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Response of sweet pepper plants to organic manure and potassium humate

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Abstract

Two field experiments were performed during two consecutive summer seasons of 2011 and 2012 at the Private Farm (El- Nagah Village), El-Kassasin region (30^{o,} 11 N, 31 ^{o,} 18 E) , Ismailia Governorate, to assess the effect of organic manure sources (control, FYM, compost and chicken manure) and potassium humate rates (control, 0.5, 1 and 1.5 g/L) as well as all possible combination between them on growth, yield and its components and chemical constituents of sweet pepper fruits (*Capsicum annuum* L.) cv. Marconi.

Organic manure fertilizers caused significant increases in growth, yield and its components and mineral contents compared with the control treatment (without organic fertilization). Meanwhile, application of chicken manure at rate 10 m^3/fed achieved the highest values of all aforementioned parameters followed by the application of compost at the rate of 20 m^3/fed and FYM at the same rate, in a descending order.

Spraying sweet pepper plants with potassium humate significantly enhanced plant growth, yield and its components as well as NPK content and uptake and total protein in fruits. In this respect, spraying plants with 1.5 g/L potassium humate attained the superiority impacts comparing the other treatments.

Hence, it can be concluded that fertilizing pepper plants with chicken manure at rate 10 m^3/fed in combined with spraying plants with potassium humate at rate 1.5 g/L gave the highest values of growth, yield and its components and NPK content and uptake as well as total protein content in fruits as compared to other interaction treatments.

Key words: Pepper, organic manure, potassium humate, growth, yield and chemical constituents

Introduction

Sweet pepper is known as a favorite vegetable crop, rich in antioxidants, vitamins and minerals for human diet.

A great attention has bean directed towards the use of organic fertilizers to reduce plant and soil contaminations with mineral fertilizers, improve the fertility of soil and reduce nutrient losses. In addition, the organic fertilizers were considered good sources of plant nutrient supply and good soil conditioners. Addition of organic matter, can improve all soil properties; such as water holding capacity, soil aggregation, aggregation stability, soil fertility, and increase cation exchange capacity. Also, organic fertilizers were used to decrease soil pH and increasing the availability of major and minor nutrients (Tahoun *et al*, 2000).

Some investigators dealt with the effect of organic manure on vegetative growth, yield and chemical constituents. They stated that application of organic manure increased dry weight/plant; N, P and K contents; number of fruits/plant; average fruit weight as well as yield/plant and feddan (Abd Alla *et al*., 1998 on common bean; El-Mansi *et al*., 1999; Nour 2004 and Atia and Bardisi 2005 on pea and Carreraa *et al*., 2007 on tomato).

Quick loss of available plant nutrients by high soil pH, leaching, fixation and/or volatilization. Adsorbed of high amounts of potassium ions by clay minerals is also one of the major problems for Egyptian agriculture. As a matter of fact soil fertility and fertilizer problems have to be confronted in order to optimize water use and crop production. Potassium is the most prominent inorganic plant solute, and as such makes a major contribution to lower the osmotic potential in the stele of roots that is a prerequisite for turgor pressure driven solute transport in xylem and the water balance of plants (Marschner, 1995). On the other hand, potassium is the prevalent cation in the plant and may be involved in maintenance of ionic balance in the cells, and it bounds ionically to the enzyme pyruvate kinase, which is essential in respiration and carbohydrates metabolism. So, potassium element is very important in the overall metabolism of the plant. In addition, Marschner (1995) reported that potassium involved in a number of steps in protein synthesis.

Some investigators studied the effect of potassium rates on vegetative growth, yield and chemical constituents, Majumdar *et al.,* (2000), Sangakkara and Frehner (2001), Balliu and Ibro (2002), Chandra *et al.*, (2003), Gent (2004) and Liu *et al*., (2008) showed that application of K fertilizers significantly improved vegetative growth, yield and chemical constituents of tested vegetable crops.

Enhancement of plant growth by using humic acid had been reported by many authors. This action may be due to increasing nutrients uptake such as N, Ca, P, K, Mg, Fe, Zn and Cu and binding toxic elements such as Al (Adani *et al.*, 1998).

Enhancement of photosynthesis, chlorophyll density and plant root respiration has resulted in great plant growth with humate application (Chen and Avaid, 1990). Humic acids are in common use as major components in biostimulant formulations (Vaughan *et al.,* 1985). Combined with humic acid and potassium can be rapidly absorbed and incorporated into plant whether via soil or foliar application methods.

Application of humic acid (HA) has several benefits. Agriculturists all over the world are accepting HA as an integral part of their fertilizer program. It can be applied directly to the plant foliage in liquid form or to the soil in the form of granules alone or as fertilizer mixture. Humic acid is one of the major components of humus. Humates are natural organic substances, high in HA and containing most of known trace minerals necessary to the development of plant life. Abd El-Al *et al*., (2005) indicated that the application of humic acid significantly increased the dry matter production of faba bean plants. El-Desuki (2004) reported that growth traits (number and fresh weight of leaves) of onion were gradually and significantly increased with increasing the level of humic acid application from 0 to 6 l/fed. Arancon *et al.,* (2004b) also found that plant height of peppers was increased considerably with humic acid. Abdel-Mawgoud *et al.,* (2007) on tomato indicated that application of humic acid increased the number of leaves, fresh and dry weights of the plants, total and marketable yield and NPK contents and uptake showed a similar positive trend.

Therefore, this study analyzed the responses of growth, yield, fruit quality and chemical constituents of pepper plants to various sources of organic manure and potassium humate rates.

Materials and methods

Two field experiments were carried out during the two successive seasons of 2011 and 2012 at the Private Farm on El- Nagah Village, El-Kassasin region, Ismailia Governorate, to assess the effect of some sources of organic manure (control, FYM, compost and chicken manure) and potassium humate rates (control, 0.5, 1 and 1.5 g/L) and different interactions between them on growth, yield and its components as well as chemical constituents of sweet pepper (*Capsicum annuum* L.) cv. Marconi. The soil of the experimental field was clay loam in texture. Physical and chemical characters of the soil under study were conducted according to (Page *et al.,* 1982) and (Klute 1986) are shown in Table 1.

Table 1. The physical and chemical properties of the experimental soil field.

Physical properties		Chemical properties	
Sand	19.10	Organic matter	1.46
Silt	34.29	pH	7.48
Clay	46.61	Available N (ppm)	39.82
Texture	Clay loam	Available P (ppm)	5.87
		Available K (ppm)	113.2

Samples of the soil were obtained from depth of 25 cm i.e. soil surface layer.

The chemical properties of the organic sources are shown in Table 2.

Table 2. The chemical properties of organic sources during 2011 and 2012 seasons.

Sources / Chemical properties	FYM		Compost		Chicken	
	2011	2012	2011	2012	2011	2012
OM %	13.36	13.65	25	30	44.53	49.82
Total N (%)	0.78	0.74	0.8	1.2	3.57	3.46
Total P (%)	0.14	0.11	0.4	0.6	1.18	1.15
Total K (%)	0.61	0.65	0.8	1.4	1.69	1.87
Available Zn (ppm)	34.01	30.53	30	40	176	193
Available Mn (ppm)	40.88	39.13	88	120	198	183
Available Fe (ppm)	70.18	71.66	100	120	289	336

Seeds were sown in nursery on 10th June in foam trays and seedlings were transplanted (with 3-4 true leaves i.e. after 40 days) from sowing on 21th and 22th July for 1st and 2nd seasons, respectively.

Treatments:

A- Organic manure sources:

1- Control (without application)
2- Farm yard manure at rate of 20 m^3/fed
3- Compost at rate of 20 m^3/fed
4- Chicken manure at rate of 10 m^3/fed

B- Potassium humate at rates:

1- Control (sprayed water)
2- 0.5 g/L
3- 1 g/L
4- 1.5 g/L

The source of potassium humate was Union for Agriculture Development Company under commercial name (Hammar), which contained humic acid, fulvic acid and K_2O at rate of 86%, 17 % 6%, respectively.

Plants were sprayed three times with potassium humate. The first spray was conducted at flowers initiation (40 days after transplanting), whereas the second and third spray were preformed later 15 days by intervals.

This experiment included 16 treatments which were the combinations between four organic manure sources and four potassium humate rates, treatments were arranged in a split plot design with three replicates, organic manure sources treatments were assigned randomly in the main plots, while sub plots were devoted to potassium humate rates. The experimental unit area was 21 m^2 (4.2 x 5 m) and each unit contained six rows with 5 m length for each and 70 cm width of them, four inner rows were possessed for yield determination, whereas the two outer rows were for determination of plant growth characters. Two rows were left between two experimental plots to avoid the overlapping.

Data recorded

A. Plant growth

A random sample of three plants from each plot was taken at age of 80 days to estimate plant height (cm), number of leaves/plant, number of branches/plant. A random sample of other three plants from each plot was also taken and weight for fresh weight, then it dried at 70^0C till constant weight and the dry weight of stem + leaves was determined.

B. Fruit yield and quality

Mature fruits were continuously harvested upon reaching suitable maturity stages and the following data were recorded:

1- Average fruit weight (g)

2- Number of fruits/plant = $\frac{\text{Total number of fruits/plot}}{\text{Number of plants/plot}}$

3-Fruit yield/plant (g) = $\frac{\text{Total weight of fruits/plot}}{\text{Number of plants/plot}}$

4- Total yield (tons/fed)

Total fruit yield was calculated on the basis of total yield along harvesting at full–ripe maturity stages by summing (the sum of all harvests).

C. NPK contents and uptakes and total protein content

Total nitrogen, phosphorus and potassium were determined in plant on the basis of dry weight according to the methods described by Horneck and Miller (1998), Olsen and Sommers (1982) and Horneck and Hanson (1998) respectively, and NPK uptake were calculated as NPK contents on dry weight basis (mg/plant). Crude protein was calculated based on total N concentration (6.25) according to A.O.A.C. (1990).

Statistical analysis

Data were statistically analyzed according to Snedecor and Cochran (1980) and the means separations were compared by using the Least Significant Difference (LSD) at level of 5%.

Results and Discussion

I- Plant growth

1. Effect of organic manure sources and potassium humate rates

Results given in Table 3 show the effect of organic manure sources and potassium humate rates under investigation on plant height, number of branches and leaves/plant as well as fresh and dry weight/plant. It is obvious from the data attained that plant growth was promoted with all organic manure application in both seasons compared with the control treatment (without application). This may be due to that organic manure contains many species of living organisms which release photohormonase such as GA_3, IAA and CYT which stimulates plant growth, absorption of nutrients and photosynthesis processes (Reyndres and Vlassake, 1982), also application of organic manures led to increase organic matter, nitrogen fixation and increasing availability of major and minor nutrients (Tahoun *et al*., 2000). Moreover, it may be improved physical, chemical and biological properties of soil, i.e., increasing the soil organic matter, cation exchange capacity, and water holding capacity, availability of water and mineral nutrients. This in turn increases plant growth parameters.

In this respect, pepper plants fertilized with 10 m^3 chicken manure/fed recorded the best values of plant growth characteristics than the other organic manure or the control, meanwhile, plants fertilized with compost at rate 20 m^3/fed had a positive increase than FYM at rate 20 m^3/fed. This may attribute to decomposition of chicken manure is relatively more rapid than compost or FYM manures, and it is rich in mineral contents as compared to the other organic manures (Table 2).

Concerning the effect of spraying pepper plants with potassium humate at rates (control, 0.5, 1 and 1.5 g/L) on plant height, number of branches and leaves/plant as well as fresh and dry weight/plant.

It is obvious from Table 3 that vegetative growth was gradually increased with increasing potassium humate rate from 0 to 1.5 g/L. These results may be due to potassium humate contains humic acid, fulvic acid and K_2O at rate 86%, 17 % and 6%, respectively, which reflected a positive effect on vegetative growth. Moreover, Potassium, present within plants as the cation K^+, plays an important role in regulation of the osmotic potential of plant cells and activates many enzymes involved in respiration and photosynthesis (Marschner, 1995 and Lincoln and Zeiger, 2002).

Table 3. Effect of organic manure sources, potassium humate rates and their interaction between them on vegetative growth of pepper during seasons 2011 and 2012.

Charact.		Plant height (cm)		No. of branches		No. of leaves		Fresh weight/plant		Dry weight/plant	
Treatments		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Effect of organic manure sources											
Control		46.59	40.93	4.86	4.29	72.98	67.15	151.80	145.04	10.55	8.72
FYM		49.91	46.23	5.88	5.45	79.52	74.99	162.01	156.20	11.33	9.44
Compost		56.75	53.46	6.45	6.18	90.46	84.64	175.87	170.58	12.29	10.29
Chicken manure		66.81	61.45	6.97	6.81	99.30	95.30	187.74	184.10	13.13	11.14
$LSD_{0.05}$		2.08	1.78	0.33	0.60	1.95	1.80	3.84	2.06	0.29	0.15
Effect of potassium humate rates											
Control		51.31	46.82	5.56	5.19	81.47	76.30	164.53	158.90	11.48	9.58
0.5 gm/L		53.98	49.38	5.97	5.50	84.72	78.89	167.62	162.20	11.67	9.80
1.0 gm/L		56.52	51.75	6.16	5.81	87.34	82.25	170.88	166.02	11.96	9.98
1.5 gm/L		58.25	54.13	6.48	6.23	88.73	84.63	174.39	168.80	12.19	10.22
$LSD_{0.05}$		1.67	1.01	0.27	0.38	1.19	0.97	0.96	1.20	0.11	0.12
Effect of organic manure sources X potassium humate rates											
Control	Control	44.26	38.59	4.40	3.67	68.30	64.14	148.03	142.13	10.30	8.60
	0.5 gm/L	46.21	39.66	4.73	4.20	71.84	65.33	149.93	143.53	10.30	8.69
	1.0 gm/L	47.30	41.78	5.00	4.53	75.39	68.91	152.97	146.37	10.72	8.63
	1.5 gm/L	48.60	43.68	5.30	4.77	76.39	70.22	156.27	148.13	10.89	8.95
FYM	Control	47.30	43.01	5.47	4.90	75.67	69.73	157.57	149.57	11.03	9.01
	0.5 gm/L	48.36	45.51	5.77	5.13	79.05	73.70	160.47	154.37	11.17	9.35
	1.0 gm/L	51.65	47.20	5.90	5.57	81.38	77.01	163.20	158.37	11.44	9.57
	1.5 gm/L	52.32	49.19	6.40	6.20	81.98	79.50	166.80	162.50	11.67	9.82
Compost	Control	51.62	49.11	6.17	5.87	87.08	80.73	169.73	164.30	11.81	9.88
	0.5 gm/L	55.63	52.36	6.37	6.07	89.71	83.20	174.00	168.40	12.17	10.17
	1.0 gm/L	59.12	54.82	6.60	6.20	91.62	86.00	178.10	173.27	12.46	10.45
	1.5 gm/L	60.63	57.57	6.67	6.60	93.42	88.63	181.63	176.33	12.73	10.64
Chicken manure	Control	62.06	56.55	6.20	6.33	94.82	90.60	182.77	179.60	12.80	10.82
	0.5 gm/L	65.71	59.98	7.00	6.60	98.28	93.33	186.07	182.50	13.03	10.99
	1.0 gm/L	68.03	63.21	7.13	6.93	100.97	97.10	189.27	186.07	13.23	11.29
	1.5 gm/L	71.43	66.07	7.53	7.37	103.13	100.17	192.87	188.23	13.48	11.48
$LSD_{0.05}$		3.33	2.01	0.54	0.76	N.S	1.94	1.91	2.40	0.21	0.24

Enhancement of plant growth by using humic acid may be due to increasing nutrients uptake such as N, Ca, P, K, Mg, Fe, Zn and Cu (Adani *et al.*, 1998) and binding toxic elements such as Al. Enhancement of photosynthesis, chlorophyll density and plant root respiration has resulted in greater plant growth with humate application (Chen and Avaid, 1990). Application of humic acid and potassium simultaneously could be it rapidly absorbed and incorporated into plant whether via foliar application methods (Lincoln and Zeiger, 2002).

Moreover, foliar application of humate consistently enhanced antioxidants such as α-tocopheral, β-carotene, superoxide dismutases, and ascorbic acid concentrations in turfgrass species (Zhang, 1997). These antioxidants may play a role in the regulation of plant. Foliar spray with HA significantly increased dry weight/plant (El-Bassiony *et al.*, 2010 and Khalil *et al.*, 2012).

2. Effect of the interaction between organic manure sources and potassium humate rates

Data Presented in Table 3 illustrated the effect of the interactions between organic manure sources (control, FYM, compost and chicken manure) and potassium humate rates (control, 0.5, 1 and 1.5 g/L) on vegetative growth. It is clearly that all interactions between organic manure sources and potassium humate rates had a significant effect on plant height, number of branches and leaves/plant as well as fresh and dry weight/plant, except the number of leaves/plant in the first season only.

The most increases in the vegetative growth was observed with plants fertilized with chicken manure and sprayed with 1.5 g/L potassium humate as compared to the other interaction treatments. On the other hands, control treatment (without organic manure and potassium humate) showed the lowest values of vegetative growth characteristics.

II- Fruit yield and quality

1. Effect of organic manure sources and potassium humate rates

The effect of fertilization with different organic manure sources and sprayed plants with different potassium humate rates on yield and its components are shown in Table 4. It is evident from the data attained that organic manure sources had positive and significant effects on fruit yield and quality, where the number of fruits/plant, fruit weight, fruits yield/plant and fruits yield/fed were promoted with all organic manure sources as compared to the control treatment, which recorded the lowest values. It can be noticed that, chicken manure increased all characters under study more than the other organic manure and the control treatments, but, compost treatment had a positive increase than FYM treatment. These results are in good line with those obtained from the data of vegetative growth in Table 3.

The beneficial effect of organic manure on yield may be not only due to that the organic manure improves the soil structure conditions which encouraged the plant to have a good root development by improving the aeration of soil, but also due to that mineral N fertilizer helps the living organisms in organic manure to multiply (El-Shafie and El-Shikha, 2003). Organic fertilizers have also, release nutrients slowly and they are considered sources of trace elements as well as they increase the soil organic matter content (Rumpel, 1998).

The effect of potassium humate rates on yield and its components are also shown in the same Table. Significant increases in the number of fruits/plant, fruit weight, fruits yield/plant and fruits yield/fed as the rates of potassium humate increasing up to 1.5 g/L. These results could be explained that potassium counteracts the damaging effects of excessive nitrogen and exerts a balancing effect on both nitrogen and phosphorus and consequently it is especially important in a mixed fertilizer. Potassium also aids in the development of heavy kernels (Brady, 1984).

Table 4. Effect of organic manure sources, potassium humate rates and their interaction between them on yield and its components of pepper during seasons 2011 and 2012.

Treatments	Charact.	No. of fruits/plant		Fruit weight (g)		Fruit yield/plant (g)		Fruit yield/fed (tons)	
		2011	2012	2011	2012	2011	2012	2011	2012
Effect of organic manure sources									
Control		10.13	7.94	27.90	25.12	283.61	200.16	8.508	6.005
FYM		12.34	10.27	30.96	27.18	384.10	280.55	11.523	8.416
Compost		15.10	13.08	33.43	29.86	505.26	391.82	15.158	11.754
Chicken manure		17.43	16.28	34.84	32.71	608.01	534.23	18.240	16.027
$LSD_{0.05}$		0.93	0.51	1.34	0.88	27.30	25.83	0.819	0.786
Effect of potassium humate rates									
Control		12.68	10.85	31.03	27.72	401.16	309.26	12.035	9.278
0.5 gm/L		13.42	11.53	31.53	28.41	431.19	336.81	12.936	10.104
1.0 gm/L		14.10	12.18	32.03	29.12	458.76	364.89	13.763	10.947
1.5 gm/L		14.81	13.01	32.54	29.63	489.88	395.80	14.696	11.874
$LSD_{0.05}$		0.27	0.34	0.42	0.49	8.89	12.29	0.541	0.371
Effect of organic manure sources X potassium humate rates									
Control	Control	9.40	6.93	27.07	24.57	254.76	170.39	7.643	5.112
	0.5 gm/L	9.80	7.80	27.47	24.97	269.80	195.23	8.094	5.857
	1.0 gm/L	10.47	8.33	28.40	25.20	297.80	210.81	8.934	6.324
	1.5 gm/L	10.87	8.70	28.67	25.73	312.08	224.22	9.362	6.727
FYM	Control	11.23	9.27	29.93	26.00	337.26	241.24	10.118	7.237
	0.5 gm/L	12.00	9.83	30.77	26.90	371.41	265.43	11.142	7.963
	1.0 gm/L	12.53	10.60	31.20	27.67	392.05	294.63	11.761	8.839
	1.5 gm/L	13.60	11.37	31.93	28.17	435.68	320.90	13.070	9.627
Compost	Control	13.77	11.97	32.87	28.87	452.52	345.71	13.575	10.371
	0.5 gm/L	15.00	12.53	33.23	29.50	498.56	370.46	14.957	11.114
	1.0 gm/L	15.45	13.20	33.60	30.27	519.31	399.79	15.579	11.994
	1.5 gm/L	16.17	14.63	34.03	30.80	550.66	451.31	16.520	13.539
Chicken manure	Control	16.33	15.23	34.27	31.43	560.09	479.69	16.803	14.391
	0.5 gm/L	16.87	15.97	34.67	32.27	584.99	516.13	17.550	15.484
	1.0 gm/L	17.93	16.60	34.90	33.33	625.88	554.32	18.776	16.630
	1.5 gm/L	18.60	17.33	35.53	33.80	661.09	586.79	19.833	17.604
$LSD_{0.05}$		0.54	0.67	N.S	N.S	17.99	24.57	0.541	0.737

The promoting impact of potassium humate application on the yield of pepper may be to the effect of humate on fruit set and/or fruit growth. Rincon *et al*., (1995) found that the absorption of N, P and K was greatest in the period of greatest fruit production of pepper plants.

These results agree with those repoted by Khalil *et al.,* (2012) showed that the highest humic acid concentration (2 g/L) achieved significant increases in the yield of pepper as compared to the other treatments (0 and 1 g/L).

2. Effect of the interaction between organic manure sources and potassium humate rates

It is quite clear from the data shown in Table 4 that the combinations between organic manure sources and potassium humate rates achieved significant increases of the number of fruits/plant, fruits yield/plant and fruits yield/fed in both seasons. But it's had insignificant effect on average fruit weight in both seasons. The interaction between chicken manure at rate 10 m^3/fed and potassium humate at rate 1.5 g/L were the best treatment for stimulating number of fruits/plant, fruits yield/plant and fruits yield/fed. However, the control treatments (without organic matter and potassium humate) gave the lowest values of fruit yield and quality.

III- NPK and total protein content

1. Effect of organic manure sources and potassium humate rates

It can be seen from the recorded data in Table 5 that all applications of organic manure had significant enhancing effects on NPK and total protein content in fruit sweet pepper comparing to untreated plants during the two growing seasons. However, plants fertilized with chicken manure at rate 10 m^3/fed were the superior in NPK and total protein contents in fruit sweet pepper as compared to the other organic manure sources, meanwhile; plants fertilized with compost at rate 20 m^3/fed had a positive increase than FYM at the same rate. This may be attributed to that chicken manure decomposition is rich in mineral contents as compared to the other organic manures. Also, compost manure rich in mineral contents than FYM (Table 2).

Table 5. Effect of organic manure sources, potassium humate rates and their interaction between them on NPK and total protein contents in pepper plants during seasons 2011 and 2012.

Treatments \ Charact.		N %		P %		K %		Total protein	
		2011	2012	2011	2012	2011	2012	2011	2012
Effect of organic sources									
Control		1.92	1.87	0.44	0.42	1.12	1.10	11.98	11.67
FYM		1.95	1.93	0.49	0.45	1.17	1.15	12.20	12.04
Compost		2.04	1.99	0.53	0.48	1.22	1.19	12.74	12.42
Chicken manure		2.08	2.05	0.56	0.53	1.25	1.23	13.01	12.80
$LSD_{0.05}$		0.01	0.01	0.02	0.01	0.02	0.02	0.04	0.09
Effect of potassium humate rates									
Control		1.99	1.94	0.49	0.46	1.15	1.13	12.41	12.13
0.5 gm/L		1.99	1.95	0.50	0.46	1.17	1.16	12.45	12.19
1.0 gm/L		2.00	1.96	0.51	0.47	1.20	1.19	12.51	12.26
1.5 gm/L		2.01	1.98	0.52	0.48	1.23	1.21	12.56	12.35
$LSD_{0.05}$		0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.04
Effect of organic manure sources X potassium humate rates									
Control	Control	1.91	1.85	0.43	0.41	1.11	1.08	11.94	11.56
	0.5 gm/L	1.92	1.86	0.43	0.41	1.11	1.10	11.98	11.63
	1.0 gm/L	1.92	1.87	0.45	0.42	1.13	1.12	12.00	11.71
	1.5 gm/L	1.92	1.88	0.45	0.43	1.13	1.13	12.02	11.77
FYM	Control	1.94	1.91	0.47	0.44	1.12	1.10	12.13	11.96
	0.5 gm/L	1.95	1.92	0.48	0.44	1.14	1.13	12.17	12.00
	1.0 gm/L	1.95	1.93	0.50	0.45	1.18	1.17	12.21	12.06
	1.5 gm/L	1.97	1.94	0.50	0.46	1.22	1.20	12.29	12.15
Compost	Control	2.03	1.97	0.51	0.47	1.16	1.14	12.67	12.29
	0.5 gm/L	2.03	1.98	0.53	0.48	1.20	1.18	12.69	12.40
	1.0 gm/L	2.05	1.99	0.54	0.49	1.24	1.21	12.79	12.44
	1.5 gm/L	2.05	2.01	0.54	0.49	1.27	1.24	12.81	12.56
Chicken manure	Control	2.06	2.03	0.55	0.51	1.20	1.19	12.90	12.69
	0.5 gm/L	2.08	2.04	0.56	0.53	1.22	1.21	12.98	12.75
	1.0 gm/L	2.09	2.05	0.57	0.54	1.27	1.25	13.04	12.81
	1.5 gm/L	2.10	2.07	0.57	0.55	1.30	1.28	13.10	12.94
$LSD_{0.05}$		0.02	0.03	0.03	0.02	0.03	0.03	0.05	0.08

These increases in NPK content might be due to that organic manure contains microorganisms have ability to supply the grown plants with fixed N and release phyotohormones, which could increase the growth and dry weight of pepper plants. This in turn increases NPK content in tissues of pepper plants. In addition, organic manure may play a favourable role in increasing nutrients availability in most soils, through the processes of chelating, biochemical processes and production of several organic acids during decomposition of organic manure as reported by Hammad *et al*., (1990).

These results coincided with those reported by El-Mansi *et al*., (1999), Nour (2004) and Atia and Bardisi, (2005) on pea and Carreraa *et al*., (2007) on tomato, who found that the application of organic manure to the soil increased NPK and total protein contents in plants.

The effect of potassium humate on NPK and total protein content in sweet pepper fruits are also shown in Table 5. Data in this Table clearly showed that potassium humate at different rates significantly enhanced NPK and total protein content in fruits as compared to the control treatment, and its were gradually increased with increasing potassium humate rates. The highest values attained when spraying plants with potassium huamte at rate 1.5 g/L.

Maintenance of adequate potassium levels is essential for plant survival in saline habitats. Potassium is the most prominent inorganic plant solute, and as such makes a major contribution to low the osmotic potential in the stele of roots that is a prerequisite for turgor-pressure-driven solute transport in xylem and the water balance of plants (Marschner, 1995). Enhancement of NPK and total protein contents by using humate may be due to increasing nutrients uptake such as N, Ca, P, K, Mg, Fe, Zn and Cu (Adani *et al.*, 1998) and binding toxic elements such as Al. Combination of potassium with humic acid can be it rapidly absorbed and incorporated into plant whether via foliar application methods.

These results coincided with those reported by Balliu and Ibro, (2002), Chandra *et al.*, (2003), Gent (2004), Abdel-Mawgoud *et al.,* (2007) Liu *et al*., (2008) and Khalil *et al.,* (2012).

2. Effect of the interaction between organic manure sources and potassium humate rates

Data obtained in Table 5 showed that the interaction between organic manure sources and potassium humate rates had significant effects on NPK and total protein content in sweet pepper fruits. Pepper plants fertilized with 10 m^3/fed chicken manure combined with spraying by 1.5 g/L potassium humate recorded the maximum values of NPK and total protein content in fruits. On the other hand, control treatment (without organic manure and potassium humate) showed the lowest values of NPK and total protein contents.

IV- NPK uptake

1. Effect of organic manure sources and potassium humate rates

Data in Table 6 represent the effect of organic manure sources and potassium humate rates on NPK uptake of sweet pepper plants. It is evident that all treatments had positive effects on such characters under study in the two growing seasons.

Concerning the effect of organic manure sources, its clearly showed that fertilization plants with 10 m^3 chicken manure/fed gave the highest values of NPK uptake as compared to the control treatment and the other organic manure sources. Meanwhile, plants fertilized with compost manure at rate 20 m^3/fed had a positive increase than FYM at the same rate. This may be attributed to that chicken manure decomposition is relatively more rapid than compost or FYM manures. Moreover chicken manure is rich in mineral contents as compared to the other organic manures. On the other hand, compost manure rich in mineral contents than FYM (Table 2). The increment in NPK uptake by pepper plants could be explained on the basis of that organic manure can attract and hold nutrients and water on its surface to supply the plants with suitable amounts for longer time and this in turn improve NPK uptake and reflected on growth and dry weight of pepper plants.

The obtained results are in harmony with those reported by El-Fakhrani (1997) and El-Shafie and El-Shikha (2003) on faba bean who found that application of organic manures (FYM and chicken manure) increased NPK uptake, but chicken manure was superior to farmyard manure.

It can be seen from the data in Table 6 that potassium humate had a significant effect on NPK uptake by sweet pepper plants, and they were gradually increased with increasing potassium humate rates. Potassium is the most prominent inorganic plant solute, and it contributes to low the osmotic potential in the stele of roots that is a prerequisite for turgor-pressure-driven solute transport in xylem and the water balance of plants (Marschner, 1995). Enhancement of NPK uptake by using humate may be due to increasing nutrients uptake such as N, Ca, P, K, Mg, Fe, Zn and Cu (Adani *et al.*, 1998) and binding toxic elements such as Al. Combination of potassium with humic acid can be rapidly absorbed and incorporated into plant whether via foliar application methods. Shehata *et al.,* (2011) indicated that humic substances may indirectly impact nutrient uptake through the function of humic acid, and directly impact the plants when they were absorbed by roots; humic acid promoted the accumulation of reducible sugar which increased wilting resistance through enhancing the osmotic pressure inside plants, enhancement by humic acid of peroxidase activity, seed germination, nutrient uptake, and root growth.

2. Effect of the interaction between organic manure sources and potassium humate rates

Data presented in Table 6 indicate that the interaction between organic manure sources and potassium humate rates had significant effect on NPK uptake, and the most effective interaction treatment was fertilized plants by chicken manure with sprayed plants by 1.5 g/L potassium humate, which recorded the highest values of NPK uptake as compared to other treatments, on the other hands, the control treatment (without organic manure and without potassium humate) showed the lowest values of NPK uptake.

Table 6. Effect of organic manure sources, potassium humate rates and their interaction between them on NPK uptake by pepper plants during seasons 2011 and 2012.

Treatments	Charact.	N uptake (mg/plant) 2011	N uptake (mg/plant) 2012	P uptake (mg/plant) 2011	P uptake (mg/plant) 2012	K uptake (mg/plant) 2011	K uptake (mg/plant) 2012
Effect of organic sources							
Control		202.40	162.77	46.49	36.35	118.25	96.30
FYM		221.12	181.91	55.37	42.22	132.10	109.00
Compost		250.59	204.51	64.88	49.61	149.71	122.88
Chicken manure		273.37	228.22	73.80	59.61	163.68	137.38
$LSD_{0.05}$		5.56	3.50	1.73	1.83	3.11	1.82
Effect of potassium humate rates							
Control		228.52	186.38	56.60	44.10	131.92	108.36
0.5 gm/L		233.15	191.83	58.46	45.90	136.99	113.70
1.0 gm/L		240.16	196.46	61.93	47.84	144.33	118.99
1.5 gm/L		245.65	202.73	63.55	49.95	150.50	124.51
$LSD_{0.05}$		2.25	2.48	0.58	0.85	1.73	1.69
Effect of organic manure sources X potassium humate rates							
Control	Control	196.73	159.15	43.95	35.00	114.00	92.65
	0.5 gm/L	197.46	161.69	43.96	35.65	114.72	95.34
	1.0 gm/L	205.93	161.67	48.64	36.26	120.83	96.36
	1.5 gm/L	209.48	168.56	49.40	38.49	123.45	100.83
FYM	Control	214.00	172.42	52.23	39.36	123.55	99.43
	0.5 gm/L	217.46	179.64	53.26	41.50	127.75	106.04
	1.0 gm/L	223.54	184.70	57.24	42.80	134.69	112.28
	1.5 gm/L	229.47	190.86	58.74	45.22	142.39	118.25
Compost	Control	239.28	194.36	59.82	46.49	136.96	113.00
	0.5 gm/L	247.13	201.76	64.12	48.53	146.51	120.39
	1.0 gm/L	255.03	208.01	66.87	50.89	154.13	126.51
	1.5 gm/L	260.92	213.89	68.72	52.53	161.26	131.63
Chicken manure	Control	264.07	219.60	70.38	55.56	153.17	128.37
	0.5 gm/L	270.55	224.21	72.52	57.94	158.98	133.02
	1.0 gm/L	276.12	231.48	74.98	61.40	167.66	140.82
	1.5 gm/L	282.73	237.60	77.32	63.54	174.90	147.33
$LSD_{0.05}$		4.49	4.96	1.16	1.70	3.47	3.38

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استجابة نباتات الفلفل الحلو الى التسميد العضوى وهيومات البوتاسيوم

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أجريت تجربتان حقليتان خلال الموسم الصيفى لعامى 2011 و 2012 في مزرعة خاصة بقرية النجع منطقة القصاصين، محافظة الاسماعيلية لدراسة تأثير مصادر التسميد العضوى (كنترول، سماد بلدى، سماد كمبوسست، سماد دواجن) ومعدلات من هيومات البوتاسيوم (كنترول، 0.5 ، 1.0، 1.5 جم/لتر) ومختلف معاملات التفاعل بينهم على النمو والمحصول ومكوناته والمحتوى المعدنى لثمار الفلفل الحلو صنف ماركونى.

وقد تركزت أهم النتائج فيما يلى:

1- أدى التسميد العضوى إلى زيادة نمو النبات والمحصول ومكوناته وتحسن محتوى ثمار الفلفل من العناصر الغذائية والبروتين الكلى مقارنة بمعاملة الكنترول (بدون تسميد عضوى)... وقد تحققت أعلى القيم بالنسبة لجميع المقاييس السابقة عند التسميد بسماد الدواجن بمعدل 10 م^3/فدان تلاه التسميد بالكمبوست ثم السماد البلدى بمعدل 20 م^3/فدان لأى منهما.

2- أدى رش نباتات الفلفل الحلو بهيومات البوتاسيوم بمعدل 1.5 جم/لتر إلى زيادة معنوية فى النمو الخضرى والمحصول ومكوناته ومحتوى ثمار الفلفل من العناصر الغذائية والبروتين الكلى مقارنة بمعاملة الكنترول وباقى المعدلات الأخرى المضافة من هيومات البوتاسيوم.

وعلية يمكن التوصية بتسميد نباتات الفلفل الحلو بسماد الدواجن بمعدل 10 م^3/فدان مع الرش بهيومات البوتاسيوم بمعدل 1.5 جم/لتر للحصول على أعلى القيم لجميع مقاييس النمو الخضرى والمحصول ومكوناته وأفضل محتوى للثمار من العناصر الغذائية والبروتين الكلى مقارنة بباقى المعاملات المختبرة.