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INFLUENCE OF POTASSIUM LEVELS AND SOME ANTI-SALINITY MATERIALS ON SWEET PEPPER GROWN IN SANDY SOIL AND IRRIGATION WITH HIGH SALINTY WATER UNDER NORTH SINAI CONDITIONS

S.A.A Abuo El-kasem

Veg. Res. Dept., Hort. Res. Inst., Agric. Res. Center, Agric. Res. Station, El-Arish, North Sinai, Ministry of Agric. &Soil Reclam., Cairo, Egypt.

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ABSTRAC: *The present work was carried out during the two successive seasons of 2013 and 2014 at the Agriculture Research Station of Hortic. Dept., Agric. Res. Center, in El- Arish, North Sinai Governorate, Egypt. Sweet Pepper (Capsicum annum L.) Local hybrid "Fares" was used in this study . The objective of the experiments was to study the effect of four potassium rates i.e., 200 (K1)/fed., 250 (K2)/fed., 300 (K3)/fed., and 350 (K4)Kg/fed. from potassium sulfate 48%) with four treatments of foliar spray by some anti-salinity using (1g/ l^{-1} Zinc, 5 cm/ l^{-1} Humic acid, and 0.5g/ l^{-1} Salicylic acid, and beside the control) under sandy soil which irrigated with high salinity water and saline water irrigation in North Sinai, on the growth, yield and some chemical contents in leaves and fruits of pepper plants as well as fruit quality. Split plot design was used in the experiment. The results showed that all growth parameters, gave the highest values with application of potassium level at the rate of 350 Kg per fed. with foliar spray by any of Humic acid 5 cm/ l^{-1}, Salicylic acid 0.5g/ l^{-1}, and ZN 1g/ l^{-1} , respectively as well as all fresh and dry weights of pepper plant organs expressed in roots, leaves, and stems, as well as clusters fresh weight and both total fresh and dry weight of pepper plants in the both seasons compared to application of potassium the other levels at (K1, K2 and K3) with any of foliar spray of (Zn, Humic and Salicylic acids). Application of the high potassium level (350 Kg per fed.) with the foliar spray by Humic acid, Zn, and Salicylic acid, showed a significant increase in marketable yield of fruit weight per plant (g), number of fruits per plant, average fruit weight as well as total yield per fed. in addition high potassium level (K4) with the foliar spray with any of salicylic acid, Humic acid and Zn, respectively gave the low contents of Na^+ and proline in the leaves and fruits compared to the low levels of potassium in the both seasons. Application of potassium levels K4 or K3 with spraying by Zn, Humic acid and salicylic acid gave the highest values for V.C content and T.S.S in sweet pepper fruits.*

Key words: *Sweet pepper, Potassium levels- foliar spray with some anti-salinity treatments- under sandy soil*

INTRODUCTION

Pepper (*Capsicum annum* L.) is one of most popular and favorite vegetable crop cultivated in Egypt. Pepper are an important agricultural crop, not only for their economic importance but also for the nutritional value of its fruits, mainly because it is an excellent source of natural pigments and antioxidant compounds in addition to their excellent flavor and pungency Navarro *et al.* (2002). Pepper is very rich in vitamin C, B and B6 and pro-vitamin A. Moreover it is very high in N, P, and K and contains high amounts from magnesium and iron Sparky (2006). The Chilies and Pepper are cultivated in Egypt as annual production of about 601289 tonnes according to Statistics of 2014 season FAO (2016).

Water quality is a major constraint for crop production in the North Sinai region, as well as the fruit yield with dependence on the water quality. The underground water is the main irrigation source under drip irrigation system and most of irrigation water characterized with high salinity. Most of North Sinai locations which are exposed to combinations of environmental stress conditions, including low water quality, temperature fluctuations, and high irradiance. Also, most soils have low water holding capacity and low soil organic matter content. Under the condition of these reigns the water is the major limiting factor for plant growth. The environmental stress conditions may lead to reduce plant growth by affecting various physiological and biochemical processes, such as photosynthesis, respiration, translocation, ion uptake, carbohydrates, nutrient metabolism and growth promoters Jalleel *et al.* (2008).

The salinity causes some types of stresses in plants: osmotic, ionic, and oxidative. NaCl, causes stresses such as reduce absorption and induce a massive efflux of water and (K^+) ions in plant cells, resulting in water and nutritional imbalances. The accumulation of Na^+ to toxic concentrations and the production of reactive oxygen species (ROS) reduce the growth, yield, and production of economically important crops, such as cereals and vegetables (Bojórquez-Quintal *et al.,* 2012; Munns and Tester, 2008).

Many investigators studied the responses of plants to application of Potassium in the soil and foliar spray with Zinc, Hmic and salicylic acid for tolerating stress. Concerning to known that it is not constituent of any plant structures or organs, but it plays potassium effect part in many it is an important regulatory roles in the plant; i.e., osmo-regulation process, regulation of plant stomata and water use, translocation of sugars and formation of carbohydrates, energy status of the plant, the regulation of enzyme activities, protein synthesis and many other processes needed to sustain plant growth and reproduction Hsiao and Luchli (1986). It is a highly mobile element in the plant and has a specific phenomenon, it is called luxury consumption. In addition, it plays a very important role in plant tolerance of biotic and abiotic stresses (Marschner., 1995).

The regulation of K^+ homeostasis is essential for plant adaptation to biotic and abiotic stresses. This adaptation is associated with the wide range of functions in which K^+ participates Shabala and Pottosin (2014). Recently it found that, K^+ retention in the cells of roots and leaves has been identified as an important trait for salt tolerance. A strong negative correlation between the magnitude of salt-induced K^+ loss and salt tolerance, observed in various crop species, suggested K^+ retention as a selection criterion between salt tolerant and sensitive varieties (Lin Duo and Danfeng 2003; Wu *et al.,* 2013).

Concerning to the role of Zinc several investigators reported that Zinc (Zn) is closely involved in a wide range of cellular processes, such as free radical defense, electron transport, protein and auxin biosynthesis, cell proliferation, and reproduction in plants. The Zn plays very important role in plant metabolism by influencing the activities of hydrogenase and carbonic anhydrase, stabilization of ribosomal fractions and synthesis of cytochrome Tisdale *et al.* (1984). It was found that, to induce tolerance to environmental stress conditions adding high amounts from Zn to regulate and maintain the expression of genes needed to protect cells from the detrimental effects of stress Cakmak (2005). Also, Zn is an essential micronutrient for all organisms and serves as a cofactor for more than 300 enzymes Gonzalez-Guerrero *et al.* (2005). In addition, Sawan, *et al.* (2002) found that Zn is required in the synthesis of tryptophan, which is a precursor in the synthesis of indole-3-acetic acid; hormone that it is inhibits abscission of squares and bolls. Zinc is an essential micronutrient and has particular physiological functions in all living systems, such as the maintenance of structural and functional integrity of biological membranes and facilitation of protein synthesis and gene expression. Among all metals, Zn is needed by the largest number of proteins. Zinc binding proteins make up nearly 10 % of the proteomes in eukaryotic cells, and 36% of the eukaryotic Zn-proteins are involved in gene expression Andreini *et al.* (2006).

Regarding to humic acid substance which it contributing indirect and direct effects on plant growth. Indirect effects are through enrichment in soil nutrients, increase biological activities of microorganisms and higher cation exchange capacity (CEC), improvement of soil structure; whereas direct effects are various biochemical actions exerted on the cell wall, membrane or cytoplasm and mainly of a hormonal nature Cheny (2004). The hormone like activities of HA are well documented in various papers, in particular auxin, cytokinin and gibberellin like effects on the other hand, directly affect the processes associated with the uptake and transport of humic substances into the plant tissues Nardi *et al.* (2002). Several studies showed that the application of the Humic substance under water stress increased leaf water retention, increases the water holding capacity of the soil and the photosynthetic as well as antioxidant, positive influence on quantitative and qualitative traits of pepper plants Ameri and Tehranifar, (2012).

Recently, it is found that, salicylic acid acts as a potential non-enzymatic antioxidant as much as plant growth regulator, playing an important role in regulating a many plant physiological processes. SA has been identified as a signaling component in numerous plant responses to stress, including UV-B, exposure to ozone and pathogen attack. SA is also involved in the activation of the stress induced antioxidant system stimulates flowering in many plants, increase flower life, control ion uptake by roots and stomata conductivity Muthulakshmi *et al* (2017).

The objective of this work was to study the effect of potassium levels as soil application and some anti-salinity treatments i.e. foliar spray with (Zn, Humic, and SA) on sweet pepper production under saline irrigation water and sandy soil conditions in Northern Sinai.

MATERIALS AND METHODS

The present work was carried out during the two successive seasons of 2013 and 2014 at the Agriculture Research Station of Hortic. Dept., Agric. Res. Center, in El-Arish, North Sinai Governorate, Egypt. Sweet Pepper (*Capsicum annum* L.) Local hybrid "Fares" was used in this study. The seeds were sown on 15^{th} April in the nursery in both seasons. Uniform Seedlings were selected and transplanted on 5^{th} and 10^{th} Jun in 2013 and 2014 seasons, respectively. Seedlings were transplanted besides drippier lines, the distance between every two drippier lines in each row were 100 cm. The distance between plants in the same line was 40 cm. The plot area was 12 m^2 (12 m long and 100 cm between each two dripper lines in each row).

The drip irrigation system was followed and the other normal cultural practices were used according to the recommendations of Ministry of Agriculture. for fertilizing pepper plants without adding potassium fertilizer, which it using it in several rates as the main treatment in the experiment.

The objective of this study was objective to study the effect of four potassium rates, i.e. 200 Kg (K1), 250 Kg (K2),300 Kg (K3) and 350 Kg (K4) from potassium sulfate 48% K_2O with four treatments of foliar spray of anti-salinity using (Zinc 1g/ l^{-1} "Global Chelated Zinc 14 %", Humic acid 5 cm/ l^{-1}, Its contents include "Humic acid 18%, Fulvic acid 14%, Amino acid 19.93%, Nitrogen 4.03%, P_2O_5 0.3%, K_2O 3.72%, Zn 0.1%, Fe 380 mg l^{-1}, Mn 29.1 Mg l^{-1} and Cu 17 mg l^{-1}", Salicylic acid 0.5g/ l^{-1}, and control which used its as the recommendation of the ministry).

The treatments were arranged randomly in a split-plot design, in three replications, where the four potassium levels were randomly arranged in the main plots which it added thought 4 times, i.e. 25 % of the different levels were added at four stages, the first during soil preparation, the second after one month from transplanting, the third at the flowering and the beginning fruit setting stage, the fourth at fruiting stage. Foliar spraying of treatments (Zinc, Humic acid, Salicylic acid, beside the control), were randomly distributed in the sub plots. Foliar spraying took place after 20, 40, 60 and 80 days from transplanting

Some physical and chemical properties of the experimental soil and chemical analysis of irrigation water were presented in Tables 1 and 2, respectively, (According to Ryan *et al.,* 1999).

The following Data were recorded:

1. Vegetative growth

A random sample of 5 plants from each sub plot was taken at 90 days after transplanting and the following vegetative characters were recorded: fresh weight of roots, stems, leaves, clusters (g), and dry weight of roots, stems, as well as leaves (g), and total fresh and dry weight/plant (g).

2. Yield and its components

Yield was divided into two grades (Marketable yield and unmarketable yield). The following measurements were studied: number of fruits per plant, average fruit weight (g). Fruits weight per plant (g), yield per fed. for marketable yield (ton/fed.) as well as total yield per fed.

3. Fruit quality

At the green ripe stage (the marketable stage or edible stage) of the third picking samples of ten fruits were randomly taken from each sub plot and the following data were recorded:

a. Ascorbic acid (V.C)

It was determined in fruit juice (as mg/100ml juice) using 2, 6 diclorophenol endophenol as described in A.O.A.C. (1990).

b. pH

It was measured using pH meter A.O.A.C. (1990).

c. Fruit total soluble solids (TSS %)

It was measured using a hand refractometer A.O.A.C. (1990).

Table 1: Mechanical and chemical properties of the experimental soil.

Mechanical analysis %			Chemical analysis (soluble ion in (1:5 extract)														Organic matter %
Sand	silt	clay	Total (ppm)			meq./l									ECe	pH	
						Cations				Anions							
88.7	4	7.3	N	P	K	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$So^{--}4$	Cl-	Co_3	Hco_3	Ca Co_3			
Soil texture (Sand)			10	57.6	26	2.0	2.0	0.82	0.23	2.4	2.4	-	0.2	0.2	0.5	7.9	0.08

Table 2: Chemical analysis of irrigation water.

pH	EC (dSm^{-1})	Soluble ions($meq.1^{-1}/L$)								S.S.P%	S.A.R	R.S.C
		Cations				Anions						
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	HCO_3^{-}	CO_3^{--}	SO_4^{--}			
7.86	8.28	15.4	14.6	45.2	0.2	47.5	2.6	-	25.93	12.9	64.3	25.7

4. Chemical continues of N, P, K, Na^+ and Proline in the leaves and fruits.

a. Total nitrogen was determined using the method described by Bremner and Mulvancy (1982), b. Phosphorus content was determined using the method described by Ryan *et. al.* (1999), Potassium and Sodium contents were measured by flame photometer as described by Irri (1976), and c. Proline was determined spectrophotometrically following the ninhydrin method described by Bates *et al.* (1973).

5. Statistical analysis

Statistical analysis of the obtained data was carried out according to statistical analysis of variance according to Snedecor and Cochran (1980). Duncan's multiple range tests was used for comparison among the means (Duncan, 1958). The M stat C program was used for analysis.

RESULTS AND DISCUSSION

1. Fresh and dry weight of pepper plant organs:

1.1. Effect of potassium fertilization levels

Data in Table (3) show significant effects on most studied traits of fresh and dry weight of sweet pepper plants. except on leaves and clusters fresh weight in the both seasons. Potassium application level at 350 Kg/fed. gave the highest values in all fresh and dry weights of pepper plant organs expressed on roots, leaves, stems, as well as the clusters fresh weight, in the both seasons followed by the level at 300 kg/fed. The increment in fresh and dry weight of pepper plant organs may be due to the application of the high levels of potassium which induce enhancement and increase of root system efficiency which reflected to induce the growth and development of the roots. Potassium is related to the synthesis of proteins, carbohydrates, sugars and starch storage and this stimulated the growth, improved utilization of water and improve the resistance of the stress (Faquin, 1994). Many studies showed that the ability of plants to retain K^+ and to maintain K^+/Na^+ selectivity has been considered the key in the feature of salt tolerance (Tester and Davenport, 2003). Potassium deficient on crops causes grow slowly and have poorly developed root systems, Marco *et al.* (2011) on pepper plant, indicated that roots and shoots K^+ content were greater than Na^+ content, suggesting that K^+ may act as the major monovalent cationic osmoregulator.

1.2. Effect of foliar spray with anti-salinity treatments

Data in Table (3) show that foliar spray with any of Zinc, humic acid or salicylic acid, induced significant effects on fresh and dry weight of different pepper plant organs more than the control in the both seasons except leaves, clusters and total plant fresh weight. The highest values, were obtained from the foliar spray with humic acid at rate of 5 cm per liter Foliar spray by using humic acid had a positive effect on plant growth, i.e. fresh and dry weight per plant. (Cheny, 2004; Nardi *et al.,* 2002; and Varanin and Pinton, 2001) reported that the increasing in growth might be due to the effect of humic acid on biochemical actions exerted on the cell wall, membrane or cytoplasm which led to building and activities of hormones; i.e., auxin, cytokinin, and gibberellin like. Several studies showed that foliar spray with humic molecules under water stress gave an increase in photosynthetic, antioxidant metabolism and increased leaf water retention, consequently increased the plant growth of plant organs. (Fahram *et al.* 2014; Fu Jiu, 1995; and Nardi, 2002)

Table 3: Effect of potassium fertilizer levels and foliar spray with some anti-salinity treatments on fresh and dry weight of pepper plants during 2013-2014 seasons.

Characters		Fresh weight (g)					Dry weight (g)			
Variables		Roots	Leaves	Branches	Clusters	Total	Roots	Leaves	Branche	Total
Effect of potassium levels					90 Days from transplanting					
					Season 2013					
K1		26.79b	74.56a	123.52c	574.57a	799.45b	4.254c	16.28b	36.51d	57.04d
K2		29.48b	81.85a	131.19bc	622.03a	864.56ab	4.84bc	19.38ab	39.95c	64.18c
K3		38.11a	90.37a	144.94ab	693.36a	966.80ab	5.46b	21.89ab	45.76b	73.13b
K4		40.32a	107.73a	152.21a	750.27a	1050.55a	6.39a	23.19a	53.10a	82.70a
					Season 2014					
K1		29.14b	77.52a	129.86c	583.13a	819.66b	5.32c	18.16c	37.91d	61.39d
K2		31.85b	85.62a	138.21bc	640.50a	896.20ab	5.99bc	20.77bc	41.38c	68.15c
K3		39.76a	92.53a	151.24ab	703.71a	987.24ab	6.44b	23.43ab	47.69b	77.57b
K4		44.33a	110.46a	161.28a	754.88a	1070.96a	7.66a	25.34a	55.03a	88.04a
Effect of foliar spray					Season 2013					
Witout		29.12b	73.96a	122.03c	588.61a	813.73a	4.40b	14.68b	38.75c	57.84c
Zinc		33.77ab	94.35a	142.58ab	684.55a	955.26a	5.49ab	21.67a	44.11b	71.27b
Humic		37.64a	98.7a	150.68a	707.65a	994.72a	5.819a	24.94a	49.74a	80.51a
Salicylic		34.16ab	87.47a	136.57b	659.43a	917.65a	5.25ab	19.46ab	42.71b	67.43b
					Season 2014					
without		31.73b	77.59a	129.10c	598.84a	837.27a	5.638b	16.38c	40.51c	62.53c
Zinc		36.59ab	96.91a	150.35ab	692.41a	976.27a	6.52ab	23.01ab	45.68b	75.21b
Humic		40.71a	100.81a	157.34a	722.99a	1021.85a	7.00a	26.84a	51.85a	85.70a
Salicylic		36.05ab	90.83a	143.80b	667.98a	938.66a	6.25ab	21.48b	43.98b	71.72b
Effect of the interaction					Season 2013					
K1	without	21.66g	60.10d	109.21h	496.66c	687.65f	3.46f	10.22f	33.41i	47.09i
	Zinc	28.69fg	78.52cd	130.65ef	610.00a-c	847.86c-f	4.62c-e	18.02b-e	36.83hi	59.47gh
	Humic	28.47fg	85.07b-d	136.99c-e	625.29a-c	875.83b-f	4.83cd	22.18a-d	39.81gh	66.83d-f
	Salicylic	28.33fg	74.56cd	117.23gh	566.33a-c	786.46d-f	4.09d-f	14.70ef	35.99i	54.78h
K2	without	22.62g	70.323cd	120.39f-h	546.51b-c	759.85e-f	3.69ef	15.02ef	35.57i	54.29h
	Zinc	31.66d-f	88.36b-d	133.63de	630.33a-c	883.99b-f	5.24b-d	22.43a-c	40.55fg	68.23de
	Humic	33.18c-f	85.25b-d	143.95b-d	688.66a-c	951.05a-e	5.54bc	23.71ab	43.79df	73.04cd
	Salicylic	30.45ef	83.47b-d	126.80e-g	622.62a-c	863.35b-f	4.91cd	16.39de	39.87gh	61.17fg
K3	without	35.67b-f	75.18cd	124.64e-g	628.03a-c	863.53b-f	4.86cd	16.22de	41.67e-g	62.76e-g
	Zinc	36.41b-e	95.22a-c	150.23b	722.88a-c	1004.75a-d	5.65bc	22.57a-c	47.19cd	75.42c
	Humic	42.58ab	100.88a-c	156.07a	731.66ab	1031.20a-c	5.73bc	26.77a	49.89bc	82.40b
	Salicylic	37.79b-e	90.21b-d	148.81bc	690.88a-c	967.70a-e	5.62bc	22.01a-d	44.31de	71.94cd
K4	without	36.55b-e	90.23b-d	133.87de	683.22a-c	943.88a-e	5.60bc	17.26c-e	44.37de	67.24d-f
	Zinc	38.33b-d	115.29ab	155.82ab	775.10a	1084.45ab	6.43ab	23.67ab	51.87b	81.98b
	Humic	46.33a	123.757a	165.71a	785.08a	1120.79a	7.17a	27.12a	65.48a	99.77a
	Salicylic	40.06a-c	101.66a-c	153.46ab	757.88ab	1053.08a-c	6.38ab	24.74a	50.69bc	81.82b
					Season 2014					
K1	without	23.76h	62.77d	115.60i	500.913d	703.06e	4.44g	11.93f	34.72i	51.09h
	Zinc	30.33fg	81.30cd	137.04e-g	631.73a-d	880.41b-e	5.66ef	20.07c-e	38.08h	63.81fg
	Humic	31.45fg	87.46cd	143.68de	630.05a-d	892.64b-e	6.073d-f	23.54b-d	41.64fg	71.26de
	Salicylic	31.02fg	78.54cd	123.12hi	569.85b-d	802.54c-e	5.10fg	17.10e	37.21h	59.41g
K2	without	25.35gh	76.98cd	127.12gi	549.52cd	778.99de	5.67ef	16.83e	37.57h	60.08g
	Zinc	34.57d-f	90.85b-d	140.30d-f	648.79a-d	914.53b-d	5.87d-f	23.72b-d	42.07fg	71.66de
	Humic	35.39d-f	88.02cd	151.38cd	725.33a-c	1000.13a-c	6.61c-e	24.69bc	44.86e	76.17cd
	Salicylic	32.09ef	86.64cd	134.04e-h	638.37a-d	891.15b-e	5.81d-f	17.85e	41.04g	64.70fg
K3	without	36.85c-f	77.85cd	131.24f-h	633.15a-d	879.10b-e	5.72ef	17.89e	43.91ef	67.52ef
	Zinc	38.37b-e	97.72bc	158.67bc	726.42a-c	1021.20ab	6.76b-e	23.75b-d	48.58d	79.10c
	Humic	43.83b	102.04a-c	159.00bc	751.72a-c	1056.60ab	6.86b-d	28.49ab	52.21bc	87.57b
	Salicylic	39.98b-d	92.51bc	156.03bc	703.54a-d	992.07a-c	6.42de	23.59b-d	46.07e	76.08cd
K4	without	40.96b-d	92.75bc	142.45d-f	711.77a-c	987.94a-d	6.71b-e	18.87de	45.83e	71.42de
	Zinc	43.09bc	117.75ab	165.39ab	762.72ab	1088.95ab	7.78ab	24.50bc	53.98b	86.27b
	Humic	52.17a	125.71a	175.28a	784.88a	1138.05a	8.47a	30.62a	68.71a	107.80a
	Salicylic	41.10b-d	105.62a-c	162.02bc	760.15a-c	1068.90ab	7.68a-c	27.38ab	51.60c	86.67b

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

K1,K2,K3 and K4; Rates of potassium fertilization as follows: 200, 250, 300, and 350Kg per fed. Respectively.

Application of foliar spray, i.e. Without spray, Zinc, Humic acid, and Salicylic acid., The spraying rates were as follows, 0.0 , 1.0g/ l^{-1} , 5.0 cm/ l^{-1},and 0.5 g/ l^{-1} ,Respectively.

1.3. Effect of the interactions between potassium levels and foliar spray of anti-salinity treatments

The results of the interactions between potassium levels and foliar spray by Zn, Humic acid and Salicylic acid on fresh and dry weight of sweet pepper plants were presented in Table (3). The data show significant effects of the interaction between potassium application levels and foliar spray with Zn, humic and Salicylic acids on most studied traits, i.e., fresh and dry weight of pepper plant. In general, the highest values of the previous characters were recorded with the highest potassium levels i.e. 350 Kg/fed. and foliar spray with Humic acid 5 cm/ l^{-1}, followed by ZN 1g/ l^{-1}. These results may be due to the role of potassium element in metabolism and many processes needed to sustain and promote plant vegetative growth and development El-Bassiony *et al.* (2010 found that application of potassium sulfate at a rate of 200 kg/fed presented the highest values of plant height, number of leaves, number of branches per plant and both of fresh and dry weights leaves of sweet pepper plants compared to the addition of 50 Kg per fed., They reported also that K-humate application led to increasing and improving plant growth parameters. Application of K-humate had beneficial effects on nutrient uptake by plants and was particularly important for the transport and availability of micro nutrients which it is necessary for optimal plant growth and development. Moreover, many studies proved that the need for the K element to regulate some vital activities in many physiological and biochemical processes such as cell division, elongation, metabolism of carbohydrates and protein compounds, enzyme activation, photosynthesis, osmo-regulation, stomata movement, energy transfer, phloem transport, cation-anion balance and stress resistance (Karakurt *et al.,* 2009; Zaky *et al.,* 2006).

2. Yield and its components

2.1. Effect of potassium fertilization levels

Data presented in Table (4) indicate that increasing potassium fertilization levels recorded the highest values on most studied traits of yield and its components. Application of potassium at a rate of 350 Kg per fed. gave the highest values of marketable and unmarketable yield in both seasons followed by the level of 250 Kg per fed. application of 350 Kg per fed. of potassium sulfate gave the highest values of fruit weight per plant, number of fruits per plant and average fruit weight, as well as total yield (marketable yield + unmarketable yield per fed.), these results were observed in the first and the second seasons. The increment in total fruit yield may be due to the increase in number of fruits per plant and average fruit weight (Table 4) the promotion effect of K may be due to its role in enhancement accumulation of carbohydrates, proteins, activate of enzymes, activate and movement of mineral and stomata movement for water retention in branches and leaves as well as more tolerance of salt stress. These results confirm other reports on pepper plants, that number of fruit per plant and fruit size increased with the increasing of potassium levels and consequently increased both of the early and total yield (Bhuvaneswari *et al.,* 2013; and Fawzy *et al.,* 2005).

2.2. Effect of foliar spray with anti-salinity treatments

Data in Table (4) show significant effects of foliar spray with anti-salinity treatments on marketable yield traits, except, average fruit weight in the first season. Concerning unmarketable yield, data in the same table show significant effects for fruit weight in both seasons with highest values with spraying salicylic acid in both seasons; significant effects in the first season only for spraying treatments with the highest values with spraying of salicylic acid also; other traits had no significant effects in both season. Regarding to the total yield, data in the same table indicate significant effects by foliar spray treatments in both seasons except total marketable yield and total unmarketable yield in the second season, the highest total marketable yield and total yield (ton/fed.) were recorded with spraying humic acid, while the highest unmarketable yield was recorded with spraying salicylic acid or zinc in the first season. This result may be due to the material used in this experiment (Humic acid) which contain mixture compounds; i.e., Humic acid 18%, Fulvic acid 14%, Amino acid 19.93%, Nitrogen 4.03%, P_2O_5 0.3%, K_2O 3.72%, Zn 0.1%, Fe 380 mg l^{-1}, Mn 29.1 Mg l^{-1} and Cu 17 g l^{-1}, These contents in the structure of the Humic acid contain some major elements, micro elements, organic acids and amino ribatonic on a high degree of availability for absorption by the plants, in addition to the natural composition makes them fixed and gave the requirements of plants for various physiological and biochemical processes. The increase in yield may due to that humic acids enhance the absorbance capacity of nutrients through the roots by having carboxyllic and phenolic groups and increasing H^+-ATP as activity in the root cells Canellas *et al.* (2002). Also, Karakurt *et al.* (2009) reported that humic acid application affected pepper growth and fruit characteristics and had a positive influence on quantitative and qualitative traits of pepper plant. Increasing the rates of humic acid (1, 2 and 3 ml L-1) increased pepper yield (quality and quantity) as compared with untreated plants (Abd El-Rheem *et al.,* 2012).

2.3. Effect of the interaction between potassium levels and foliar spray with anti-salinity treatments

Data in Table (4) show significant effects of the interaction between potassium fertilization levels and foliar spray on all studied traits, except the number of fruits per plant for unmarketable yield, total marketable and unmarketable yield (ton per fed.) in the second season. Application of potassium level (k4) with foliar spray by Humic acid recorded the highest values of marketable yield traits and total yield (total marketable + total unmarketable yield) in both seasons. The highest values of unmarketable fruit weight (g/plant) were recorded with the application of 200 Kg potassium sulfate with foliar spray of Zinc. The highest values of unmarketable average fruit weight were recorded with the application of 300 Kg potassium sulfate with spraying by zinc in the first season and by application of 300 Kg potassium sulfate with spraying by humic acid in the second season. The increment in the total yield per fed. by the addition of the high level of potassium, i.e. 350 Kg per fed. with humic acid at the rate of 5 cm per liter this might owe to the highest fruit weight and average fruit weight per plant and per fed. for marketable yield. Similar results were noticed on tomato by Padem and Ocal (1999) who demonstrated that increasing K-humate application dose led to a significant increase in fruit weight and total yield for tomato plant., In addition El-Bassiony *et al.* (2010) indicated that the highest total yield of sweet pepper plants was produced by using 200 kg per fed. from potassium sulfate, the highest values of fruit yield obtained when sweet pepper plants was sprayed with K-humate (4 gm/l-^{l}) followed by potassium oxide (4 cm/1^{-1}).

3. Chemical contents of pepper leaves and fruits.

3.1. Effect of potassium fertilization levels

Data in Table (5) show significant effects for the application of potassium levels on most studied traits of sweet pepper plants in the both seasons, except, proline and P content during the both seasons., data in the same table indicate that the application of potassium level (K4) recorded the highest values of the N, P and K in both leaves and fruits. Application of potassium level (K4) recorded the lowest values for Na^+ and

Table 4: Effect of potassium fertilizer levels and foliar spray with some anti-salinity treatments on yield and its components of pepper plants during 2013-2014 seasons

Characters		Yield and its components								
		Marketable			Unmarketable			Total yield (ton/fed.)		
Variables		Fruit weight (g/plant)	N0.fruis (per plant)	Average fruit weight (g/plant)	Fruit weight (g/plant)	N0.fruits (per plant)	Average fruit weight (g/plant)	Marketable Yield.	Non Marketable Yield.	Total yield
Effect of potassium levels					Season 2013					
K1		246.04c	6.47c	37.37b	44.81a	1.374a	32.36a	3.56c	0.65a	4.21c
K2		283.86c	6.91c	40.78b	26.02d	0.89b	29.82a	4.11c	0.37c	4.49c
K3		363.57b	8.23b	44.10ab	28.56c	0.81b	35.35a	5.27b	0.41c	5.687b
K4		509.34a	10.07a	50.57a	38.32b	1.08b	35.86a	7.38a	0.556b	7.94a
					Season 2014					
K1		256.985d	6.27c	40.58b	49.31a	1.30a	37.34a	3.71a	0.71a	4.442d
K2		309.77c	6.702c	45.79ab	33.00d	0.84a	39.77a	4.49a	0.47a	4.97c
K3		380.71b	7.93b	47.80ab	35.179c	0.76a	47.71a	5.52a	0.51a	6.03b
K4		523.51a	10.05a	52.01a	43.55b	0.99a	43.99a	7.59a	0.63a	8.22a
Effect of foliar spray					Season 2013					
without		244.34c	6.32c	37.85a	23.02d	0.82c	28.75a	3.543c	0.33c	3.87c
Zinc		371.97b	8.34b	44.07a	40.12b	1.14ab	35.32a	5.39b	0.58a	5.975b
Humic		451.27a	9.60a	46.55a	33.07c	0.93bc	35.59a	6.54a	0.48b	7.022a
Salicylic		335.25b	7.42bc	44.35a	41.49a	1.26a	33.71a	4.86b	0.60a	5.46b
					Season 2014					
without		256.48c	6.08c	41.55b	27.79c	0.74a	38.82a	3.71a	0.40a	4.12c
Zinc		383.17b	8.067b	47.02ab	46.01a	1.10a	42.12a	5.55a	0.66a	6.22b
Humic		480.256a	9.51a	49.97a	40.20b	0.89a	46.65a	6.96a	0.58a	7.54a
Salicylic		351.08b	7.29b	47.63ab	47.02a	1.17a	41.21a	5.09a	0.68a	5.77b
Effect of the interaction					Season 2013					
K1	without	152.01h	5.06fg	30.04d	29.25g	1.12cd	26.17bc	2.20h	0.42e	2.63i
	Zinc	293.15e	7.49cd	39.15c	53.50a	1.60a	33.43a-c	4.25ef	0.78a	5.02fg
	Humic	332.343	8.06b-d	41.24bc	46.75c	1.31bc	35.71a	4.81de	0.68b	5.49e-g
	Salicylic	206.66g	5.29fg	39.06c	49.75b	1.46ab	34.13a-c	3.00gh	0.72b	3.72h
K2	without	164.17h	4.55g	36.06cd	18.33k	0.74fg	25.09c	2.383h	0.26g	2.64i
	Zinc	294.09e	7.05c-e	42.26bc	27.00h	0.84e-g	31.92a-c	4.26ef	0.39e	4.65g
	Humic	391.26c	9.32ab	42.06bc	22.50i	0.69g	32.72a-c	5.67cd	0.33f	6.00de
	Salicylic	285.93ef	6.74de	42.75bc	36.25f	1.28bc	29.55a-c	4.14ef	0.53d	4.67g
K3	without	242.34f	6.02e-f	41.44bc	17.50k	0.58g	30.02a-c	3.513fg	0.25g	3.77h
	Zinc	362.50c	8.25bc	43.92bc	37.50e	0.99d-f	38.13a	5.25cd	0.54d	5.80d-f
	Humic	487.50b	10.66a	45.71bc	21.00j	0.58g	36.93a	7.06b	0.30fg	7.37c
	Salicylic	361.94cd	7.98cd	45.32bc	38.25e	1.10c-e	36.31a	5.247cd	0.55d	5.80d-f
K4	without	418.82c	9.67a	43.85bc	27.00h	0.83fg	33.74a-c	6.07c	0.39e	6.46d
	Zinc	538.12a	10.56a	50.97ab	42.50d	1.14cd	37.79a	7.80ab	0.62c	8.42ab
	Humic	593.97a	10.37a	57.19a	42.05d	1.147cd	37.02a	8.61a	0.61c	9.22a
	Salicylic	486.47b	9.69a	50.26ab	41.74d	1.20b-d	34.877ab	7.05b	0.60c	7.66bc
					Season 2014					
K1	without	161.95i	4.85gh	33.53e	30.03f	1.03a	29.12c	2.31a	0.44a	2.78i
	Zinc	299.67e	7.18c-e	41.88d	58.53a	1.52a	38.33bc	4.34a	0.85a	5.19fg
	Humic	342.60d	7.98c	42.94cd	55.11b	1.25a	44.04b	4.97a	0.81a	5.77e-g
	Salicylic	223.71gh	5.09gh	43.98cd	53.56b	1.42a	37.87bc	3.24a	0.78a	4.02h
K2	without	179.867hi	4.31h	41.80d	24.59g	0.66a	37.79bc	2.61a	0.35a	2.96i
	Zinc	309.19ef	6.85de	45.55cd	33.98e	0.84a	40.29b	4.48a	0.49a	4.97g
	Humic	448.19c	9.293b	48.18b-d	28.63f	0.69a	41.62b	6.50a	0.41a	6.91c
	Salicylic	301.86ef	6.35ef	47.61b-d	44.82d	1.19a	39.38bc	4.37a	0.65a	5.02g
K3	without	256.82f	5.753fg	45.30cd	23.20g	0.53a	43.76b	3.72a	0.33a	4.06h
	Zinc	373.94d	8.01c	46.67b-d	43.00d	0.95a	45.15b	5.42a	0.62a	6.04de
	Humic	525.34b	10.41a	50.52bc	29.28f	0.51a	57.97a	7.61a	0.42a	8.04b
	Salicylic	366.76d	7.54cd	48.71b-d	45.23d	1.05a	43.94b	5.32a	0.66a	5.97d-f
K4	without	427.31c	9.43ab	45.58cd	33.36e	0.76a	44.62b	6.19a	0.48a	6.67cd
	Zinc	549.87b	10.21ab	54.00ab	48.56c	1.09a	44.72b	7.97a	0.70a	8.67b
	Humic	604.89a	10.37a	58.24a	47.80c	1.11a	42.99b	8.77a	0.69a	9.46a
	Salicylic	512.72b	10.20ab	50.22b-d	44.47d	1.02a	43.64b	7.42a	0.64a	8.07b

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

K1,K2,K3 and K4; Rates of potassium fertilization as follows: 200, 250, 300, and 350Kg per fed. Respectively. Application of foliar spray, i.e. Without spray, Zinc, Humic acid,and Salicylic acid., The spraying rates were as follows, 0.0 , 1.0g/ l^{-1} , 5.0 cm/ l^{-1},and 0.5 g/ l^{-1} ,Respectively.

Table 5: Effect of potassium fertilizer levels and foliar spray with some anti- salinity treatments on N, P, K, Na and proline in the leaves and fruits of pepper plants during 2013-2014 seasons.

Characters		N,P,K,Na, and proline in leaves (% of dry weight)					N,P,K,Na, and proline in fruits(% of dry weight)				
Variables		N	P	K	Na	Proline	N	P	K	Na	Proline
Effect of potassium levels											
Season 2013											
K1		2.69d	0.262b	2.56c	1.76a	5.48a	1.65b	0.165a	3.49a	1.66a	3.49a
K2		2.77c	0.289ab	2.76bc	1.58b	5.34a	1.81a-c	0.172a	3.46a	1.38ab	3.46a
K3		3.17b	0.335ab	3.13ab	1.23c	5.14a	2.01ab	0.187a	3.22b	1.01ab	3.22b
K4		3.47a	0.362a	3.24a	0.87d	4.61a	2.27a	0.211a	2.85c	0.91b	2.85c
Season 2014											
K1		2.87b	0.281b	2.58b	1.78a	5.49a	1.81a-c	0.169a	3.10b	1.67a	3.51a
K2		2.88ab	0.304a-	2.78ab	1.60b	5.36a	2.06ab	0.175a	3.24ab	1.39b	3.47a
K3		3.38ab	0.353ab	3.18a	1.27c	5.16a	2.25ab	0.191a	3.69ab	1.02c	3.23b
K4		3.67a	0.378a	3.27a	0.88d	4.63a	2.48a	0.213a	3.89a	0.92c	2.86c
Effect of foliar spray											
Season 2013											
without		2.70b	0.290a	2.75a-c	1.51a	5.33a	1.74b	0.175a	3.35a	1.37b	3.35a
Zinc		3.07ab	0.312a	2.94ab	1.39ab	5.19a	1.88ab	0.182a	3.27a	1.25ab	3.27a
Humic		3.30a	0.328a	3.05a	1.23c	5.02a	2.17a	0.192a	3.21a	1.15a	3.21a
Salicylic		3.02ab	0.318a	2.95ab	1.29bc	5.03a	1.96ab	0.185a	3.19a	1.19ab	3.19a
Season 2014											
without		2.91b	0.305a-	2.78b	1.53a	5.34a	1.93a-c	0.177a	3.19b	1.38a	3.37a
Zinc		3.23ab	0.332ab	2.98ab	1.41ab	5.21a	2.15ab	0.185a	3.53ab	1.26ab	3.29a
Humic		3.49a	0.347a	3.09a	1.27b	5.04a	2.36a	0.197a	3.67a	1.17b	3.22a
Salicylic		3.18ab	0.331ab	2.98ab	1.32b	5.05a	2.16ab	0.189a	3.52ab	1.20ab	3.20a
Effect of the interaction											
Season 2013											
K1	without	2.27f	0.232g	2.53bc	1.86a	5.56a	1.47f	0.155b	3.53a	1.77fg	3.53a
	Zinc	2.72c-f	0.266e-g	2.56bc	1.793ab	5.55a	1.51ef	0.166ab	3.51a	1.67e-g	3.51a
	Humic	3.067a-	0.277d-g	2.57bc	1.68b	5.41ab	1.92b-e	0.172ab	3.47a	1.58d-f	3.47a
	Salicylic	2.72c-f	0.272e-g	2.57bc	1.70b	5.40ab	1.70d-f	0.165ab	3.48a	1.63f-g	3.48a
K2	without	2.49ef	0.254fg	2.22c	1.81ab	5.44ab	1.68d-f	0.164ab	3.53a	1.56g	3.53a
	Zinc	2.84b-f	0.297c-f	2.93ab	1.68b	5.34a-c	1.77c-f	0.175ab	3.49a	1.43c-e	3.49a
	Humic	3.18a-d	0.312b-f	2.97ab	1.41c	5.31a-c	2.00b-d	0.177ab	3.41a	1.21b-e	3.41a
	Salicylic	2.57d-f	0.294c-f	2.92ab	1.41c	5.27a-c	1.80c-f	0.172ab	3.42a	1.33d-g	3.42a
K3	without	2.80b-f	0.322a-e	3.12ab	1.41c	5.38ab	1.83b-f	0.183ab	3.44a	1.11c-e	3.44a
	Zinc	3.21a-c	0.336a-d	3.13ab	1.24d	5.11b-d	2.02b-d	0.187ab	3.21b	1.01a-c	3.21b
	Humic	3.39ab	0.347a-c	3.14ab	1.04e	5.02c-e	2.10b-d	0.194ab	3.15b	0.97a-c	3.15b
	Salicylic	3.27a-c	0.337a-d	3.13ab	1.23d	5.04c-e	2.08b-d	0.184ab	3.07bc	0.95a-d	3.07bc
K4	without	3.24a-c	0.351a-c	3.15ab	0.98ef	4.93de	1.96b-d	0.197ab	2.91cd	1.05a-d	2.91cd
	Zinc	3.53a	0.352a-c	3.15ab	0.86fg	4.78e	2.21bc	0.198ab	2.88cd	0.88a-c	2.88cd
	Humic	3.59a	0.377a	3.51a	0.80g	4.33f	2.66a	0.227a	2.82d	0.85a	2.82d
	Salicylic	3.52a	0.369ab	3.16ab	0.84fg	4.40f	2.25b	0.221a	2.78d	0.86ab	2.78d
Season 2014											
K1	without	2.60d	0.244f	2.54bc	1.90a	5.58a	1.61e	0.159c	2.84hi	1.76a	3.57a
	Zinc	2.88b-d	0.285d-f	2.59bc	1.80ab	5.56a	1.69de	0.169a-	3.12g-i	1.68a	3.52ab
	Humic	3.17a-d	0.299b-f	2.61bc	1.69b	5.42ab	2.05b-e	0.179a-	3.28e-h	1.60ab	3.47ab
	Salicylic	2.85b-d	0.294c-f	2.59bc	1.72b	5.41ab	1.90c-e	0.168a-	3.16f-i	1.65a	3.49ab
K2	without	2.61d	0.265ef	2.24c	1.82ab	5.45a	1.90c-e	0.165bc	2.80i	1.57ab	3.54ab
	Zinc	2.89b-d	0.305b-e	2.94ab	1.70b	5.35a-c	2.10b-d	0.178a-	3.34d-g	1.44bc	3.51ab
	Humic	3.31a-c	0.342a-d	2.99ab	1.44c	5.34a-c	2.20bc	0.180a-	3.59b-f	1.23de	3.42a-c
	Salicylic	2.71cd	0.303b-f	2.95ab	1.45c	5.29a-d	2.06b-e	0.176a-c	3.24e-i	1.33cd	3.43a-c
K3	without	2.92b-d	0.338a-d	3.15ab	1.43c	5.39ab	2.07b-e	0.187a-	3.45c-g	1.12ef	3.45ab
	Zinc	3.47b	0.359ab	3.16ab	1.27d	5.13b-e	2.30bc	0.191a-	3.84a-c	1.02fg	3.23a-d
	Humic	3.67a	0.367a	3.22ab	1.11e	5.05d-f	2.36bc	0.197a-	3.77a-d	0.98fg	3.16b-e
	Salicylic	3.48ab	0.347a-c	3.21ab	1.28d	5.07c-f	2.26bc	0.190a-c	3.69a-e	0.96fg	3.07c-e
K4	without	3.50ab	0.374a	3.18ab	0.99ef	4.94f	2.14b-d	0.198a-	3.68a-e	1.06e-g	2.93de
	Zinc	3.68a	0.377a	3.21ab	0.87fg	4.80f	2.52ab	0.203a-	3.83a-c	0.90g	2.90de
	Humic	3.81a	0.381a	3.52a	0.83g	4.35g	2.83a	0.229a	4.06a	0.86g	2.83e
	Salicylic	3.68a	0.379a	3.19ab	0.85fg	4.44g	2.43ab	0.223ab	4.00ab	0.87g	2.79e

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

K1,K2,K3 and K4; Rates of potassium fertilization as follows: 200, 250, 300, and 350Kg per fed. Respectively. Application of foliar spray, i.e. Without spray, Zinc, Humic acid,and Salicylic acid., The spraying rates were as follows, 0.0 , 1.0g/ l^{-1} , 5.0 cm/ l^{-1},and 0.5 g/ l^{-1} ,Respectively.

proline content in both leaves and fruits of pepper plants compared to application potassium levels at (K3,K2 and K1), respectively, in both seasons. These results are in agreement with previous investigations indicated by Zhang *et al.* (2002), and Lin Duo and Danfeng (2003) they found that increment in vegetative growth, net photosynthetic rate; NPK content and chlorophyll content were associated with enhancement of K levels. Rubio *et al.* (2003) found that increase in the external K concentration, from 0.1 to 1 mM, reduced Na uptake by 25% and a further increase to 10 mM K reduced the rate of Na uptake by 44% with regard to the 1 mM K treatment. Sarrwy *et al.* (2010) found that foliar application of K, improved the chlorophyll and fruits NK contents.

3.2. Effect of foliar spray with anti-salinity treatments

Data in Table (5) show significant effects of the foliar spray treatments on most studied traits in both seasons, except, proline content in the leaves and P content in the fruits in both seasons, K in leaves and fruits in the first season. Foliar spray with Humic acid at the 5 cm/ l^{-1} recorded the highest values of N, P and K content in the leaves and fruits in the both seasons, concerning the contents of Na^+ and proline in the leaves and fruits; it was found that the highest values were recorded with the control treatment in both seasons. These results are in harmony with those reported by Ayas and Gulser, (2005), they reported that the application of Humic acid was the main cause for enhanced nitrogen uptake in spinach plants. Ameri and Tehranifar (2012) found that the application of humic acid was significantly affected on nutrient uptake of N, P, and K for *Fragaria ananassa* plants.

3.3. Effect of the interaction between potassium levels and foliar spray with anti-salinity treatments

Data presented in Table (5) show significant effects of the interactions between the application of potassium levels and foliar spray treatments on contents of N, P, K and Na as well as proline in the leaves and fruits of sweet pepper plants. Application of potassium level (K4) with foliar spray by Humic acid recorded the highest values for content of N and P in the both seasons, and the content of K in the leaves in both seasons and fruit in the second season. Also, Addition of potassium level (K4) with foliar spray by any of salicylic acid, Humic acid and Zn respectively gave the low contents of Na^+ and proline in the leaves and fruits in both seasons. In support of these findings, Kazemi (2013) found that foliar spray by Humic acid and potassium nitrate (40 ppm +100 mg/L) alone or in combinations affected significantly on the content of N and K of cucumber plant leaves.

4. Fruit quality

4.1. Effect of potassium fertilization levels

Data in Table (6) show significant effect of potassium fertilization levels on quality traits of sweet pepper fruits. The highest values of all studied traits i.e. T.S.S, V. C and pH of fruit juice were recorded with application of high potassium rates; viz, K2, K3 and K4 without significant differences among them, where the lowest values of previous characters were with the low rate of potassium(K1) In this respect Marschner (1995) reported that the optimum potassium supply determines fruit quality viz, T.S.S, titratable acidity, V. C and pH of juice of tomato fruits in relation to addition of potassium levels. Increasing potassium fertilizer levels in the nutrient solution confirm that K played an important role in the configuration of quality profile in tomato fruits. Potassium is the most abundant cation present in the phloem sap (almost 80% of the total cations) as a consequence of sugar charging and transport mechanisms processes through the phloem into sink

Table 6: Effect of potassium fertilizer levels and foliar spray with some anti-salinity treatments on pH, vitamin C and total soluble solids in fruits of pepper plants during 2013-2014 seasons.

Characters / Variables		pH	V.C (mg/100gm)	TSS (%)	pH	V.C (mg/100gm)	TSS (%)
Effect of potassium levels		Season 2013			Season 2014		
K1		5.17b	109.43b	5.29b	5.26b	113.88b	5.38b
K2		5.34b	132.11a-c	5.50ab	5.38b	134.82ab	5.55b
K3		5.66a	151.24a	5.63ab	5.74a	153.77a	5.67a
K4		5.66a	147.80ab	6.28a	5.72a	150.58a	6.33a
Effect of foliar		Season 2013			Season 2014		
without		5.35a-c	116.39b	5.44a	5.42ab	120.93b	5.51a-c
Zinc		5.44ab	142.48ab	5.74a	5.52ab	145.13ab	5.78ab
Humic		5.49a	148.85a	5.90a	5.57a	151.71a	5.94a
Salicylic		5.55a	132.86ab	5.63a	5.59a	135.27ab	5.70ab
Effect of the interaction		Season 2013			Season 2014		
K1	without	5.10g	78.66e	5.20f	5.20e	86.78g	5.26f
	Zinc	5.15fg	116.00d	5.26ef	5.25e	119.33ef	5.33ef
	Humic	5.15fg	129.53cd	5.53d-f	5.27de	133.56c-f	5.60d-f
	Salicylic	5.30e-g	113.54d	5.16f	5.33de	115.87f	5.35ef
K2	without	5.30e-g	118.66d	5.16f	5.36de	122.33ef	5.27f
	Zinc	5.32ef	140.00a-d	5.63d-f	5.37de	142.29b-f	5.65d-f
	Humic	5.33d-f	141.51a-d	5.73c-e	5.37de	144.00a-e	5.76c-f
	Salicylic	5.40de	128.25cd	5.50d-f	5.40de	130.66d-f	5.53d-f
K3	without	5.46c-e	137.56b-d	5.43ef	5.48cd	139.66b-f	5.50ef
	Zinc	5.65a-c	161.66ab	5.66d-f	5.75ab	164.32ab	5.70d-f
	Humic	5.75ab	156.32a-c	5.76c-e	5.88a	158.98a-c	5.80c-e
	Salicylic	5.80a	149.45a-c	5.66d-f	5.85ab	152.11a-d	5.70d-f
K4	without	5.55b-d	130.66cd	5.96b-d	5.63bc	134.95c-f	6.03b-d
	Zinc	5.66a-c	152.26a-c	6.40ab	5.74ab	154.60a-d	6.46ab
	Humic	5.72ab	168.05a	6.56a	5.75ab	170.33a	6.60a
	Salicylic	5.72ab	140.22a-d	6.20a-c	5.78ab	142.45b-f	6.24a-c

Values having the same alphabetical letter(s) did not significantly differ at 0.05 levels of significance, according to Duncan's multiple range test.
K1,K2,K3 and K4; Rates of potassium fertilization as follows: 200, 250, 300, and 350Kg per fed. Respectively. Application of foliar spray, i.e. Without spray, Zinc, Humic acid, and Salicylic acid., The spraying rates were as follows, 0.0 , 1.0g/ l^{-1} , 5.0 cm/ l^{-1},and 0.5 g/ l^{-1} ,Respectively.

organs Cakmak (2005). It is known that potassium plays a key role in carbohydrate metabolism and photosynthesis. Balibrea *et. al.* (2006) on tomato reported that the content of T.S.S increased with increasing potassium levels in the nutrient solution. El-Nemr (2012) on tomato found that the contents of T.S.S and pH in fruit juice were influenced by K levels in the nutrient solution.

4.2. Effect of foliar spray with anti-salinity treatments

Data presented in Table (6) show significant effect of foliar spray with Zn, Humic acid and Salicylic acid on all fruit quality traits of sweet pepper fruits. The three spraying treatments; viz, Zinc, Humic acid and Salicylic acid resulted in higher values of all studied traits i.e. T.S.S, V. C and pH of fruit juice compared with the control treatment without significant differences among the three spraying treatments. Soheila (2014) on tomato found that humic acid as foliar application had a significant effect on fruit firmness, T.S.S, vitamin C content, and total phenol content.

4.3. Effect of the interactions between potassium levels and foliar spray with anti-salinity treatments

Table (6) show significant effect of the interactions between application of potassium levels and foliar spray with Zn, Humic acid and Salicylic acid on fruit quality traits. The application of K4 or K3 with spraying by Zinc, Humic and Salicylic acid were the best treatments for all studied traits. Fawzy *et al.* (2005) on sweet pepper plants, found that adequate of K nutrition associated with increased in the contents of soluble solids and ascorbic acid. They added also that, application of potassium improved fruit color, and increased shelf life in fruits.

Conclusion and recommendations

It is obvious from the obtained results that, fertilization of pepper plants grown in sandy soil during the summer season under drip irrigation using saline water (Ec 8.22 ds m^{-1}) with potassium sulphat (350 Kg/fed.) and spraying the plants with Humic acid at (5cm/1^{-1}), or salicylic acid (0.5 g/1^{-1}) or Zn (1g/1^{-1}), respectively produced highest marketable fruit yield with best quality comparing to the control or the other treatments as well as the lowest contents from sodium and proline in the pepper leaves or fruits under the conditions of El-Arish , North Sinai were obtained by the previous treatments..

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تأثير مستويات من البوتاسيوم وبعض المواد المضاده للملوحه على الفلفل الحلو النامى فى الاراضى الرملية والرى بالمياه عالية الملوحة تحت ظروف شمال سيناء

سامح عبد الحفيظ علي أبوالقاسم
محطه البحوث الزراعيه بالعريش شمال سيناء - اقسام بحوث الخضر-معهد بحوث البساتين
-مركز البحوث الزراعية-الجيزة-مصر.

الملخص العربى

أجريت تجربة حقلية خلال الموسميين الصيفيين 2013، 2014 بمزرعة محطة البحوث الزراعية بالعريش- شمال سيناء. واستخدم فى الزراعة الهجين المحلى للفلفل "فارس" وكان الهدف من البحث هو دراسة تاثير اربعة معدلات من التسميد بالبوتاسيوم فى صورة سلفات البوتاسيوم 48% أكسيد بوتاسيوم وكانت المعدلات هى (200، 250، 300، 350 كجم/فدان) مع الرش بثلاث معاملات كمضادات للملوحه بالاضافة الى معاملة الكنترول وهما (الزنك المخلبى بمعدل 1جم/ اللتر وحامض الهيومك بمعدل 5 سم/اللتر و حامض السالسيلك بمعدل 0.5 جم/اللتر و معاملة الكنترول) تحت ظروف الاراضى الرمليه والتى تروى بالمياه عالية الملوحه بمحافظة شمال سيناء وذلك على النمو والمحصول والمحتوى الكيماوى فى الاوراق والثمار وصفات الجودة لثمار الفلفل. وإستخدم نظام القطع المنشقه مره واحده فى تصميم التجربة، وكانت أهم النتائج المتحصل عليها هى:- أدى إضافة سلفات البوتاسيوم بمعدل 350 كجم للفدان مع الرش بحامض الهيومك بمعدل 5سم/اللتر أو حامض السالسيلك بمعدل 0.5جم/اللتر أو الزنك المخلبى بمعدل 1جم/اللتر على التوالى إلى الحصول على أعلى القيم للأوزان الطازجه والجافه لنباتات الفلفل ممثلا فى وزن كلا من الجذور والاوراق والافرع والوزن الطازج للعناقيد الزهريه فى الموسمين مقارنة مع معدلات الاضافه الاقل من سلفات البوتاسيوم (200،250،300 كجم/الفدان) مع الرش باى من مضادات الملوحه. وكذلك أدى إضافة التسميد بسلفات البوتاسيوم بمعدل 350 كجم/الفدان مع الرش بحامض الهيومك أو الزنك المخلبى أوحامض السالسيلك على التوالى للحصول على أعلى محصول تسويقى ومكوناته ممثلا فى متوسط وزن وعدد الثمار على النبات ومتوسط وزن الثمرة وبالتالى إنعكس على إنتاج المحصول الكلى/الفدان. أما بالنسبة لمحتوى الاوراق والثمار من الصوديوم والبرولين فقد أظهرت النتائج إنخفاضهما معنويا بإضافة التسميد بسلفات البوتاسيوم بمعدل 350كجم/الفدان والرش بحامض السالسيلك أوحامض الهيومك أو الزنك المخلبى على التوالى، كما تم الحصول على أفضل صفات جوده لمحتوى ثمار الفلفل من فيتامين سي والمواد الصلبة الكلية بإضافة التسميد بسلفات البوتاسيوم بمعدل 350 او 300 كجم/الفدان مع الرش الورقى بالزنك المخلبى أو حامض الهيوميك أو السالسيلك على التوالى فى الموسمين.