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EFFECT OF MAGNETITE, HUMIC ACID AND BIOFERTLIZER AS WELL AS N, P AND K LEVELS APPLICATION ON GROWTH AND YIELD OF PEA *(Pisum sativum* L.*)*

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ABSTRACT

Two field experiments were carried out during winter seasons of 2010 - 2011 and 2011-2012, at the Experimental Farm of El Kassasein Horticultural Research Station, Ismailia Governorate, Egypt, to study the effect of NPK levels (25, 50 and 100 % of recommended dose), foliar applications (Control, HA, EM and HA+ EM) and magnetite levels (without and 150 kg/fed.) on growth, yield and its components of pea plants (*Pisum sativum* L.) cv. Master B under sandy soil conditions.

Results indicated that increasing NPK fertilizer levels up to 100% recommended dose cause a significant increases in plant growth (plant height, number of branches and leaves/plant and dry weight/plant) and yield and its components (pod length, number of seeds/pod, weight of 100 seeds and green pods yield/fed).

Spraying pea plants with a mixture of HA+ EM gave the highest values of vegetative growth parameters and yield and its components. In the same trends, treated plants with magnetite recorded the highest values of vegetative growth and yield and its components as compared to untreated plants.

application of 50% NPK and spraying plants with humic acid + EM plus magnetite at 150 kg/fed recorded higher values of plant growth and green pod yield per feddan as compared to 100% NPK alone (control) without significant difference between both treatments. Fertilizing pea plants with 100% NPK and spraying plants with combination of humic acid + EM with application of 150 kg/fed magnetite gave the highest values of plant growth parameters, yield and its components as compared to other interaction treatments.

INTRODUCTION

Pea (*Pisum sativum* L.) is a very popular vegetable crop and is considered one of the most important legume crops in Egypt for local consumption and exportation. This crop is widely used as a source of protein in human diets due to its high content of protein, ascorbic acid, carbohydrates, balanced amino acids composition and good digestibility. In general, this crop gives high yield and ensures high profits, especially when cultivated for green pods. Therefore, it occupies a prominent position among other legumes in the egyptian agriculture.

Many investigators reported that increasing NPK fertilizer levels increased plant height, number of branches and leaves/plant, dry weight of branches and leaves/plant and yield and its components (Patel *et al.* 1998; Kakar *et al*. 2002; Mishra *et al*. 2010) on pea, (El-Bassiony *et al*., 2010; El-Awadi *et al*., 2011) on snap bean. Humic acid is a commercial product contains many elements which improve the plant growth. Many investigators

reported that spraying plants with humic acid improved plant growth and productivity (Khan *et al,.* 2012) on pea, (El-Bassiony *et al*. 2010; Hanafy *et al.* 2010) on snap bean, (El-Hefny 2010; Azarpour *et al*., 2011) on cowpea.

Many researchers have reported an increase in crop growth and yield by applying EM (Khaliq *et al*., 2006; Javaid and Shah, 2010).

Magnetite (magnetic iron) is one of the most important factors affecting plant growth and yield and its components. Several workers found that magnetite (magnetic iron) application increased the growth and yield of many vegetable crops (Abd El-Al, 2003 on eggplant; Ramadan, 2008 on cauliflower; El-Hifny, 2010 on celery; Ramadan, 2012 on cabbage). This work aimed to study the effect of NPK levels, foliar application and magnetite levels on pea growth and productivity under sandy soil conditions.

MATERAILS AND METHODS

Two field experiments were carried out during winter seasons of 2010-/2011 and 2011-2012, at the Experimental Farm of El Kassasein Horticultural Research Station, Ismailia Governorate, Egypt, to study the effect of NPK, foliar applications and magnetite levels on pea cv. Master B on growth, yield and its components grown under sandy soil conditions.

The physical and chemical properties of soil are shown in Table (1).

Table (1): The physical and chemical properties of the experimental soil

Physical properties	First season 2010-2011	econd season 2011-2012
Sand (%)	83.0	88.24
Silt (%)	13.0	4.25
Clay (%)	3.32	7.51
O.M (%)	0.68	0.44
F.C. (%)	7.7	7.3
W.P. (%)	2.8	2.94
Texture	sandy	sandy
Chemical properties		
pH	7.9	7.2
E.C. (mmohs/cm)	1.66	1.41
HCO_3^- Mol/L	2.50	2.00
Cl^- Mol/L	8.00	7. 4
SO_4^{--} Mol/L	7.46	9.0
Ca^{++} Mol/L	4.68	4.56
Mg^{++} Mol/L	2.04	2.00
Na^+ Mol/L	6.48	7.1
K^+ Mol/L	0.58	0.71
Available N (mg/100g.soil)	1.23	1.3
Available P (mg/100g.soil)	1. 99	2.0
Available K(mg/100g.soil)	5.19	4.9

Samples of the soil were obtained from depth of 25 cm i.e. soil surface layer.
O.M.: Organic matter F.C.: Field capacity
W.P.: Wilting point E.C.: Electric conductivity

1. Layout of the experiment and treatments:

The experiments were arranged in split-split plot design with three replicates. NPK levels treatments were assigned at random in the main plots, while sub plots were devoted to foliar applications and magnetite were

allotted in sub-sub plots. Each experiment included 24 treatments, which were combination between (NPK) levels, foliar applications and magnetite as follows:

A. (NPK) levels:

1- 25 % NPK (10 kg N_2, 7.5 kg P_2O_5 and 12.5 kg K_2O).

2- 50 % NPK (20 kg N_2, 15 kg P_2O_5 and 25 kg K_2O).

3- 100 % NPK (40 kg N_2, 30 kg P_2O_5 and 50 kg K_2O) recommended mineral fertilizer.

Three levels of NPK fertilizers, namely 25, 50 and 100% of the recommended dose as the recommendation of Ministry of Agriculture and Land Reclamation for pea. Nitrogen at 40 Kg/fed as a form of ammonium sulphate (20.5% N), phosphorus at 30 Kg /fed as a form of calcium superphosphate (15.5 % P_2O_5) and potassium at 50 Kg /fed as a form of potassium sulphate (48 % K_2O).

B. Foliar applications.

1- **Control (tap water)**

2- **Humic Acid (HA)**

Humic acid was obtained from microbiology department, Soil Water and Environment Research Institute, Agric. Res. Center, Giza, Egypt, and was added as a foliar application at a rate of 2 cm^3 / L in the three times, the first was after three weeks from sowing, the second was added after one week from the first and the third after one week from the second addition

3- **Biofertilization (EM)**

EM was applied as foliar sprays at three times at the rate of 3 cm^3 / L, the first spray was conducted after 21 days from sowing, whereas the second and third spray was preformed later 7 days by intervals. EM contained high populations of lactic acid bacteria at 1×10^{11} cfu mL^{-1}, photosynthetic bacteria at 1×10^6 cfu mL^{-1}, and 1×10^3 cfu mL^{-1}, yeast suspension (Higa, 2000). Stock culture was diluted by adding tap water to prepare a 0.2% solution. The fresh solution was used immediately.

4- (HA 2 cm^3 / L**) + (EM** 3 cm^3 / L**).**

C. Magnetite:

1-Without (untreated)

2-150 kg/fed.

Magnetite is a natural row rock that has very high iron content. Magnetite has a black color. It has a hardness of about 6 on the Mohs hardness scale. It is one of two natural row rocks in the world that is naturally magnetic. The used magnetite contained 3.72 % SiO_2, 14.90% TiO_2, 1.23% Al_2O_3, 76.56% Fe_2O_3, 0.35% MnO, 1.21% MgO, 0.45% CaO, 0.42% Na_2O, 0.05% K_2O, 0.07% P_2O_5, 0.09% Cl, 0.05% SO_3 andz0.60%2L.O.I,.as.shown by the samples analyzed by The Egyptian Geological Survey and Mining Authority. Magnetite was added as a soil application at a rate of 150 kg / fed before sowing.

The experimental unit area was 10.5 m^2 and it contains 3 dripper's lines with 5 m length for each and 70 cm width. The distance between drippers was 15 cm . Seeds were sown in hills (2 seeds /hill) at spacing 10 cm between plants on 20th October for 1st and 2nd seasons. All plots received

farmyard manure by rate of 20 m^3/fed. The seeds were obtained from Horticultural Research Institute, Agriculture Research Center.

2. Data recorded

The obtained data in this study were as follows.

A. Plant growth parameters

Six plants from each plot were taken at random from each plot at 45 days after sowing to evaluate the following vegetative characters.

Plant height
Number of branches/plant
Number of leaves/plant
Dry weight of plant

B. Yield and its components

Mature green pods were continuously harvested at suitable maturity stages and the following data were calculated:

Average pod length
Number of seeds/pod
Average weight of 100 seeds
Total green pods yield /fed

3. Statistical analysis

Data were statistically analyzed of variance using the normal (F) test 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

1. Vegetative growth

1.1 Effect of NPK levels

Data in Table (2) show the effect of NPK levels on vegetative characters of pea plants, i.e., plant height, number of branches and leaves/ plant and dry weight of plant. It is obvious from such data that vegetative growth parameters were increased with increasing NPK levels. Using NPK fertilizers at 100% as a recommended dose gave the highest significant value of vegetative growth parameters as compared to other levels.

This increment in vegetative growth of pea plant growth may be attributed to the beneficial effects of nitrogen on stimulating the merestimatic activity for producing more tissues and organs, since it plays major roles in the synthesis of structural proteins and other several macro molecules, in addition to its vital contribution in several biochemical processes that related to plant growth (Marschner, 1995). The promoting effect of phosphorus application on growth parameters could be attributed to phosphorus as structural part of high energy compounds (Sarg, 2004). It is also a constituent of the cell nucleus and is essential for cell division and the merestimatic tissues development (Frank, 2002). Potassium is 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).

These results are in harmony with those reported by Patel *et al*. (1998), Kakar *et al.* (2002) and Mishra *et al.* (2010) on pea , El-Bassiony *et al.* (2010) and El-Awadi *et al.* (2011) on snap bean.

Table (2): Effect of NPK levels, foliar applications and magnetite on vegetative characters of pea plant during 2010-2011 and 2011-2012 seasons.

Characters	Plant height (cm)		No. of branches / plant		No. of leaves/ plant		Dry weight / plant (gm)	
Treatments	Seasons							
	2010	2011	2010	2011	2010	2011	2010	2011
NPK level.								
25% N P K	36.04	37.80	2.47	2.64	19.13	23.37	3.03	3.62
50% N P K	42.17	45.30	3.10	3.49	24.65	33.88	4.12	5.06
100% N P K	49.19	52.08	3.85	4.20	35.42	41.78	5.29	6.21
LSD 0.05	0.86	0.77	0.20	0.14	1.05	1.35	0.25	0.13
Foliar application								
Control	36.40	37.80	2.28	2.61	20.54	26.45	3.10	3.52
HA	40.30	42.50	3.06	3.23	23.60	31.01	3.68	4.56
EM	42.90	46.20	3.38	3.76	28.56	35.08	4.53	5.55
HA + EM	50.05	53.70	3.86	4.17	32.91	39.50	5.28	6.23
LSD 0.05	0.78	0.93	0.20	0.17	1.19	0.61	0.13	0.12
Magnetite								
without	40.8	43.13	2.98	3.33	25.22	31.88	3.91	4.75
MAG	44.0	47.05	3.30	3.55	27.59	34.15	4.38	5.18
F. test	*	*	*	*	*	*	*	*

HA: humic acid EM: effective micro-organisms MAG: magnetite
100% NPK: (40kg N_2, 30 kg P_2O_5 and 50 kg K_2O) recommended mineral fertilizer

1.2. Effect of foliar applications

Data in Table (2) show the effect of Humic acid and EM on vegetative growth characters of pea plants. It is obvious from such data that vegetative growth parameters were promoted with all foliar application in both seasons upon control (tap water). In this respect, spraying plants with EM recorded the highest significant values than humic acid and control. The treatment which showed the highest response was the spray plants with a mixture of humic acid with EM as compared to Humic acid or EM alone or control treatments. 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). The benefits of EM compound are stated by Abou-Hussein *et al.* (2002a) and Anwar (2005) who mentioned that it increases microorganisms living in the soil and help plant growth by increasing the number and biological activity of desired microorganisms in the root environment and its ability to release plant growth promoter, activate absorption and efficiency of nutrients as well as the metabolism processes and improved root growth and functions. These results are in harmony with those reported by Khan *et al.* (2012) on pea, El-Bassiony *et al*. (2010). Hanafy *et al.* (2010) on snap bean, El-Hefny (2010) and Azarpour *et al*. (2011) on cowpea

1.3. Effect of magnetite

Also data in Table (2) show the effect of Magnetite on vegetative characters of pea plants. It is clear from such data that Magnetic treatments improved plant height, number of branches, and number of leaves per plant and dry weight of total plant compared to control. It was also clear that all previously mentioned characters were progressively increased with application of magnetite compared to control plants. The satisfactory stimulation of plant growth due to the application of magnetite may be referred to the increment in the available nutrients (N, P, K, Ca, S and Fe) and reduction of Mg, Na and Cl in soil along with the encouragement of N, P, K, Ca, S and Fe uptake and reduction of Na, Cl and Mg uptake in leaves (Ramadan, 2012). Moreover, the magnetic process separate all chlorine, toxic and harmful gases from soil hence increasing salt movement and solubility of nutrients (Hilal, 1999; Anonymous, 2006). Magnetic treatments may affect phyto-hormone production leading to improved cell activity and plant growth (Maheshwari, 2009).

1.4 Effect of interactions

It is evident in Table (3) that interaction between NPK levels and foliar application had a significant effect on plant height, number of leaves per plant and dry weight of plant, while number of branches had no significant effect in both growing seasons. It is clear that interaction between NPK 100 % and humic acid + EM being the most effective treatments and recorded the greatest increments of plant height, number of leaves per plant and dry weight of plant in both seasons

Also, it is quite clear from data in Table (3) that the interaction between NPK levels and magnetite had no significant effect on all growth parameter, except of plant height in both seasons and number of leaves per plant in first season. Such results in Table (3) indicate that the interaction between foliar applications and magnetite had a significant effect on plant height and number of leaves/plant; meanwhile, number of branches and dry weight of plant were not significantly affected. Spraying plants with HA+ EM and application of 150 kg/fed of Magnetite recorded the highest values of plant height and number of leaves/plant.

Concerning the effect of interaction among NPK levels, foliar applications and magnetite on vegetative characters of pea plant, i.e., plant height, number of branches and leaves are shown in Table (4). Data show that interaction among NPK levels, foliar applications and magnetite had a significant effect on all vegetative characters except number of branches in both seasons. It is clear that interaction among 100 % NPK plus HA + EM and 150 kg/fed of magnetite being the most effective treatments and recorded the greatest increments of plant height, number of leaves per plant and dry weight /plant in both seasons followed by 100 % NPK plus EM and 150 kg/fed. Treatment of 100 % NPK plus HA and 150 kg/fed came in the third order. It is worth to notice that application of 50% NPK and EM, HA or EM+HA plus magnetite recorded higher significant values of all measured parameters except

Table (3): Effect of dual interaction between NPK levels, foliar applications and Magnetite on vegetative characters of pea plant during 2010-2011 and 2011-2012 seasons.

Interaction between NPK level and Foliar applications									
Characters / Treatments		Plant height (cm)		No. of branches/ plan		No. of leaves / plant		Dry weight / plant (gm)	
NPK level	Foliar applications	Seasons							
		2010	2011	2010	2011	2010	2011	2010	2011
25% N P K	Control	30.3	31.0	1.77	2.61	14.50	17.73	1.99	2.56
	HA	33.6	34.8	2.27	3.22	17.67	22.05	2.70	3.37
	EM	36.3	38.1	2.70	3.76	20.15	25.80	3.40	4.07
	HA + EM	43.8	47.5	3.15	4.16	24.19	27.81	4.03	4.56
50% N P K	Control	36.3	37.5	2.20	1.94	18.73	25.33	3.44	3.76
	HA	41.6	44.0	3.09	2.35	22.33	31.50	3.85	4.66
	EM	42.6	46.5	3.35	3.05	25.91	36.50	4.22	5.54
	HA + EM	48.0	53.3	3.77	3.21	31.65	42.13	4.97	6.27
100% N P K	Control	42.6	45.0	2.86	2.57	28.40	36.30	3.88	4.24
	HA	45.6	48.8	3.82	3.35	30.81	39.41	4.48	5.65
	EM	49.8	54.0	4.09	3.80	39.61	42.86	5.96	7.03
	HA + EM	58.3	60.5	4.65	4.23	42.88	48.56	6.85	7.94
LSD at 0.05		1.3	1.6	N.S	N.S	2.06	1.06	0.22	0.21
Interaction between NPK level and Magnetite									
NPK level	Magnetite	Seasons							
		2010	2011	2010	2011	2010	2011	2010	2011
25% N P K	without	34.7	36.1	2.32	2.57	18.25	22.40	2.85	3.45
	MAG.	37.3	39.5	2.63	2.70	20.00	24.20	3.20	3.81
50% N P K	without	40.4	43.1	2.93	3.37	23.11	32.59	3.85	4.84
	MAG.	43.9	47.5	3.28	3.60	26.20	35.18	4.39	5.27
100% N P K	without	47.5	50.1	3.70	4.05	34.29	40.50	5.03	5.95
	MAG.	50.7	54.1	4.01	4.35	36.56	42.90	5.56	6.48
LSD at 0.05		0.5	0.8	N.S	N.S	0.58	N.S	N.S	N.S
Interaction between foliar applications and Magnetite									
Foliar applications	Magnetite	Seasons							
		2010	2011	2010	2011	2010	2011	2010	2011
Control	without	35.2	36.5	2.91	2.50	19.85	25.4	2.87	3.33
	MAG.	37.7	39.1	3.21	2.72	21.23	27.4	3.33	3.71
HA	without	39.1	40.7	3.21	3.12	22.57	30.6	3.40	4.44
	MAG.	41.5	44.3	3.55	3.33	24.63	31.4	3.95	4.68
EM	without	41.8	43.8	3.72	3.65	26.99	33.6	4.35	5.31
	MAG.	44.0	48.5	3.99	3.87	30.13	36.5	4.70	5.78
HA + EM	without	47.3	51.3	2.91	4.05	31.45	37.8	5.01	5.92
	MAG.	52.7	56.2	3.21	4.27	34.36	41.2	5.56	6.55
LSD at 0.05		0.6	0.8	N.S	N.S	0.67	0.83	N.S	N.S

HA: humic acid EM: effective micro-organisms MAG: magnetite

100% NPK: (40kg N_2, 30 kg P_2O_5 and 50 kg K_2O) recommended mineral fertilizer

Table (4): Effect of interaction among NPK levels, foliar applications and magnetite on vegetative characters of pea plant during 2010-2011 and 2011-2012 seasons.

Characters / Treatments			Plant height (cm)		No. of branches/ plant		No. of leaves / plant		Dry weight / Plant (gm)	
NPK level	Foliar applications	Magnetite	Seasons							
			2010	2011	2010	2011	2010	2011	2010	2011
25 % N P K	Control	without	28.6	29.6	1.66	1.88	14.01	16.80	1.88	2.40
		MAG.	32.0	32.3	1.88	2.00	15.00	18.60	2.10	2.73
	HA	without	33.0	33.3	2.10	2.20	16.50	20.80	2.44	3.19
		MAG.	34.3	36.3	2.44	2.50	18.84	23.20	2.96	3.56
	EM	without	35.3	36.0	2.55	2.99	19.20	25.16	3.23	3.92
		MAG.	37.3	40.3	2.86	3.11	21.09	26.60	3.57	4.21
	HA + EM	without	42.0	45.6	2.98	3.21	23.31	26.90	3.86	4.31
		MAG.	45.6	49.3	3.32	3.21	25.08	28.60	4.20	4.68
50 % N P K	Control	without	35.3	36.3	1.98	2.40	17.25	24.00	3.08	3.52
		MAG.	37.4	38.6	2.43	2.75	20.21	26.60	3.80	4.00
	HA	without	39.3	41.6	2.98	3.30	21.33	32.70	3.63	4.73
		MAG.	44.0	46.3	3.20	3.40	23.30	30.46	4.07	4.58
	EM	without	42.0	43.3	3.10	3.73	23.60	34.30	3.90	5.35
		MAG.	43.3	49.6	3.60	3.86	28.20	38.60	4.50	5.74
	HA + EM	without	45.0	51.3	3.65	4.06	30.20	39.30	4.75	5.78
		MAG.	51.0	55.3	3.88	4.40	33.06	44.90	5.20	6.76
100 % N P K	Control	without	41.6	43.6	2.63	3.22	28.30	35.60	3.65	4.07
		MAG.	43.6	46.3	3.08	3.42	28.50	37.00	4.11	4.40
	HA	without	45.0	47.3	3.65	3.86	29.90	38.30	4.15	5.41
		MAG.	46.3	50.3	4.00	4.11	31.73	40.50	4.82	5.90
	EM	without	48.0	52.3	3.98	4.22	38.13	41.30	5.90	6.66
		MAG.	51.3	55.6	4.20	4.66	41.10	44.40	6.03	7.40
	HA + EM	without	55.0	57.0	4.54	4.88	40.80	47.10	6.43	7.66
		MAG.	61.6	64.0	4.77	5.22	44.90	50.03	7.28	8.21
LSD 0.05			1.1	1.5	N.S	N.S	1.16	1.44	0.26	0.34

HA: humic acid EM: effective micro-organisms MAG: magnetite
100% NPK: (40kg N_2, 30 kg P_2O_5 and 50 kg K_2O) recommended mineral fertilizer
number of branches as compared to 100% NPK alone (control).

2. Yield and its component

2.1. Effect of NPK levels

The effect of NPK levels on yield and its components of pea plants are presented in Table (5). Results showed that there were significant effects on pod length, number of seeds per pod, weight of 100 seeds and green pods yield per fed in both seasons. Total yield and its components were gradually increased with increasing NPK fertilizer level. The maximum values were recorded with 100% NPK as recommended dose.

These results may be due to the role of mineral fertilizer such as nitrogen on chlorophyll, enzymes and protein synthesizes, phosphorous on root growth and development and potassium on promotion of enzymes activity and enhancing the translocation of assimilates (Yadav *et al*., 2005). Also the increase of pea yield may be due to increment of vegetative growth parameters as shown in Table (2). Similar results were found by Kakar *et al*. (2002) on pea, Kehinde *et al*. (2011) on eggplant, and Imamsaheb *et al.* (2011) on tomatoes.

Table (5): Effect of NPK levels, foliar applications and magnetite on yield and its components during 2010-2011 and 2011-2012 seasons.

Characters	Pod length (cm)		No. of seeds/ pod		Wt. of 100 seeds (gm)		Green pods yield tons/fed	
Treatments	Seasons							
	2010	2011	2010	2011	2010	2011	2010	2011
NPK level.								
25% N P K	7.91	9.60	7.79	8.21	40.59	41.35	3.131	3.189
50% N P K	8.35	10.58	8.21	9.08	47.35	48.05	3.705	3.725
100% N P K	8.47	11.26	8.83	9.54	52.86	53.83	4.344	4.360
LSD 0.05	0.20	0.47	0.49	0.92	0.29	0.38	0.031	0.015
Foliar applications								
Control	7.68	9.55	7.33	8.05	43.09	43.65	3.415	3.455
HA	8.14	10.49	8.11	8.67	46.09	47.10	3.667	3.692
EM	8.32	10.58	8.50	9.16	47.89	48.73	3.808	3.837
HA + EM	8.82	11.29	9.16	9.89	50.67	51.51	4.018	4.059
LSD 0.05	0.22	0.48	0.47	0.67	0.42	0.52	0.026	0.011
Magnetite								
without	7.68	10.27	8.03	8.69	46.22	46.92	3.687	3.709
MAG.	8.14	10.69	8.52	9.19	47.65	48.57	3.767	3.807
F. test	*	*	*	*	*	*	*	*

HA: humic acid EM: effective micro-organisms MAG: magnetite
100% NPK: (40kg N_2, 30 kg P_2O_5 and 50 kg K_2O) recommended mineral fertilizer

2.2. Effect of foliar application

Data in Table (5) show the effect of Humic acid and EM on yield and its components. Results clear that yield and its components of pea plants were significantly affected by spraying with humic acid and EM either in single form or mixed together compared with control (tap water). Application of humic acid + EM being the most effective treatment and recorded the greatest increments yield and its components of pea plants in both seasons.

The increase in yield may be due to that humic acids enhance the absorbance capacity of nutrients of the roots by having carboxyllic and phenolic groups and increasing H^+-ATP activity in the root cells (Canellas *et al.,* 2002). Dorneanu *et al.* (2008) reported that humic acid enhances the penetration of nutritive ions in leaves, stimulates the formation of some physiological active metabolite compounds and enlarge the capacity of plants for root absorption of elements from soil. The influence of biofertilizer (EM) may be due to increasing microorganisms in the soil, which convert the unavailable forms of nutrients elements to available forms. As well as producing growth promoting substances which increase the plant growth parameters as shown in Table (2), which reflected on yield and its components.

2.3. Effect of magnetite

As presented in Table (5) the effect of magnetite on yield and its components, such results clear that Magnetite application significantly improved pod length, number of seeds per pod, weight of 100 seeds and green pods yield/fed as compared with untreated plants. Many workers found that magnetite (magnetic iron) application increased the yield of many

vegetable crops (Abd El-Al, 2003 on eggplant; Ramadan, 2008 on cauliflower; El-Hifny, 2010 on celery Ramadan, 2012 on cabbage).

2.4 Effect of interactions

Such results in Table (6) indicate that interaction between NPK levels and foliar applications had a significant effect on yield and its components, except pod length in first season only and number of seeds /pod in both seasons, the best interaction between NPK and foliar application were recorded with application of 100% NPK and spraying pea plant with (humic acid + EM).

Table (6): Effect of dual interaction between NPK levels, foliar applications and Magnetite on yield and its components of pea plant during 2010-2011 and 2011-2012 seasons.

Interaction between NPK level and Foliar applications									
Characters / Treatments		Pod length (cm)		No. of seeds/ pod		Wt. of 100 seeds(gm)		Green pods yield tons/fed	
NPK level	Foliar applications	Seasons							
		2010	2011	2010	2011	2010	2011	2010	2011
25% N P K	Control	7.31	8.25	6.67	7.16	37.35	37.88	2.717	2.802
	HA	7.98	9.67	7.83	7.83	40.50	41.22	3.064	3.097
	EM	7.98	9.83	8.17	8.50	41.70	42.32	3.287	3.384
	HA + EM	8.35	10.67	8.50	9.33	42.81	44.02	3.458	3.472
50% N P K	Control	7.73	9.75	7.50	8.00	43.10	43.60	3.422	3.436
	HA	8.25	10.57	8.00	9.00	45.23	46.23	3.600	3.649
	EM	8.41	10.58	8.17	9.50	48.28	49.37	3.768	3.750
	HA + EM	8.76	11.42	9.17	9.83	52.80	53.03	4.030	4.067
100% N P K	Control	8.00	10.66	7.83	9.00	48.83	49.47	4.106	4.128
	HA	8.20	11.25	8.50	9.16	52.55	53.85	4.337	4.330
	EM	8.58	11.33	9.17	9.50	53.68	54.52	4.369	4.376
	HA + EM	9.36	11.78	9.83	10.50	56.38	57.50	4.566	4.607
LSD at 0.05		0.37	NS	NS	NS	0.73	0.90	0.045	0.019
Interaction between NPK level and Magnetite									
NPK level	Magnetite	Seasons							
		2010	2011	2010	2011	2010	2011	2010	2011
25% N P K	without	7.75	9.33	7.42	7.83	39.88	40.52	3.100	3.133
	MAG.	8.07	9.87	8.17	8.58	41.30	42.19	3.163	3.244
50% N P K	without	8.17	10.34	8.00	8.92	46.67	47.29	3.665	3.682
	MAG.	8.34	10.82	8.42	9.25	48.03	48.82	3.745	3.769
100% N P K	without	8.53	11.13	8.67	9.33	52.10	52.95	4.295	4.312
	MAG.	8.62	11.38	9.00	9.75	53.62	54.72	4.393	4.408
LSD at 0.05		NS	NS	NS	NS	NS	NS	NS	NS
Interaction between foliar applications and Magnetite									
Foliar applications	Magnetite	Seasons							
		2010	2011	2010	2011	2010	2011	2010	2011
Control	without	7.58	9.44	7.00	7.67	42.178	42.44	3.364	3.400
	MAG.	7.79	9.67	7.67	8.44	44.011	44.85	3.466	3.511
HA	without	8.03	10.04	7.89	8.55	45.622	46.57	3.634	3.659
	MAG.	8.25	10.94	8.33	8.77	46.567	47.62	3.700	3.724
EM	without	8.11	10.35	8.22	9.00	47.444	48.25	3.779	3.781
	MAG.	8.54	10.81	8.78	9.33	48.333	49.21	3.837	3.893
HA + EM	without	8.60	11.23	9.00	9.55	49.633	50.41	3.969	3.997
	MAG.	9.05	11.34	9.33	10.22	51.700	52.62	4.067	4.101
LSD at 0.05		NS	NS	NS	NS	0.50	0.67	0.025	0.160

HA: humic acid EM: effective micro-organisms Mag: magnetite

100% NPK: (40kg N_2, 30 kg P_2O_5 and 50 kg K_2O) recommended mineral fertilizer

In the same in Table (6) results indicate that interaction between foliar applications and magnetite had no significant effect on pod length and number of seeds/pod, meanwhile, it had a significant effect on weight of 100 seeds and green pods yield/fed.

Concerning the effect of interaction among NPK levels, foliar applications and magnetite, results in Table (7) show that no significant effect on pod length, number of seeds per pod and weight of 100 seeds is detected, while green pod yield per feddan is significantly affected by the triple interaction.

Table (7): Effect of interaction among NPK levels, foliar applications and magnetite on yield and its components during 2010-2011and 2011-2012 seasons.

Characters / Treatments			Pod length (cm)		No. of seeds/ pod		Wt. of 100 seeds (gm)		Green pods yield tons/fed	
NPK level	Foliar applications	Magnetite	Seasons							
			2010	2011	2010	2011	2010	2011	2010	2011
25 % N P K	Control	without	7.100	8.167	6.00	6.66	36.13	36.567	2.632	2.712
		MAG.	7.533	8.333	7.33	7.66	38.56	39.200	2.802	2.893
	HA	without	7.933	9.167	7.67	7.667	40.00	40.800	3.050	3.080
		MAG.	8.033	10.16	8.00	8.000	41.00	41.633	3.077	3.114
	EM	without	7.900	9.333	7.67	8.333	41.46	41.667	3.281	3.292
		MAG.	8.067	10.33	8.67	8.667	41.93	42.967	3.293	3.476
	HA + EM	without	8.067	10.67	8.33	8.667	41.93	43.067	3.436	3.451
		MAG.	8.633	10.66	8.67	10.00	43.70	44.967	3.481	3.494
50 % N P K	Control	without	7.967	9.500	7.33	7.667	42.36	42.667	3.392	3.397
		MAG.	7.800	10.00	7.66	8.333	43.83	44.533	3.453	3.475
	HA	without	8.000	10.13	7.66	9.000	44.83	45.533	3.566	3.599
		MAG.	8.500	11.00	8.33	9.000	45.63	46.933	3.634	3.699
	EM	without	8.067	10.40	8.00	9.333	47.76	49.200	3.714	3.712
		MAG.	8.767	10.76	8.33	9.667	48.80	49.533	3.823	3.789
	HA + EM	without	8.667	11.33	9.00	9.667	51.73	51.767	3.988	4.020
		MAG.	8.867	11.50	9.33	10.00	53.87	54.300	4.072	4.115
100 % N P K	Control	without	7.967	10.67	7.66	8.667	48.03	48.100	4.069	4.092
		MAG.	8.030	10.67	8.00	9.333	49.63	50.833	4.143	4.165
	HA	without	8.167	10.83	8.33	9.000	52.03	53.400	4.285	4.300
		MAG.	8.233	11.67	8.66	9.333	53.06	54.300	4.389	4.361
	EM	without	8.367	11.33	9.00	9.333	53.10	53.900	4.343	4.339
		MAG.	8.800	11.33	9.33	9.667	54.26	55.133	4.394	4.414
	HA + EM	without	9.067	11.70	9.66	10.33	55.23	56.400	4.484	4.520
		MAG.	9.667	11.86	10.0	10.66	57.53	58.600	4.648	4.694
LSD 0.05			NS	NS	NS	NS	NS	NS	0.044	0.029

HA: humic acid EM: effective micro-organisms Mag: magnetite
100% NPK: (40kg N_2, 30 kg P_2O_5 and 50 kg K_2O) recommended mineral fertilizer

The highest values of green pod yield per feddan were recommended dose plus magnetite and sprayed with (humic acid + EM).

It is worth to notice that application of 50% NPK and spraying plants with humic acid + EM plus magnetite recorded higher values of green pod yield per feddan as compared to 100% NPK alone (control) without significant difference between both treatments.

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تـاثير اضـافة الماجنيتيـت ،حمـض الهيومـك و التسـميد الحيـوي مـع مسـتويات مـن التسميد المعدني علي النمو والمحصول في البسلة

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****** قسم بحوث الخضر- معهد بحوث البساتين – مركز البحوث الزراعية.**

أجريت تجربتان حقليتان خلال موسمي٢٠١٠-٢٠١١ ، ٢٠١١-٢٠١٢ بمزرعة محطة بحوث البساتين بالقصاصين ، محافظة الإسماعيلية، لدراسة تأثير الماجنتيت ، حمض الهيوميك وال EM بالاضافة الى مستويات مختلفة من التسميد المعدنى الموصى به والتفاعل بينهم على النمو و والمحصول ومكوناته تحت ظروف الأراضي الرملية.

ادي زيادة مستوى التسميد المعدني الي١٠٠% من التسميد الموصى به الي زياده معنوية في النموالخضرى (ارتفاع النبات وعدد الافرع و الاوراق للنبات ، الوزن الجاف للنبات) وكذلك المحصول ومكوناته (طول القرن وعدد البذور للقرن ،وزن ١٠٠بذرة و محصول القرون الخضراء للفدان).

ادي رش نباتات البسلة بحمض الهيوميك + EM الي زياده معنوية في النمو (ارتفاع النبات وعدد الافرع و الاوراق للنبات ، الوزن الجاف للنبات)وكذلك المحصول ومكوناتة (طول القرن ،عدد البذور للقرن ،وزن١٠٠ بذرة و محصول القرون الخضراء للفدان). معاملة نباتات البسلة بالماجنتيت سجلت أعلى القيم بالنسبة لمعدلات للنمو (ارتفاع النبات وعدد الافرع و الاوراق للنبات ، الوزن الجاف للنبات) وكذلك المحصول ومكوناته (طول القرن ،عدد البذور للقرن ،وزن ١٠٠بذرة و محصول القرون الخضراء للفدان).

اضافة التسميد المعدني بمعدل ٥٠% مع الرش بحمض الهيوميك + EM و اضافة الماجنتيت بمعدل ١٥٠ كجم / فدان ادي الي تسجيل قيم عالية لجميع مقاييس النمو الخضرى والمحصول ومكوناته مقارنة بالتسميد بمعدل ١٠٠% من التسميد المعدني بدون اضافات (كنترول).

تسميد نباتات البسله بمعدل ١٠٠% من التسميد المعدني مع الرش بحمض الهيوميك + EM و اضافة الماجنتيت بمعدل ١٥٠ كجم / فدان ادى الى الحصول على أعلى القيم لجميع مقاييس النمو الخضرى والمحصول ومكوناته مقارنة بباقى المعاملات.

قام بتحكيم البحث

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