	56.29cd	39.51c-e	20.79a-c	60.30d-f

Effect of seaweed extracts

Data in Table 4 illustrate the effect of seaweed extracts on dry weight of tomato hybrids. It is markedly shown that foliar spraying with seaweed extracts at the highest rate (2g/l) on tomato hybrids plants had positive significant effect on dry weight of leaves and total dry weight as compared with untreated plants. The increment in dry weight of different plant organs might owe much to the increase in plant growth (Table 3). These results were

in accordance with those reported by Temple and Bomke (1989) on beans, El-Aidy *et al.* (2002) on sweet pepper and Awad *et al.* 2006 on potato.

Effect of interaction

According to the effect of the interaction between tomato hybrids and foliar spray with seaweed extracts on dry weight of tomato plant. It is obvious from data in Table 4 that the interaction treatments reflected significant effect on dry weight of different organs of tomato plant, these results were true during both seasons of study. It is obvious that the interaction between tomato hybrid K615 and foliar spray with seaweed extract at a rate of 2g/l was the superior treatment, while the interaction between tomato hybrid K111 and without foliar spray with seaweed extract (0.0) recorded the lowest values of dry weight.

Flowering and Fruit Setting

Effect of tomato hybrids

Data of the effect of tomato hybrids on flowering, fruiting and fruit setting percentage on different trusses and the total per plant are shown in Table 5. The results declare that the studied hybrids were differently affected in flowering, fruiting and fruit setting (%) which appeared on different trusses. All tomato hybrids did not show any significant effect on number of flowers and setting(%)on different trusses except number of flowers on first truss. It is also clear that, number of fruits per plant was at maximum values on first truss, but it was minimum on third one. In addition, it is of interest to observe that K306 hybrid recorded the highest values of number of both flowers and fruits per plant as well as average of setting %.

These differences in flowering characters may be due to the genetic constitution of the hybrids. Obtained results are in agreement with those obtained by Hewedy (1988) on tomato.

Effect of seaweed extracts

Presented data in Table 5 indicate the effect of foliar spray with seaweed extracts on flowering, fruiting and fruit setting. In general, it is evident that spraying tomato hybrids with seaweed extracts had insignificant effect on flowering of different trusses as well as total per plant.

Regarding number of fruits on different trusses, it was significantly affected by foliar spray with seaweed extracts and it was maximum on first truss, followed by second truss. It is also clear from the obtained results that, increasing the dose of applied seaweed extracts was associated with marked stimulative effect on number of fruits. On the other hand, foliar spray with seaweed extracts reflected a significant effect on setting percentage except on first and second trusses. Setting percentage was at maximum on second truss, while the minimum was on fourth truss followed by third truss.

Effect of interaction

According to the effect of the interaction between tomato hybrids and foliar spray with seaweed extracts on flowering, fruiting and fruit setting, it is obvious from data in Table 5 that the interaction treatments reflected significant effect on flowering of different trusses as well as total per plant.

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Regarding number of fruits on different trusses, it was significantly affected by the interaction treatments, the maximum values were recorded by the interaction between K306 hybrid and foliar spray with seaweed at a rate of 1g or 2g/l in all trusses except first truss. On the other hand, the interaction treatment between K306 hybrid and foliar spray with seaweed extracts at a rate of 2g/l reflected significant effect on setting percentage on all trusses as well as average of setting percentage, setting percentage was maximum on first truss while the minimum was on fourth truss followed by third truss

Physical fruit characters

Effect of tomato hybrids

Data presented in Table 6 clearly indicate that tomato hybrid K306 recorded the highest values of different studied physical fruit characters; i.e., fruit length, fruit diameter and fruit shape index as compared with other hybrids. These results might be attributed to hereditary differences between hybrids.

Effect of seaweed extracts

Results in Table 6 show the effect of foliar spray with seaweed extracts on physical characters of tomato fruits; i.e., fruit length, fruit diameter and fruit shape index. It is obvious from the data that spraying tomato hybrids with seaweed extracts did not reflect any significant effect on physical characters of tomato fruits.

Table 6. Effect of tomato hybrid, seaweed extracts and their combinations on physical characteristics of tomato hybrids during 2008 and 2009 seasons

Treatments		Physical characteristics / plant					
		2008 Season			2009 Season		
Tomato hybrids	Seaweed extracts	Fruit length (cm)	Fruit diameter (cm)	Fruit index (L/D)	Fruit length (cm)	Fruit diameter (cm)	Fruit index (L/D)
Master R.S.		5.72c	5.80a	1.00ab	5.99b	6.14b	0.98bc
K615		5.73c	6.29a	0.91b	5.95b	6.54a	0.91c
K111		6.03b	5.58a	1.08a	6.60a	5.97b	1.11a
K306		6.74a	6.23a	1.09a	6.95a	6.69a	1.05ab
	Control	5.97a	6.06a	0.99a	6.28a	6.53a	0.97a
	1 gm/l	5.95a	6.05a	0.99a	6.33a	6.26a	1.02a
	2 gm /l	6.24a	5.81a	1.08a	6.51a	6.23a	1.05a
Master R.S.	Control	5.87d	6.65ab	0.88f	6.04c-e	6.85b	0.88d
	1 gm/l	5.36e	5.46de	0.99de	5.68de	5.79f	0.98b-d
	2 gm /l	5.93d	5.28e	1.12b	6.25b-d	5.79f	1.08a-c
K615	Control	5.28e	5.63c-e	0.94ef	5.62e	5.89ef	0.96b-d
	1 gm/l	6.05cd	6.98a	0.87f	6.21b-d	7.03b	0.88d
	2 gm /l	5.86d	6.27bc	0.93ef	6.00c-e	6.71bc	0.90d
K111	Control	5.88d	5.26e	1.12b	6.36bc	5.78f	1.10ab
	1 gm/l	5.88d	5.41de	1.09bc	6.73ab	5.87ef	1.15a
	2 gm /l	6.32bc	6.07b-d	1.04b-d	6.70ab	6.26de	1.07a-c
K306	Control	6.87a	6.71ab	1.03b-d	7.08a	7.59a	0.93cd
	1 gm/l	6.50b	6.36ab	1.02c-e	6.70ab	6.34cd	1.06a-c
	2 gm /l	6.87a	5.61de	1.23a	7.08a	6.15d-f	1.16a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test

Effect of interaction

Data presented in Table 6 illustrate the effect of the interaction between tomato hybrids and foliar spray with seaweed extracts on physical characters of tomato fruits. Results declared that there were significant differences among the interaction treatments on all studied physical characters of tomato fruits, these results were true in both growing seasons. In general, the interaction between tomato hybrid K306 and foliar spray with seaweed extracts at 2g/l gave the maximum values of fruit length and fruit index as compared with other interaction treatments.

Yield and its Components

Effect of tomato hybrids

Results in Table 7 illustrate the effect of tomato hybrids on yield and yield components; i.e., average fruit weight, number of fruits per plant, yield per plant and total yield per feddan. It is obvious from the data that no significant differences were found among the tested tomato hybrids in this respect. In addition, tomato hybrid K306 was superior as compared with the other hybrids, since it gave the uppermost values. These results might be attributed to the good balance between flowering and vegetative growth at flowering stage, higher percentage of fruit setting, increasing average fruit parameters (length, diameter and weight), number of flowers per cluster and to the hybrid effect. These results are in agreement with those reported by Hewedy (1988), Ben-Oliel *et al.* (2005) and Almeselmani *et al.* (2010) on tomato.

Effect of seaweed extracts

The results listed in Table 7 clearly show the effect of seaweed extracts on yield and yield components of tomato hybrids, the results indicate that foliar spray with seaweed at a rate of 2g/l gave the highest results on yield and yield components, but without reaching to the statistical level, the increases occurred on yield and its components might be attributed to the increasing in vegetative growth parameters (Table3). Similar results were reported by Verkleij, (1992); Csizinszky (1994) and Crouch and Van Staden (1992)on tomato, Hamed (1997) and El-Aidy *et al.* (2002) on sweet pepper and Awad *et al.* (2006) on potato.

Effect of interaction

Effect of the interaction between tomato hybrids and foliar spray with seaweed extracts on yield and yield components is shown in Table 7. It is evident from these results that such interaction treatments generally had a promotive effect on average fruit weight, number of fruits per plant, yield per plant and total yield per feddan. The interaction treatment between tomato hybrid K306 and foliar spray with seaweed extracts at 2g/l resulted in the maximum values of the above mentioned yield parameters as compared with other interaction treatments.

Chemical Constituents

Effect of tomato hybrids

The results reported in Table 8 show the effect of tomato hybrid on chemical constituents of tomato fruits expressed as N, P, K and protein percentage as well as total soluble solids (T.S.S.), such results indicate that all tomato hybrids (Master R.S., k615, k111 and K306) had insignificant effect on chemical constituents of tomato fruits except P%.

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Tomato hybrid K111 recorded the highest values of P% as compared with other hybrids. Obtained results contradict with those reported by Hewedy (1988) and Ben-Oliel *et al.* (2005) on tomato.

Effect of seaweed extracts

Presented data in Table 8 indicate the effect of foliar spray with seaweed extracts on chemical constituents of tomato fruits. In general, it is evident that spraying tomato plants with seaweed extracts at a rate of 2g/l significantly increased T.S.S. and gave the best results of N, P, K and protein (%) but without reaching to the statistical level. These results are in harmony with those reported by Hamed (1997) and El-Aidy *et al.* (2002) on sweet pepper and Awad *et al.* (2006) on potato.

Effect of interaction

According to the effect of the interaction between tomato hybrids (Master R.S., k615, k111 and K306) and foliar spray with seaweed extracts on chemical constituents of tomato fruits, it is obvious from such data in Table 8 that all the interaction treatments reflected significant effect on all parameters of chemical constituents, the combination between K615 and foliar spray with seaweed extracts at 2g/l seemed to be superior in this regard.

Recommendation

From the previous results of this investigation it could be recommend that, spraying tomato hybrids K306 or K615 with seaweed extracts at a rate of 2g/l were the superior treatments for enhancing growth, dry weight, setting, physical characters, and yield and its components as well as chemical constituents of tomato fruits grown in summer season under sandy soil conditions .

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تأثيرالرش الورقى بمستخلصات الأعشاب البحرية على النمو والعقد و المحصول فى الطماطم فى العروة الصيفية

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أجريت تجربتان حقليتان خلال موسمى صيف ٢٠٠٨ و ٢٠٠٩ فى مزرعة التجارب البحثية بمحطة بحوث البساتين بالقصاصين ، محافظة الأسماعيلية ، لدراسة تأثير استجابة أربعة من هجن الطماطم المحلية (ماستر R.S , K615 , K111 , K306) للرش الورقى بمستخلصات الأعشاب البحرية (بدون رش،١جم/لتر،٢جم/لتر) والتفاعل بينهم على النمو والوزن الجاف والتزهير والعقد والصفات الفيزيائية للثمار والمحصول والمحتوى الكيماوى لثمارالطماطم فى العروة الصيفية تحت ظروف الأراضى الرملية.

سجل هجين الطماطم K615 أعلى القيم بالنسبة للمساحة الورقية ،وعدد الأوراق/نبات ،والوزن الجاف للأوراق ،و الوزن الجاف الكلى / نبات ،و النسبة المئوية لعقد الثمار،و قطر الثمرة، ومتوسط عدد الثمار على النبات، بينما سجل الهجين k306 أعلى القيم بالنسبة لإرتفاع النبات ،و النسبة المئوية لعقد الثمار ،و طول الثمرة ، وعدد الثمار/نبات ،و محصول النبات ،و المحصول الكلى للفدان، والنسبة المئوية لمحتوى الثمار من البوتاسيوم.

أدى الرش الورقى لمستخلصات الأعشاب البحرية بمعدل ٢جم/لتر إلى الحصول على أفضل القيم بالنسبة لصفات النمو الخضرى ،و الوزن الجاف للأوراق،و الوزن الجاف الكلى /نبات ،بينما أدى الرش بتركيز ١ أو ٢جم/لتر إلى زيادة النسبة المئوية لعقد الثمار ،و عدد الثمار على النبات ،ومتوسط محصول النبات ،ومتوسط المحصول الكلى للفدان، ونسبة المواد الصلبة الذائبة الكلية مقارنة بالكنترول.

سجلت معاملة التفاعل بين الهجين K615 والرش الورقى بمستخلصات الأعشاب البحرية بمعدل ٢جم/لتر أعلى القيم بالنسبة لعدد الأوراق ، وعدد الأفرع ،و المساحة الورقية ،و الوزن الجاف للأوراق والأفرع ،والوزن الجاف الكلى /نبات ،و قطر الثمرة ،وعدد الثمار/نبات،و محتوى الثمار من النيتروجين والبروتين، و المواد الصلبة الذائبة الكلية. فى حين سجلت معاملة التفاعل بين الهجين k306 والرش الورقى بمستخلصات الأعشاب البحرية بمعدل ٢جم/لتر أفضل القيم بالنسبة لإرتفاع النبات ،و عدد الأفرع ، و النسبة المئوية لعقد الثمار ،وطول الثمرة ،ومحصول النبات ،و المحصول الكلى للفدان، ومحتوى الثمار من البوتاسيوم.

قام بتحكيم البحث

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Table 5: Effect of tomato hybrid, seaweed extracts and their combinations on flowering, fruiting and fruit setting percentage of tomato hybrids during 2009 season

Treatments		First truss			Second truss			Third truss			Fourth truss			Total / plant		Average setting %
Tomato hybrids	Seaweed extracts	No. of flowers	No. of fruits	Setting %	No. of flowers	No. of fruits	Setting %	No. of flowers	No. of fruits	Setting %	No. of flowers	No. of fruits	Setting %	No. of flowers	No. of fruits	
Master R.S.		17.3a	10.6a	60.9a	14.6a	8.8a	59.8a	11.7b	6.8b	57.7a	12.8a	7.0b	54.6a	56.5a	33.1a	58.4a
K615		16.6ab	10.2a	60.5a	13.2a	8.0a	61.4a	13.4a	7.7a	57.7a	13.4a	7.5ab	55.8a	56.6a	33.5a	59.2a
K111		14.7b	9.4a	63.9a	14.3a	9.0a	62.9a	11.9b	7.0ab	58.6a	13.6a	7.8a	57.3a	54.4a	33.1a	60.9a
K306		15.9ab	10.0a	63.6a	15.9a	10.1a	63.3a	12.5ab	7.5ab	60.0a	13.1a	8.6ab	57.5a	57.4a	35.2a	61.2a
	Control	15.3a	8.7a	57.4a	13.8a	7.8a	56.6a	12.1a	6.4b	53.1b	12.6a	6.4b	51.1b	53.7a	29.3b	54.6a
	1 gm/l	17.7a	11.1a	63.2a	14.4a	9.1a	62.9a	13.3a	8.0a	60.2ab	14.1a	8.0a	56.8ab	59.4a	36.1a	60.9a
	2 gm /l	15.4a	10.2a	66.1a	15.3a	10.1a	66.3a	11.9a	7.4ab	62.2a	13.0a	7.9a	60.9a	55.6a	35.7a	64.3a
Master R.S.	Control	12.4de	7.1e	58.1a	15.6ab	8.3cd	53.2c	11.8c-d	6.4bc	54.3c-e	12.3ef	6.1d	49.7f	52.1e	27.9d	63.7d
	1 gm/l	19.6a	12.0ab	61.4a	13.2bc	8.3cd	61.9a-c	12.0b-d	7.0b	58.6b-d	13.6a-d	7.4b	54.5de	58.4a-c	34.7bc	59.4a-d
	2 gm /l	20.0a	12.7a	63.5a	15.1a-c	9.7a-c	64.4ab	11.5cd	6.9b	60.2ab	12.4d-f	7.4b	59.6a-c	59.0a-c	36.7a-c	62.2ab
K615	Control	16.4b	9.2c-e	56.5a	12.2c	7.1d	58.6a-c	13.1a-c	6.8bc	52.0e	12.9c-e	6.5cd	50.4f	54.6de	29.6d	54.3d
	1 gm/l	17.3b	10.7a-d	61.9a	14.7a-c	8.9b-d	61.1a-c	14.1a	8.4a	59.6a-c	14.3ab	8.1a	56.7cd	60.4ab	36.1a-c	59.8a-d
	2 gm /l	16.0bc	10.6a-d	63.2a	12.6c	8.1cd	64.6ab	13.0a-c	8.0a	61.5ab	13.1b-f	7.9ab	60.4ab	54.7de	34.6bc	63.4a
K111	Control	16.0bc	9.4b-e	58.7a	13.3bc	7.6d	57.4bc	11.8b-d	6.2c	52.5e	13.0c-f	6.8c	52.3ef	54.1de	30.0d	55.4b-d
	1 gm/l	16.4b	10.6a-d	64.7a	13.1bc	8.2cd	62.4a-c	13.5ab	8.2a	60.7ab	14.5a	8.4a	57.9b-d	57.5b-d	35.4a-c	61.6a-c
	2 gm /l	11.7e	8.0de	68.4a	16.4a	11.3a	68.9a	10.4d	6.5bc	62.4ab	13.2b-f	8.1a	61.6ab	51.7e	33.9c	65.6a
K306	Control	16.4b	9.2c-e	56.4a	14.2a-c	8.1cd	57.1bc	11.6cd	6.2c	53.5de	12.1f	6.3cd	52.1ef	54.3de	29.8d	54.9cd
	1 gm/l	17.3b	11.2a-c	65.0a	16.5a	10.8ab	65.4ab	13.4ab	8.3a	62.0ab	13.9a-c	8.1a	58.3bc	61.1a	38.4a	62.9a
	2 gm /l	14.0cd	9.6b-e	69.4a	16.9a	11.4a	67.5ab	12.6a-c	8.1a	64.4a	13.4a-e	8.3a	62.0a	56.9cd	37.4ab	65.8a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test

Table 7: Effect of tomato hybrid, seaweed extractsand their combinations on yield and yield components of tomato hybrids during 2008 and 2009 seasons

Treatments		Yield and yield components							
		2008 Season				2009 Season			
Tomato hybrids	Seaweed extracts	Average fruit weight (g)	Number of fruits / plant	Yield / plant (g)	Total yield (ton/fed.)	Average fruit weight (g)	Number of fruits / plant	Yield / plant (g)	Total yield (ton/fed.)
Master R.S.		122.2a	26.9b	3.287a	27.614a	117.7a	28.1a	3.303a	27.752a
K615		109.3a	29.9a	3.281a	27.565a	114.1a	30.7a	3.509a	29.480a
K111		109.9a	30.5a	3.337a	28.034a	110.5a	31.4a	3.464a	29.100a
K306		111.7a	31.6a	3.546a	29.793a	117.3a	31.9a	3.751a	31.511a
	Control	113.5a	26.5a	2.996a	25.165a	111.7a	27.9a	3.112a	26.143a
	1 gm/l	110.8a	30.6a	3.396a	28.525a	115.4a	30.5a	3.519a	29.566a
	2 gm /l	115.6a	32.1a	3.697a	31.063a	117.7a	33.1a	3.889a	32.673a
Master R.S.	Control	128.4a	23.3d	2.988bc	25.105bc	120.9ab	25.1d	3.037de	25.517de
	1 gm/l	112.6b-d	29.1a-c	3.286a-c	27.608a-c	115.3a-c	28.3b-d	3.268c-e	27.452c-e
	2 gm /l	125.7ab	28.5bc	3.586ab	30.128ab	117.0a-c	30.8a-c	3.605a-d	30.287a-d
K615	Control	101.5d	26.8cd	2.718c	22.832c	103.8d	28.4b-d	2.948e	24.768e
	1 gm/l	116.9a-d	29.2a-c	3.419a-c	28.721a-c	120.9ab	30.1a-c	3.637a-d	30.554a-d
	2 gm /l	109.6cd	33.8a	3.707ab	31.141ab	117.4a-c	33.6a	3.942ab	33.119ab
K111	Control	121.1a-c	25.8cd	3.134bc	26.325bc	112.8b-d	27.1cd	3.054de	25.660de
	1 gm/l	101.8d	32.6ab	3.321a-c	27.896a-c	105.4d	32.4ab	3.419b-e	28.726b-e
	2 gm /l	106.9cd	33.3ab	3.557ab	29.880ab	113.3a-d	34.6a	3.918ab	32.913ab
K306	Control	103.0d	30.4a-c	3.143bc	26.399bc	109.2cd	31.3a-c	3.408b-e	28.629b-e
	1 gm/l	111.9b-d	31.8ab	3.556ab	29.876ab	119.9ab	31.3a-c	3.753a-c	31.531a-c
	2 gm /l	120.2a-c	32.9ab	3.938a	33.105a	122.9a	33.3a	4.092a	34.373a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 8: Effect of tomato hybrid, seaweed extract and their combinations on chemical constituents of tomato hybrids during 2008 and 2009 seasons

Treatments		Chemical constituents									
		2008 Season					2009 Season				
Tomato hybrids	Seaweed extracts	N%	P%	K%	Protein %	TSS	N%	P%	K%	Protein %	TSS
Master R.S.		1.846a	0.364b	1.43a	11.54a	4.83a	1.784a	0.348b	1.27a	11.15a	5.11a
K615		1.820a	0.321b	1.37a	11.38a	4.67a	1.741a	0.278c	1.33a	10.88a	4.89a
K111		1.831a	0.500a	1.32a	11.44a	4.11a	1.727a	0.412a	1.35a	10.79a	4.56a
K306		1.798a	0.305b	1.49a	11.24a	4.56a	1.719a	0.292bc	1.46a	10.75a	4.94a
	Control	1.728a	0.367a	1.46a	10.80a	4.00a	1.650a	0.324a	1.37a	10.32a	4.29b
	1 gm/l	1.832a	0.343a	1.33a	11.45a	1.58b	1.735a	0.312a	1.32a	10.85a	4.91ab
	2 gm /l	1.911a	0.406a	1.42a	11.94a	5.04a	1.843a	0.364a	1.36a	11.52a	5.42a
Master R.S.	Control	1.748a-c	0.345c-e	1.52a	10.93a-c	4.33b-d	1.715bc	0.335bc	1.34ab	10.72b-d	4.67b-e
	1 gm/l	1.904ab	0.331c-e	1.34b-d	11.90ab	4.83a-c	1.763a-c	0.292c	1.18b	11.02a-c	5.00a-c
	2 gm /l	1.886a-c	0.417bc	1.43a-c	11.79a-c	5.33a	1.875a	0.417ab	1.30ab	11.72a	5.67a
K615	Control	1.729bc	0.335c-e	1.30cd	10.81bc	4.00cd	1.616c	0.292c	1.30ab	10.10d	4.17de
	1 gm/l	1.806a-c	0.292de	1.34b-d	11.29a-c	4.67a-c	1.720bc	0.292c	1.39ab	10.75b-d	4.83b-d
	2 gm /l	1.925a	0.335c-e	1.47ab	12.03a	5.33a	1.887a	0.250c	1.30ab	11.79a	5.67a
K111	Control	1.735a-c	0.417bc	1.47ab	10.84bc	3.67d	1.627c	0.335bc	1.39ab	10.17cd	4.00e
	1 gm/l	1.834a-c	0.500ab	1.21d	11.46a-c	4.17b-d	1.709bc	0.417ab	1.34ab	10.68b-d	4.67b-e
	2 gm /l	1.924a	0.583a	1.30cd	12.02a	4.50a-d	1.844ab	0.500a	1.34ab	11.52ab	5.00a-c
K306	Control	1.701c	0.374cd	1.56a	10.63c	4.00cd	1.644c	0.335bc	1.47a	10.28cd	4.33c-e
	1 gm/l	1.784a-c	0.250e	1.43a-c	11.15a-c	4.67a-c	1.750a-c	0.250c	1.39ab	10.94a-d	5.17ab
	2 gm /l	1.908ab	0.292de	1.47ab	11.93ab	5.00ab	1.764a-c	0.292c	1.52a	11.03a-c	5.33ab

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.