THE INTEGRATED EFFECT OF SOME ORGANIC MANURES COMBINED WITH EM (EFFECTIVE MICRO-ORGANISMS) ON GROWTH, CHEMICAL COMPOSITION, YIELD AND ITS QUALITY OF WHEAT PLANTS

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ABSTRACT: *Two pot experiments were carried out at the Experimental Farm, Faculty of Agriculture, Minufiya University during 2007/2008 and 2008/2009 seasons. The current study aimed to identify the integrated effect of different sources of organic manures such as farmyard (FYM), chicken (Chi.), pigeon (Pig.), compost (Com.) and humic acid (HA) with effective micro-organisms (EM) on growth characters, chemical composition, yield and its components as well as grain quality of wheat (Triticum aestivum L.) plants. The obtained results showed that, most studied characters of growth, photosynthetic pigments, total soluble sugars, total carbohydrates, total phenols, minerals (N, P, K% and uptake), yield and its components showed a significant increase by the application of organic manures or EM individual or combined compared with control plants. The obtained results indicated also that, using of HA or Com. manure gave the best results compared with other treatments of organic manures. All interaction treatments exerted highly significant influences on all traits under study except for number of leaves and tillers / plant. As for effect of the combined treatments, it was noticed that application of EM in combination with HA gave the best results for all studied characters. Moreover, the best results for harvest index and grain quality (an increase in total carbohydrates and protein with the decrease of total fibers) were obtained from the application of HA + EM. So it could be recommended to use organic fertilizers (HA or Com.) to increase the productivity of wheat crop with good quality especially if combined with EM. This treatment may reduce the needed amounts of chemical fertilizer, its cost and environmental pollution.*

Key words: *Wheat, organic manures, effective micro-organisms, chlorophyll, carbohydrates, phenols, fibers, minerals, yield.*

INTRODUCTION

Wheat is one of the most important cereal crops since, it considered the main food in Egyptian diet. Wheat is normally fertilized with mineral fertilizers, which may have hazardous effect on the environment and induce poor quality. Adaptation and developing a fertilizers management that minimized these adverse effects has a renewed the interest in using of organic manure to supply part or all of plant nutrients needs of subsequent crops (Salah and Abd El-Fattah, 1997). Organic manures serve two purposes in soil, it supplies both macro and micronutrients for plant and microorganisms. It also improves the soil physical condition (Mowafy, 2002). Whalen *et al.* (2000) and Abd El-Nasser and Hussein (2001) concluded that application of the organic manures to the soil increased the available soil nutrients, i.e., N, P, K, Ca, Mg, Fe, Mn, Cu and Zn. Hassan and Mohey El-Din (2002) reported that N, P and K uptake by grains of wheat was increased due to the application of organic manures. Shafeek and El-Habbasha (2000) reported that all organic manures improve the behaviours of several elements in soil through their active group (fluvic and humic acid) which have the ability to retain the elements in a complex or chelate forms and consequently, improve the plant growth and yield quantitatively and qualitatively.

Humic acids have been found to have profound effect on not only the biological activity and soil structure, but also on the plant its self. This is due to positive effect on the increment in plant nutrients and their availability to the growing plants (El-Fakharani, 1999). Nardi *et al.* (1999) attributed the beneficial effect of humic substances on plant growth to its acting as plant growth hormones, since it had a gibberellins like activity, exhibiting higher amounts of phenolic and a considerable amount of carboxyl showed the best metabolic effect.

Micro-organisms technology on growth and developments of plants was suggested by many investigators, such as Cho-Cho-Myint *et al.* (1999) who found that effective micro-organisms, when applied with agriculture hyproducts such as plant residues and farm manures, showed improvement not only in production of some crops, but also in chemical and physical properties of cultivated soil. Moreover, these compounds could be considered as a suitable option for agriculture and production of organic food (Yu *et al.*, 1999). Efficacy of effective micro-organisms is attributed to its role on accelerating the mineralization processes of organic and help nutrient release under temperature conditions and this enhance utility values of organic matter (Yadav, 1999). Hussain *et al.* (1999) found that, application of effective micro-organisms in a long-term experiment, increased significantly the grain and straw yields of wheat. This may be attributed to its positive effect on photosynthesis rate and dry matter accumulation (Nissanka and Sangakkara, 1999).

It is well known that addition of organic manure has shown considerable increase in crop yield and exert significant influence on physical, chemical and biological properties of soil. But its use alone is not sufficient to meet the requirement of nutrients.

The current work aims to identify the integrated effect of some organic manures in combination with effective micro-organisms on growth characters, chemical constituents, yield and its components as well as grain quality of wheat plants.

MATERIALS AND METHODS

Two pot experiments were carried out at the Experimental Farm, Faculty of Agriculture, Minufiya University, Shibin El-Kom during the winter seasons of 2007/2008 and 2008/2009. The study aimed to identify the integrated effect of different sources of organic manures such as farmyard manure (FYM), chicken manure (Chi.), pigeon manure (Pig.), compost manure (Com.) and humic acid (HA) with effective micro-organisms (EM) on growth characters, chemical constituents, yield and its components as well as grain quality of wheat plants.

Grains of wheat (*Triticum aestivum* L.) cultivar Gemmeiza 9 were obtained from the Agriculture Research Center, Giza, Egypt. Ten uniform grains were sown on 15th November, 2007 and 2008 seasons in plastic pots (25 cm inner diameter). Each pot was filled with 6 kg of air dried soil. Forteen days after sowing, the seedlings were thinned to four uniform plants in each pot. Clay soil was used in these experiments, physical and chemical properties were determined according to Jackson (1967), and are given in Table (1).

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

Physical properties		Chemical properties	
Mechanical analysis:		EC (dSm^{-1})	0.62
Sand (%)	15.6	Soluble ions (meq/100 g soil):	
Silt (%)	31.6	HCO_3^-	1.20
Clay (%)	52.8	Cl^-	0.41
Soil texture	Clayey	SO_4^{-2}	1.51
		Na^+	1.50
pH (1 : 2.5)	7.97	K^+	0.32
Organic matter (%)	1.98	Ca^{+2} + Mg^{+2}	1.30
$CaCO_3$ (%)	2.85	Total N (%)	0.12
		Avail. P ($\mu g.g^{-1}$)	0.99

Farmyard, chicken and compost manures were mixed with the soil at the rate of 10 m^3 / fed. (3 g / pot) during pot preparation for cultivation. Pigeon manure at the rate of 5 m^3 / fed. (1.5 g / pot) was thoroughly mixed with the soil two weeks before planting. Humic acid in a solid form as K-kumate, 250 kg/fed. (1.5 g / pot dissolved in water) was applied after two months from planting. Effective micro-organisms solution was added (10 cm/liter) with irrigation water three times, the first dose after 45 days from sowing and the other ones were added every 30 days.

All pots were fertilized with 1.2 g P_2O_5 (200 kg / fed.) as a calcium superphosphate (15.5 % P_2O_5) before planting. N and K were also added in two equal doses at 20 and 55 days from sowing in the form of ammonium nitrate (33% N) and potassium sulphate (48% K_2O) at the rates of 0.9 g N / pot (150 kg / fed.) and 0.6 g K_2O / pot (100 kg / fed.), respectively. Moisture in the soil was kept at field capacity (65% of water holding capacity). The chemical analysis of organic manures is given in Table (2).

Each experiment included 12 treatments of the previous amendments, with six replicates arranged in split-plot design. Organic fertilizers were arranged randomly as a main plot (A), where biofertilizer was distributed as a sub plot (B).

After 96 days from sowing, five plants were randomly selected from each treatment and the following data were recorded:

1. Vegetative growth parameters:

Plant height (cm), numbers of tillers and leaves / plant, leaf area and flag leaf area (cm^2/plant) using the dry weight method according to Aase (1978). Shoots and roots were separated and dried in an electric oven at 70°C for 72 hrs and dry weights were measured in gms.

2. Chemical constituents:

a) Photosynthetic pigments: Ch. a + b and carotenoids were extracted from fresh leaves using acetone 85% and determined according to Moran (1982) then calculated as mg/g dry weight.

b. Total soluble sugars and total carbohydrates: determined in dry shoots using the method described by Dubois *et al.* (1956).

c) Total phenols: estimated in dried shoots following Snell and Snell (1953).

d) Mineral concentration: measured in dried shoots, nitrogen was measured using micro-kjeldahl method (Ling, 1963), phosphorus was determined colourimetrically by the method described by Snell and Snell (1954), potassium was estimated using flamephotometer method described by Chapman and Pratt (1961), then both their concentrations (%) and uptake (mg/plant) were calculated.

3. Yield and its attributes:

At harvest time (150 days after sowing), spikes number and weight (g / plant), spikeletes number / spike, grains number and weight (g / spike), grain yield / plant, weight of 1000 grains (g), straw yield (g / plant) and harvest index (grain yield / grain and straw yields × 100) were recorded.

Table (2): The chemical analysis of the used organic manures.

FYM		Characters	Chicken manure	Nile compost	Humic acid		Pigeon manure	
Characters	Value				Characters	Value	Characters	Value
pH	6.6	Weight of qubic meter (kg)	510	400	Potassium humates (%)	56	Organic matter(%)	45
Ec (dsm)	2.6	Moisture (%)	55	30	Potassium oxide (%)	16.5	pH	6.9
Organic matter (%)	12.4	pH	6.5	8.5	Fe (%)	2.4	Ec (mmhos)	17.6
T.C (%)	7.17	Ec (mmhos)	5.7	5	Mn (%)	1.2	N (%)	4.67
T.N (%)	0.48	Organic carbon (%)	32	41	Zn (%)	0.5	P (%)	0.99
C/N ratio	14.93	Organic matter (%)	26.5	70	Cu (%)	0.6	K (%)	1.8
Avail. P (ppm)	0.41	Total nitrogen (%)	2.95	2	Polymers (%)	0.4	Fe (ppm)	6525
Avail. K. (ppm)	120	C/N ratio	1.11	1.17	Amino acids (%)	3	Mn (ppm)	370
		Total phosphorous (%)	1.14	0.6			Zn (ppm)	140
		Total K (%)	1.8	1.2			Cu (ppm)	50
		Iron (mg / kg)	1.68	7900			Pb (ppm)	7.9
		Manganese (mg / kg)	241	190			Ni (ppm)	6.0
		Copper (mg / kg)	92	20				
		Zinc (mg / kg)	110	4.75				

4. Grain quality:

a) Total carbohydrates concentration in dried grains estimated as above mentioned for dry shoots.

b) Total protein concentration was calculated by multiplication of total nitrogen in grains by 5.7 (as above mentioned by shoot).

c) Total fibers in grains were determined using the methods described by Sadasivam and Manickam (1992).

All obtained data were subjected to statistical analysis with the help of COSTAT-C Program, and the L.S.D. at 5% level was calculated according to Snedecor and Cochran (1972).

RESULTS AND DISCUSSION

1. Vegetative growth parameters:

Data given in Table (3) and illustrated in Fig. (1) indicate that plant height, number of tillers, number of leaves, leaf area, flag area, dry weights of shoot and root/plant were significantly increased as a result of treating wheat plants with effective micro-organisms (EM) compared with control plants. Similar results were obtained in both seasons. The positive effects of the EM on vegetative growth may be due to gibberellins produced from *Aspergillus niger* fungi presented in EM (EL-Bahrawy, 1983). The obtained results are in agreement with Kato *et al.* (1999), who reported that the promotion of root development by EM application might be due to the effect of plant growth regulators (auxins, gibberellins and kinetin-like substances) produced by inoculated microbes. EM is also effective in improving soil fertility. Zaki and Salama (2006) found that application of EM, improved cucumber plant height and leaf area per plant.

The data given in the previous Table show also that most used treatments of organic manures increased significantly wheat plant growth over the control. Organic manures contribute to plant growth through improving the physical and chemical soil characteristics, i.e., bulk density, hydraulic conductivity, soil strength, available water content, pH value, organic matter content and the released content of available nutrients, i.e., N, P, K, Fe, Mn, Zn, as well as, it extends to plant content of these nutrients (El-Sayed *et al.*, 2002). In this concern, the superiority of each chicken and pigeon manures compared with FYM may be due to the complete decomposition of organic matter of both and release nutrients in the available form, than FYM (Tahoun *et al.*, 2000 and Awad *et al.*, 2003). The best growth parameters were noticed when HA was applied compared to other organic fertilizers. This may be due to humic acids which are reported to increase the permeability of plant membranes, promoting the uptake of nutrients leading to high dry matter production (Albuzio *et al.*, 1994). In spite, humic acids have been reported to enhance mineral nutrient uptake by plants, through increasing the

Table (3): Vegetative growth parameters of wheat plants as affected by bio- and organic fertilizers during 2007/2008 and 2008/2009 seasons.

Parameters / Treatments	2007/2008 season							2008/2009 season						
	Plant height (cm)	Number of tillers / plant	Number of leaves / plant	Leaf area cm² / plant	Flag leaf area cm² / plant	Dry weight of shoot (g/plant)	Dry weight of root (g/plant)	Plant height (cm)	Number of tillers / plant	Number of leaves / plant	Leaf area cm² / plant	Flag leaf area cm² / plant	Dry weight of shoot (g/plant)	Dry weight of root (g/plant)
0.0	53.78	2.39	10.83	170.23	33.65	2.31	0.58	0.55	2.5	10.28	168.99	32.52	2.36	0.54
EM	63.28	2.83	12.55	203.68	37.16	2.89	0.71	61.55	2.94	11.67	203.63	38.30	2.65	0.60
0.0	50.33	2.17	8.67	162.40	32.58	1.47	0.42	51.00	2.17	8.67	141.63	29.37	1.53	0.38
FYM	55.83	2.17	10.50	163.30	33.31	2.32	0.57	55.50	2.17	9.83	159.90	30.93	2.11	0.53
Chi.	57.50	2.50	11.17	169.30	33.60	2.54	0.61	58.00	2.50	10.67	174.55	33.32	2.45	0.55
Pig.	59.83	2.83	11.83	191.65	34.01	2.93	0.67	60.00	2.83	11.33	200.85	37.07	2.79	0.59
Com.	62.83	2.83	13.17	206.50	36.60	3.09	0.73	61.66	3.17	11.83	211.70	39.58	3.00	0.67
HA	64.83	3.16	14.83	228.55	42.35	3.22	0.87	63.50	3.50	13.50	229.25	42.17	3.18	0.70
0.0	47.33	1.67	7.33	151.30	30.00	1.21	0.36	49.33	1.67	8.00	138.40	25.10	1.37	0.35
FYM	50.33	2.00	9.33	160.20	31.00	2.14	0.55	51.33	2.00	9.00	140.10	27.25	2.03	0.52
Chi.	53.00	2.33	10.33	163.20	32.00	2.35	0.57	54.00	2.33	10.00	170.80	30.31	2.40	0.54
Pig.	56.00	2.67	11.33	170.20	33.00	2.51	0.60	57.33	2.67	10.67	178.40	34.11	2.61	0.58
Com.	57.67	2.67	12.67	175.40	36.10	2.73	0.65	58.67	3.00	11.33	183.30	37.22	2.78	0.63
HA	58.33	3.00	14.00	201.70	40.50	2.90	0.75	59.33	3.33	12.67	207.10	41.12	3.00	0.65
0.0	53.33	2.67	10.00	174.10	35.10	1.74	0.48	52.67	2.67	9.33	159.30	33.65	1.69	0.42
FYM	61.33	2.33	11.67	166.40	37.02	2.51	0.59	59.67	2.33	10.67	169.70	34.61	2.19	0.55
Chi.	62.00	2.67	12.00	175.50	35.30	2.73	0.66	61.00	2.67	11.33	178.30	36.33	2.50	0.57
Pig.	63.33	3.00	12.33	213.10	34.20	3.35	0.74	62.67	3.00	12.00	223.30	40.03	2.98	0.61
Com.	68.00	3.00	13.67	237.60	37.10	3.45	0.82	64.67	3.33	12.33	240.10	41.95	3.28	0.71
HA	71.33	3.33	15.66	255.40	44.20	3.55	1.00	67.67	3.67	14.33	251.10	43.23	3.37	0.75
L.S.D at 5%	A=1.0	A=0.59	A=0.87	A=3.18	A=1.42	A=0.14	A=0.04	A=1.09	A=0.77	A=0.73	A=6.65	A=1.70	A=0.16	A=0.01
	B=0.49	B=0.27	B=0.64	B=2.46	B=0.83	B=0.07	B=0.02	B=0.57	B=0.40	B=0.71	B=3.12	B=1.03	B=0.06	B=0.008
	AB=1.21	AB=N.S	AB=N.S	AB=5.99	AB=2.03	AB=0.20	AB=0.05	AB=1.38	AB=N.S	AB=N.S	AB=7.63	AB=2.52	AB=0.15	AB=0.02

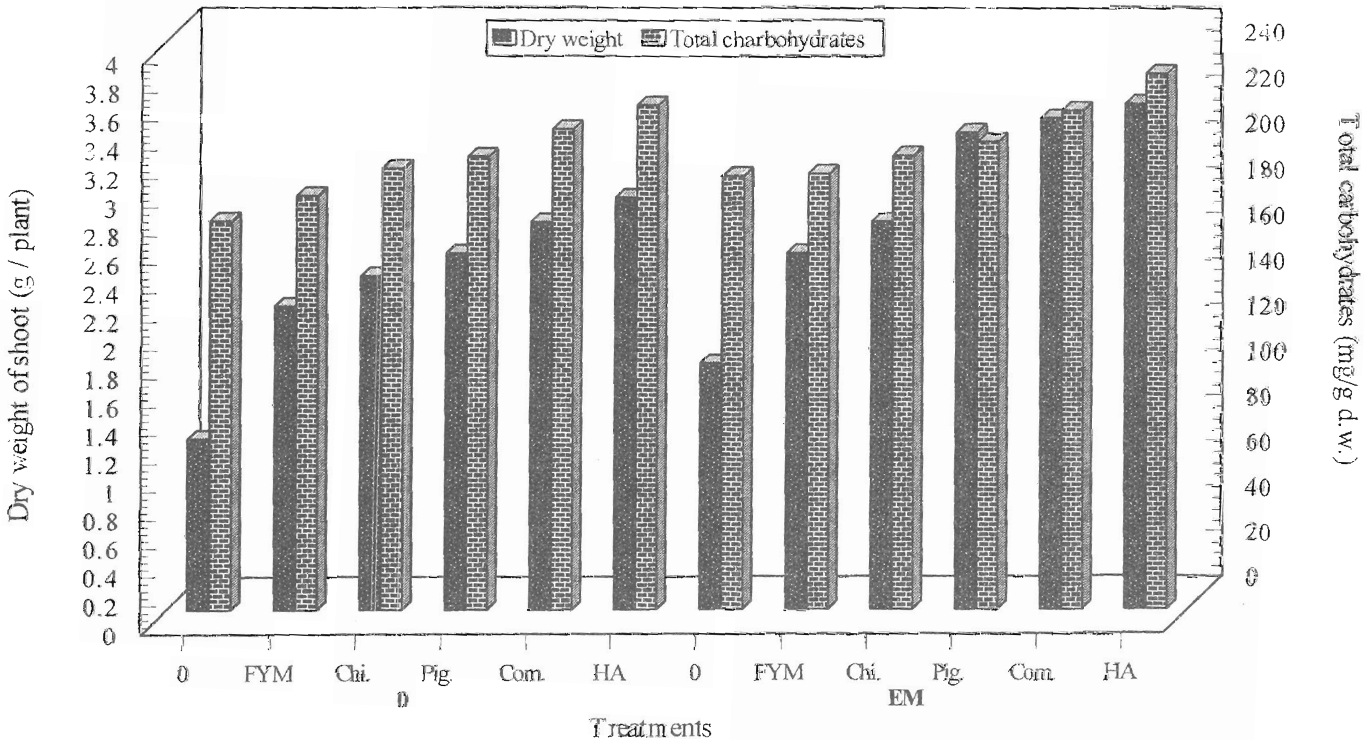

Fig. (1). Dry weight and total carbohdyrates in wheat shoot as affected by bio- and organic fertilizers during 2007/2008 season.

permeability of membranes of the root cells (Valdrighi *et al.,* 1996).

Results also showed that the combined treatments of EM with organic manures stimulated most growth parameters, where EM + HA treatment gave the highest increase compared to other treatments in both seasons. The differences of the interaction recorded significant values for all growth characters except number of tillers and leaves per plant.

2. Chemical constituents:

a) Photosynthetic pigments:

Concerning the effect of EM only or combined with organic manures on photosynthetic pigments in wheat leaves, data presented in Table (4) revealed that concentrations of chl. (a + b) and carotenoids were increased significantly compared with control plants in the two seasons. The maximum increases were detected at the treatment EM + HA. This effect may be due to the certain microorganisms in EM culture such as photosynthetic and N-fixing bacteria, which enhanced the plant photosynthetic rates as reported by Xu *et al.* (2001). These increases in photosynthetic pigments may be due to suitable vegetative growth under better physical and chemical condition of treated soil. Organic manures contains many species of living organisms which release phytohormones. That may stimulate the plant growth, absorption of nutrients and photosynthesis (El-Mansi *et al.,* 1999). Application of organic manure enhanced NPK concentrations, these elements may stimulate chlorophyll biosynthesis and may play an important role in chloroplast stability (Sugtha and Krishnappa, 1995). Some findings may prove the role of phosphorus in stimulating chlorophyll synthesis through encourage pyridoxal phosphate enzymes formation which play an important role in α-amino levulinic acid synthetase as a primary compound in chlorophyll synthesis (Ewais *et al.,* 2004). Similar results confirmed those obtained by Selim *et al.* (2009) on rice.

b) Total soluble sugars and total carbohydrates:

Data in Table (4) demonstrate that, the concentrations of total soluble sugars (TSS) and total carbohydrates (TC) were significantly increased with the addition of EM compared to control plants in both seasons. Results presented in the same Table indicate that application of organic fertilizers recorded a significant values of TSS and TC. In this respect, plants which received compost or humic acid gave the highest values compared with other organic manures. The results held well in both experimental seasons. The interaction between organic manures and EM gave a significant increase in TSS and TC concentrations. In this respect, HA treatment showed superiority over other treatments. Moreover, the lowest values of TSS and TC

Table (4): Physiological parameters in wheat plants as affected by bio- and organic fertilizers during 2007/2008 and 2008/2009 seasons.

Parameters / Treatments	2007/2008 season					2008/2009 season				
	Chl. a + b (mg/g d.w)	Caroten-oids (mg/g d.w)	Total soluble sugars (mg/g d.w)	Total carbohyd-rates (mg/g d.w)	Total phenols (mg caticol / 100 g d.w)	Chl. a + b (mg/g d.w)	Caroten-oids (mg/g d.w)	Total soluble sugars (mg/g d.w)	Total carbohyd-rates (mg/g d.w)	Total phenols (mg caticol / 100 g d.w)
0.0	5.59	2.77	19.01	196.40	18.03	5.48	2.56	17.64	191.93	17.74
EM	6.68	3.05	20.82	206.80	20.92	6.86	3.35	20.60	207.44	20.39
0.0	5.25	2.47	16.66	180.70	18.01	4.98	2.23	16.36	178.60	17.07
FYM	5.72	2.55	18.40	186.80	18.43	5.78	2.46	17.70	185.70	17.88
Chi.	5.92	2.77	18.81	196.70	19.11	6.22	2.86	18.81	195.90	18.76
Pig.	6.12	2.90	19.67	202.20	19.72	6.22	3.16	19.55	202.50	19.82
Com.	6.53	3.26	20.65	215.00	20.45	6.59	3.34	20.67	212.20	19.98
HA	7.28	3.52	25.30	228.20	21.12	7.21	3.68	21.65	223.10	20.90
0.0	5.03	2.27	15.11	171.00	17.11	4.84	2.09	13.71	166.10	16.03
FYM	5.22	2.58	17.80	182.10	17.32	5.01	2.25	16.01	177.90	17.00
Chi.	5.35	2.66	18.22	194.00	17.63	5.41	2.48	17.55	195.10	17.58
Pig.	5.44	2.71	19.33	199.00	18.04	5.50	2.67	18.06	197.40	18.10
Com.	6.01	3.02	20.11	211.00	18.85	5.78	2.89	19.37	203.10	18.35
HA	6.51	3.44	23.50	221.30	19.25	6.32	3.31	20.67	215.30	19.41
0.0	5.48	2.67	18.25	190.50	19.00	5.12	2.38	19.01	191.50	18.11
FYM	6.23	2.67	19.00	191.50	19.55	6.55	3.00	19.40	193.60	18.77
Chi.	6.50	2.91	19.40	199.40	20.60	7.04	3.24	20.07	200.00	19.94
Pig.	6.80	3.10	20.01	205.40	21.40	7.27	3.65	21.05	207.60	21.54
Com.	7.05	3.50	21.20	219.10	22.05	7.40	3.79	22.04	221.30	21.61
HA	8.06	3.61	27.11	235.10	23.00	8.29	4.08	22.80	231.00	22.40
L.S.D at 5%	A=0.20 B=0.08 AB=0.17	A=0.16 B=0.08 AB=0.17	A=0.24 B=0.13 AB=0.30	A=2.48 B=0.98 AB=2.39	A=0.57 B=0.24 AB=0.58	A=0.25 B=0.18 AB=0.43	A=0.19 B=0.10 AB=0.25	A=0.36 B=0.49 AB=1.19	A=2.21 B=1.51 AB=3.69	A=0.47 B=0.23 AB=0.56

were recorded due to the combination of FYM with EM. These results are in accordance with those obtained by Gabr *et al.* (2001) who found that, the combination of 80 kg N/fed. and inoculated with biofertilizer in pepper plants significantly increased total carbohydrates of pepper leaves. El-Gamal and Selim (2005) pointed out that, organic manures alone or combined with inorganic fertilizer significantly increased TSS and TC compared to control. Moreover, El-Gamal *et al.* (2007) reported that EM + chemical fertilizer increased total carbohydrates of strawberry. The superiority of HA + EM treatment could be attributed to the beneficial effects of both HA and EM which are rich in both organic and mineral substances essential to plant growth.

c. Total phenols:

Applying biofertilizer (EM) led to a significant increase in total phenols concentrations in wheat plants compared with control plants in both seasons (Table 4). In this connection Abd El-Fattah and Sorial (1998) reported that, total phenols in lettuce leaves were significantly enhanced by application of biofertilizer alone or combined with N-levels. These results are in harmony with those obtained by Hammad and EL-Gamal (2004) on pepper. On the contrary organic fertilizers tended to increase total phenols concentration compared to control plants. Generally, it could be concluded that farmyard and chicken manures gave the lowest values than the other ones. As for the interaction effect, it is clear from Table (4) that the highest values in total phenols concentration were obtained by the EM supplied with humic acid or compost. In this respect Nardi *et al.* (1999) attributed the beneficial effect of humic acids on plant growth to its action as plant growth hormones, since it had a gibberelline like activity and suggested that, humic acids fraction exhibited an auxin like activity, exhibiting higher amounts of phenolic and considerable amount of carboxyl and consequently showed the best metabolic effect.

d) Mineral concentration:

The data listed in Table (5) and illustrated in Fig. (2-a, b, c) indicate that both NPK percentage and uptake in shoot tissues were significantly increased with adding EM fertilizer in the two seasons compared with control plants. These results are in agreement with those of Zaki and Salama (2006). This effect might be due to the release of nutrients from organic matter when EM was applied (Yadav, 1999 and Sangakkara and Weerasekera, 2001). In this regard, El-Gamal *et al.* (2007) reported that applying biofertilizer (EM) alone or combined with mineral fertilizer significantly affected N, P and K concentration of strawberry plants.

Table (5): Minerals concentration in wheat plants as affected by bio- and organic fertilizers during 2007/2008 and 2008/2009 seasons.

Parameters / Treatments	2007/2008 season						2008/2009 season					
	N (%)	N uptake (mg / plant)	P (%)	P uptake (mg / plant)	K (%)	K uptake (mg / plant)	N (%)	N uptake (mg / plant)	P (%)	P uptake (mg / plant)	K (%)	K uptake (mg / plant)
0.0	3.34	8.03	0.38	0.91	2.36	5.47	3.30	8.13	0.36	0.89	2.28	5.44
EM	3.63	10.71	0.40	1.17	2.86	8.46	3.59	9.72	0.38	1.09	2.52	6.82
0.0	2.87	4.33	0.29	0.43	2.29	3.31	2.70	4.46	0.29	0.44	2.21	3.42
FYM	3.39	7.89	0.35	0.82	2.48	5.77	3.25	6.87	0.35	0.74	2.29	4.83
Chi.	3.55	9.04	0.40	1.03	2.53	6.46	3.53	8.65	0.38	0.94	2.37	5.82
Pig.	3.56	10.63	0.41	1.21	2.56	7.57	3.63	10.15	0.39	1.10	2.43	6.82
Com.	3.64	11.57	0.42	1.31	2.58	8.03	3.72	11.32	0.41	1.25	2.51	7.65
HA	3.89	12.78	0.44	1.44	3.22	10.65	3.83	12.08	0.42	1.46	2.62	8.23
0.0	2.50	3.02	0.25	0.30	2.25	2.72	2.57	3.81	0.27	0.37	2.03	2.78
FYM	3.38	7.23	0.35	0.75	2.31	4.94	3.15	6.39	0.33	0.67	2.25	4.57
Chi.	3.51	8.25	0.40	0.94	2.36	5.55	3.47	8.33	0.38	0.91	2.27	5.45
Pig.	3.60	9.04	0.41	1.03	2.39	6.00	3.55	9.26	0.39	1.02	2.31	6.03
Com.	3.65	9.96	0.42	1.15	2.41	6.58	3.60	10.01	0.40	1.11	2.37	6.59
HA	3.70	10.73	0.44	1.28	2.45	7.10	3.66	10.98	0.42	1.26	2.40	7.20
0.0	3.25	5.65	0.33	0.57	2.33	4.05	3.03	5.12	0.31	0.52	2.40	4.06
FYM	3.41	8.56	0.36	0.90	2.65	6.65	3.36	7.36	0.37	0.81	2.33	5.10
Chi.	3.60	9.83	0.41	1.12	2.70	7.37	3.59	8.97	0.39	0.97	2.48	6.20
Pig.	3.65	12.23	0.42	1.40	2.73	9.14	3.71	11.05	0.40	1.19	2.55	7.59
Com.	3.82	13.18	0.43	1.48	2.75	9.49	3.85	12.63	0.42	1.38	2.66	8.72
HA	4.08	14.84	0.45	1.60	4.00	14.20	4.00	13.48	0.43	1.66	2.75	9.27
L.S.D at 5%	A=0.23 B=0.11 AB=0.25	A=0.42 B=0.27 AB=0.66	A=0.13 B=0.006 AB=0.01	A=0.04 B=0.02 AB=0.05	A=0.13 B=0.07 AB=0.17	A=0.21 B=0.13 AB=0.31	A=0.16 B=0.10 AB=0.24	A=0.32 B=0.16 AB=0.39	A=0.01 B=0.006 AB=0.01	A=0.01 B=0.009 AB=0.02	A=0.09 B=0.04 AB=0.10	A=0.19 B=0.10 AB=0.25

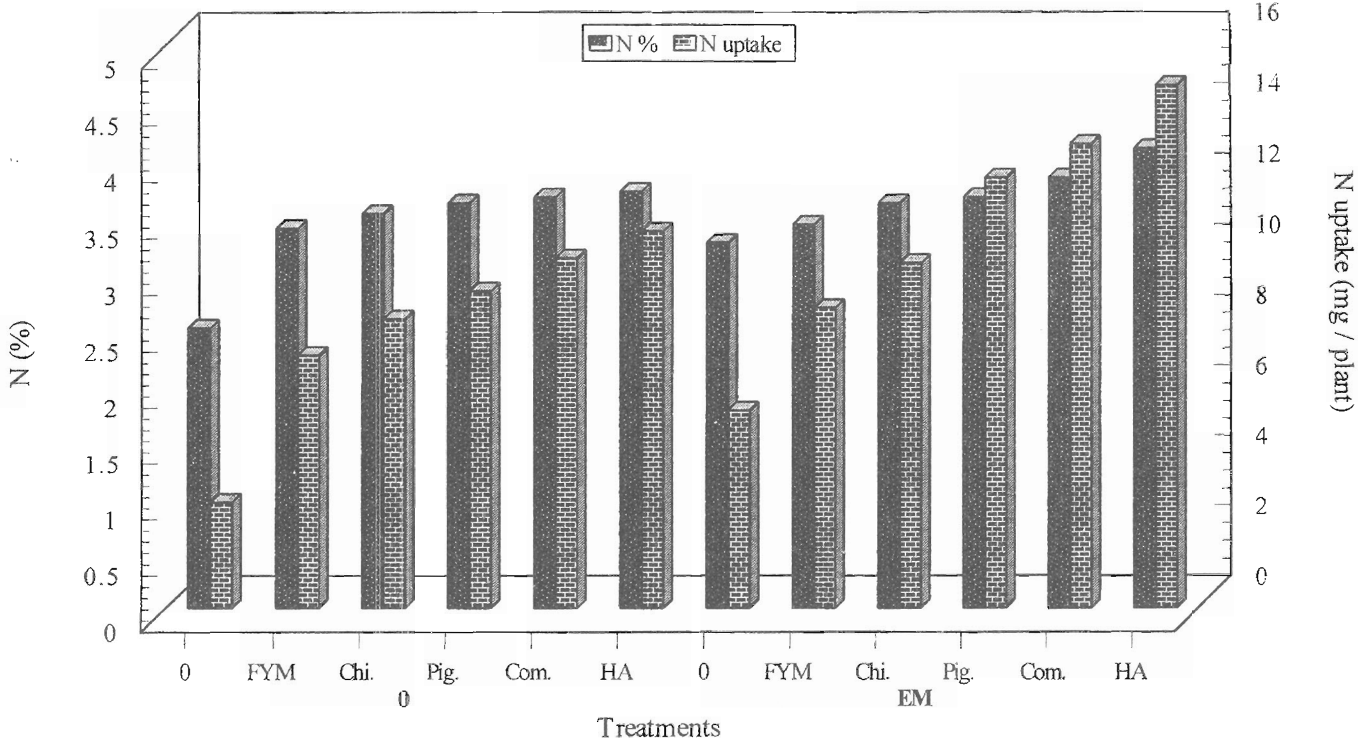

Fig. (2-a). Nitrogen concentration and uptake in wheat shoots as affected by bio- and organic fertilizers during 2007/2008 season.

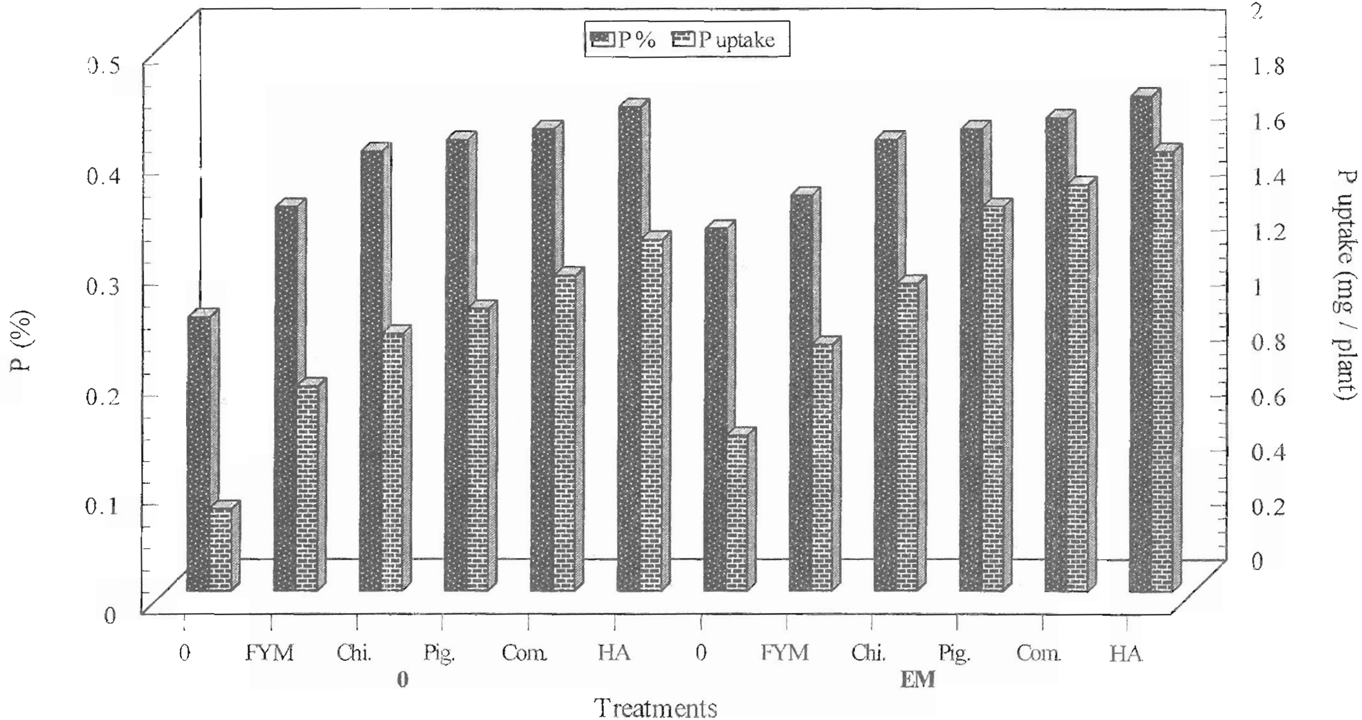

Fig. (2-b). Phosphours concentration and uptake in wheat shoots as affected by bio- and organic fertilizers during 2007/2008 season.

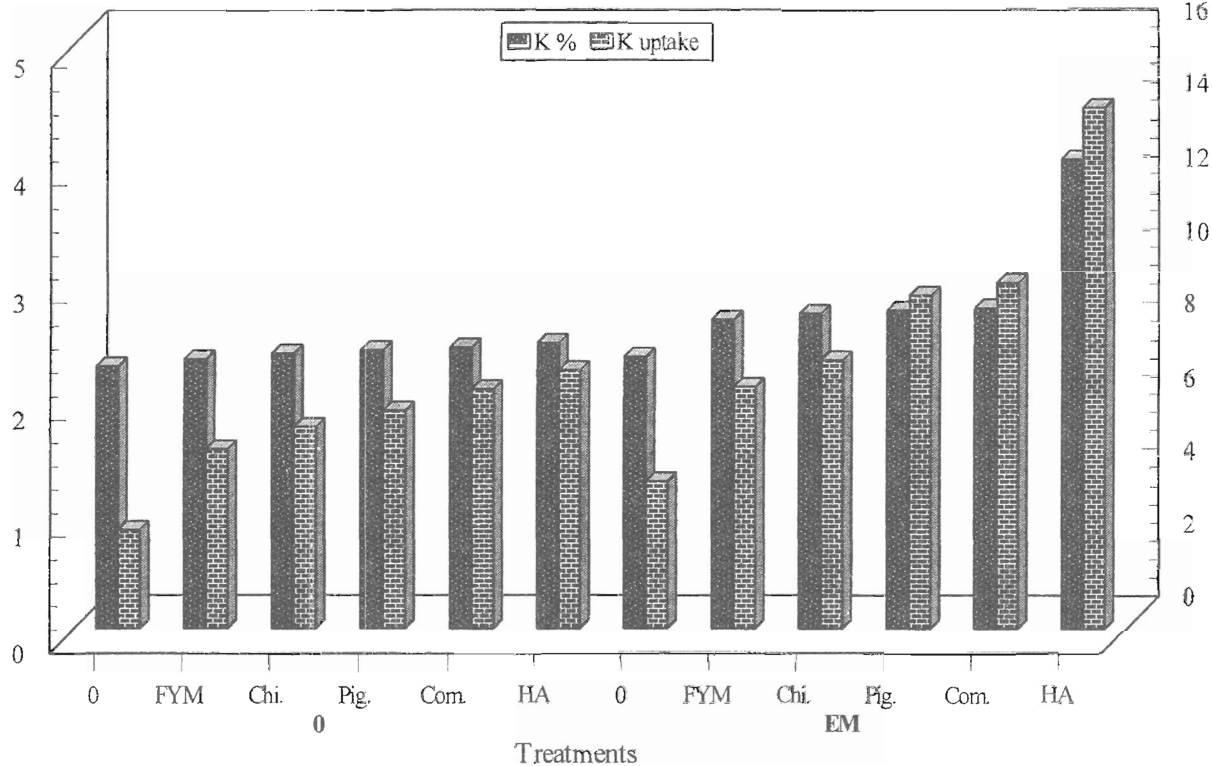

Fig. (2-c). Potassium concentration and uptake in wheat shoots as affected by bio- and organic fertilizers during 2007/2008 season.

The results in the same Table clearly show that organic manures improved the concentration of N, P and K in shoot tissues. Both HA treatments alone or combined with EM recorded the highest values, meanwhile FYM treatment recorded the lowest one. These results are in harmony with the trends noticed by Habashy and Aly (2005) who reported that, there was a significant increase in N-uptake of wheat plants treated with humic acid. These results are mainly due to the different components of these manures formation and accumulation of some gases, i.e., methan, ethylene and carbon dioxide with different amounts as a result of the biological decomposition, which increase soil acidity, organic matter, available N, P, K, exchangeable Zn and Mn and this, in turn, affect plant growth, dry matter and absorption of macro and micronutrients. Abdel-Ghani and Bakry (2005) found that, N, P and K taken in wheat plants were significantly increased due to the application of different N rates and sources. They added that, organic fertilizer improved the soil P supply power through direct and indirect effects. The direct effect includes the continuous release of inorganic P in available form, while indirect through organic and inorganic acids as well as the other compounds, yielded upon mineralization of the organic fraction.

Data in the same Table show also that nutrients concentration and uptake in wheat plants were significantly increased by the interaction between the application of organic and biofertilizers in both seasons. The combined treatments of HA + EM or Com. + EM were superiority as compared with other organic manures. This finding indicated a positive role of EM for improving the efficiency of nutrient uptake. On the contrary, applying of FYM + EM gave the lowest values of the nutritional elements.

3. Yield and its attributes:

It is clearly apparent from data in Tables (6 and 7) that, the applying of microorganisms significantly increased the number and weight of spikes / plant, spikeletes number / spike, grains number and weight / spike, grain yield / plant, 1000 grains weight, straw yield / plant and harvest index compared to control. These findings were similar in the two experimental seasons. The enhancing effect of biofertilizer inoculation on yield and its components was observed by Tomar *et al.* (1998) on wheat plants. The obtained yield increases may mainly be due to the stimulating effects on root growth, changing root morphology, enhancing the uptake of minerals and its involvement in phytohormones production (Noel *et al.*, 1996). The increase of grain yield due bacterial inoculation may be attributed to their effect on nitrogen fixation and increasing the endogenous phytohormones i.e., IAA, GA_3 and CYT, which play an important role in formation of big active root system and hence increasing the nutrient uptake, photosynthesis rate and translocation (Ibrahim *et al.*, 2004). Similar results were obtained by Bassal *et al.* (2001) and Abdel-Ghani and Bakry (2005) who found

Table (6): Yield and its components of wheat plants as affected by bio- and organic fertilizers during 2007/2008 and 2008/2009 seasons.

Parameters / Treatments	2007/2008 season						2008/2009 season					
	Spikes number / plant	Spikes weight (g/plant)	Spikelets number / spike	Grains number / spike	Grains weight (g / spike)	Grain yield (g/plant)	Spikes number / plant	Spikes weight (g/plant)	Spikelets number / spike	Grains number / spike	Grains weight (g / spike)	Grain yield (g/plant)
0.0	3.67	5.51	34.00	28.17	0.60	2.24	3.53	5.21	34.67	28.33	0.63	2.42
EM	5.05	6.27	40.17	35.77	0.67	3.48	4.50	5.89	39.33	34.94	0.71	3.08
0.0	3.50	3.83	30.00	21.50	0.51	1.84	2.83	3.44	29.00	23.00	0.50	1.53
FYM	3.83	5.58	32.00	25.50	0.59	2.28	3.50	5.12	31.00	25.50	0.62	2.21
Chi.	4.00	5.92	37.00	31.00	0.63	2.53	3.83	5.63	35.50	31.00	0.66	2.47
Pig.	4.33	6.43	38.50	33.50	0.66	2.87	4.17	6.05	40.00	33.50	0.73	3.06
Com.	4.83	6.64	41.00	37.50	0.71	3.47	4.50	6.27	42.00	36.50	0.74	3.35
HA	5.67	6.93	44.00	41.50	0.72	4.15	5.16	6.77	44.50	40.33	0.78	3.87
0.0	3.33	3.20	25.00	19.00	0.48	1.60	2.67	2.86	27.00	21.00	0.46	1.23
FYM	3.33	5.05	28.00	22.00	0.55	1.83	3.00	4.50	29.00	23.00	0.52	1.56
Chi.	3.33	5.59	35.00	28.00	0.61	2.03	3.33	5.32	34.00	27.00	0.62	2.06
Pig.	3.67	6.07	37.00	30.00	0.64	2.05	3.67	5.91	38.00	31.00	0.72	2.64
Com.	4.00	6.36	37.00	32.00	0.66	2.64	4.00	6.07	39.00	32.00	0.73	2.92
HA	4.33	6.75	42.00	37.00	0.69	2.99	4.33	6.61	41.00	36.00	0.76	3.29
0.0	3.67	4.43	35.00	24.00	0.57	2.09	3.00	4.03	31.00	25.00	0.54	1.62
FYM	4.33	6.18	36.00	29.00	0.63	2.73	4.00	5.75	33.00	28.00	0.73	2.92
Chi.	4.67	6.25	39.00	33.00	0.65	3.03	4.33	5.95	37.00	35.00	0.70	3.03
Pig.	5.00	6.80	40.00	34.00	0.68	3.40	4.67	6.27	42.00	36.00	0.75	3.50
Com.	5.67	6.93	45.00	41.00	0.76	4.31	5.00	6.48	45.00	42.00	0.76	3.80
HA	7.00	7.12	46.00	42.00	0.76	5.32	6.00	6.93	48.00	44.00	0.81	4.86
L.S.D at 5%	A=0.34	A=0.17	A=1.11	A=1.06	A=0.02	A=0.37	A=0.66	A=0.25	A=1.22	A=1.24	A=0.08	A=0.21
	B=0.66	B=0.09	B=0.63	B=0.81	B=0.01	B=0.17	B=0.17	B=0.17	B=0.69	B=0.84	B=0.03	B=0.10
	AB=0.83	AB=0.24	AB=1.53	AB=1.98	AB=0.02	AB=0.39	AB=0.39	AB=0.25	AB=1.69	AB=2.06	AB=0.05	AB=0.25

Table (7): Yield and its attributes as well as grain quality of wheat plants as affected by bio- and organic fertilizers during 2007/2008 and 2008/2009 seasons.

Parameters / Treatments	2007/2008 season						2008/2009 season					
	1000 grains weight (g)	Straw yield (g / plant)	Harvest index	Total carbohy-drates / grains (mg / g d.w)	Total protein / grains (%)	Total fibers / grains (%)	1000 grains weight (g)	Straw yield (g / plant)	Harvest index	Total carbohy-drates / grains (mg / g d.w)	Total protein / grains (%)	Total fibers / grains (%)
0.0	39.77	4.11	35.50	427.75	19.04	1.90	38.53	3.85	36.72	448.03	18.79	1.83
EM	43.58	4.98	40.93	437.30	20.32	1.73	43.50	4.34	42.20	462.81	20.95	1.61
0.0	37.73	3.57	34.00	393.20	16.76	1.74	36.87	2.91	32.67	422.10	17.14	1.76
FYM	40.64	3.93	36.45	416.40	19.36	2.07	39.69	3.47	38.43	441.50	19.07	1.92
Chi.	40.93	4.39	37.36	427.20	19.87	1.86	41.05	3.90	39.13	454.40	19.80	1.81
Pig.	41.69	4.75	38.15	438.30	19.96	1.80	41.77	4.42	41.41	462.60	19.94	1.73
Com.	43.32	5.24	39.33	455.70	20.42	1.77	42.84	4.57	42.03	471.80	20.97	1.61
HA	45.76	5.39	42.66	464.20	21.67	1.64	44.50	5.29	43.10	479.90	22.30	1.51
0.0	34.00	3.15	33.68	385.30	14.31	1.84	31.03	2.83	30.29	414.00	15.61	1.81
FYM	39.25	3.40	34.99	409.30	19.05	2.09	36.38	2.94	34.67	431.90	18.24	2.00
Chi.	39.41	4.04	33.44	422.10	19.70	1.93	38.81	3.57	36.59	447.30	19.00	1.91
Pig.	40.35	4.51	34.26	435.10	19.81	1.90	39.79	4.05	39.46	455.10	19.31	1.81
Com.	42.11	4.72	35.86	451.30	20.50	1.86	41.66	4.41	39.84	462.40	20.00	1.78
HA	43.52	4.84	38.18	463.40	21.30	1.75	43.50	4.97	39.83	477.50	20.61	1.69
0.0	41.46	4.00	34.32	401.20	19.21	1.65	42.71	3.00	35.06	430.20	18.33	1.71
FYM	42.03	4.47	37.91	423.50	19.68	2.05	43.01	4.00	42.20	451.20	19.90	1.85
Chi.	42.46	4.74	42.86	432.30	20.05	1.80	43.30	4.24	41.68	461.60	20.61	1.71
Pig.	43.03	5.00	40.47	441.50	20.11	1.70	43.75	4.57	43.37	470.20	20.58	1.65
Com.	44.53	5.76	42.80	460.20	20.80	1.65	44.02	4.73	44.55	481.30	21.94	1.45
HA	48.00	5.94	47.24	465.10	22.05	1.54	44.60	5.62	46.37	482.40	24.00	1.33
L.S.D at 5%	A=0.47	A=0.13	A=1.94	A=4.98	A=0.77	A=0.09	A=0.69	A=0.34	A=0.21	A=2.42	A=0.70	A=0.06
	B=0.64	B=0.09	B=1.15	B=1.87	B=0.48	B=0.03	B=0.34	B=0.18	B=0.12	B=2.02	B=0.39	B=0.04
	AB=1.55	AB=0.18	AB=2.80	AB=4.58	AB=1.16	AB=0.08	AB=0.83	AB=0.43	AB=0.25	AB=4.93	AB=0.95	AB=0.09

that, inoculation of wheat grains with ceraline recorded the highest means values of grains yield and its major components compared with uninoculation.

Data recorded in the same Table show that, the application of fertilizers significantly enhanced wheat yield and its attributes. Best results were observed by applying compost or humic acid in both seasons. In this connection El-Mansi *et al.* (1999) reported that using organic manure increased organic matter, availability of nutrients, nitrogen-fixation, rhizosphere microorganisms that secrete phytohormones, and hormone-like substance and, in turn, increased growth, dry matter accumulation, average weight and number of pods / plant. In this respect (Cheng *et al.,* 1998) reported that spraying HA decreased the loss of soil moisture, enhanced water retention, increased the ability rate of wheat leaves photosynthesis, increased the grain filling intensity and its thousand grain weight. The increase in yield of wheat plants might be directly due to the increase of root primordial in which CYT synthesized. There was dose relationship between root primordial and leaf area duration and also rapid leaf expansion which lead to an increase in photosynthesis rate, and this, in turn, increase yield (Marschner, 1995).

The obtained data revealed also that, the combination of organic manures with EM was more effective on yield and its attributes than the organic manure alone. It is worthy to mention that, the applied HA + EM treatment surpassed all the tested ones. Moreover, the lowest values for the obvious characters were noticed when FYM was applied with EM. Similar results were observed in the second season.

3. Grain quality:

a) Total carbohydrates:

Data presented in Table (7) show that all studied fertilizers alone or in combination significantly increased total carbohydrates in wheat grains. In this respect, the highest increments were observed in the case of humic acid followed by compost manure compared with other treatments and control. Such results were true during both growing seasons. This increase may be due to grains high N-content which increases the protein synthesis and activity of carbohydrates hydrolyzing enzymes (Edmond *et al.,* 1981).

b) Total protein:

Average percentage of wheat grain protein for the tested fertilizers was significantly increased compared to untreated plants in both seasons (Table 7). In this concern, humic acid was superior over the other ones. Significant differences were observed between organic manures and effective microorganisms, the greatest mean values were obtained by applying HA + EM, meanwhile the lowest one were recorded when plants were treated with

FYM + EM. These results are in line with those obtained by Hassan and Mohey El-Din (2002) who reported that N uptake in grains was increased due to application of organic manures. Abd El-Malek (1971) noticed that release of nitrogen during the degradation of the organic manure increased soil microflora activity (Azotobacter as well as Azotspirillium and other microorganisms), which could in turn encourage fixed-air-nitrogen used by plant roots. Furthermore, Kotb (1998) showed that, the increased uptake of N by wheat plants due to inoculation with a mixture of Azospirillium & Bacillus might be the cause of increasing protein content.

c) Total fibers:

As shown in Table (7), the total fibers were significantly decreased in wheat grains in plants treated with micro-organisms compared to control plants in both seasons. Organic manures showed a significant effect in total fibers. In this respect, total fibers were increased in plants treated with FYM, Chi. and Pig. Manures, meanwhile were decreased significantly when plants treated with Com. or HA fertilizers compared to control plants.

Significant differences in the total fibers of wheat grains were recorded due to the interaction between organic manures and EM. The obtained results indicated that, the lowest values were recorded in HA + EM treatment in the two seasons. This could be the beneficial effects of both humic acid and EM, since HA rich in both organic and mineral substance essential to plant growth, stimulating the seed germination and activating the biochemical processes in plants (respiration, photosynthesis and chlorophyll content), which increased the wheat quality and quantity (Malik and Azam, 1986).

Generally, it can be concluded that, from the previous results, the application of organic fertilizers especially if combined with EM can promote growth characters, physiological parameters as well as yield and its quality of what plants. Therefore, it can be recommended to use HA or Com. in combination with EM to increase the productivity of wheat crop with good quality and to reduce the chemical fertilizer with special reference to its cost and environmental pollution.

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التأثير المتكامل لبعض الأسمدة العضوية مع المخصب الحيوى EM على النمو والتركيب الكيماوى والمحصول وجودته فى نباتات القمح

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الملخص العربى :

أجريت تجربتان أصص بكلية الزراعة جامعة المنوفية خلال موسمى ٢٠٠٧/٢٠٠٨ ، ٢٠٠٨/٢٠٠٩ بهدف استبيان مدى التأثير المتكامل لمختلف الأسمدة العضوية مثل سماد الماشية وزرق الدواجن ، زرق الحمام ، كمبوست ، حامض الهيوميك مع المخصب الحيوى EM على صفات النمو والتركيب الكيماوى والمحصول ومكوناته وأيضاً جودة الحبوب فى نباتات القمح . وقد أوضحت النتائج ما يلى : إضافة الأسمدة العضوية أو المخصب الحيوى كإضافات منفردة أو مشتركة أدت إلى زيادة فى معظم الصفات المدروسة بالنمو وصبغات التمثيل الضوئى والسكريات الكلية الذائبة والكربوهيدرات الكلية والفينولات الكلية والعناصر (ن ، فو ، بو % والممتص) والمحصول وجودته قد زادت معنوياً بالمقارنة نباتات الكونترول. أوضحت النتائج أيضاً أن استخدام حامض الهيوميك أو الكمبوست أدى إلى الحصول على أفضل النتائج بالمقارنة بالمعاملات الأخرى للأسمدة العضوية (سماد الماشية ، زرق الدواجن ، زرق الحمام) . أوضحت جميع التفاعلات تأثيراً معنوياً فى جميع الصفات تحت الدراسة عدا عدد الأوراق والأفرع / نبات . لوحظت أفضل النتائج للمعاملات المشتركة عند إضافة المخصب الحيوى EM + حامض الهيوميك للصفات المدروسة علاوةً على ذلك فإن المعاملة المشتركة لحامض الهيوميك والمخصب الحيوى حققت أفضل النتائج لدليل الحصاد وجودة الحبوب (زيادة الكربوهيدرات الكلية والبروتين مع نقص فى الألياف الكلية) وبالتالى يُمكن التوصية باستخدام الأسمدة العضوية (حامض الهيوميك أو الكمبوست) خاصة بالإشتراك مع المخصب الحيوى EM لزيادة إنتاجية وجودة القمح مع تقليل الأسمدة الكيماوية وخفض التكاليف والتلوث البيئى .