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THE PRODUCTIVITY OF GARLIC PLANT AS AFFECTED BY THE ADDITION OF NITROGEN FERTILIZER IN THE FORM OF ORGANIC AND / OR INORGANIC

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ABSTRACT

Two field experiments were carried out during the two seasons of 2001 and 2002 at the Experimental Station farm of National Research Centre at Shalakan " Kalioubia Governorate" to study the response of garlic plant to nitrogen fertilizers, i. e. 3 organic sources (cattle, chicken and town refuse) and 3 chemical rates (the recommended rate RR, ½ RR and ¼ RR). The important results are as following:

1- The best plant growth parameters (length of plant, number of leaves and fresh and dry weight of whole plant and its different organs, all of them were associated with addition organic nitrogen at rate 60 kg N/ fed. in the form of chicken. Also the heaviest bulbs yield and the gloves tissues content of minerals were correlated with chicken manure addition.
2- Addition of the recommended rate (RR) of chemical nitrogen (60 kg N/ fed.) resulted the tallest and the heaviest fresh and dry weight of garlic plant. Also the heaviest garlic bulb yield and its nutritional values, i. e. N, P, K, Fe, Mn, Zn and Cu were correlated with the addition (RR).
3- The interaction treatments showed that using chicken manure with the RR of chemical nitrogen resulted the superiority in plant growth characters as well as the best garlic bulb yield and its content of N, P, K, Fe, Mn, Zn and Cu.

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. The "Chinese" cultivar is a good bulb quality and high yield. Investigating the NPK requirements of garlic plants received a great attention and the most important element was nitrogen (AbdEl- Hamid *et al.* 1996, GadEl-Hak and AbdEl- Mageed 2000 and Ali *et al.* 2001).

The need for supplying vegetable crops with organic and inorganic fertilizers was proved to be very essential for the production of higher yield and for improving its quality. For garlic plants many other investigators reported that, addition of organic fertilizers had a major effect on plant growth (Asandhi 1989, Setty *et al.* 1989 Osman et al. 1991, Cho *et al.* 1994, Ali *et al.* 2001, Awad 2002 and Fatma 2002) all of them stated that, organic manure contains higher levels of relatively available nutrient ional elements which are essentially required for plant growth. Moreover, it plays an important role for improving soil physical properties. Other authors added that, organic manures are slow release forms of nitrogen where natural organic materials are broken down slowly by the soil microorganisms (Hegazy *et al.* 1994 and Rizk 2001).

The aim of this work was to study the effect of different sources of organic manure (chicken, cattle and town refuse) and chemical fertilizer (NPK) at different rates on growth, yield and quality of garlic plants.

MATERIALS AND METHODS

Two field experiments were carried out at the experimental station of the National Research Centre, Shalakan, "Kalubia Governerate" during the two successive seasons of 2001 and 2002 to study the response of garlic plant to the interaction between organic (different source) and chemical (different levels of NPK) fertilizers on growth, yield and its quality of garlic plant. The soil of experimental field was clay loam in texture with EC. 2.3 m mhos/cm, and pH 7.80, available N was 141 meq/L., P 4.9 meq/L. and exchangeable K was 0.32 meq/L. while chemical analysis of chicken, cattle and town refuse manures are given in Table (1).

Table (1): The chemical analysis of the used chicken, cattle and town refuse manures.

Characters	Chicken	Cattle	Town refuse
PH	6.5	7.5	7.86
EC (m mhos)	5.7	4.1	4.6
Organic carbon %	32	7.9	12.25
Organic matter %	63.2	6.5	32.45
Nitrogen %	2.95	0.42	1.16
C/ N ratio	11.1	19.1	10.1
Phosphorus %	1.14	0.41	0.5
Potassium %	1.8	0.85	0.5
Iron mg/ kg	168	650	5.8
Mn mg/ kg	241	135	0.3
Cu mg/ kg	22	11	0.4
Zn mg/ kg	110	105	101.5

The experimental design used in the two growing seasons was split plot with three replicates, the three sources of organic manures (chicken, cattle and town refuse) were arranged at random in main plots, while the three levels of chemical nitrogen fertilizer were distributed within the sub-plots. Each plot area was 12.8 m^2 consisted of four ridges; each was 0.8 m^2 in width and 4 m^2 in length. Organic nitrogen was applied to the soil during preparing it for planting. But, the chemical nitrogen fertilizer (ammonium sulphate) at rate of 61.2 kg N/ fed. used at 3 rates, i. e. recommended rate (RR), half(1/2RR) and one quarter(1/4RR) of the recommended rate. However, for all experimental plots the chemical phosphorus and potassium were added at rate of 200 and 150 kg/ fed. as calcium super phosphate and potassium sulphate respectively. Phosphorus and potassium were applied at once time during preparing the soil for planting and 75 days old respectively. Whereas, Nitrogen added at two equal quantities i. e. before planting and 60 days of plant old.

The Chinese cv. of garlic cloves was planted on the first third of October month in the seasons of 2001 and 2002. the gloves were sown at 20 cm distances on the two sides of each ridge. The normal cultural treatments of growing and irrigation of garlic plant were followed. After 3 months from planting, samples of garlic plants from the three replicates were taken and

vegetative growth characters were measured (plant length, number of leaves, fresh and dry weight of whole plant and its leaves, neck and bulb). At harvest and after curing period (15 days), the total yield per feddan as tons were accounted also the average bulb diameter was recorded. Nitrogen, phosphorus and potassium content in tissues of garlic gloves were determined depending on the methods which were described by Jackson (1958), Troug and Moyar(1939) and Brown and Lilleland (1946) respectively. However, Fe, Mn, Zn and Cu contents were determined using flame ionization atomic absorption, Spectrometer model 1100 B of perkin Elemer and according to the method of Chapman and Pratt (1978). All data values were subjected to the analysis of variance to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A- Plant growth characters.

1. Effect of organic sources:

Data presented in Table (2) show clearly that garlic plants received chicken manure as a source of organic nitrogen recorded the heightest plants which carried the largest leaves number, the heaviest total fresh and dry weight of plants and its different organs. These findings were true in both experimental seasons. This superiority upon the other using organic manures were statistically significance at 5% level for all plant growth criteria in 1 st season, But the parameter of total fresh weight of plant and its leaves and neck in 2 nd season no statistically varied. With most plant growth characters, the obtained data reveals that plants supplied cattle and town refuse, as organic nitrogen fertilizer had no great differences in both seasons. It could be concluded that, the best plant growth of garlic plant may attributed to the highest available elemental nutrition i. e. N,P,K and some other micro elements (Table 1), consequently increasing these elements in rooting zone area. Many investigators obtained data support the recent results (Kunwar and Pandey 1992, Selvaraj *et al.* 1993, Cho *et al.* 1994 and Ali *et al.* 2001).

2. Effect of chemical nitrogen application rate:

The data of Table (2) shows the response of garlic plant growth parameters to the application rate of chemical nitrogen in two experiments of 2001 and 2002. Addition of the recommendation rate (R) of nitrogen (300 kg of ammonium sulphate which equal about 61.8 kg of nitrogen / fed.) for garlic plants resulted in the highest values of plant length, the biggest number of leaves, the heaviest fresh and dry weight of whole plant and its different organs. These findings were true in both experimental seasons of 2001 and 2002. With other words, that plants which supplied the recommended rate (RR) gave superiority in all plant growth characters over than the ½RR and or ¼RR. These increments amounted by 4.2, 11.7% for plant fresh weight and by 5.9,11.3 % for total dry weight respectively for 1 st and 2 nd seasons. Generally, the obtained data clearly showed that, the garlic plant recorded a good response to the application of chemical fertilizer and its growth might be recording better values if the application rate were increased over than the recommended rate (61.8 nitrogen units / fed.). In spite the response of garlic

plant to the addition of chemical fertilizer, many investigators recorded other data supported that data written in this study (Gunadi and Asandhi 1986, AbdEl- Hamid *et al.* 1996, GadEl-Hak and AbdEl-Mageed 2000 and Ali *et al.* 2001)

Table (2) : Effect of organic (sources) and chemical (levels) of nitrogen fertilizer on the vegetative growth characters of garlic plant during 2001 season.

Nitrogen treatments Organic	Chemical	Plant length (cm)	Leaves number	Fresh wt. g/ plant				Dry wt. g/ plant			
				Leaves	Neck	Bulb	Total	Leaves	Neck	Bulb	Total
Checkin	RR	60.53	8.03	52.01	14.37	17.43	83.82	7.41	4.59	4.89	16.89
	1/2RR	55.00	7.17	45.72	12.83	15.30	73.85	6.50	4.26	4.31	15.06
	1/4RR	52.90	6.50	42.18	11.62	14.06	67.86	6.02	3.84	4.01	13.87
Mean		56.14	7.24	46.64	12.94	15.60	75.18	6.64	4.23	4.40	15.27
Cattle	RR	52.43	6.04	39.07	10.82	13.04	62.93	5.56	3.61	3.70	12.86
	1/2RR	50.77	5.92	38.22	10.67	12.77	61.66	5.47	3.45	3.60	12.52
	1/4RR	49.07	5.80	37.50	10.44	12.52	60.46	5.37	3.45	3.54	12.36
Mean		50.76	5.92	38.26	10.64	12.78	61.68	5.47	3.50	3.61	12.58
Town refuse	RR	56.23	6.41	41.60	11.54	13.84	66.98	5.92	3.83	3.94	13.69
	1/2RR	54.17	6.30	40.93	11.35	13.63	65.91	5.84	3.76	3.83	13.42
	1/4RR	51.20	6.03	39.07	10.82	13.04	62.93	5.56	3.59	3.66	12.81
Mean		53.87	6.25	40.53	11.24	13.50	65.27	5.77	3.73	3.81	13.31
Mean	RR	56.40	6.83	44.23	12.24	14.77	71.24	6.30	4.01	4.17	14.48
	1/2RR	53.31	6.46	41.62	11.62	13.90	67.14	5.93	3.82	3.91	13.67
	1/4RR	51.06	6.11	39.58	10.96	13.21	63.75	5.65	3.63	3.74	13.01
L.S.D at 5%	Sources	0.26	0.06	0.30	0.05	0.18	0.42	0.06	0.03	0.03	0.06
	NPK	0.17	0.05	0.19	0.02	0.13	0.26	0.05	0.02	0.03	0.06
	interaction	0.29	0.08	0.33	0.04	0.22	0.44	0.08	0.04	0.05	0.11

RR = means the recommended Rate (200 kg/ fed. of Ammonium sulphate).
1/2RR= means half of RR.
¼ RR= one quarter of RR.

Table (2) : Effect of organic (sources) and chemical (levels) of nitrogen fertilizer on the vegetative growth characters of garlic plant during 2002 season..

Nitrogen treatments Organic	Chemical	Plant length (cm)	Leaves number	Fresh wt. g/ plant				Dry wt. g/ plant			
				Leaves	Neck	Bulb	Total	Leaves	Neck	Bulb	Total
Checkin	RR	71.70	9.23	58.97	15.83	19.93	94.73	8.43	5.18	5.66	19.27
	1/2RR	64.13	9.00	53.90	14.30	18.73	86.93	7.80	4.71	5.29	17.80
	1/4RR	60.73	8.43	52.67	13.63	17.40	83.70	7.60	4.62	4.91	17.13
Mean		65.52	8.89	55.18	14.59	18.69	88.46	7.94	4.84	5.29	18.07
Cattle	RR	59.27	7.13	60.27	12.27	16.57	89.10	7.10	4.24	4.56	15.90
	1/2RR	56.07	6.13	47.73	11.93	10.60	70.27	6.95	4.00	4.31	15.26
	1/4RR	54.43	5.33	45.90	11.43	14.24	71.58	6.80	3.74	4.16	14.71
Mean		56.59	6.20	51.30	11.88	13.80	76.98	6.95	4.00	4.34	15.29
Town refuse	RR	65.60	8.13	51.93	13.60	17.30	82.83	7.42	4.40	4.87	16.69
	1/2RR	62.77	7.20	49.77	13.10	16.57	79.43	7.30	4.35	4.64	16.29
	1/4RR	59.90	6.80	47.13	12.37	15.97	75.47	7.01	4.21	4.55	15.77
Mean		62.76	7.38	49.61	13.02	16.61	79.24	7.24	4.32	4.69	16.25
Mean	RR	65.52	8.17	57.06	13.90	17.93	88.89	7.65	4.61	5.03	17.29
	1/2RR	60.99	7.44	50.47	13.11	15.30	78.88	7.35	4.36	4.75	16.45
	1/4RR	58.36	6.86	48.57	12.48	15.87	76.91	7.14	4.19	4.54	15.87
L.S.D. at 5%	Sources	0.56	0.24	N.S.	N.S.	3.48	N.S.	0.06	0.11	0.03	0.11
	NPK	1.04	0.25	5.64	N.S.	N.S.	N.S.	0.04	0.11	0.04	0.11
	Interaction	1.79	0.43	N.S.	N.S.	N.S.	N.S.	0.07	0.19	0.07	0.19

RR = means the recommended Rate (200 kg N/ fed. of Ammonium sulphate).
1/2RR= means half of RR.
¼ RR= one quarter of RR.

3. Effect the interaction:

The interaction within organic nitrogen sources and the rates of chemical application affected the garlic plant growth characters as shown in Table (2) for seasons of 2001 and 2002. Whereas, this effect was more clearly in 1 st season, where the statistical analysis of the obtained data reveals that, the differences within different interaction treatments were significantly for all parameters of plant growth. Moreover, in spite of the no significant effect as influenced by the interaction treatment in total fresh weight of garlic plant and its different organs in 2 nd season, but the registrated data (Table 2) showed clearly that, the longest length of plants which carried the biggest leaves number, fresh and dry weight of plant and its varies organs all of these characters recorded with that plants received chicken manure at the recommended rate of NPK (200, 200 and 100 kg/ fed. of calcium super phosphate, ammonium sulphate and potassium sulphate respectively).

B- Total garlic bulb yield and its characteristics.

1. Effect of organic nitrogen sources:

The presented data in Table (3) of the total bulb yield as ton/ fed., diameter of bulbs as well as its nutritional values, i. e. N, P, K, Fe, Mn, Zn and Cu as affected by the addition of chicken, cattle and town refuse as organic nitrogen fertilizer in 2001 and 2002 seasons. The heaviest tonnage (1.41/ fed.) of bulb yield was registrated with that garlic plants which received chicken manure, followed in lowering order by the application of town refuse and lastly by that plants supplied cattle manure. Whereas, the statistical analysis of the obtained data reveals that the differences within organic nitrogen sources treatments were enough to reach the 5% levels of significant. These results were true in both experiments. By other means, using chicken manure caused an increment in total bulb yield counted by 29.3, 2.2 % in 1 st season, and by 30.6, 12.8 % in 2 nd season respectively over than that of using cattle and /or town refuse. Moreover, the biggest garlic bulb was associated with the largest total yield. It could be concluded that, the heaviest and the biggest garlic bulbs had a positive correlation with using chicken manure as an organic nitrogen fertilizer. Many previous investigators studies that relationship and their findings are in accordance with that data obtained here (Lima et al, 1984, Shobahalan and Arumugam 1991, Kunwar and Pandey 1992, Cho et al, 1994, Neeteson 1995 and Ali et al, 2001).

Response of the nutritional elements (N, P, K, Fe, Mn, Zn and Cu) to the different organic nitrogen sources in the two experimental seasons followed the same pattern of change like that which mentioned previously. Generally, the data of Table (3) showed clearly that garlic plants, which supplied chicken manure, had a great bulb yield as well as the best bulb quality parameters particularly elemental contents. The high content of N, P, K, Fe, Mn, Zn and Cu of garlic bulb will support the opportunity of exportation, so increase the foreign income, consequently help us to import the other needed of food requirements.

Table (3) : Effect of organic (sources) and chemical (levels) of nitrogen fertilizer on total yield and some phisical and chemical properties of garlic bulb during 2001 season.

Nitrogen treatments Organic	Chemical	Bulb diamerer (cm)	Total yield (ton/ fed.)	%			ppm			
				N	P	K	Fe	Mn	Zn	Cu
Checkin	RR	3.02	1.50	0.84	0.12	0.69	0.93	19.13	17.23	16.13
	1/2RR	2.91	1.41	0.77	0.11	0.67	0.91	18.40	15.00	15.23
	1/4RR	2.80	1.31	0.72	0.09	0.65	0.90	16.10	14.07	13.70
Mean		2.91	1.41	0.78	0.10	0.67	0.91	17.88	15.43	15.02
Cattle	RR	2.61	1.20	0.70	0.09	0.58	0.79	13.40	12.50	11.60
	1/2RR	2.41	1.07	0.68	0.07	0.57	0.78	12.27	12.20	11.33
	1/4RR	2.22	1.00	0.64	0.06	0.54	0.74	11.53	12.00	11.00
Mean		2.41	1.09	0.67	0.07	0.56	0.77	12.40	12.23	11.31
Tawn refuse	RR	2.80	1.44	0.73	0.11	0.63	0.86	17.07	13.73	12.73
	1/2RR	2.73	1.41	0.70	0.10	0.61	0.82	15.13	13.03	12.50
	1/4RR	2.71	1.31	0.69	0.07	0.60	0.81	14.17	12.67	11.77
Mean		2.75	1.39	0.71	0.09	0.61	0.83	15.46	13.14	12.33
Mean	RR	2.81	1.38	0.76	0.30	0.63	0.86	16.53	14.49	13.49
	1/2RR	2.68	1.30	0.72	0.29	0.62	0.84	15.27	13.41	13.02
	1/4RR	2.58	1.21	0.68	0.21	0.60	0.81	13.93	12.91	12.16
L.S.D. at 5%	Sources	0.09	0.03	0.02	0.15	0.01	N.S	0.10	0.17	0.13
	NPK	0.04	0.02	0.01	N.S	0.01	0.01	0.13	0.14	0.11
	Interaction	0.06	0.04	0.02	N.S	0.01	0.01	0.22	0.25	0.19

RR = means the recommended Rate (200 kg N/ fed. of Ammonium sulphate).
1/2RR= means half of RR.
¼ RR= one quarter of RR.

Table (3) : Effect of organic (sources) and chemical (levels) of nitrogen fertilizer on total yield and some phisical and chemical properties of garlic bulb during 2002 season.

Nitrogen treatments Organic	Chemical	Bulb diamerer (cm)	Total yield (ton/ fed.)	%			ppm			
				N	P	K	Fe	Mn	Zn	Cu
Checkin	RR	3.65	1.71	0.82	0.11	0.65	0.92	20.13	16.36	15.43
	1/2RR	3.41	1.61	0.76	0.10	0.63	0.90	18.21	14.31	14.60
	1/4RR	3.30	1.43	0.71	0.09	0.60	0.86	17.17	13.13	12.79
Mean		3.45	1.58	0.76	0.10	0.63	0.89	18.50	14.60	14.27
Cattle	RR	2.95	1.31	0.69	0.07	0.55	0.77	14.20	11.30	10.54
	1/2RR	2.85	1.21	0.65	0.07	0.54	0.74	12.50	11.00	10.07
	1/4RR	2.70	1.11	0.63	0.07	0.52	0.71	11.80	10.80	9.83
Mean		2.83	1.21	0.66	0.07	0.54	0.74	12.83	11.03	10.15
Tawn refuse	RR	3.24	1.44	0.75	0.11	0.61	0.84	16.30	12.67	12.27
	1/2RR	3.12	1.42	0.73	0.09	0.59	0.81	15.13	12.37	12.17
	1/4RR	3.05	1.34	0.71	0.08	0.57	0.78	14.10	12.03	11.90
Mean		3.14	1.40	0.73	0.09	0.59	0.81	15.18	12.36	12.11
Mean	RR	2.28	1.49	0.75	0.10	0.61	0.84	16.88	13.44	12.75
	1/2RR	3.13	1.41	0.72	0.09	0.59	0.82	15.28	12.56	12.28
	1/4RR	3.02	1.29	0.68	0.08	0.57	0.79	14.36	11.99	11.51
L.S.D. at 5%	Sources	0.04	0.07	0.01	N.S	0.02	0.01	0.14	0.17	0.13
	NPK	0.02	0.04	0.01	N.S	0.01	0.01	0.10	0.08	1.12
	Interaction	0.04	0.07	0.01	N.S	N.S	N.S	0.17	0.14	0.20

RR = means the recommended Rate (200 kg N/ fed. of Ammonium sulphate).
1/2RR= means half of RR.
¼ RR= one quarter of RR.

2. Effect of chemical nitrogen application rate:

Addition of the recommended rate of nitrogen (61.2 kg N/ fed.) as chemical nitrogen for garlic plants had the highest bulb yield (1.38 and 1.49 ton/ fed. for 1 st and 2 nd seasons respectively). However, the total bulb yield decreased by 12.30 and 13.41% in 1 st and 2 nd season respectively when the only addition of 25% of the recommended nitrogen rate. The size of the garlic bulb was associated with the behavior of total yield.

With regarding to the response of nutritional elements value in tissues of garlic gloves, the obtained data indicates that, the highest N, P, K, Fe, Mn, Zn and Cu were recorded with that plants received the recommended nitrogen rate (61.2 kg N/ fed.). With decreasing the addition nitrogen rate, the values of the before mentioned elements decreased to record its lowest values with application the lowest nitrogen rate (1/4 of the recommended rate). The obtained results reveal that, the chemical nitrogen fertilizer had a great effect on the total bulbs yield of garlic, where the heaviest and the biggest bulbs as well as that which contains the highest chemical properties were obtained. These findings were true in both experimental seasons. Many investigators had a similar trend of results which support that data written here (Gunadi and Asandhi 1986, AbdEl- Hamid *et al.*, 1996, GadEl-Hak and AbdEl-Mageed 2000 and Ali *et al.*, 2001).

3. Effect of the interactions:

The interaction treatments between using the different organic nitrogen sources and rates of chemical as affected on the total garlic bulb yield and its some chemical contents are shown in Table (3). The recorded data shows that, in spite of the no significant response of P in both seasons and K, Fe in 1 st season only, but as a general the addition of chicken manure as organic nitrogen source and chemical nitrogen at rate of 61.2 kg N/ fed. had the heaviest and biggest weight of bulbs as well as the highest N, P, K, Mn, Zn and Cu contents in the tissues of garlic cloves. These results were true in 2001 and 2002 seasons.

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إنتاجية محصول الثوم الصيني تحت تأثير التسميد العضوي و المعدني

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أجريت تجربتان حقليتان في محطة التجارب الزراعية بشلقان محافظة القليوبية خلال الموسم الشتوي لعامي ٢٠٠١ و ٢٠٠٢ و ذلك لدراسة استجابة محصول الثوم الصيني لثلاث مصادر من التسميد العضوي (سماد الدواجن و الماشية و مخلفات المدن) مع ثلاث معدلات من التسميد المعدني (المعدل الموصى به ونصف المعدل وربع المعدل) و كانت أهم النتائج التي تم التوصل إليها الآتي:

١- نتج أفضل نمو خضري لنباتات الثوم الصيني معبرا عنة بطول النبات و عدد الأوراق و الوزن الطازج و الجاف للنباتات و أعلى محصول و أفضل محتوى للفصوص من العناصر المعدنية عند أضافه ٦١,٢ كيلو جرام نيتروجين للفدان من سماد الدواجن و ذلك مقارنة بسماد مخلفات المدن و سماد الماشية.

٢- أضافه المعدل الموصى به من عنصر النيتروجين (16.2 كيلو جرام نيتروجين للفدان) أنتج أعلى قيم لطول النبات و أكبر وزن طازج و جاف و كذلك أعلى محصول للرؤس و أحسن محتوى للفصوص من عناصر النيتروجين و الفوسفور والبوتاسيوم و الحديد و المنجنيز و الزنك و النحاس.

٣- أضافه سماد الدواجن مع المعدل الموصى بة من النيتروجين الكيماوى لمحصول الثوم الصيني أعطى زيادة معنوية في نمو النباتات و محصول الرؤس و محتوى الفصوص من النتروجين و الفوسفور و البوتاسيوم و الحديد و المنجنيز و الزنك و النحاس.