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Improving Growth, Fruit Setting, Total Yield and Fruit quality of Sweet Pepper Plants (*Capsicum annum* L.) by using Antioxidant and Seaweed Extracts

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ABSTRACT

Two field experiments were conducted at El-Baramoun farm, Mansoura Horticulture Research Station during late hot summer seasons of 2011 and 2012, to study the improving productivity of sweet pepper plants (*Capicum annum L.*) c.v."California Wander" by foliar application of individual seaweeds extract, salicylic acid, vitamin C or vitamin E and their mixed of them to improving plant growth characters, fruit setting, total yield and fruit quality. The important detected results are as following: spraying individually or mixture of seaweed extract with some antioxidant materials (salicylic acid, ascorbic acid and \ or vitamin E) gained a significantly increasing the most plant growth parameters expressed as (plant height, number of shoots/plant**,** number of leaves/plant, dry weight/ plant and leaf area\ plant) as well as nutrient uptake, fruit setting %, total fruit yield (ton\ fed.) and fruit quality compared with untreated control. However, foliar spraying by mixture of seaweed plus salicylic acid plus vitamin C produced the highest plant growth, total yield and fruit quality of sweet pepper.

Key words: Sweet pepper, seaweed extracts, salicylic acid, ascorbic acid and \ or vitamin E- growth- yield , fruit quality.

Introduction

Sweet pepper is an important agricultural crop, not only because of its economic importance, but also for the nutritional values of its fruits, mainly due to the fact that they are an excellent source of natural colors and antioxidant compounds (Howard *et al*., 2000). In the same respect, pepper fruit is considered an excellent source of bioactive nutrients such as carotenoids, vitamin C and phenolics compounds (Navarro *et al*., 2006).

Liquid extracts obtained from seaweeds have gained importance as foliar sprays for several crops Thivy, (1961) and Bokil, *et al* (1974) because the extract contains growth promoting hormones (IAA and IBA), cytokinins and trace elements (Fe, Cu, Zn, Co, Mo, Mn and Ni) as well as vitamins and amino acids (Zodape *et al.* 2011). Aqueous extract of *Sargassum wightii* when applied as a foliar spray on *Zizyphus mauritiana* showed an increased yield and quality of vegetable crops (Rama Rao 1991). Applying seaweed extract increased the response of different growth parameters and yield responses of watermelon (Abdel-Mawgoud *et al* 2010). In the same respect, Shehata *et al* (2011) on Celeriac plants**,** Fawzy *et al* (2012) on Chinese garlic plants and on tomato plants Hernández *et al* (2013) and Shabana *et al* (2015) found that foliar spraying of seaweed extract obtain the highest values of vegetative growth, yield and its fruit quality. However, Ghurbat (2013) on sweet pepper plants reported that spraying seaweed extract led to positive significant difference in plant height(cm), leaves chlorophyll content % and total yield as well as fruit diameter, fruit length, fruit dry weight, TSS %, Vitamin C, fruit weight, yield per plant and total yield as compared to untreated plants.

Salicylic acid is widely present in plants and functions as a hormonal mediator of the systemic acquired resistance response. Thus, it presents in a large scale of fruits, vegetables, herbs and spices of dietary relevance. The recognized effect of consuming fruits and vegetables on lowering risk of colon cancer may be partly attributed to salicylates in plant-based foods (Paterson *et al.,* 2006). Application of salicylic acid at 20 ppm on pea plants enhanced plant growth as indicated by plant height, number of leaves, fresh and dry weights in both seasons (El-Shraiy and Hegazi 2009). Foliar spray with salicylic acid increased the fresh and dry weight of plant, pod setting and total proteins of leaves and fruits Sanaa *et al.,* (2001). Salicylic acid retarded the growth and green pod yield and its components as well as weight of dry seed of common bean (Amer, 2004). Using 150 ppm of salicylic acid as a foliar application gave the highest increment in number of branches, fresh and dry weight and total protein as well as number of pods, pods setting and green pods yield of snap bean **(**Kmal *et al.,* 2006). Also spraying tomato plants with salicylic acid at 100 ppm increased vegetative growth, dry weight, yield

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and its components and NPK content as well as total protein (Ali *et al.,* 2009). 1.5 mM concentration of salicylic acid had a stimulating effect on the growth, dry weight and protein of pepper as compared with other concentrations 5 and 10 mM (Canakci 2011). In general, adding salicylic acid significantly relieved the harsh effects of drought on okra germination and growth parameters and it seems that salicylic acid were able to enhance the tolerant ability of the plant to drought stress **(**Baghizadeh and Hajmohammadrezaei, 2011). In the same respect, Nour *et al* (2012) found that, plant growth, yield and its components and chemical constituents of pods were significantly affected by treating snap bean plants with different antioxidants materials. However, Magda, *et al* (2013) reported that all concentrations of salicylic acid (25, 50, 75 and 100 mg/l) was significant on growth characters, yield and its components (except crop index and migration coefficient) and photosynthetic pigments content. Moreover, Shafeek *et al* (2014) reported that foliar spraying of high level of salicylic acid significantly increased growth, yield and pods quality of bean plants. Also, Shokr *et al* (2014) found that, using salicylic acid improving vegetative growth and yield and its attributes, as well as pod soluble solid substances (S.S.S) and pigments constituents of leaves and pods of snap bean plants compared with untreated control (tap water) in both seasons.

Tocopherols are a group of compounds synthesized also occurs is response to variety of a biotic stresses including high light, drought, salt and cold and may provide on additional line of protection from oxidative damage. Vitamin E is considered as highly antioxidant at the membrane site (Hess, 1983) which is a highly effective antioxidant at the membrane site. And has a positive effect on chlorophyll content of bean plants (Schmitz and Noga, 1998). Foliar application of Vitamin E at 0.1 ml/l and 0.3 ml/l significantly improved vegetative growth and yield of bean plants compared to control plants especially at the higher concentrations (El-Tohamy and El-Greadly, 2007). However, El-Bassiouny *et al* (2005) reported that foliar spray with – tocopherol (vitamin E) on bean plants induced increments in growth parameters, yield components, chlorophyll a, b and carotenoids content. In the same respect, Nour *et al* (2012) and Shafeek *et al* (2014) found that, plant growth; yield and its components and chemical constituents of pods were significantly affected by treating snap bean plants with different antioxidants materials.

Ascorbic acid has been shown to protect plants from oxidation and it is known to control cell differentiation and to promote plant growth Talaat (2003). The application of ascorbic acid can mitigate the harmful effects and may have stimulatory effects on plants growth, for example, ascorbic acid is synthesized in the higher plants and affects plant growth and development. It is a product of D-glucose metabolism which affects some nutritional cycle's activity in higher plants and plays an important role in the electron transport system El-Kobisy *et al* (2005). Moreover, the application of ascorbic acid caused significantly increases on growth parameters and total yield of tomato plants AbdEl-Halim (1995). In the same respect, El-Hifny and EL-sayed (2011) detected that foliar application of ascorbic acid increased the content of macronutrients N P K of sweet pepper fruits. Other investigators found similar results on the stimulatory effects of ascorbic acid on other plants such as on potato El-Banna *et al* (2006), eggplant El-Tohamy *et al* (2008)**,** sweet pepper Shehata *et al* (2002), Masahumi *et al* (2008), Khafagy *et al* (2009) and lettuce Shafeek *et al* (2013) **.** The interaction between seaweed extract and foliar spraying ascorbic acid was significantly enhanced all detected traits, since pepper plants received 2 ml.\ L seaweed extract and sprayed with 1 g\.L of ascorbic acid were characterized by the highest values of plant height, fruit weight, fruit number/plant, yield per plant, total yield fruit diameter and fruit length (Ghurbat, 2013).

This study was planned to determine the effect of individually or mixture of seaweed extract and some antioxidant materials (salicylic acid, ascorbic acid and vitamin E) on growth, yield and fruit quality of sweet pepper plants, especially under hot stress condition.

Materials and Methods

Two separated field experiments were conducted at El-Baramoun farm, Mansoura Horticulture Research Station during two successive late summer seasons of 2011 and 2012, to study the effect of individual seaweeds extract, salicylic acid, vitamin C, vitamin E and their mixed of them on improving plant growth characters, fruit setting, total yield and fruit quality of sweet pepper (*Capicum annum L.*) c.v. California Wander.

Table 1: Monthly air temperature mean in El-Mansoura during 2011 and 2012 seasons.

Months	Air temperature °C			
	2011		2012	
	Maximum	Minimum	Maximum	Minimum
May	31.3	18.9	31.5	17.7
June	35.0	20.7	34.3	20.1
July	36.5	22.5	35.5	22.7
August	37.4	23.4	36.4	22.0
September	34.3	22.0	32.7	21.2

A commercial seaweed extract product "Alga 600" (Techno green company) mixed of three seaweed viz., *Ascophyllum nodosum, Laminaria* spp and *Sargassum sp*. Seaweed extract also contains N (1%), K (18.5%), Ca (0.17%), Mg (0.42%), Fe (0.06%), S (2.2%), alganic acids (10-12%) and plant hormones (600 ppm).

Pepper transplants (40 days old) were transplanted in 6th of June during both seasons at 50 cm apart on one side of ridge that is 5 m long and 0.75 m wide. Experimental unit area was 11.25 m^2. A complete randomized blocks design in three replicates was adopted in both experiments. Plants sprayed four times with different assigned treatments, the first one was 25 days after transplanting and repeated each 7 days. All agricultural practices were performed as recommended.

Treatments were as follows:

1-Control treatment (spray only with tap water)
2-Seaweeds extract (2.5 ml/L)
3-Salicylic acid (20 ppm)
4-Vitamin C (200 ml/L)
5-Vitamin E (50 ml/L)
6- Seaweeds extract (2.5 ml/L) + Salicylic acid (20 ppm)
7-Seaweeds extract (2.5 ml/L) + Vitamin C (200 ml/L)
8- Seaweeds extract (2.5 ml/L) + Vitamin E (50ml/L)
9-Seaweeds extract (2.5 ml/L) + Salicylic acid (20 ppm) + Vitamin C (200 ml/L)
10-Seaweeds extract (2.5 ml/L) + Salicylic acid (20 ppm) + Vitamin E (50 ml/L)

Experimental parameter:-

Three plants from each treatment were randomly taken at 60 days after transplanting and the following data were recorded: plant height, number of shoots and leaves per plant, leaf area per plant and dry weight per plant. Chlorophyll a and b and caroteniods were determined as described by Wettstein (1957). Also nitrogen was determined in dry matter of leaves at 60 days after transplanting by using wet digestion according to Pepper (1947), using microkjeldahl (Horneck and Miller, 1998). Phosphorus was determined calorimetrically according to Sandell (1950). Potassium was determined according to Horneck and Hanson (1998). Calcium was determined according to Jackson (1967). At flowering stage, ten plants per each plot were randomly chosen, labeled and fruit setting % was calculated.

At harvesting time fruit yield expressed as number of fruits per plant was recorded, while the marketable, non-marketable, total yield were recorded as kg/plot, then calculated as ton/fed. At breaker stage, ten ripe sweet pepper fruits/plot were picked and used for determination of TSS % by hand refractomater and vitamin C and titratable acidity according to A.O.A.C. (1990).

Statistical analysis:-

Data were statistically analyzed and the means were compared using the Least Significant Difference test (L.S.D.) at 5% level according to Snedecor and Cachran (1980).

Results and Discussion

Plant growth characters:

Table (2) shows that spraying individually or mixture of seaweed extract with some antioxidant materials (salicylic acid, ascorbic acid and vitamin E) gained a significantly increasing the most plant growth parameters expressed as (plant height, number of shoots/plant**,** number of leaves/plant, dry weight/ plant and leaf area\ plant) compared control treatment in both seasons. However, foliar spraying sweet pepper plants by mixture of seaweed extract + salicylic acid + vitamin C produced the highest plant height (cm), number of shoots/plant**,** number of leaves/plant. In the same time, the mixture of seaweed extract + salicylic acid + vitamin E produced the highest dry weight \plant (g) and leaf area \plant (cm^2). These findings were true in both seasons. It could be concluded that, the increase in vegetative growth characters caused by Seaweed extracts may be due to the role of Seaweed extracts as bio stimulants for plant growth and development because of presence of trace elements, organic substances like amino acids and plant growth regulators such as auxin, cytokine and gibberellins which improve nutritional status, vegetative growth (El-Moniem and Abd-Allah 2008). However, Jensen (2004) showed that seaweed extract contain many of micro elements (Co, B, Mo, Zn, Cu) as well as macro elements, Auxins, Gibberellins and Cytokinins and when sprayed on plants increased root ability for growth and nutrient absorption and enhanced stem thickness and strong vegetative and root growth. Seaweeds and their extracts also increase soil health by ameliorating moisture holding capacity and by stimulating the growth of beneficial soil microbes (Khan *et al.*, 2009). These increases in the above parameters by using ascorbic acid may be due to the

fact that ascorbic acid as an antioxidant has an effect as plant growth regulators (Johnson *et al.,*1999) and its role in activating both cell division and elongation in meristematic tissues, as well as the biosynthesis of organic foods (Nijjar, 1985). Ascorbic acid has a well documented role in many aspects of radix control and antioxidant activity in the plant cell, this botanical briefing highlight recent development in a another aspect of Ascorbic acid metabolism (Seth *et al.*, 2007).

Table 2: Effect of different individual or mixed application of antioxidants and seaweed treatments on vegetative growth characters of sweet pepper plants during 2011 and 2012 seasons.

Characters / Treatments	Season 2011				
	Plant height (cm)	NO. of shoots/plant	NO. of leaves/plant	Dry wt/plant (gm)	Leaf area /plant (cm2)
Control	37.1	2.33	101.33	112.5	2.01
Sw	43.2	3.00	220.00	145.9	2.20
Sal	41.1	2.67	186.67	130.4	2.14
V. C	41.5	3.00	218.00	136.7	2.15
V. E	41.0	2.79	214.33	139.0	2.16
Sw + Sal	46.4	3.33	330.67	148.2	2.31
Sw + V. C	48.4	4.00	315.00	140.5	2.24
Sw + V. E	47.3	3.33	321.33	150.9	2.23
Sw + Sal + VC	58.7*	4.67*	354.33*	161.4	2.37
Sw+ Sal+ V. E	56.4	4.33	344.67	165.3*	2.42*
LSD at 5%	3.7	0.25	20.34	17.6	0.13
Treatments	Season 2012				
Control	38.0	2.00	120.00	115.3	2.10
Sw	46.4	3.33	188.67	152.8	2.29
Sal	43.6	2.67	177.33	140.5	2.23
V.C	44.0	3.33	182.33	143.7	2.30
V.E	43.0	3.33	178.00	146.2	2.33
Sw + Sal	47.8	4.00	290.00	155.9	2.43
Sw + V. C	49.9	4.33	284.33	145.8	2.41
Sw + V. E	47.0	4.67	292.67	146.3	2.36
Sw + Sal + VC	60.1	5.33*	350.00	170.4	2.44
Sw+ Sal+ V E	61.2*	5.00	352,67*	172.5*	2.47*
LSD at 5%	5.03	0.29	22.12	20.30	0.16

Sw : Seaweeds extract; Sal. :Salicylic acid; V.C. : Vitamin C;, V.E. :Vitamin E

Photosynthetic pigments and mineral uptake of sweet pepper plants:

Data presented in Table (3) reported that, foliar spraying of individually or mixtures of antioxidant and seaweed materials had enhancement total photosynthetic pigments i.e. (Chlorophyll A, Chlorophyll B and Carotenoids) as well as plant uptake of the percentage of N, P, K and Ca contents compared control treatment. However, the combination of seaweed extract + salicylic acid + vitamin C gained the highest contents of sweet pepper leaves on total photosynthetic pigments compared individually treatments and control. But, the plant uptake of the percentage of N, P, K and Ca were significantly increased by spraying the combination of seaweed extract + salicylic acid + vitamin E. It could be concluded that, these results may be the role of seaweed and antioxidant materials on promoting vegetative growth characters (Table 2). Antioxidants intercept free radicals and protect cells from the oxidative damage that leads to aging and disease (Karadeniz *et al*., 2005). Active oxygen scavengers (antioxidants) could be beneficial in the protection of the structure and function of the photo systems against excess light (Rajagopal *et al.,* 2005). Antioxidants play role in the reduction or prevention of enzymatic by inhibiting polyphenol oxidase (Maurice *et al.,* 2000). However, Wassel *et al*. (2007) assumed that the effect of ascorbic acid on the plant growth might be due to the auxinic action of ascorbic acid as well as, its improved role in many metabolic and physiological processes and enhancing the synthesis of carbohydrates. In the same respect, the superiority of spraying salicylic acid and vitamin E these results may be due to the role of antioxidants in enhancing some physiological and biochemical aspects (Maity and Bera 2009) or increasing N,P,K and Ca content, activity in antioxidant enzymes and glutathione content (Khan *et al* 2009) on pea plant. It be concluded that, many of these photochemical may help to protect cells against oxidative damage caused by free radicals (Wada and Ou, 2002).

Fruit setting and yield parameters:

Concerning to the effect of foliar application i.e. seaweed extract, salicylic acid, vitamin C and vitamin E individual or in mixtures on the total yield of sweet pepper fruits (Table 4), the resulted data showed that all treatments of seaweed extract and antioxidant materials had an enhancement in fruits yield and its components if compared with that plant no received (control). The presented data revealed that, foliar application of the mixture of seaweed extract, salicylic acid and vitamin C resulted the heaviest fruits yield (17.00 and 18.10

Table 3: Effect of different individual or mixed application of antioxidants and seaweed treatments on photosynthetic pigment contents and chemical composition of sweet pepper plants during seasons of 2011 and 2012.

Characters / Treatments	Season 2011						
	Chlorophyll (A) (mg/g F.W.)	Chlorophyll (B) (mg/g F.W.)	Carotenoids (mg/100g F.W.)	N%	P%	K%	Ca%
Control	0.652	0.593	0.269	1.09	0.37	1.58	0.73
Sw	0.905	0.709	0.369	3.23	0.72	1.67	1.55
Sal	0.746	0.641	0.351	3.11	0.43	1.60	1.34
V.C	0.833	0.630	0.355	2.27	0.40	1.65	1.49
V.E	0.846	0.701	0.340	3.12	0.45	1.61	1.47
Sw + Sal	0.965	0.785	0.373	3.40	0.60	1.70	1.65
Sw + V. C	1.092	0.813	0.378	3.44	0.65	1.69	1.82
Sw + V. E	1.088	0.958	0.370	3.42	0.63	1.72	1.65
Sw+ Sal + VC	1.211*	0.973*	0.393*	3.79	0.77	1.90*	1.98*
Sw + Sal + VE	1.183	0.929	0.381	4.03*	0.83*	1.89	1.92
LSD at 5%	0.087	0.033	0.014	0.16	0.11	0.07	0.15
Treatments	Season 2012						
Control	0.705	0.680	0.279	1.13	0.41	1.57	0.76
Sw	0.867	0.935	0.345	2.47	0.67	1.71	1.50
Sal	0.784	0.712	0.328	3.02	0.48	1.63	1.41
V.C	0.822	0.900	0.333	2.96	0.45	1.69	1.52
V.E	0.769	0.853	0.341	3.13	0.48	1.65	1.50
Sw + Sal	0.811	0.907	0.338	3.51	0.55	1.75	1.69
Sw + V. C	0.989	0.986	0.348	3.38	0.62	1.77	1.77
Sw + V.E	1.006	0.891	0.350	3.44	0.70	1.75	1.72
Sw + Sal + VC	1.222*	0.991*	0.401	3.66	0.89*	1.93*	2.02*
Sw + Sal + VE	1.192	0.964	0.980*	3.76*	0.82	1.88	1.97
LSD at 5%	0.096	0.051	0.022	0.17	0.13	0.09	0.19

Sw : Seaweeds extract; Sal. :Salicylic acid; V.C. : Vitamin C;, V.E. :Vitamin E

Table 4: Effect of different individual or mixed application of antioxidants and seaweed treatments of fruit setting and yield parameters of sweet pepper plants on 2011 and 2012 seasons.

Characters / Treatments	Season 2011				
	Fruit setting (%)	Fruit No./plant	Marketable Yield (ton/fed.)	Unmarketable Yield (ton/fed.)	Total yield (ton/fed.)
Control	32.3	9.67	7.23	1.70*	8.93
Sw	38.1	17.33	13.31	1.43	14.74
Sal	36.2	13.33	9.14	1.52	10.66
V.C	36.5	15.67	13.88	1.37	15.25
V.E	38.5	17.67	13.52	1.36	14.88
Sw + Sal	45.4	18.67	14.73	1.34	16.07
Sw + V. C	45.7	18.33	15.19	1.20	16.39
Sw + V.E	46.9	20.00	14.60	1.21	15.81
Sw + Sal + VC	48.3	19.67	15.80*	1.20	17.00*
Sw + Sal+ V E	49.7*	20.33*	15.41	1.11*	16.52
LSD at 5%	2.3	1.66	0.76	0.11	0.85
Treatments	Season 2012				
Control	35.1	10.67	7.95	1.56	9.51
Sw	43.5	16.67	13.86	1.50	15.36
Sal	37.8	14.33	10.22	1.48	11.70
V.C	40.2	16.00	14.44	1.46	15.90
V.E	42.9	15.67	13.38	1.48	14.86
Sw + Sal	44.7	18.00	14.48	1,40	15.88
Sw + V. C	44.2	19.00	15.11	1.39	16.50
Sw + V.E	46.9	19.33	14.65	1.35	16.00
Sw + Sal+ VC	47.7	20.00	16.88	1.22*	18.10*
Sw+ Sal+ V E	50.1*	20.33*	16.99*	1.25	17.44
LSD at 5%	2.7	1.81	0.91	0.13	0.91

Sw : Seaweeds extract; Sal. :Salicylic acid; V.C. : Vitamin C;, V.E. :Vitamin E

ton\fed) in 1st and 2 seasons respectively). The response of number of fruits/plant, fruit setting % and total marketable yield ton /fed. to the application of some antioxidant materials nearly followed the same pattern of change which mentioned before. Generally, it could be abstracted that, foliar application of the mixture contained seaweed extract, salicylic acid and vitamin C or vitamin E was the best favorable effect on the total yield of sweet pepper fruits. Seaweeds have gained importance as foliar sprays for several crops because the extract contains growth promoting hormones (IAA and IBA), cytokinins, trace elements (Fe, Cu, Zn, Co, Mo, Mn and Ni) as well as vitamins and amino acids (Zodape *et al.* 2011). Also, vitamin C is a product of D-glucose metabolism which affects some nutritional cycle's activity in higher plants and plays an important role in the electron transport system El-Kobisy *et al* (2005). However, Antioxidants materials intercept free radicals and protect cells from the oxidative damage that leads to aging and disease (Karadeniz *et al*., 2005). Active oxygen

scavengers (antioxidants) could be beneficial in the protection of the structure and function of the photosystems against excess light (Rajagopal *et al.,* 2005). Antioxidants play role in the reduction or prevention of enzymatic browning by inhibiting polyphenol oxidase (Maurice *et al.,* 2000).

Chemical fruit quality:

The application of seaweed extract, salicylic acid, vitamin C and vitamin E as individual and/or mixture for sweet pepper fruits Table (5) resulted more nutritional values, i.e., TSS %, total acidity % and vitamin C (mg\100 g) in fruits tissues if compared with the no supplied plants. Moreover, that plants which treated with the mixture of seaweed extract, salicylic acid, vitamin C or vitamin E resulted the best chemical properties as in a comparison with that plant received the individual treatments. These results were similar in the two experiments of 2011 and 2012. It could be concluded that, foliar spraying with the mixture of these treatments had an enhancement in the chemical constituents of pepper fruits. This might be attributed to the role of each treatment in plant metabolism which reflected on the total fruits yield and its properties. Many authors studied the response of vegetable fruits yield to the foliar application of seaweed extract and same antioxidant treatments and their reports are in good accordance with that which written here (El-Hifny and El-sayed 2011, Hernández *et al* 2013, Ghurbat 2013, Shafeek *et al* 2014, Shokr *et al* 2014, and Shabana *et al* 2015).

Table 5: Effect of different individual or mixed application of antioxidants and seaweed treatment of pepper chemical fruit quality during 2011 and 2012 seasons.

Characters	Season 2011		
Treatments	T.S.S (%)	Total acidity (%)	Vitamin C (mg/100gfw.)
Control	4.21	0.62	50.33
Sw	4.84	0.68	60.00
Sal	4.73	0.68	58.50
V.C	4.83	0.70	64.20
V.E	4.60	0.67	60.10
Sw+ Sal	4.78	0.70	61.23
Sw+ V. C	4.89	0.75	66.20
Sw+ V.E	4.88	0.70	63.40
Sw + Sal + VC	4.90*	0.78	67.23*
Sw+ Sal+ V E	4.89	0.80*	65.80
LSD at 5%	0.40	0.05	7.39
Treatments	Season 2012		
Control	4.26	0.60	49.21
Sw	4.73	0.66	58.90
Sal	4.60	0.68	56.87
V.C	4.75	0.67	63.44
V.E	4.61	0.65	58.82
Sw+ Sal	4.73	0.71	60.33
Sw+ V. C	4.87	0.77	65.04
Sw+ V.E	4.84	0.73	62.11
Sw+ Sal+ VC	4.88*	0.80*	67.91*
Sw+ Sal+ V E	4.87	0.79	65.84
LSD at 5%	0.40	0.07	7.00

Sw: Seaweeds extract; Sal. : Salicylic acid; V.C. : Vitamin C;, V.E. :Vitamin E

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