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RESPONSE OF GARLIC PLANTS GROWN IN SANDY SOILS TO ORGANIC AND INORGANIC FERTILIZERS

Sabah M. A. El-Gamal and A. H. Selim

Agric Botany Dept., Faculty of Agric., Minufiya Univ., Shibin El-Kom, Egypt.

ABSTRACT

Two pot experiments were carried out at the Experimental Farm, Faculty of Agriculture, Minufiya University during 2003/2004 and 2004/2005 seasons, to study the effect of humic acid and/or pigeon manure and NPK fertilizers alone and their combinations on the growth and chemical composition as well as yield and its quality of two garlic cultivars (Chinese and Balady cultivars) grown in sandy soils. The obtained results indicated that, significant increases in plant height, root system length, number of leaves/plant, length and diameter of neck, length and width of the 5th leaf as well as the fresh and dry weights of whole plant when they supplied with humic acid and/or pigeon manure combined with $^1/_2$ and 1NPK compared with organic manures or NPK treatments alone. Also, the same treatments gave higher concentrations of photosynthetic pigments, total carbohydrates, N, P and K in leaves and bulb, as well as higher yield ton/fed and a greater diameter of bulb as compared with the other treatments. The best vegetative growth and the highest total yield (ton/fed) were obtained when plants treated by pigeon manure or humic acid with 1 NPK or $^1/_2$ NPK. The respective increase in diameter of neck and width of the 5th leaf, fresh and dry weight of whole plant, total yield as well as bulb diameter were higher in Chinese cultivar, whereas the N,P, and K concentrations in leaves and bulb were greater in Balady cultivar. The highest yield was obtained by Chinese cultivar treated with pigeon manure with 1 or $^1/_2$ NPK.

Keywords: Garlic, humic acid, pigeon manure, NPK fertilization, chemical analysis and total yield.

INTRODUCTION

Garlic (*Allium sativum* L.) is one of the most important vegetable crops for local consumption and exportation. It is used as spice or condiment or for many medicinal purposes.

Because of the shortage of the cultivated lands, the state gives due care to the sandy soils. These soils have low fertility, low soil water retention as well as poor physical, chemical and biological properties. Therefore, growing vegetables in these soils are faced by the mentioned various problems. Improvement of such conditions could be accomplished by the addition not only the organic materials, but also the inorganic one.

Organic manures contain higher levels of relatively available nutritional elements which are essentially required for plant growth. Moreover, they play an important role for improving soil physical properties. Other authors added that, organic manures are slow release nitrogen ferttilizers where natural organic materials are broken down slowly by the soil microorganisms (Marschner, 1995 and Rizk, 2001). Moreover, organic fertilizer is considered as an important source of humus, macro and micro elements carrier, and at

the same time increases the activity of the useful microorganisms (El-Gizy, 1994). Alphonse and Saad (2000 b) showed that applying organic manure to the growing media significantly increased N, P and K contents in cucumber leaves.

Also, humic substances can regulate plant growth, improving physical and chemical soil properties, favouring a higher concentration of ions in soil and acting as a source and a sink for nutrient such as phosphorus (P), nitrogen (N), potassium (K) (Maria *et al.*, 2001). Recently, Norman *et al.* (2003) indicated that leaf area, plant heights and above ground dry matter weights considerably increased in plants grown in pots containing humic acids ranged from 20 to 4000 mg of humates/kg soil.

It is well known that inorganic fertilizer are essential in most cropping systems if maximum yields are to be realized. However, in long term field experiments where only inorganic fertilizers have been used, soil structure has been deteriorated and crop yield steadily decreased. The best means of maintaining soil fertility and productivity level could be achieved through periodic addition of proper organic materials in combination with inorganic fertilizers (Sakr *et al.*, 1992).

The combination of organic and mineral NPK fertilizers may increase productivity of garlic and reduce the plant contaminations by reducing the input of mineral-N (Osman, 2004). Also, Hiranmai and Vijayakumari (2003) found that FYM and neem cake and N, P, K fertilizing were effective in improving various biometric parameters. Moreover, Arisha *et al.* (2003) concluded that application of 40 m^3 farmyard manure + 120 or 180 kg N/fed. gave the highest total dry weight/plant, total NPK uptake, early and total average fruit weight, average fruit number/plant and early and total yield/fed. for pepper, cv, Balady.

Therefore, this investigation aimed to study the effects of humic acid and/or pigeon manure as organic fertilizers each alone or in combination with inorganic fertilizer on vegetative growth, chemical composition, as well as the yield and its quality of two garlic cultivars grown in sandy soils.

MATERIALS AND METHODS

Two pot experiments using sand soils (sand culture technique) were carried out at the Experimental Farm, Faculty of Agriculture, Minufiya University, Shibin El-Kom, during the growing 2003/2004 and 2004/2005 seasons to study the response of growth, chemical composition as well as yield and its quality of two garlic cultivars grown in sandy soil to organic manure and inorganic fertilizers.

Some physical and chemical properties of the experimental soil were as follows: pH = 8.0, Ec (dsm^{-1}) = 2.1, sand (%) = 85.0, silt (%) = 12.0, clay (%) = 3, available N (ppm) = 10.21 available P (ppm) = 11.4 and available K (ppm) = 60. Also, chemical analysis of humic acid according to Technogreen Groups Company and pigeon manure are shown in Table (1).

Table (1). Chemical analysis of humic acid and pigeon manure.

Humic acid Characters	Value	Pigeon manure Characters	Value
Potassium hummates (%)	56	Organic matter (%)	45
Potassium oxide (%)	16.5	pH	6.9
Fe (%)	2.4	EC (mmhos)	17.6
Mn (%)	1.2	N (%)	4.67
Zn (%)	0.5	P (%)	0.99
Cu (%)	0.6	K (%)	1.8
Polymers (%)	0.4	Fe (ppm)	6525
Amino acids (%)	3	Mn (ppm)	370
		Zn (ppm)	140
		Cu (ppm)	50
		Pb (ppm)	7.9
		Ni (ppm)	6.0

Planting was done on October, 1 and 10 for the first and second seasons, respectively. The pots used to have inner diameter of 50 cm filled with about 12 kg dry acid-washed sand.

This experiment included 18 treatments, two cultivars × nine treatments. The two used cultivars were Chinese and Balady. The fertilizer treatments were as follows:

1. Control (1 NPK) at the recommended rate 450 kg ammonium nitrate (33.0%), 300 kg/fed potassium sulphate (48% K_2O) and 200 kg/fed calcium superphosphate (15.5% P_2O_5).
2. Humic acid at the rate of 5 g/kg soil.
3. Humic acid at the rate of 5 g/kg soil + 1 NPK.
4. Humic acid at the rate of 5 g/kg soil + $^1/_2$ NPK.
5. Humic acid at the rate of 5 g/kg soil + $^1/_4$ NPK.
6. Pigeon manure at the rate of 6 m^3/fed.
7. Pigeon manure at the rate of 6 m^3/fed + 1 NPK
8. Pigeon manure at the rate of 6 m^3/fed + $^1/_2$ NPK
9. Pigeon manure at the rate of 6 m^3/fed + $^1/_4$ NPK

The pigeon manure was thoroughly mixed with 0 – 30 cm of the surface soil layer two weeks before sowing. Humic acid and calcium superphosphate were applied during soil preparation. While ammonium nitrate and potassium sulphate were equally divided and added every 7 days through irrigation water, beginning at four weeks after sowing.

The experimental design was split-plot in randomized complete block design with five replications. The cultivars were assigned as in the main plots, whereas, the fertilizer treatments were assigned at random in sub-plots.

After 135 days from sowing, five plants from each treatment were randomly taken and the following data for growth and chemical characters were recorded.

1. **Vegetative growth characters:** plant height (cm), root system length (cm), number of leaves/plant, length and diameter of the neck (cm), length and width of the 5th leaf, as well as fresh and dry weights of the whole plant (g).

2. Chemical analysis:

a- Photosynthetic pigments and total carbohydrates:

Photosynthetic pigments were estimated in fresh leaves as described by Wettestein (1957) and total carbohydrates concentration in dry matter determined colorimetrically using the phenol sulphuric acid method of Dubois *et al.* (1956). The previous parameters were calculated as mg/g dry weight.

b- Minerals concentrations: total nitrogen was estimated in the dry matter of leaves using Microkjeldahl method according to Ling (1963), while both P and K were determined as mentioned by A.O.A.C. (1990).

3. Yield and its quality:

a- Total yield and bulb diameter: At the harvest time (6 months after sowing) total yield as ton/feddan and diameter of bulb were recorded.

b. Minerals concentration in bulb: Total nitrogen was estimated using Microkjeldahl method according to Ling (1963), while both P and K were determined as mentioned by A.O.A.C (1990).

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

RESULTS AND DISCUSSION

1. Vegetative Growth characters:

Growth characters of Chinese and Balady garlic cultivars were affected by pigeon manure, humic acid and inorganic fertilizer and their combinations are presented in Table (2).

Concerning the effect of fertilizers on some growth characters of garlic, data showed that there are significant increases in plant height, root system length, number of leaves/plant, length and diameter of neck, length and width of the 5th leaf, as well as fresh and dry weights of whole plant when the plants supplied with humic acid or pigeon manure with $^1/_2$ NPK or 1 NPK compared with control or organic manure alone. In this concern, the best results were obtained from pigeon manure + 1 NPK followed by pigeon manure + $^1/_2$ NPK then Humic acid + 1 NPK. The positive effect of the combination treatments may be due to the positive effect of additional inorganic manure by soil microbes. Then, the release of plant nutrients increased and consequently, the plant growth was increased (Ewais *et al.*, 2004). The stimulative effect of organic manures contributed 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, moreover, it extends content of these nutrients (Fekry and Osman, 2005). Humic acid was more effective on dry matter production and this might be due to an increase in the permeability of cell membranes, so promoting the uptake of nutrients and reflected to high of dry matter content for plant (Albuzio *et al.*, 1994).

Table (2). Effect of humic acid, pigeon manure, mineral fertilizers and their combinations on some vegetative growth characters of garlic plant during 2003/2004 and 2004/2005 seasons.

Characters / Treatments	2003/2004 season														
	Plant height (cm)			Root system length(cm)			Number of leaves /plant			Length of neck (cm)			Diameter of neck (cm)		
Cvs / Fert.	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean
NPK (control)	48.0	50.0	49.0	11.0	12.0	11.5	6.00	6.00	6.00	8.00	7.50	7.75	0.80	0.70	0.75
HA alone	36.7	39.7	38.2	9.7	10.0	9.9	5.00	4.70	4.85	6.30	7.00	6.65	0.50	0.53	0.52
Pm alone	43.3	43.0	43.2	11.0	10.0	10.5	6.00	6.00	6.00	7.70	7.30	7.50	0.60	0.60	0.60
HA + 1 NPK	61.7	74.7	68.2	14.7	16.7	15.7	7.70	6.00	6.85	9.00	10.30	9.65	1.00	0.73	0.87
HA + 1/2 NPK	60.7	68.3	64.5	13.0	16.3	14.7	8.30	6.30	7.30	9.70	8.70	9.20	0.97	0.73	0.85
HA + 1/4 NPK	50.0	69.0	59.5	11.0	14.7	12.9	6.00	5.00	5.50	8.00	8.70	8.35	0.83	0.73	0.78
Pm + 1 NPK	66.0	79.3	72.7	14.7	15.1	14.9	8.70	7.70	8.20	10.70	9.30	10.00	1.10	0.73	0.92
Pm + 1/2 NPK	62.0	75.0	68.5	15.3	15.3	15.3	7.30	8.30	7.80	10.00	8.10	9.05	0.93	0.70	0.82
Pm + 1/4 NPK	55.0	65.7	60.4	12.8	12.7	12.8	7.00	7.00	7.00	8.00	8.10	8.05	0.80	0.65	0.73
Mean	53.7	62.7		12.6	13.6		6.89	6.33		8.60	8.33		0.84	0.68	
L.S.D 5% cvs		n.s		n.s			n.s			n.s			0.03		
Fert.		3.9		1.1			0.70			0.30			0.07		
Cv × Fert.		6.8		1.5			1.20			1.00			0.09		
	2004/2005 season														
NPK (control)	50.0	53.0	51.5	11.0	12.0	11.5	7.00	7.00	7.00	9.30	8.60	8.95	0.90	0.61	0.76
HA alone	38.3	40.0	39.2	9.0	11.7	10.4	5.00	4.85	4.93	7.00	6.00	6.50	0.57	0.40	0.49
Pm alone	39.3	45.0	42.2	10.0	11.0	10.5	6.30	6.15	6.23	7.50	7.00	7.25	0.60	0.58	0.59
HA + 1 NPK	66.0	77.3	71.7	15.0	18.0	16.5	8.00	7.50	7.50	10.00	9.00	9.50	1.00	0.77	0.89
HA + 1/2 NPK	55.3	67.7	61.5	13.7	16.3	15.0	8.00	7.65	7.83	10.70	8.50	9.60	1.00	0.73	0.87
HA + 1/4 NPK	52.3	54.4	53.4	11.0	14.0	12.5	7.70	7.35	7.53	11.00	8.00	9.50	0.83	0.63	0.73
Pm + 1 NPK	67.3	81.7	74.5	15.0	18.3	16.7	8.30	8.50	8.40	11.70	10.30	11.00	1.20	0.80	1.00
Pm + 1/2 NPK	61.7	71.0	66.4	14.0	17.3	15.7	9.70	8.70	9.20	9.70	9.00	9.35	1.03	0.80	0.92
Pm + 1/4 NPK	59.7	66.7	63.2	13.7	15.0	14.4	7.70	6.85	7.28	8.50	8.30	8.40	0.90	0.75	0.83
Mean	54.4	61.9		12.5	14.8		7.52	7.17		9.49	8.30		0.89	0.67	
L.S.D 5% cvs	n.s.			0.9			n.s.			n.s.			0.03		
Fert.	6.4			0.9			0.70			0.60			0.07		
Cv × Fert.	9.5			1.2			1.20			0.63			1.00		

HA = humic acid (5g / kg soil) Pm = pigeon manure (6 m^3/fed.) NPK = 1 NPK (recommended doses)

Table (2). Continued.

Characters / Treatments / Cvs / Fert.	Length of the 5th leaf (cm)			Width of the 5th leaf (cm)			Fresh weight / plant (g)			Dry weight / plant (g)		
	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean
2003/2004 season												
NPK (control)	26.0	30.0	28.0	1.00	1.10	1.10	60.3	45.2	52.8	15.50	10.60	13.05
HA alone	19.0	24.0	21.5	0.80	0.80	0.80	25.4	20.9	23.2	8.45	5.20	6.83
Pm alone	26.7	26.0	26.4	0.80	0.90	0.85	30.9	22.3	26.6	9.54	6.97	8.26
HA + 1 NPK	31.0	42.7	36.9	1.50	1.01	1.26	80.9	56.4	68.7	16.59	12.82	14.71
HA + 1/2 NPK	26.0	37.7	31.9	1.40	1.01	1.21	76.5	51.1	63.8	15.10	10.10	12.60
HA + 1/4 NPK	24.0	30.0	27.0	0.90	1.00	0.95	59.7	43.0	51.4	12.20	9.20	10.70
Pm + 1 NPK	30.7	42.3	36.5	1.80	1.30	1.55	87.8	60.5	74.2	18.40	12.08	15.24
Pm + 1/2 NPK	28.0	40.0	34.0	1.60	1.30	1.45	85.5	58.8	72.2	17.60	11.53	14.57
Pm + 1/4 NPK	25.0	37.7	31.4	1.40	1.20	1.30	64.6	45.5	55.1	14.96	9.50	12.23
Mean	26.3	34.5		1.24	1.07		63.5	44.9		14.26	9.78	
L.S.D 5% cvs	n.s			0.04			3.6			0.28		
Fert.	1.3			0.08			7.8			0.64		
Cv × Fert.	2.0			0.12			10.8			0.83		
2004/2005 season												
NPK (control)	26.0	30.0	28.0	1.00	1.00	1.00	55.0	43.2	49.1	13.50	8.20	10.85
HA alone	20.0	20.3	20.2	0.73	0.70	0.72	25.4	20.7	23.1	7.56	5.56	6.56
Pm alone	23.0	20.7	21.9	0.90	0.60	0.75	28.2	25.4	26.8	8.57	6.10	7.34
HA + 1 NPK	35.3	39.0	37.2	1.50	1.30	1.40	83.4	57.4	70.4	18.00	12.90	15.45
HA + 1/2 NPK	30.0	36.0	33.0	1.30	1.30	1.30	80.7	51.4	66.1	16.50	12.00	14.25
HA + 1/4 NPK	28.7	26.0	27.4	1.20	1.10	1.15	49.6	40.2	44.9	10.73	8.00	9.37
Pm + 1 NPK	35.0	40.7	37.9	1.60	1.40	1.50	84.0	61.5	72.8	19.50	13.40	16.45
Pm + 1/2 NPK	33.3	35.0	34.2	1.50	1.20	1.35	88.9	58.3	73.6	18.10	12.73	15.42
Pm + 1/4 NPK	29.7	30.0	29.9	1.30	1.00	1.15	52.4	45.6	49.0	13.30	9.09	11.20
Mean	29.0	30.9		1.23	1.07		60.8	44.9		13.97	9.78	
L.S.D 5% cvs	n.s			0.002			1.8			0.43		
Fert.	1.8			0.050			3.9			0.69		
Cv × Fert.	2.5			0.070			5.5			1.30		

HA = humic acid (5g / kg soil) Pm = pigeon manure (6 m^3/fed.) NPK = 1 NPK (recommended doses)

As for the effect of garlic cultivars on growth characters, data presented in Table (2) indicated that there were significant differences among garlic cultivars in growth characters, especially the diameter of neck and width of the 5th leaf, as well as fresh and dry weights of whole plant. In this respect, the Chinese cultivar showed the highest values. The results were similar in the two growing seasons.

Concerning the effect of the interactions between fertilizers treatments and garlic cultivars, the results indicated generally that, the Chinese cultivar treated with pigeon manure + 1 NPK gave the best growth compared with the other combinations. The diameter of neck was increased by 37.5% and 33.3%, fresh weight of plant by 45.6% and 52.7% as well as dry weight of plant by 18.7% and 44.4% over the control plants (NPK alone) in the first and second seasons, respectively. The stimulation effects of applying nitrogen on vegetative growth characters of garlic plants may be attributed to the well known functions of nitrogen in plant life, being a part of protein, it is an important constituent of protoplasm. Also, enzymes, the biological catalytic agent, which speed up life processes, have N as their major constituents. Moreover, nitrogen involves in many organic compounds of plant system. A sufficient supply of various nitrogenous compounds is, therefore, required in each plant cell for its proper function (Mengel and Kirkby, 1987). These results agree with those reported by Arisha and Bardisi (1999). The above mentioned data can be justified on the role of phosphorus element as an essential component of the energy transfer compounds, genetic information system, cell membranes and phosphoproteins (Gardener *et al.,* 1985). Application of nitrogen, phosphorus and potassium fertilizers to pea plants caused significant increments in plant growth characters (Mohamed *et al.,* 1994 and Ewais *et al.,* 2004).

2. Chemical analysis:

a- Photosynthetic pigments and total carbohydrates concentrations:

The effect of organic manure (pigeon manure and humic acid) alone or in combined with inorganic fertilizers on the concentration of pigments and total carbohydrates in garlic leaves are presented in Table (3). The results indicated that concentrations of chl. (a + b) and carotenoids as well as the total carbohydrates were significantly increased when the plants treated with humic acid and/or pigeon manure combined with inorganic fertilizer compared with each fertilizer alone. The maximum increases were detected at the treatment pigeon manure + 1 NPK over all other treatments. These results are in agreement with those obtained by Sujutha and Krishnappa (1995), who found that application of organic manure improved the physical condition of the soil. Nardi *et at.* (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. Moreover, the enhancing effect of NPK may be due to that these elements stimulated chlorophyll biosynthesis and play an important role in chloroplast stability (Mengel and Kirkby, 1987). These findings may prove the role of phosphorus

in stimulating chlorophyll synthesis through encouraging 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). In this respect, Maiti *et al.* (1988) reported that leaf chlorophyll concentration of mungbean plants was pronounced at higher level of phosphorus fertilizer (100 kg P_2O_5/ha).

Concerning the cultivars effect, results in Table (3) showed that the Chinese cultivar had a significant increase in chl. (a + b) and total carbohydrates concentration as compared with the Balady cultivar. The results were similar in the two seasons.

As for the interaction effect, it is clear from the given data in Table (3) that the highest values in chl. (a + b) as well as total carbohydrates were obtained by the Chinese cultivar supplied with pigeon manure or humic acid + 1 NPK.

b- Minerals concentration:

Data of minerals concentration affected by applied organic and mineral fertilizers are given in Table (3). Results indicated that an addition of mineral fertilizers induced a more beneficial effect on N, P and K concentrations compared with addition of organic manures alone. Data also indicated that adding of organic manure with mineral fertilizers to sandy soil had a marked effect on the concentrations of N, P and K. The highest values N and P were obtained with pigeon manure combined with $^1/_2$ or 1 NPK compared with other treatments, whereas the highest value of K was obtained with humic acid plus 1 NPK. This was due to increase the available contents of organic manure and mineral fertilizer application. These results are in agreement with those observed by Aly (1999) who found a significant increase in N, P and K contents in maize as a result of combined effect of organic manure and inorganic (NPK) fertilizers applied to sandy soil. So, the application of organic manure to sandy soil increased the efficiency of mineral fertilizers used. Also, organic material improves the physical and chemical properties of sandy soil through its ability to absorb nutrients on active groups of colloidal surfaces, consequently, increased the efficiency of nutrients uptake by plants which reflected on plant growth and productivity (Ewais *et al.*, 2004). In spite of, humic acids have been reported to enhance mineral nutrient uptake by plants, by increasing the permeability of membranes of the root cells (Valdrighi *et al.*, 1996).

As for the effect of cultivars on the N, P and K concentrations Balady cultivar had higher N, P and K concentrations than Chinese cultivar in both seasons. Results also indicated that the interaction effect between cultivars and fertilizers on N, P and K concentrations, were significant in both seasons. Balady cultivar gave the highest N, P and K concentrations when plants treated with pigeon manure or humic acid + 1 NPK.

3. Yield and its quality:

a- Total yield and bulb diameter

Data presented in Table (4) indicated that total yield and bulb diameter were significantly increased when plants supplied with NPK alone compared with the organic fertilizers. The treatments received humic acid or pigeon manure + 1 NPK or $^1/_2$ NPK gave the highest significant increase in total yield and diameter of bulb.

Table (3). Effect of humic acid, pigeon manure, mineral fertilizers and their combinations on photosynthetic pigments, total carbohydrates and minerals concentration of garlic leaves during 2003/2004 and 2004/2005 seasons.

Characters / Treatments / Cvs / Fert.	Total chl. (a + b) (mg/g d.wt)			Carotenoids (mg / g d.wt)			Total carbohydrates (mg/g d.wt)			N %			P %			K %		
	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean
2003/2004 season																		
NPK (control)	4.30	4.00	4.20	2.56	2.70	2.63	300.0	285.3	292.7	2.70	2.90	2.80	0.25	0.26	0.26	2.50	2.80	2.65
HA alone	2.97	2.59	2.78	1.75	1.50	1.63	200.0	234.2	217.1	2.10	2.10	2.10	0.15	0.20	0.18	2.00	2.20	2.10
Pm alone	3.13	3.10	3.12	1.97	2.00	1.99	273.8	241.9	257.9	2.40	2.30	2.35	0.19	0.20	0.20	2.20	2.20	2.20
HA + 1 NPK	6.85	5.38	6.12	3.70	3.97	3.84	421.0	385.9	403.5	3.00	3.40	3.20	0.43	0.46	0.45	3.50	4.50	4.00
HA + 1/2 NPK	5.88	4.78	5.33	3.80	3.00	3.40	390.0	308.6	349.3	2.80	3.00	2.90	0.30	0.38	0.34	3.00	2.80	2.90
HA + 1/4 NPK	4.73	3.64	4.19	2.80	2.67	2.74	361.7	291.1	326.4	2.70	2.90	2.80	0.23	0.30	0.27	2.80	2.60	2.70
Pm + 1 NPK	6.35	5.77	6.06	3.25	3.99	3.62	577.7	429.7	503.7	3.90	4.20	4.05	0.45	0.49	0.47	3.40	4.00	3.70
Pm + 1/2 NPK	6.02	5.00	5.51	2.97	3.50	3.24	410.0	364.2	387.1	3.60	3.80	3.70	0.31	0.33	0.32	3.00	3.00	3.00
Pm + 1/4 NPK	4.62	4.54	4.58	2.50	2.80	2.65	337.1	278.3	307.7	2.80	2.90	2.85	0.24	0.30	0.27	2.60	2.90	2.75
Mean	4.98	4.31		2.81	2.90		363.5	313.2		2.89	3.05		0.28	0.32		2.78	3.00	
L.S.D 5% cvs	0.31			0.12			5.48			0.05			n.s			0.04		
Fert.	0.44			0.27			12.23			0.12			0.01			0.08		
Cv × Fert.	0.67			0.35			16.44			0.16			0.02			0.10		
2004/2005 season																		
NPK (control)	4.40	4.10	4.25	2.90	3.20	3.05	290.8	240.5	265.7	3.50	3.80	3.65	0.25	0.30	0.28	2.50	2.70	2.60
HA alone	3.07	2.43	2.75	2.03	1.90	1.97	206.7	190.4	198.6	2.20	2.30	2.25	0.17	0.21	0.19	1.90	2.00	1.95
Pm alone	3.27	2.63	2.95	2.00	2.00	2.00	243.3	203.3	223.3	2.30	2.40	2.35	0.20	0.22	0.21	2.10	2.20	2.15
HA + 1 NPK	6.32	5.47	5.90	3.60	3.90	3.75	418.6	276.0	347.3	3.90	4.30	4.10	0.43	0.46	0.45	3.00	4.30	3.65
HA + 1/2 NPK	5.00	4.47	4.74	3.77	3.60	3.69	362.8	247.2	305.0	3.90	4.10	4.00	0.32	0.36	0.34	2.90	3.20	3.05
HA + 1/4 NPK	4.60	4.17	4.40	3.50	2.70	3.10	310.5	274.2	292.4	2.60	4.00	3.30	0.24	0.28	0.26	3.40	3.60	3.50
Pm + 1 NPK	6.90	5.17	6.04	3.33	3.97	3.65	528.6	427.0	477.8	4.60	4.90	4.75	0.46	0.50	0.48	2.80	2.70	2.75
Pm + 1/2 NPK	6.37	4.27	5.32	3.00	3.63	3.32	400.3	327.0	363.7	4.10	4.50	4.30	0.34	0.44	0.39	2.50	3.00	2.75
Pm + 1/4 NPK	4.70	4.00	4.40	2.80	3.00	2.90	343.2	276.2	309.7	3.80	4.00	3.90	0.25	0.36	0.31	2.70	2.90	2.80
Mean	4.96	4.10		2.99	3.10		344.9	273.5		3.43	3.81		0.30	0.35		2.64	2.96	2.78
L.S.D 5% cvs	0.23			0.05			6.27			0.03			0.01			0.02		
Fert.	0.52			0.14			10.20			0.07			0.01			0.04		
Cv × Fert.	0.67			0.14			18.80			0.10			0.02			0.05		

HA = humic acid (5g / kg soil) Pm = pigeon manure (6 m^3/fed.) NPK = 1 NPK (recommended doses)

Table (4). Effect of humic acid, pigeon manure, mineral fertilizers and their combinations on total yield and some physical and chemical properties of garlic bulb during 2003/2004 and 2004/2005 seasons.

Characters / Treatments / Cvs / Fert.	2003/2004 season														
	Yield (ton / fed.)			Bulb diameter (cm)			N %			P %			K %		
	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean	Chinese	Balady	Mean
NPK (control)	7.24	5.42	6.33	3.80	2.60	3.20	2.40	2.80	2.60	0.20	0.25	0.23	2.30	2.50	2.40
HA alone	3.05	2.51	2.78	2.40	1.90	2.15	1.87	2.07	1.97	0.13	0.17	0.15	1.73	1.80	1.77
Pm alone	3.71	2.68	3.20	3.20	2.10	2.65	1.80	2.00	1.90	0.16	0.19	0.18	1.83	2.00	1.92
HA + 1 NPK	9.71	6.77	8.24	4.30	3.30	3.80	3.67	3.80	3.74	0.36	0.34	0.35	2.83	2.90	2.87
HA + 1/2 NPK	9.18	6.13	7.66	4.20	3.30	3.75	2.90	3.20	3.05	0.28	0.30	0.29	2.70	2.90	2.80
HA + 1/4 NPK	7.16	5.16	6.16	3.90	2.70	3.30	2.50	2.90	2.70	0.23	0.28	0.26	2.40	2.70	2.55
Pm + 1 NPK	10.54	7.26	8.90	4.30	3.90	4.10	2.80	3.50	3.15	0.39	0.46	0.43	2.63	2.90	2.77
Pm + 1/2 NPK	10.26	7.10	8.68	4.60	2.90	3.75	2.80	3.20	3.00	0.30	0.35	0.33	2.40	2.80	2.60
Pm + 1/4 NPK	7.75	5.46	6.61	4.10	2.80	3.45	2.50	3.00	2.75	0.22	0.27	0.25	2.30	2.60	2.45
Mean	7.62	5.39		3.87	2.83		2.58	2.94		0.25	0.29		2.35	2.57	
L.S.D 5% cvs	0.75			0.14			n.s			0.007			0.23		
Fert	1.80			0.43			0.27			0.010			0.22		
Cv × Fert.	2.20			0.46			0.90			0.008			0.29		
	2004/2005 season														
NPK (control)	6.60	5.18	5.89	4.00	3.50	3.75	2.30	2.60	2.45	0.22	0.25	0.24	2.20	2.60	2.40
HA alone	3.05	2.48	2.77	2.60	2.20	2.40	1.80	1.83	1.82	0.16	0.21	0.19	1.80	1.80	1.80
Pm alone	3.38	3.05	3.22	3.00	2.60	2.80	1.90	2.00	1.95	0.18	0.21	0.20	1.80	2.00	1.90
HA + 1 NPK	10.01	6.89	8.45	4.60	3.90	4.30	3.20	3.70	3.45	0.37	0.46	0.42	3.30	4.10	3.70
HA + 1/2 NPK	9.68	6.17	7.93	4.70	3.77	4.24	3.47	3.53	3.50	0.29	0.30	0.30	2.80	2.90	2.85
HA + 1/4 NPK	5.95	4.82	5.39	4.00	3.50	3.75	2.60	2.80	2.70	0.26	0.29	0.28	2.30	2.60	2.45
Pm + 1 NPK	10.08	7.38	8.73	4.77	3.70	4.24	3.00	4.20	3.60	0.40	0.43	0.42	3.60	4.30	3.95
Pm + 1/2 NPK	10.67	7.00	8.84	5.07	4.40	4.74	3.73	4.50	4.12	0.32	0.40	0.36	2.50	2.90	2.70
Pm + 1/4 NPK	6.29	5.47	5.88	4.83	4.10	4.47	2.70	2.73	2.72	0.30	0.28	0.29	2.40	2.80	2.60
Mean	7.30	5.38		4.17	3.52		2.74	3.09		0.28	0.31		2.52	2.89	
L.S.D 5% cvs	0.71			0.12			0.07			0.01			0.09		
Fert.	1.90			0.36			0.16			0.02			0.15		
Cv × Fert.	2.10			0.36			0.21			0.02			0.83		

HA = humic acid (5g / kg soil) Pm = pigeon manure (6 m^3/fed.) NPK = 1 NPK (recommended doses)

The addition of organic manure in the presence of inorganic NPK could help in increasing nutrients availability from applied and native sources (Ibrahim *et al.,* 1986). Also, 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 substances and in turn increased growth, dry matter accumulation, average weight and number of pods/ plant. Such results are in coincidence with those reported by Gabr (2000). Cheng *et al.* (1998) reported that spraying humic acids decreased the loss of soil moisture, enhanced the water retention, increased the ability rate of wheat leaves photosynthetic process, increased the grain filling intensity, enhanced the drought resistance of wheat and increased its thousand grains weight. The obtained data revealed also that the combination of humic acid and/or pigeon manure with inorganic NPK fertilizers were more effective on total yield and bulb diameter than the organic manure treatments alone. The increase in total yield and bulb diameter might be directly due to that nitrogen increases root primordia in which CYT synthesized and there was close relationship between root primordia and leaf area duration and also rapid leaf expansion which lead to an increase in photosynthesis, and this in turn increase yield (Marschner, 1995). Halimark and Barber (1984) found that adding P, significantly increased root surface area and this was important in supplying the nutrients needed by plant. This conclusion agrees with those reported by Patil and Biradar (2001), who reported that application of NPK + FYM to pepper plant produced the highest yield as compared to organic or inorganic fertilizer applied alone.

Chinese cultivar had a significant increment in total yield ton/fed and diameter of bulb as compared with Balady cultivar in both seasons Table(4). These results may be due to the increment in some growth aspects and chemical characteristics viz., fresh and dry weight/plant as well as photosynthetic pigments (Tables 2 and 3) in Chinese cultivar as compared with balady cultivar. As for the interaction, the highest values of total yield ton/fed. and diameter of bulbs were found in Chinese cultivar when treated with pigeon manure + 1 NPK, followed by pigeon manure + $^1/_2$ NPK then humic acid + 1 NPK. Meanwhile, the lowest one was found in balady cultivar fertilized with humic acid.

b. Mineral concentrations in bulb:

Data presented in Table (4) indicated that, application of humic acid and/or pigeon manure combined with mineral fertilizers to sandy soil had a marked effect on the N, P and K concentrations in bulb. The highest values were obtained by humic acid or pigeon manure combined with 1 NPK whereas the lowest was recorded by humic acid alone if compared with the other treatments. This was due to increase the available contents of those elements through improving soil conditions as a result of organic material and mineral fertilizer application (Ewais *et al.,* 2004). These results are in agreement with those observed by Aly (1999), who obtained a significant increase in N, P and K contents in maize as a result of combined effect of organic manure and inorganic (NPK) fertilizers applied to sandy soil.

As for the effect of cultivars, Balady cultivar had higher N, P and K

concentrations than Chinese cultivar in the both seasons. As for the interactions, the highest concentration of N, P and K was found in Balady cultivar treated with pigeon or humic acid combined with 1 NPK or1/2 NPK.

Finally, it can be concluded that using pigeon manure or humic acid combined with NPK fertilizers (1/2 or complete recommended doses) have an importance in improving the physical and chemical prosperities of sandy soils, which, in turn, increase the growth and yield and its quality of garlic plants especially Chinese cultivar grown in sandy soils.

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استجابة نباتات الثوم المنزرعة في أرض رملية للأسمدة العضوية والمعدنية

صباح محمد أحمد الجمل ، عبد الفتاح حسن سليم

قسم النبات الزراعى – كلية الزراعة – شبين الكوم – جامعة المنوفية

أجريت تجربتى أصص بمزرعة تجارب كلية الزراعة بشبين الكوم جامعة المنوفية خلال موسمى ٢٠٠٣/٢٠٠٤، ٢٠٠٤/٢٠٠٥ بهدف دراسة تأثير كل من حمض الهيوميك (٥ جم / كجم تربة) وزرق الحمام (٦ متر^{3} للفدان) والتسميد المعدنى (NPK) الموصى به كل بمفرده أو خلط الأسمدة العضوية مع السماد المعدنى بمعدلات مختلفة (المعدل الكامل أو نصف المعدل أو ربع المعدل) على بعض صفات النمو الخضرى والصفات الكيماوية والمحصول لصنفين من الثوم (الصينى والبلدى) تحت ظروف الأراضى الرملية.

ويُمكن تلخيص أهم النتائج المتحصل عليها فى الآتى :

- أدى إضافة حمض الهيوميك أو زرق الحمام مع نصف المعدل أو المعدل كله من السماد المعدنى (NPK) إلى زيادة معنوية فى طول النبات وطول المجموع الجذرى وعدد الأوراق وطول وعرض الورقة الخامسة وطول وقطر الرقبة والوزن الأخضر والجاف للنبات ككل والكلوروفيلات (أ + ب) والكاروتينيدات **والكربوهيدرات الكلية فى الأوراق مقارنة بكل سماد على حده.**
- كما أدت أيضاً نفس المعاملات السابقة إلى زيادة محصول الثوم للفدان وكذلك قطر البصلة ومحتوى الفصوص من العناصر NPK مقارنة بحمض الهيوميك أو زرق الحمام أو السماد المعدنى كل بمفرده .
- تفوق الصنف الصينى على الصنف البلدى فى قطر الرقبة وعرض الورقة الخامسة والوزن الأخضر والجاف للنبات ككل والمحصول الكلى للفدان وكذلك قطر البصلة ، بينما تفوق الصنف البلدى فى محتوى الأوراق والفصوص من العناصر NPK .
- أظهرت نتائج التفاعلات بين الأصناف والأسمدة أن أفضل نمو وأكبر محصول تم الحصول عليها عند إمداد نباتات الثوم الصنف الصينى بالسماد العضوى (زرق الحمام أو حمض الهيوميك) مضاف إليهم نصف المعدل أو المعدل كله من الـ NPK الموصى به .

وعليه توصى الدراسة باستخدام الأسمدة العضوية : حمض الهيوميك أو زرق الحمام مع نصف أو كل معدل السماد المعدنى الموصى به لتسميد نباتات الثوم الصنف الصينى النامية فى أرض رملية للحصول على أعلى محصول .