Growth, Yield and Fruit Quality of Sweet Pepper Plants (*Capsicum annuum* L.) as Affected by Potassium Fertilization

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Abstract: Two field experiments were conducted during the two successive summer seasons of 2009 and 2010 at the Experimental Farm of the National Research Centre in El-Nobaria region, Behira Governorate, to investigate the response of sweet pepper plants cv. California wonder to different rates of potassium fertilization (50, 100 and 200 kg/fed.) as potassium sulfate in addition to foliar application by potassium oxide (2 and 4 cm/L) and potassium humate (4 gm/L) as a stimulative dose. Potassium foliar applications were made 3 times in a 15 days interval with the same doses during the growing period (30, 45 and 60 days after transplanting). The highest potassium fertilization rate (200 kg/fed.) gave the tallest sweet pepper plants, the highest number of leaves and branches per plants and the highest fresh and dry weights of leaves as well as the highest total yield. Also, the obtained results reported that the fruit measurements expressed as fruit length, average fruit weight and vitamin C content, as well as leaves chemical composition (N, P, K and total chlorophyll) were increased with increasing potassium fertilization rate. On the other hand, spraying sweet pepper plants with potassium humate at rate of 4 gm/L markedly increased vegetative growth, yield, fruit quality and chemical composition. The favorable effects of the potassium on the growth, total yield and fruit parameters were obtained when sweet pepper plants fertilized with 200 kg/fed. potassium sulfate plus foliar application of potassium humate 4 gm/L followed statistically by 200 Kg/fed. potassium sulfate with foliar application of either 2 or 4 gm/L potassium oxide with no significant differenced between them but both of them were significantly higher than control.

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1. Introduction:

Sweet pepper (*Capsicum annuum* L) is a member of the solanaceous fruity vegetables group. It is one of the most important, popular and favorite vegetable crops cultivated in Egypt for local consumption and exportation, it is commonly called "filfil akhdar", where "filfil" means pepper and "akhdar" means green. It covers a production area of 42,136 ha in year 2007 that yielded 684,640 tons according to Ministry of Agriculture Statistics.

Plant high yields, depend on many factors, the most important factor amongst them is plant nutrition. The nutrients should be provided through suitable sources on adequate amounts and forms in a right time to ensure that plants have adequate amounts of the nutrients required for high yields. There are two ways of application nutrients, first through plant roots and it is the main way and the second through foliar application (additional way). The interest in foliar fertilizers arose due to the multiple advantages of foliar application methods. It is also recognized that supplementary foliar fertilization during crop growth can improve the mineral status of plants and increase the crop yield and quality (Kolota and Osinska, 2001).

Although, potassium is not a constituent of any plant structures or compounds, but it plays a part in many 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 Läuchli, 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). Potassium is also known as the quality nutrient because of its important effects on quality factors (Imas and Bansal, 1999 and Lester *et al.*, 2006). With the exception of nitrogen, potassium is required by plants in much greater amounts than all the other soil-supplied nutrients (Tisdale *et al.*, 1985).

Nowadays, in Egypt, potassium fertilizers became a highly expensive ones of input factors in production processes (ton ~ 1250 $), so many farmers minimizing the used amount to the minimum dose. In addition to use any other newly and cheapest potassium sources through foliar application as a stimulative dose to overcome such problem and to maximize their net return to cover the additional cost of this K fertilizer source.

Increasing plant vegetative growth, yield as well as fruit quality and chemical composition due to increasing potassium fertilization levels have been reported by many workers on different crops El-Masry (2000), Nassar *et al.* (2001) and Fawzy *et al.* (2005) on sweet pepper, Chen Zhen De *et al.* (1996) and Fawzy *et al.* (2007) on eggplant, Nanadal *et al.* (1998), Al-Karaki (2000) and Gupta and Sengar (2000) on tomato and Lester *et al.*, (2006) on muskmelon. Potassium humate can be used as a non-expensive source for potassium and it could be used as soil dressing, drenching or foliar applications. It was already subjected to many studies in various areas of agriculture. The mechanism of humate material in promoting plant growth is not completely known. It was reported by many researchers that K-humate application increased the plant growth, nutrient uptake and plant yield and quality as well (Böhme and Thi Lua, 1997; Padem and Ocal, 1999; Hoang and Böhme, 2001; Türkmen *et al.*, 2005; Zaky *et al.*, 2006 and Karakurt *et al.*, 2009).

Soil and/or foliar K-humate applications might successfully be used to obtain higher fruit yield and can significantly enhance pepper fruit quality as demonstrated by Arancon *et al.* (2006). Also, El-Bassiony (2006) and Fawzy *et al.* (2007) found that spraying potassium oxide as a stimulative dose led to the highest plant growth (plant length, number of leaves/plant, and fresh weight of leaves) as well as the highest yield and quality of onion and aubergine plants, respectively. In the same regard, Lester *et al.* (2006) concluded that soil K with foliar K applications during muskmelon fruit development and maturation improved fruit quality by increasing sugar content, ascorbic acid, and ß-carotene levels.

The main objective of this study was to investigate the effect of different potassium fertilization rates in addition to foliar spraying of potassium oxide or K-humate as stimulative doses on the vegetative growth parameters, total fruit yield and its physical and chemical constituents of sweet pepper plants.

2. Materials and methods

Sweet pepper seeds cv. "California wonder" were sown in 209 cell foam trays filled with peat moss:vermiculite (1:1 v/v) media. Afterwards, trays were kept in the greenhouse at the Experimental Station of the National Research Centre in El-Nobaria region, Behira Governorate, and cared by regular practices for seedlings production in greenhouse. After 8 weeks, uniform pepper seedlings were transplanted into the field on the second week of March in both seasons of 2009 and 2010. Seedlings were planted on ridges of 100 cm width, 8 m length on both sides of ridge and 50 cm apart. Each experimental plot included 4 ridges with a net area of 32 m^2. The physical properties and chemical analysis of the experimental soil are presented in Table (1). All agricultural practices were carried out according to the recommendations of Ministry of Agriculture for sweet pepper production in El-Nobaria region.

Potassium sulfate fertilizer (50% K_2O and 18% S, Tessenderlo Co., Belgium) was applied as a fertigation application through drip irrigation system with rates of 50, 100 and 200 kg/fed. Regarding potassium stimulative doses, sweet pepper plants were foliar sprayed for three times in a 15 days interval with the same doses of potassium oxide (2 and 4 ml/L, 37.5% K_2O, Kafr El Zayat Pesticides & Chemicals Co., Egypt), potassium humate (4 gm/L, Power Humus, 12% K_2O, Humintech Co., Germany) and with tap water as control treatment, during the growing period at 30, 45 and 60 days after transplanting. Few drops of wetting agent (Sticky, AGRICO International Co., Egypt) were added to spraying solution.

Experimental design and statistical analysis

The experiment was arranged in a split plot design with four replicates, where potassium fertilization rates were arranged randomly within the main 3 plots, while stimulative doses of potassium foliar spraying treatments plus control treatment were distributed in the sub-plots. The obtained data were statistically analyzed and means separation were done using LSD test according to the method described by Gomez and Gomez (1984).

Table (1): Physical properties and chemical analysis of the experimental soil.

Physical properties							
Sand	Clay	Silt	Texture	F.C.%	W.P.%		
90.08	9.26	0.66	Sandy	16.57	5.25		
Chemical analysis							
E.C. mmohs/cm	pH	meq./L					
		Ca	Mg	Na	K	HCO_3	Cl
1.7	8.2	7.02	0.527	0.982	0.310	1.3	0.566

Measured parameters:

Five plants were chosen randomly from each sub-plot at 90 days after transplanting date and transferred to laboratory to record the following data:

1- Vegetative growth characters

1- Plant height (cm).
2- Number of leaves/plant.
3- Number of branches/plant.
4- Fresh and dry weights of leaves (gm).

2- Fruit yield and quality

At harvesting time, samples of green pepper fruits were randomly harvested from each sub-plot to measure fruit length, fruit diameter and average fruit weight. In addition, total weight of fruits in each treatment were recorded by harvesting pepper fruits twice weekly and then the total yield as ton/fed. was calculated.

3- Chemical content

Fruit samples were randomly taken at harvesting time to determine vitamin C content in the fruit as mg/100gm fresh weight according to method described by A.O.A.C. (1990). Also, total chlorophyll content in fully expanded leaves was measured as SPAD units using Minolta SPAD-501 chlorophyll Meter (Minolta Co. Ltd., Japan). Leaf samples were oven dried at 68°C for 72 hours, then fine grinded and used to determine ion contents on a dry weight basis. Total nitrogen and phosphorus contents were determined using Kieldahl method and colorimetric method using spectrophotometer (SPECTRONIC 20D, Milton Roy Co. Ltd., USA), respectively, according to the procedure described by Cottenie (1980). Potassium content was measured using flame photometer method (JENWAY, PFP-7, ELE Instrument Co. Ltd., UK) as described by Chapman and Pratt (1982).

3. Results and Discussion:

Vegetative growth characters

There were significant increases of all vegetative growth characters with increasing potassium fertilization rates from 50 to 200 kg/fed. except for number of branches per plant in the second season only, where no significant effect was realized (Table 2). In general, the highest values of plant height, number of leaves, number of branches per plant and fresh and dry weights of leaves of sweet pepper plants were recorded by plants which received 200 kg/fed. potassium sulfate, while the lowest values were recorded by plants received 50 kg/fed. These findings were true in both seasons. These results may be due to the role of potassium element in metabolism and many processes needed to sustain and promotion plant vegetative growth and development. Moreover, many studies proved that K plays a major role in many physiological and biochemical processes such as cell division and elongation and metabolism of carbohydrates and protein compounds (Hsiao and Läuchli, 1986 and Marschner, 1995). The obtained results are in harmony with those of El-Masry (2000), Nassar *et al.* (2001) and Fawzy *et al.* (2005) on sweet pepper, Fawzy *et al.* (2007) on eggplant, Al-Karaki (2000) and Gupta and Sengar (2000) on tomato and Lester *et al.* (2006) on muskmelon.

Concerning the foliar spraying of potassium as a stimulative dose (Table 2), there were significant increases in all vegetative growth parameters with using potassium as foliar application in both seasons, except for number of branches per plant in the second season only. The highest values of plant growth characters expressed as plant height, number of leaves, number of branches per plant and fresh and dry weights of leaves were recorded by using 4 gm/L of K-humate followed by 4 ml/L of potassium oxide when compared with control treatment. The above findings were completely similar in both seasons.

These results are in agreement with those of Hoang and Böhme (2001); Türkmen *et al.* (2005); Zaky *et al.* (2006) and Karakurt *et al.* (2009). They reported that K-humate application led to increasing and improving plant growth parameters. In addition, Böhme and Thi Lua (1997) reported that K-humate had beneficial effects on nutrient uptake by plants and was particularly important for the transport and availability of micro nutrients needed for optimal plant growth and development. In the same respect, spraying potassium oxide led to the highest values of plant growth characters (plant length, number of leaves/plant and fresh weight of leaves) as reported by El-Bassiony (2006) on onion and Fawzy *et al.* (2007) on eggplant.

Regarding the interaction effect, there were significant differences in all measured vegetative parameters except for number of branches per plant in both seasons. Generally, it could be stated that the highest plant growth characters were recorded by using 200 kg/fed. potassium sulfate with foliar application of K-humate (4 gm/L) followed by using 200 kg/fed. potassium sulfate with foliar application of potassium oxide (4 ml/L) and these findings were true in both experimental seasons.

Fruit yield and quality

Data presented in Table (3) clearly demonstrated that there were significant differences in the total yield and all fruit quality parameters except for the average of fruit diameter. The highest total yield of sweet pepper plants was produced by using 200 kg/fed. potassium sulfate. Concerning, fruit quality measurements (fruit length and average fruit weight), the obtained results concluded that there were significant increases in sweet pepper fruit parameters with increasing potassium levels from 50 to 200 kg/fed. While, potassium sulfate fertilization had no significant effect on pepper fruit diameter. These findings were true in both experimental seasons.

Table (2): Effect of different potassium levels and potassium foliar application on vegetative growth parameters of pepper plant in seasons of 2009 and 2010.

Characters		2009					2010				
		Plant length (cm)	**Leaf number**	**Branch number**	**Leaves fresh weight (g)**	**Leaves dry weight (g)**	**Plant length (cm)**	**Leaf number**	**Branch number**	**Leaves fresh weight (g)**	**Leaves dry weight (g)**
Treatments		**Effect of potassium level**									
50 kg/ fed.		37.27	158.5	6.81	77.42	18.58	39.14	180.25	8.81	85.59	20.12
100 kg/fed.		41.57	182.5	8.44	95.00	26.47	47.90	203.75	10.25	100.89	26.61
200 kg/fed.		43.88	191.0	9.13	106.01	28.76	49.66	212.50	9.75	110.95	29.92
LSD at 5%		**1.55**	**8.77**	**1.45**	**6.18**	**1.32**	**1.36**	**6.56**	**NS**	**7.87**	**2.08**
		Effect of foliar application									
Control		36.65	165.67	6.58	81.94	21.63	39.89	177.67	7.08	86.31	22.29
2 cm/L K_2O		37.74	167.33	7.75	87.90	23.46	42.23	189.33	9.00	92.52	24.12
4 cm/L K_2O		42.71	184.67	8.75	90.94	24.97	46.46	200.00	10.67	94.57	26.50
4 gm/L K-humate		46.52	191.67	9.42	110.45	28.35	53.67	228.33	11.67	123.17	29.27
LSD at 5%		**4.32**	**9.47**	**1.15**	**3.24**	**1.02**	**2.14**	**9.42**	**NS**	**3.69**	**1.73**
		Effect of the interaction									
50 kg/fed.	Control	35.54	150	6.25	74.67	16.32	31.67	162	7.50	77.85	17.33
	2 cm/L K_2O	34.35	147	6.50	74.98	17.03	34.50	175	8.00	79.38	18.15
	4 cm/L K_2O	37.50	158	7.00	76.01	18.35	39.22	182	9.25	83.67	21.32
	4 gm/L K-humate	41.67	179	7.50	84.01	22.63	51.15	202	10.50	101.44	23.67
100 kg/fed.	Control	36.80	172	6.50	85.68	23.12	41.50	194	6.50	90.14	23.42
	2 cm/L K_2O	36.33	173	8.25	94.04	26.22	45.45	195	10.50	95.73	25.36
	4 cm/L K_2O	46.50	187	9.50	93.57	27.46	51.67	197	12.25	93.98	27.77
	4 gm/L K-humate	46.65	198	9.50	106.71	29.09	52.98	229	11.75	123.71	29.89
200 kg/fed.	Control	37.60	175	7.00	85.47	25.45	46.50	177	7.25	90.94	26.13
	2 cm/L K_2O	42.55	182	8.50	94.69	27.14	46.75	198	8.50	102.44	28.86
	4 cm/L K_2O	44.13	209	9.75	103.25	29.11	48.50	221	10.50	106.06	30.42
	4 gm/L K-humate	51.23	198	11.25	140.62	33.34	56.88	254	12.75	144.36	34.26
LSD at 5%		**2.35**	**11.16**	**NS**	**10.65**	**3.82**	**2.13**	**10.43**	**NS**	**5.72**	**2.46**

The obtained results might be due to the role of potassium in fruit quality, where it is known as the quality nutrient because of its important effects on fruit quality parameters (Imas and Bansal, 1999 and Lester *et al.*, 2006). Also, the obtained results were in accordance with those obtained by El-Masry (2000), Ni-Wu *et al.* (2001), Ruchi-Sood and Sharma (2004) and Fawzy *et al.* (2005) on pepper plants, Fawzy *et al.* (2007) on eggplant and Al-Karaki (2000) and Gupta and Sengar (2000) on tomato. They concluded that increasing potassium fertilization levels could be used to improve or enhance plant yield and fruit quality as well.

Regarding foliar application of potassium oxide or potassium humate, foliar application treatments had a significant effect on total yield and fruit quality of sweet pepper plants except for fruit diameter in both seasons. The highest values of fruit yield and quality parameters were obtained when sweet pepper plants sprayed with K-humate (4 gm/L) followed by potassium oxide (4 ml/L).

The obtained results are in agreement with Karakurt *et al.* (2009) who showed that humic acid had no significant effect on fruit length or diameter. Also, they demonstrated that humic acid applications might successfully be used to obtain higher fruit yield and can significantly enhance fruit quality in organically grown pepper. Moreover, Arancon *et al.* (2006) reported that pepper plants treated with humic acid significantly produced more fruits and flowers than untreated plants. In addition, Padem and Ocal (1999) demonstrated that increasing K-humate application dose led to a significant increase in fruit weight and total yield. In the same regard, El-Bassiony (2006) and Fawzy *et al.* (2007) summarized that spraying potassium oxide resulted in the highest yield and quality of onion and aubergine plants, respectively.

Concerning factors interaction, there was no significant interaction effect on fruit diameter in both seasons. Whereas, there were significant interaction effects on total yield, fruit weight and fruit length in both seasons. Generally, it could be mentioned that the best results were obtained when potassium sulfate was used at rate of 200 kg/fed. plus K-humate (4 gm/L) followed by using potassium sulfate at rate of 200 kg/fed. plus potassium oxide (4 ml/L) as a foliar application.

Table (3): Effect of different potassium levels and potassium foliar application on fruit yield and quality of pepper plant in seasons of 2009 and 2010.

Characters		2009				2010			
		Fruit length (cm)	**Fruit diameter (cm)**	**Fruit weight (g)**	**Total yield ton/fed.**	**Fruit length (cm)**	**Fruit diameter (cm)**	**Fruit weight (g)**	**Total yield ton/fed.**
Treatments		**Effect of potassium level**							
50 kg/fed.		7.65	5.75	66.43	7.15	8.23	6.20	67.87	7.07
100 kg/fed.		9.63	6.05	82.65	7.64	10.18	6.43	83.85	7.68
200 kg/fed.		9.85	6.63	103.22	8.59	10.40	7.08	108.30	8.64
LSD at 5%		**1.03**	**NS**	**7.34**	**0.09**	**0.15**	**NS**	**13.66**	**0.27**
		Effect of foliar application							
Control		7.27	5.13	65.89	7.10	7.50	5.67	66.83	7.09
2 cm/L K_2O		8.50	6.13	73.74	7.47	8.97	6.30	75.67	7.62
4 cm/L K_2O		9.50	6.33	93.11	8.14	10.30	6.93	95.95	8.03
4 gm/L K-humate		10.90	6.97	103.66	8.45	11.63	7.37	108.24	8.45
LSD at 5%		**1.10**	**NS**	**5.53**	**0.06**	**1.18**	**NS**	**7.54**	**0.17**
		Effect of the interaction							
50 kg/fed.	Control	6.3	4.8	49.17	6.32	6.4	5.1	50.67	6.35
	2 cm/L K_2O	7.5	6.2	55.25	6.84	8.2	6.4	58.00	6.92
	4 cm/L K_2O	7.3	5.9	77.36	7.63	8.5	6.7	78.23	7.08
	4 gm/L K-humate	9.5	6.1	83.93	7.82	9.8	6.6	84.59	7.93
100 kg/fed.	Control	8.3	5.4	71.17	7.12	8.8	5.7	71.25	6.97
	2 cm/L K_2O	9.1	6.1	69.30	7.25	9.6	6.3	75.70	7.37
	4 cm/L K_2O	9.5	6.2	93.14	7.85	9.8	6.9	93.87	8.15
	4 gm/L K-humate	11.6	6.5	96.97	8.32	12.5	6.8	94.57	8.24
200 kg/fed.	Control	7.2	5.2	77.32	7.87	7.3	6.2	78.58	7.96
	2 cm/L K_2O	8.9	6.1	96.68	8.32	9.1	6.2	93.30	8.57
	4 cm/L K_2O	11.7	6.9	108.82	8.95	12.6	7.2	115.76	8.86
	4 gm/L K-humate	11.6	8.3	130.07	9.22	12.6	8.7	145.55	9.17
LSD at 5%		**1.45**	**NS**	**18.75**	**0.36**	**1.35**	**NS**	**22.14**	**0.56**

Chemical content

Increasing potassium fertilization rates from 50 to 200 kg/fed. significantly increased all chemical composition, i.e. total chlorophyll, N, P and K in leaves and vitamin C content in fruits. In general, the highest and lowest values of measured chemical composition of sweet pepper plants were recorded by plants which received 200 and 50 kg/fed. potassium sulfate, respectively, in both seasons as shown in Table (4). These results may be due to the role of potassium in plant metabolism and many important regulatory processes in the plant. Also, it could be increased mineral uptake by plants (Hsiao and Läuchli, 1986 and Marschner, 1995).

The obtained results are in accordance with Nassar *et al.* (2001) and Fawzy *et al.* (2005) on pepper, Fawzy *et al.* (2007) on eggplant, Al-Karaki (2000) and Gupta and Sengar (2000) on tomato. They proposed that potassium fertilization levels significantly affect fruit quality parameters and plant chemical composition. In the same regard, Lester *et al.* (2006) concluded that potassium fertilization with potassium foliar applications during muskmelon fruit development and maturation improved fruit quality by increasing sugar content, ascorbic acid, and ß-carotene levels.

Table (4): Effect of different potassium levels and potassium foliar application on chemical composition of pepper plant in seasons of 2009 and 2010.

Characters		**2009**					**2010**				
		Vitamin C	**Total chlorophyll**	**N%**	**P%**	**K%**	**Vitamin C**	**Total chlorophyll**	**N%**	**P%**	**K%**
Treatments		**Effect of potassium level**									
50 kg/fed.		69.48	48.36	1.38	0.52	1.87	71.45	49.83	1.41	0.52	1.96
100 kg/fed.		79.01	53.25	1.56	0.62	2.20	81.81	53.08	1.57	0.63	2.23
200 kg/fed.		94.76	55.38	1.72	0.69	2.47	100.03	57.74	1.73	0.71	2.51
LSD at 5%		**4.25**	**1.12**	**0.05**	**0.04**	**0.09**	**7.75**	**1.55**	**0.12**	**0.05**	**0.11**
		Effect of foliar application									
Control		73.23	45.80	1.37	0.52	1.86	75.58	49.64	1.40	0.54	1.92
2 cm/L K_2O		77.90	52.95	1.46	0.57	2.09	80.24	52.30	1.51	0.58	2.12
4 cm/L K_2O		82.47	54.60	1.64	0.64	2.32	87.57	54.39	1.59	0.65	2.38
4 gm/L K-humate		90.74	55.97	1.73	0.71	2.46	94.32	57.88	1.77	0.71	2.53
LSD at 5%		**2.17**	**1.16**	**0.04**	**0.06**	**0.03**	**5.13**	**1.23**	**0.07**	**NS**	**0.12**
		Effect of the interaction									
50 kg/fed.	Control	65.13	41.50	1.23	0.44	1.65	68.22	45.70	1.35	0.45	1.73
	2 cm/L K_2O	68.12	48.25	1.34	0.51	1.74	70.09	49.20	1.37	0.49	1.86
	4 cm/L K_2O	71.15	51.30	1.41	0.52	1.95	71.72	51.30	1.38	0.56	2.03
	4 gm/L K-humate	73.52	52.40	1.52	0.61	2.15	75.76	53.13	1.52	0.59	2.23
100 kg/fed.	Control	72.52	47.90	1.36	0.51	1.92	73.76	49.73	1.35	0.54	1.95
	2 cm/L K_2O	75.25	53.10	1.47	0.59	2.16	77.95	51.60	1.55	0.59	2.23
	4 cm/L K_2O	81.11	55.50	1.67	0.64	2.35	84.76	53.67	1.63	0.67	2.33
	4 gm/L K-humate	87.36	56.50	1.72	0.73	2.37	90.75	57.33	1.75	0.71	2.42
200 kg/fed.	Control	82.23	48.00	1.52	0.61	2.02	84.76	53.50	1.49	0.63	2.09
	2 cm/L K_2O	90.32	57.50	1.56	0.62	2.37	92.67	56.09	1.62	0.67	2.26
	4 cm/L K_2O	95.15	57.00	1.83	0.75	2.65	106.23	58.20	1.75	0.73	2.77
	4 gm/L K-humate	111.35	59.00	1.95	0.79	2.85	116.44	63.17	2.05	0.82	2.93
LSD at 5%		**15.42**	**6.13**	**NS**	**NS**	**0.11**	**8.64**	**3.15**	**NS**	**NS**	**0.09**

Potassium not only increased fruit yields but also improved fruit quality by increasing dry matter and vitamin C contents, as well as increasing sugar content and titratable acidity levels of tomato as reported by Economakis and Daskalaki (2003).

Concerning foliar application of potassium oxide with rates of 2 and 4 ml/L or potassium humate with 4 gm/L as stimulative doses, it is of interest to note that they had a positive significant effect on chemical composition of sweet pepper plants except for phosphorus percentage in the second season only. Data presented in Table (4) indicated that the highest values of vitamin C content in fruits and total chlorophyll in leaves, as well as the highest percentages of N, P and K in pepper leaves were recorded when pepper plants sprayed by K-humate (4 gm/L) followed by potassium oxide (4 ml/L) treatments when compared with control treatment in both seasons.

The obtained results are in harmony with Hoang and Böhme (2001), Zaky *et al.* (2006) and Karakurt *et al.* (2009). Also, Böhme and Thi Lua (1997) showed that K-humate had beneficial effects on nutrient uptake and was particularly important for the transport and availability of micro nutrients. In addition, foliar spraying of potassium as a stimulative dose had a significant effect on N and K percentages in dry leaf tissues and significantly increased fruit quality in eggplant as reported by Fawzy *et al.* (2007). Also, Padem and Ocal (1999) and Lester *et al.* (2006) demonstrated that potassium applications can improve fruit quality, i.e. firmness, sugar content and vitamin C content in processing tomato and muskmelon fruits.

The interaction effect between potassium fertilization rates and potassium foliar application had a significant effect on vitamin C content in fruits, total chlorophyll and potassium percentage in leaves. While, no significant effects were realized on nitrogen and phosphorus percentages. These results are similar in both seasons. From data presented in Table (4) it could be clearly summarized that the highest values of vitamin C content in sweet pepper fruits, total chlorophyll and potassium percentage in sweet pepper leaves were recorded when sweet pepper plants received 200 kg/fed. potassium sulfate as fertilization plus 4 gm/L of K-humate as foliar application followed by plants that received 200 kg/fed. potassium sulfate plus 4 gm/L of potassium oxide.

4. Conclusion:

From the above mention results it could be concluded that foliar application of potassium humate (4 gm/L) or potassium oxide (4 ml/L) as a stimulative dose could be successfully used in addition to fertilization application of potassium sulfate with rate of 200 kg/fed. to obtain the highest vegetative growth parameters, total fruit yield, and significantly enhanced fruit quality and chemical composition of sweet pepper plants.

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