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POULTRY MANURE AND HUMIC ACID FOLIAR APPLICATIONS IMPACT ON CARAWAY PLANTS GROWN ON A CLAY LOAM.

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ABSTRACT

A field experiment was conducted at the Experimental Farm, Fac. of Agric., Al-Azhar Uni., Assiut, Egypt during two successive winter seasons of 2013/14 and 2014/15 to study the effect of poultry manure application (PM) and foliar application of humic acid (HA) on caraway plants growth and its yield constituents as well as some soil properties. Split plot design with three replicates was used. Four levels of PM (0, 10, 20 and 30 m^3/fed) that were side banded in one dose before sowing and the recommended dose (RD) of NPK fertilizers were assigned to the main plots. Four humic acid levels (0, 1, 2 and 3 ml/L) as foliar application were allocated to the sub- plots.

The results indicated that poultry manure, humic acid and recommended NPK dose treatments significantly increased vegetative traits (plant height, number of branches, and dry weight) of Caraway plants compared to untreated ones and could be arranged due to these increases in the order of poultry manure > recommended dose > humic acid. The highest values of vegetative traits, fruit and volatile oil yields in both season were recorded at highest level of both PM and HA (PM3HA3) followed by the recommended NPK dose with the highest level of HA (RDHA3) and then at the highest level of PM with the medium level of HA (PM3HA2). Moreover, poultry manure application, foliar application of humic acid and the recommended NPK dose significantly increased N, P, K, Fe, Mn and Cu contents of Caraway plants. Increasing the applied level of poultry manure or humic acid showed a positive effect on the soil organic matter content. The soil salinity (EC) were positively affected with using these studied materials since the EC of the soil increased with all treatments. On the other hand, the application of poultry manure or humic acid had a negative effect on the soil pH.

Keywords: Poultry manure, Foliar application, Humic acid, Caraway plants, Soil properties Macro-micronutrients

INTRODUCTION

Aromatic plants containing volatile oils represent an important source of the national income of Egypt for local consumption and export. One of the most important plants containing a volatile oil is caraway fruit (Carumcarvi, L.). Its oil is used medicinally as carminatives, mild stomachic, antispasmodic, as a tonic in the treatment digestive disorders(Valero & Giner, 2006). Medicinal and aromatic plants are used by 80% of global population for their medicinal therapeutic effects (WHO, 2008).Chemical fertilizer applications have significantly contributed to the huge increase in the world food production. The adverse impacts of excessive inputs of these fertilizers in conventional agricultural practices are well documented. Recently, unconventional efforts are used to minimize the amounts of chemical fertilizers used for medicinal and aromatic plants in order to reduce the production cost and environmental pollution without yield reduction (Abdalla et al., 2001; Ali et al., 2001 and El-Sanafawi, 2006). The indiscriminate use of mineral fertilizers without carrying out a soil test is another major problem that, adversely affects the soil chemical and physical properties causing soil nutrient imbalance (Ojeniyi, 2002 ; Nottidge et al, 2005 ; Mbah and Mbagwu, 2006).

The application of organic fertilizers resulted in improvement in the growth and yield of different vegetable and ornamental crops. So, the application of these fertilizers to grow the medicinal and aromatic plants should not only be considered as a simple objective to gain short term benefits, but also a tool to improve soil properties and overcome the mineral fertilizer environmental problems. Organic fertilizers such as poultry, chicken and cattle manure play an important role in the growth and chemical constituents of many medicinal and aromatic plants manures (Dauda et al., 2008; Banerjee et al., 2011 ; Garai et al., 2014).

There is a recognized, increasing use of humic acids for growing vegetable and non- vegetable crops, citrus, turf and flowers due to their beneficial impact on the growth of these plants particularly in organically-deficient soils. Humic acid benefits include: organic matter addition to organically-deficient soils, root vitality increase, nutrient uptake improved, fertilizer retention increase, microbial activity stimulate and healthy plants and improved yields (Graves et al., 2004 ; Mikkelsen, 2005; Ameri and Tehrainifar 2012). The application of humic acid caused a significant dry matter yield of durum wheat with respect to untreated plots. Also, humic acid application had significant effect on Mg, Fe and Mn uptake. Application of humic acid at 0.1 % raised the dry weight and N, P, K, Ca, Mg, Na, Fe, Cu, Zn and Mn uptake by plants and humic acid at 0.2% was more effective on dry weight and nitrogen uptake at high lime conditions (El Etr et al., 2004; Delfine et al., 2005 and Radwan et al., 2015).

This study aims to investigate effects of poultry manure application (PM) and foliar application of humic acid (HA) on some vegetative traits, fruit and oil yields and macro and micronutrients of caraway plants grown on a clay loam soil..

MATERIALS AND METHODS

A field experiment was conducted at the Experimental Farm, Fac. of Agric., Al-Azhar Uni., Assiut, Egypt during two successive winter seasons of 2013/2014 and 2014/2015 to study the impact of poultry manure and humic acid foliar applications on caraway grown on a clay loam. The experiment was designed as a split plot with three replicates. Some soil physical and chemical properties of the experimental site are presented in Table 1. Four levels of poultry manure (PM) (0, 10, 20 and 30 m^3/fed) were side banded in one dose before sowing and the NPK recommended dose

(RD) for caraway plants (200 kg/ fed of ammonium sulphate and calcium super phosphate as well as 50 kg potassium sulphate/ fed.) were assigned in the main plots. The chemical analysis of poultry manure is shown in Table 2. Four foliar application levels of 0, 1, 2 and 3 ml/L humic acid (as Mega power-x, contain 19% humic acid) sprayed twice (45 and 60 days from sowing) were allocated to the sub- plots. Each plot has an area of 3.6 in length × 3.2 in width m^2 and includes 6 rows with 60 cm apart; each row containes five hills at 40 cm distance in one side.

Caraway (Carumcarvi L) seeds were sown on the 30th of October in both seasons. After eight weeks, the plants were thinned to one seedling/ hill. Other agricultural practices for caraway production were conducted according to the recommendation of Agriculture Ministry. At the harvest time (on the 15th and 7th of April for the first and second seasons, respectively), the plants were cut at the soil surface, washed with distilled water and oven-dried at 70 C^o. The dried plant materials were ground using a mill and kept for plant analysis.

Table (1). Some physical and chemical properties of the studied soil.

Particles size distribution (%)			Texture	OM	$CaCO_3$	Available nutrient (mg/kg)		
Sand	Silt	Clay	Clay loam	(%)	(%)	N	P	K
25.65	38.8	35.55		0.7	2.25	70.5	8.9	289
pH (1: 2.5)	EC_e (dS/m)	Soluble ions meq/L						
		K	Ca	Mg	Na	Cl	HCO_3	SO_4
7.7	0.9	0.5	2.6	1.12	5.34	1.25	2.50	5.81

Table (2). Chemical analysis of the used poultry manure

PH (1: 2.5)	EC (dS/m)	OM (%)	C / N	Macronutrient (%)			Micronutrient (mg/kg)		
				N	P	K	Fe	Mn	Cu
6.8	3.2	32.8	12	3.1	1.5	2.6	1144	362	44

Caraway traits like plant height, number of branches, herb dry weight, and the fruit yield/ fed were measured at the time of harvest. Volatile oil in the caraway seeds was determined according to Guenther (1961). Plant samples of 0.2g were digested according to Parkinson and Allen (1975). Total N was in the digests determined according to Jackson (1967). Phosphorus was determined colorimetrically by the vanado-molybdate method and K was determined by flame photometer, while Fe, Mn and Cu were determined according to Jackson (1973) using the atomic absorption.

Soil pH was measured in a 1: 2.5 of soil to water suspensions using a glass electrode (McLean, 1982).The electrical conductivity (EC) was estimated in a soil paste extract using the salt bridge method (Rhoades, 1982). Soil organic matter was determined using Walkley and Black method according to Jackson (1973). The obtained data were statistically analyzed according to the least significant difference (L.S.D) method to test the difference between the treatment means as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Vegetative Traits

In general, the results indicated that the poultry manure application, the foliar application of humic acid and the recommended NPK dose significantly increased the plant height, number of branches, and the dry weight of Caraway plants compared to the untreated plants (Table 3). On average basis of the two seasons, the highest applied level of PM realized values of 114.28 cm and 12.22 for plant height and number of branches, respectively, regardless the humic acid effect. Also, the highest level of humic acid recorded values of 108.06 cm and 11.95 for both respective parameters regardless the PM effect. The recorded respective values of plant height and number of branches under the recommended NPK dose were 116.0 cm and 12.30 when the plants were treated with 3 ml/ L of humic acid. Vegetative increases of these parameters obtained in the poultry manure amended plots might be due to the improved soil properties and nutrient status. Zakaria and Vimala (2002) observed higher lettuce and tomato growth when the soil was treated by chicken manure than that treated with the inorganic fertilizer.

In addition, on the average basis of two the growth seasons, both poultry manure and humic acid foliar applications at the highest level, recorded herb dry weight values of 22.26 and 21.86 g/plant, respectively, while its value was 21.08 g/plant using the recommended NPK dose with the highest level of humic acid. The results showed also that the positive effect of the applied materials (organic and mineral fertilizers) and growth improver on these vegetative traits could be arranged in the order of poultry manure > recommended NPK dose > humic acid. These results may be attributed to the ability of poultry manure to supply nutrients and organic matter to the soil as well as to improve some soil properties. This finding is in an agreement with those of Salako (2008), Ayeni *et al.* (2008) and Adeleye *et al.* (2010) which the plots that were amended with poultry manure produced the highest grain yield of maize compared to other treatments.

It is clear that the vegetative traits positively responded faster for the humic acid treated plants than the untreated ones. This response action may be referred to the favorable effect of humic acid in improving the

early plant growth and increasing the dry matter accumulation in caraway plants. These results well agree with those obtained by Serenella *et al.* (2002), Zandanadi *et al.* (2007) and Rahmat *et al.* (2010). Concerning the interaction effect of the used materials, the vegetative traits (plant height, branches number/ plant and herb dry weight) showed the highest values under PM3HA3 treatment followed by RDHA3 and then PM3HA2 treatment in both seasons (Table 3).

Table (3). The effect of poultry manure, recommended NPK dose and foliar application of humic acid on some vegetative traits of Caraway plants in two successive seasons.

Main plot treatment (A)		Sub plot treatment (B)									
		First season					Second season				
		Plant height (cm)									
		HA0	HA1	HA2	HA3	Mean	HA0	HA1	HA2	HA3	Mean
Poultry manure	PM0	86.67	88.00	89.00	92.33	89.78	88.00	89.00	90.00	95.99	91.66
	PM1	87.67	89.00	90.33	94.67	91.33	88.00	89.33	90.33	95.33	91.66
	PM2	105.00	106.00	107.00	110.33	107.78	106.00	107.33	109.00	113.33	109.89
	PM3	108.33	110.00	113.00	116.00	113.00	109.67	112.00	116.00	118.67	115.56
Mean		100.33	101.67	103.44	107.00	104.04	101.22	102.89	105.11	109.11	105.70
RD		107.00	108.67	112.00	114.67	110.59	108.67	110.67	114.67	117.33	112.84
LSD at 0.05		A: 3.651		B: 0.468		AB: 1.048	A: 2.106		B: 0.672	AB: 1.502	
Number of braches/ plant											
Poultry manure	PM0	6.73	7.17	7.70	8.17	7.68	5.67	6.40	6.83	7.57	6.93
	PM1	6.33	9.00	9.73	11.40	10.04	7.17	9.70	10.23	10.83	10.25
	PM2	7.33	8.00	10.00	10.73	9.58	8.23	9.67	10.67	11.67	10.67
	PM3	9.50	11.23	12.00	13.33	12.19	9.97	11.03	12.00	13.73	12.25
Mean		7.72	9.41	10.58	11.82	10.60	8.46	10.13	10.97	12.08	11.06
RD		8.50	9.83	10.73	12.33	10.35	10.40	11.27	11.90	12.27	11.46
LSD at 0.05		A: 1.881		B: 0.758		AB: NS	A: 0.801		B: 0.355	AB: 0.793	
Herb dry weight (g/plant)											
Poultry manure	PM0	15.03	15.43	16.13	17.23	15.96	14.72	15.52	16.22	17.32	15.95
	PM1	18.13	18.43	19.03	19.53	18.78	18.22	18.52	19.12	19.62	18.87
	PM2	18.43	19.83	20.73	22.33	20.33	18.52	19.92	20.82	22.42	20.42
	PM3	20.13	22.03	23.13	23.53	22.21	20.22	22.12	23.22	23.72	22.32
Mean		18.90	20.10	20.96	21.80	20.44	18.99	20.19	21.05	21.92	20.54
RD		18.53	19.73	20.43	21.03	19.93	18.62	19.82	20.52	21.12	20.02
LSD at 0.05		A: 0.07		B: 0.06		AB: 0.13	A: 0.09		B: 0.07	AB: 0.15	

HA = humic acid RD = recommended dose

2. Fruit and Volatile Oil Yields

Fruit yield (Kg/fed) and volatile oil yield (L/fed) of Caraway plants are present in Table 4. The results generally revealed that poultry manure application, the foliar application of humic acid and the recommended NPK dose treatments significantly increased both fruit and volatile oil yields of caraway plants compared to those obtained from the untreated ones. Moreover, increasing the applied level of poultry manure or humic acid realized a positive effect on fruit and volatile oil yields. On the average basis of both growth seasons, the fruit yield was 732.01 kg/ fed at the highest applied level of PM regardless the humic acid effect. It was 668.77 kg/ fed at the highest applied level of HA regardless the PM effect. The RD treatment realized a value of 740.81 kg/ fed of fruit yield at the highest level of HA. The best treatment achieved the highest fruit yield (776.36 kg/ fed) was for the plants that received the highest level of both PM and HA. The results showed that the positive effect of these applied materials on caraway fruit yield could be arranged in the order of poultry manure > recommended NPK dose > humic acid. Caraway fruit yield positively responded faster for the plants treated with humic acid up to 2ml /L than for the untreated ones. The same trend was observed for the volatile oil yield. The highest yield of volatile oil (16.11 L/ fed) was recorded for PM3HA3 treatment followed by (14.67 L/ fed) RDHA3 treatment and then PM3HA2 treatment (13.64 L/ fed). This results coincide with those obtained by Tripath, et al (2011) who reported that caraway plants treated with farm yard manure and sulfur showed a significant, higher oil content than those treated with sulfur alone.

Table (4). The effect of poultry manure, recommended NPK dose and foliar application of humic acid on some vegetative traits of Caraway plants in two successive seasons.

Main plot treatment (A)		Sub plot treatment (B)									
		First season					Second season				
		Fruit yield (kg/fed)									
		HA0	HA1	HA2	HA3	Mean	HA0	HA1	HA2	HA3	Mean
Poultry manure	PM0	484.43	498.31	516.09	531.64	515.35	497.20	516.09	531.64	555.53	534.42
	PM1	522.20	544.42	569.42	581.65	565.16	548.31	567.76	581.64	610.53	586.64
	PM2	545.53	578.87	611.09	636.08	608.68	556.65	588.87	609.42	631.64	609.98
	PM3	631.64	656.64	736.08	763.86	718.86	673.31	702.75	743.86	788.86	745.15
Mean		566.46	593.31	638.86	660.53	630.90	592.76	619.79	644.97	677.01	647.26
RD		620.53	645.53	691.64	730.53	689.23	637.20	659.97	693.86	751.08	701.64
LSD at 0.05		A: 20.194		B: 0.6.79		AB: 15.184	A: 25.17		B: 9.484		AB: 21.208
Volatile oil yield (L/fed)											
Poultry manure	PM0	7.38	7.71	8.06	8.42	8.06	7.74	8.14	8.45	8.94	8.51
	PM1	8.15	8.62	9.12	9.43	9.06	8.71	9.11	9.46	10.02	9.53
	PM2	8.74	9.38	10.20	10.78	10.12	9.02	9.73	10.31	10.87	10.30
	PM3	10.60	11.37	13.43	15.69	13.50	11.46	12.39	13.84	16.53	14.25
Mean		9.16	9.79	10.92	11.96	10.89	9.73	10.41	11.21	12.47	11.36
RD		11.27	11.82	13.24	14.62	13.23	11.86	12.48	13.85	14.72	13.68
LSD at 0.05		A: 0.419		B: 0.252		AB:0.564	A: 0.438		B: 0.293		AB: 0.656

HA = humic acid **RD = recommended dose**

Nutrient Content of Caraway Plants.

Nitrogen, phosphorus and potassium contents

In general, poultry manure, humic acid and the recommended NPK dose treatments significantly increased nitrogen (N), phosphorus (P) and potassium (K) contents of Caraway plants (Table 5). Increasing the applied level of poultry manure and humic acid led to increases in N, P and K nutrient contents of these plants. The maximum increases in N, P and K in caraway plants were obtained when these plants received the highest level of poultry manure and/or humic acid in both seasons. On the average basis of both seasons, the highest N content (2.00 %) was found with PM3HA3 treatment followed by PM3HA2 treatment (1.89 %) and then PM3HA1 treatment (1.79 %). Poultry manure has relatively high contents of macro nutrient which are reflected on the yield and their components. Similar results were obtained by Awad (2001) found that the application of farmyard manure was more effective than the other treatments in increasing nitrogen, phosphorus and potassium contents and their uptake in the tomato plants grown in a clay soil. The recommended NPK dose (RD) treatment alone and with humic acid showed a slight increase in plant N content compared with the untreated plants. On the average basis of both seasons, the highest P and K contents (1.06 and 1.63%, respectively) were realized in caraway plant treated with PM3HA3 followed by PM3HA2 treatment (0.94 and 1.57 %, respectively) and then PM3HA1 treatment (0.91 and 1.55 %, respectively).

It is obvious that the positive effect of the investigated organic and inorganic materials on N, P and K contents of caraway plants could be arranged in the order of poultry manure > humic acid > recommended NPK dose.

Table (5). The effect of poultry manure, recommended NPK dose and foliar application of humic acid on N, P and K contents of Caraway plants in two successive seasons.

Main plot treatment (A)		Sub plot treatment (B)									
		First season					Second season				
		Nitrogen (%)									
		HA0	HA1	HA2	HA3	Mean	HA0	HA1	HA2	HA3	Mean
Poultry manure	PM0	0.98	1.12	1.15	1.16	1.14	0.98	1.13	1.16	1.16	1.15
	PM1	1.36	1.42	1.48	1.54	1.48	1.39	1.43	1.49	1.55	1.49
	PM2	1.45	1.55	1.57	1.69	1.60	1.47	1.54	1.57	1.68	1.60
	PM3	1.68	1.77	1.88	2.00	1.88	1.66	1.81	1.90	2.01	1.90
Mean		1.49	1.58	1.64	1.74	1.66	1.51	1.59	1.65	1.75	1.66
RD		1.20	1.26	1.31	1.35	1.31	1.21	1.29	1.33	1.39	1.33
LSD at 0.05		A: 017		B: 0.023	AB: 0.051		A: 0.033		B: 0.031	AB: 0.070	
Phsphrous (%)											
Poultry manure	PM0	0.10	0.12	0.25	0.30	0.22	0.11	0.12	0.26	0.32	0.23
	PM1	0.52	0.54	0.56	0.58	0.56	0.53	0.54	0.56	0.60	0.57
	PM2	0.68	0.77	0.79	0.85	0.80	0.67	0.78	0.80	0.85	0.81
	PM3	0.88	0.90	0.94	1.05	0.96	0.89	0.91	0.94	1.07	0.97
Mean		0.69	0.73	0.76	0.83	0.78	0.70	0.74	0.76	0.84	0.78
RD		0.53	0.60	0.72	0.88	0.74	0.53	0.61	0.74	0.88	0.74
LSD at 0.05		A: 0.020		B: 0.015	AB: 0.033		A: 0.019		B: 0.018	AB: 0.041	
Potassum (%)											
Poultry manure	PM0	0.93	0.98	1.10	1.16	1.08	0.91	0.95	1.01	1.07	1.01
	PM1	1.31	1.32	1.42	1.53	1.42	1.19	1.23	1.30	1.44	1.33
	PM2	1.56	1.57	1.57	1.59	1.58	1.41	1.52	1.55	1.58	1.55
	PM3	1.55	1.59	1.61	1.67	1.62	1.46	1.50	1.52	1.58	1.54
Mean		1.47	1.49	1.53	1.60	1.54	1.35	1.42	1.46	1.53	1.47
RD		1.20	1.24	1.25	1.30	1.26	1.11	1.15	1.20	1.18	1.18
LSD at 0.05		A: 0.078		B: 0.018	AB: 0.041		A: 0.155		B: 0.043	AB: NS	

HA = humic acid RD = recommended dose

Iron, manganese and copper contents

The influence of the used organic and inorganic materials on iron (Fe) , manganese (Mn) and copper (Cu) contents of caraway plants is present in Tables 6. In general, poultry manure, foliar humic acid and the recommended NPK dose treatments significantly increased Fe, Mn and Cu contents of Caraway plants. The highest applied level of poultry manure increased Fe, Mn and Cu concentrations in the plants more than the level of other used materials. Based on the average of both seasons, the highest level of PM increased Fe, Mn and Cu concentration in the plants by 159.78, 41.73 and 31.90 %, respectively, compared to the untreated plants. Organic manure applications, cause a soil pH decrease which in turn increase the solubility of soil micronutrients and their uptakes by plants. In some cases, organic materials may act as a low release fertilizer of a high content of some nutrients. The positive effects of organic fertilizers on plant growth and crop production could be attributed to their contribution in increasing the extractable levels of N, P, K, Fe, Zn and Mn. This effect may minimize the used amounts of chemical fertilizers and improve their application efficiency and subsequently avoiding the environmental pollution (El-Karamany et al., 2000).

Concentrations of Fe, Mn and Cu in the plant also increased by 61.41, 12.73 and 9.04%, respectively, at the highest applied level of HA compared to the untreated plants. Humic acid may enhance plant growth, improve root development, induce active biological conditions and enhance activities of micro-organisms leading to increases in the micronutrient availability. These results are consistent with those obtained by Graves et al., (2004) and Mikkelsen, (2005) who found that humic acid additions enhanced plant growth, improved root development and led to increased micronutrient availability, especially iron (Fe) and zinc (Zn). Also, Ameri and Tehrainifar (2012) reported that the humic acid was effective in the evapotranspiration, gas exchange and leaf uptake of nutrients. The RD treatment caused increases in Fe, Mn and Cu concentrations in the plants by 65.39, 21.38 and 14.85%, respectively, compared to the untreated ones. The micronutrient increases as a result of using the investigated fertilizer materials followed the order of iron > manganese > cupper.

As averages of both growth seasons, the highest Fe content of caraway plants (1236.17 mg/ kg) was found for PM3HA3 treatment followed by PM3HA2 treatment (1212.17 mg/ kg) and then PM3HA1 treatment (1182.10 mg/ kg). Caraway plants positively responded to the foliar application of humic acid at a low concentration (1ml / L) and with increasing the applied level of HA supported the positive effect of poultry manure. The recommended NPK dose (RD) treatment showed a slight increase in the plant Fe content compared to the untreated plants. Foliar application of humic acid also slightly enhanced the plant Fe content with RD treatment.

Table (6). The effect of poultry manure, recommended NPK dose and foliar application of humic acid on Fe, Mn and Cu contents of Caraway plants in two successive seasons.

Main plot treatment (A)		Sub plot treatment (B)									
		First season					Second season				
		Fe (mg/kg)									
		HA0	HA1	HA2	HA3	Mean	HA0	HA1	HA2	HA3	Mean
Poultry manure	PM0	442.53	565.03	657.53	712.53	645.03	436.80	559.30	651.80	706.80	639.30
	PM1	934.30	1049.30	1071.80	1077.53	1066.21	792.37	802.37	940.03	1055.03	932.48
	PM2	995.03	1090.03	1095.03	1120.03	1101.70	989.17	1084.17	1089.17	1114.17	1095.83
	PM3	1145.03	1185.03	1215.03	1239.03	1213.03	1139.30	1179.17	1209.30	1233.30	1207.26
Mean		1024.79	1108.12	1127.29	1145.53	1126.98	973.61	1021.90	1079.50	1134.17	1078.52
RD		730.03	752.37	787.17	796.80	778.78	724.30	746.80	781.50	786.50	771.60
LSD at 0.05		A: 0.183		B: 0.076	AB: 0.170		A: 0.232		B: 0.121	AB: 0.270	
Mn (mg/kg)											
Poultry manure	PM0	91.35	93.52	106.02	108.68	102.74	92.36	94.53	108.03	110.53	104.36
	PM1	118.18	118.68	120.85	123.35	120.96	120.53	120.53	123.03	125.53	123.03
	PM2	125.65	126.35	127.02	129.35	127.57	128.00	128.03	128.15	130.50	128.89
	PM3	130.02	132.95	137.04	143.28	137.76	130.36	132.90	137.90	145.40	138.73
Mean		124.62	125.99	128.30	131.99	128.76	126.30	127.15	129.70	133.81	130.22
RD		110.68	112.35	114.02	115.04	113.80	112.32	113.02	113.48	113.67	113.39
LSD at 0.05		A: 1.013		B: 0.443	AB:990		A: 0.874		B: 0.412	AB: 0.922	
Cu (mg/kg)											
Poultry manure	PM0	90.50	92.67	101.17	102.33	98.72	91.33	93.50	102.00	103.17	99.56
	PM1	107.50	111.00	113.17	113.50	112.56	108.33	111.83	114.00	114.33	113.39
	PM2	114.17	115.17	116.83	118.00	116.67	115.00	116.00	117.67	118.83	117.50
	PM3	119.50	121.17	122.50	124.00	122.56	120.33	122.00	123.33	124.83	123.39
Mean		113.72	115.78	117.50	118.50	117.26	114.56	116.61	118.33	119.33	118.09
RD		104.00	104.83	107.83	108.83	107.17	104.83	105.67	108.67	109.67	108.00
LSD at 0.05		A: 2.778		B: 1.132	AB:2.53		A:2.778		B: 1.132	AB: 2.53	

HA = humic acid **RD = recommended dose**

The positive effect of added investigated materials on plant Fe content could be arranged in the order of humic acid > poultry manure > recommended NPK dose. A similar trend was observed for plant Mn and Cu contents as affected by the added investigated materials. As averages of both growth seasons, the highest Mn and Cu content of caraway plants (144.34 and 124.42 mg/ kg, respectively) were recorded for PM3HA3 treatment followed by PM3HA2 treatment (137.47 and 122.92 mg/ kg) and then PM3HA1 treatment (132.93 and 121.58 mg/ kg).

Some Soil Properties

It is well known that the soil property evaluation is of a great concern whenever organic materials are examined. In general, the poultry manure application, foliar application of humic acid and the recommended NPK dose significantly increased the soil organic matter content (Fig. 1).

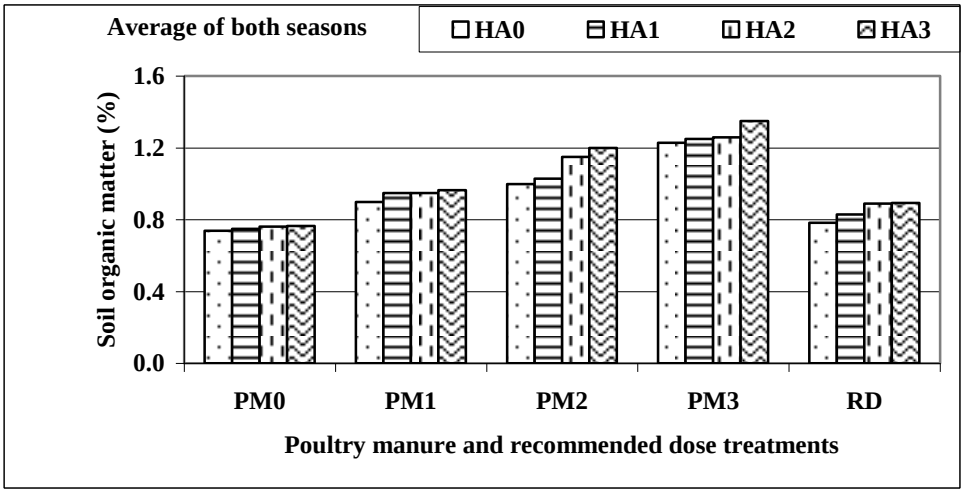

Fig. (1). The effect of poultry manure, recommended NPK dose and foliar application of humic acid on the soil organic matter content.

Increasing the applied level of poultry manure or humic acid showed a positive effect on the soil organic matter (SOM) content. On an average basis of both seasons, the SOM content was 1.29 % at the highest

level of PM regardless the humic acid effect while it was 1.17 % at the highest level of HA regardless the PM effect. The RD treatment gave a value of 0.89% of the SOM content at the highest level of HA. The best treatment achieved the highest value of the SOM content (1.35%) was that received the highest level of both PM and HA. It was noticed that the RD showed slight changes on the SOM content compared to the untreated soil (Fig. 1). The SOM content was more pronounced with using PM treatment than other treatments. These results are compatible with those obtained by Awad (2007) who reported that the soil organic matter content increased with treating soils with EDTA, vinase, poultry litter extract and humic acid.

The soil salinity (EC) was positively affected with using the investigated organic and inorganic materials (Fig.2). The poultry manure application could cause a hazardous salinity effect while the foliar application of HA or RD treatments showed a slight increase in the soil salinity. The highest soil salinity (EC =1.49 dS/m) was attained in the soil treated with the highest level of both PM and HA while the lowest one was recorded with PM0HA1 treatment. It should be mentioned that although the investigated materials increased the soil salinity but the soil is still non saline. Chouliaras and Gemtos (2002), Subash et al., (2002) and Awad (2007) reported that the high load of organic material applications which contain high salts might increase the salinity of the soil.

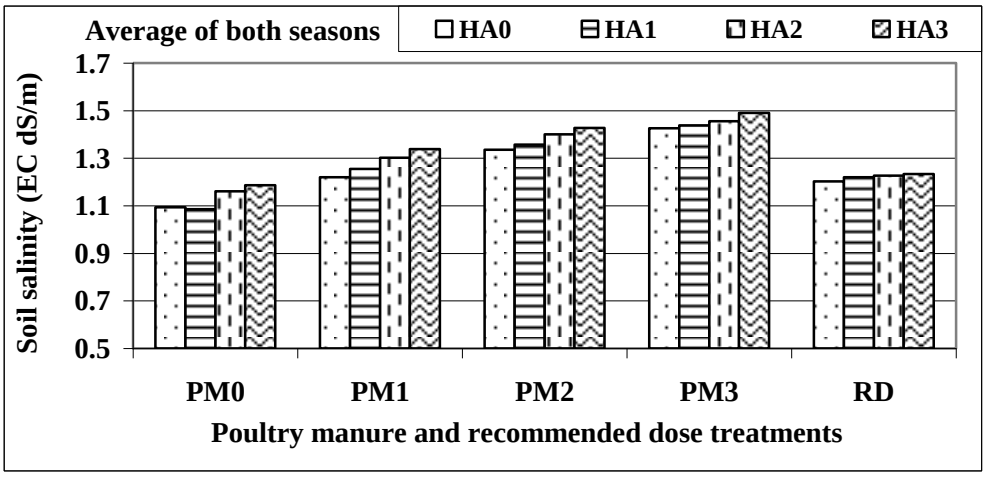

Fig. (2). The effect of poultry manure, recommended NPK dose and foliar application of humic acid on the soil salinity (EC, dS/m).

The results generally revealed that all used fertilizer materials significantly decreased the of soil reaction (pH) compared to that of the untreated soil (Fig. 3). Moreover, increasing the applied level of poultry manure or humic acid gave a negative effect on the soil pH. As an average of both growth seasons, the soil pH was 7.13 at the highest applied level of PM regardless the humic acid effect while it was 7.22 at the high level of HA regardless the PM effect. The RD treatment showed a pH value of 7.35 at the highest level of HA. The best treatment that achieved the lowest soil pH value (7.09) was the addition of both PM and HA at the highest level (Fig.3). Awad (2007) reported that the soil pH was reduced after treating different soils with EDTA, vinase, poultry litter extract and humic acid.

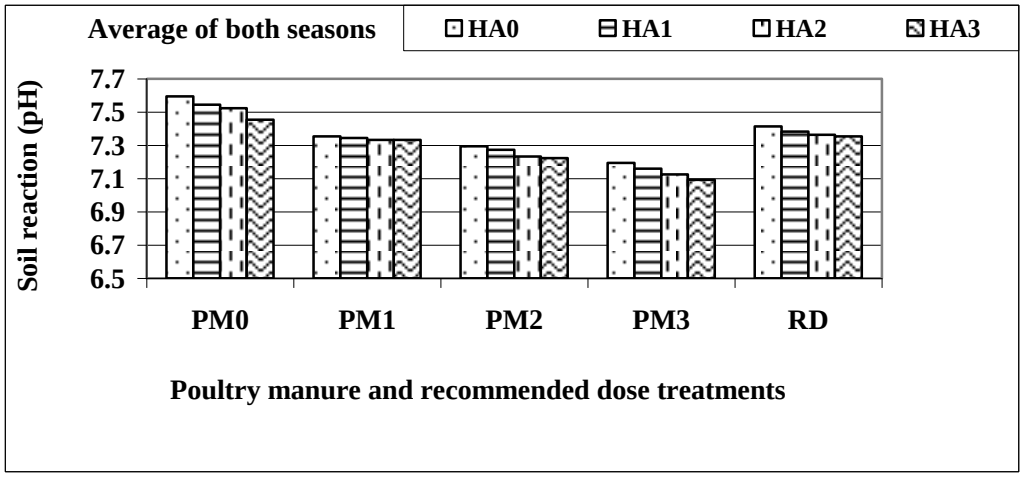

Fig. (3). The effect of poultry manure, recommended NPK dose and foliar application of humic acid on the soil reaction (pH)

CONCLUSION

It could be concluded that the application of poultry manure realized a positive effect on both soil organic matter and salinity but a negative effect on soil pH. The use of poultry manure ensures the stability of soil structure improves the soil organic matter status and nutrient availability as well as produces a high crop yield. Also, the poultry manure could be considered a good source of plant nutrients and reduce the used amount of mineral fertilizers. Moreover, the foliar application of humic acid could improve the early plant growth and increase the dry matter accumulation of the grown plants. Increasing the foliar application level of humic acid can also support the positive effect of poultry manure.

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تأثير سماد الدواجن والرش الورقى بحامض الهيوميك على نباتات الكراوية النامية على تربة طميية طينية

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أجريت تجربة حقلية في المزرعة البحثية بكلية الزراعة - جامعة الأزهر- أسيوط - مصر خلال موسمى النمو 2014/2013 2015/2014 لدراسة أثر إضافة سماد الدواجن والرش بحامض الهيوميك كمواد عضوية مع المقارنة بالموصى به من الأسمدة الكيمائية (نتروجين, فوسفور, بوتاسيوم) والكنترول على نمو نباتات الكراوية ومكونات المحصول وكذلك على بعض الخواص الكيميائية للتربة. تم تصميم التجربة في قطع منشقة مع ثلاث مكررات. وأضيف سماد الدواجن عند مستويات صفر, 10, 20 ,30 م3 /فدان كجرعة واحدة قبل الزراعة مع إضافة الجرعة الموصى من NPK على صورة معدنية كمعاملات رئيسية. كما تم رش النباتات بحامض الهيوميك عند مستويات 0، 1، 2 و 3 مل / لتر كمعاملات ثانوية.

أشارت النتائج إلى أن معاملة سماد الدواجن وحامض الهيوميك والجرعة الموصى بها من NPK أدت الى زيادة معنوية فى الصفات الخضرية (طول النبات، وعدد الأفرع، والوزن الجاف) لنباتات الكراوية مقارنة بالنباتات غير المعاملة (الكنترول)، كما يمكن ترتيب المعاملات تبعاً لتاثيرها على هذه الصفات الخضرية كما يلى: سماد الدواجن > الجرعة الموصى بها > حامض الهيوميك.

إزداد محصولي الثمار والزيت معنويا بإضافة المعاملات المختلفة وكانت أعلى زيادة من هذه المحصولية عند إضافة المستوى الأعلى لكل من سماد سماد الدواجن وحامض الهيوميك (PM3HA3) تلاه قيمة المحصولية عند إضافة المستوى الأعلى من سماد الدواجن مع المستوى المتوسط من حامض الهيوميك (PM3HA2) وذلك في كلا موسمى النمو.

أدى إضافة سماد الدواجن والرش بحامض الهيوميك الى زيادة محتوى النباتات من النتروجين, والفوسفور, والبوتاسيوم والحديد والمنجنيز والنحاس مقارنة بالكنترول . كما كان لزيادة مستوى إضافة سماد الدواجن أو حمض الهيوميك أثر إيجابي على محتوى التربة من المادة العضوية. وتأثرت قيم ملوحة التربة ايجابياً بإضافة المواد المستخدمة حيث ارتفعت قيم ال EC للتربة مع جميع المعاملات. بينما كان لزيادة مستوى كلا من سماد الدواجن وحمض الهيوميك اثر سلبى على حموضة التربة.