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EFFECT OF BIOFERTILIZERS AND NITROGEN LEVELES ON THE PRODUCTIVITY AND QUALITY OF CHINESE GARLIC UNDER SANDY SOIL CONDITIONS

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ABSTRACT: This study was conducted on garlic (*Allium sativum L.*) *cv.* "Sids- 40 plants during two successive seasons (1999-2001). The study aimed to evaluate the effect of soil dressing with chemical nitrogen levels (0, 40, 80, 120 and 160 kg N/ *fed*), either single and / or in combinations with N- biofertilizer " Rhizobacterin" at 2 or 4 kg/ *fed*, on the plant growth, yield and chemical constituents of bulbs and their storability during six months. The obtained results showed that applied N significantly increased vegetative growth and yield parameters. The increments were corresponding to the increase of N levels up to 120 kg/ *fed* which was approximately similar to 160 kg/ *fed* Biofertilizer treatment at the rate of 4 kg/ *fed* was more effective than at the rate of 2 kg /feddan.

The weight and diameter of bulb and yield of bulbs >5cm in diameter were gradually increased with increasing the applied nitrogen up to 120 kg N/*fed*, and the yield of bulbs < 5 cm were linearly reduced in both seasons. Biofertilizer was effective in this concern especially at 4 kg/ *fed* since it was more beneficial than 2 kg/ *fed*. The best results were obtained from the combination between 120 kg N/ *fed* and 4kg /*fed* Rhizobacterin. The weight of cloves were progressively increased with increasing the levels of both nitrogen and Rhizobacterin but the number of both cloves or circles per bulb were not significantly infleunced in both seasons.

Increasing the applied nitrogen levels increased the concentrations of N, K, carotenoids and volatile oils. Rhizobacterin obtained similar trend.

Increasing applied nitrogen increased weight loss percentage of stored garlic ,especially with increasing the storage period. Application of biofertilizers compensated the effect of nitrogen, so the application of 4 kg/ *fed.* brought about the lowest values of weight loss percentage and improved the keeping quality of stored garlic.

Key word: Garlic – Biofertilizers - Rhizobacterin – Nitrogen-Fertilization.

INTRODUCTION

Garlic (*Allium sativum L.*) is one of the most commercially important bulb crops in Egypt and was cultivated for both local consumption and exportation. It is commonly used as a spice or condiment as well as for many medical purposes. The planted areas in Egypt during 2001 were 22,130 *fed* as single crop plus 2989 *fed.* as intercropped crop.*

Application of N-fertilizers is considered essential to obtain the high productivity of garlic, especially in sandy soils. The continuous increase in the costs of chemical fertilizers and environmental pollution problems restrict the application of sufficient amount. Thus, it has become essential to use untraditional fertilizers as substitutes or supplements for chemical fertilizers.

Many investigators mentioned that using bio-fertilizers is considered a promoting alternative for chemical fertilizers by N_2 fixation and releasing certain nutrient elements (P, Fe, Zn, Mn and K) in addition to contributing with some phytohormones such as gibberellins and cytokinins. (Tien *et al.*, 1979 ; Bouton *et al.*, 1985 ; El-Haddad *et al.*, 1993) . Inoculation of garlic with N_2-fixing bacteria of Azospirillum or Azotobacter either single or in combination, markedly increased plant growth, yield, bulb quality and storability (Lewis *et al.*, 1995 ; Wange, 1995 ; Mahendran and Kumar, 1996 ; Gomez and Munoz, 1998 ; Wange, 1998 ; Ali *et al.*,2001 ; Gouda, 2002).

The present work aimed, mainly, to study the effect of chemical N-fertilizer rates either single and/ or in combination with bio-fertilizer "Rhizobacterin" on the garlic plants grown in sandy soil at Ismailia District.

*Agricultural statistics, 1998

MATERIALS AND METHODS

Two field experiments were carried out on garlic plants *cv.* "Sids-40" during the winter of 1999/2000 and 2000/2001 at the Experimental Research Farm, Fac. Agric., Suez Canal University, Ismailia Governorate. Physical and chemical properties of the experimental soil are presented in Table 1. The experimental design was split-plot with 4 replicates. The main plots were devoted to inorganic N- levels, while N-biofertilizer treatments were distributed at random in the sub plots. The sub plot area was 15 m^2, which contained five rows, each five m. long and 0.6 m. width. The experiment included 15 treatments which were five levels of nitrogen (0, 40, 80, 120 and 160 kg N/ *fed*), each was applied as a single or in combination with three levels (0, 2 or 4 kg/ *fed*) of N-biofertilizer "Rhizobacterin" which contains live cells of efficient bacteria, 70 % "*Azotobacter*" and 30 % "*Azospirillum*" produced by General Organization for Agriculture Equalization Fund (GOAEF), Ministry of Agriculture Egypt.

Seed cloves were prepared by soaking in running water prior to sowing and treated with gum material and dipped for five minutes in thick paste of carrier based inoculants mixed with wet soft dust (1:5 ratio).The planting was carried out during the first week of October, for both seasons of study. Nitrogen levels were applied as ammonium nitrate (33.5% N) in three equal doses ; at planting, 30 and 45 days after planting. At soil preparation of the experimental field, 40 m3 farmyard manure/ *fed* were applied. All field plots were fertilized with calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O)at rates of 90 kg P_2O_5 and 96% K_2O/fed. These fertilizers were, equally divided and added after 30 and 60 days from planting. The harvest was done in the first week of April for both seasons.

Data recorded: The following data were recorded during plant growth period and after the harvest.

A-Vegetative growth:

Representative samples; each five plants were randomly taken from each sub plot at different stages of growth; i.e.,60, 90 and 120 days after planting to estimate the following characteristics: Plant height, number of leaves/ plant, dry weight of leaves/ plant (estimated after drying at 70 °C till

Table 1 : The physical and chemical analysis of the experimental soil.

Properties	Values	Properties	Values	Properties	Values
Partical size distribution	%	Soluble anions	(meq^{-1})	Soluble cations	(meq^{-1})
Sand (%)	92.8	HCO_3^-	1.46	Na^+	3.60
Silt (%)	4.9	Cl^-	2.68	K^+	0.52
Clay (%)	2.3	SO_4^{2-}	7.23	Ca^{2+}	5.16
Texture	Sandy	Organic-C (g/kg^{-1})	0.76	Mg^{2+}	2.40
$CaCO_3$ (%)	0.58	Total-N (g/kg^{-1})	0.23		
CEC (C mol kg^{-1})	2.10	Avial. P (mg/kg)	3.85		
PH	8.1				
EC (ds/m^{-1} at 25 °C)	1.18				

Counts of some microbial groups (microbes/g^{-1} dry wt. soil)		DTPA-extractable elements	(mg/kg^{-1})
Total bacteria (X 10^5)	8.0	Fe	0.78
Actinomycetes (X 10^5)	6.0	Mn	0.61
Fungi (X10^2)	3.0	Zn	0.34
Nitrifying bacteria (X 10^2)	2.0	Cu	0.27
		Cd	0.01

Table 2 : Averages monthly air temperature and relative humidity in store room during the storage period in 2000 and 2001 seasons.

Months	2000		2001	
	Temperature (°C)	Relative humidity (%)	Temperature (°C)	Relative humidity (%)
April	15.1	56.9	16.6	58.3
May	17.6	59.3	18.1	61.6
June	19.3	61.6	19.6	63.9
July	21.3	66.1	22.4	65.2
August	22.9	67.8	22.9	68.1
September	21.6	69.2	20.5	68.8
October	18.7	70.1	18.6	70.3

constant weight, leaf area according to the formula described by Koller (1972), and crop growth rate according to Richards (1969).

B. Yield and its components:

At harvest time, all plants of each plot were harvested, weighted in kg. After curing for 3 days and converted to record the following characteristics:

1.Total yield (ton/ *fed*)

2.Yield of bulbs >5 cm diameter (ton/ *fed*)

3.Yield of bulbs <5 cm diameter (ton/ *fed*)

4.Bulb traits; bulb weight (gm)- bulb diameter and bulbing ratio [neck diameter (cm)/ bulb diameter (cm)] as described by Mann (1952).

C. Cloves trait; clove weight (gm)- number of cloves/ bulb and number of cloves circles/ bulb.

D-Chemical constituents: Dried cloves of each treatment were ground and wet digested as described by Hese (1971) to determine total nitrogen according to Pregl (1945)- phosphorus as reported by John (1970), potassium according to Brown and Lilleland (1946), total carotenoids (mg/kg dry weight), according to the method of Both (1958), volatile oils content (%); extracted and determined according to the method of Guenther (1961) and nitrate content (NO_3- ppm) determined by modified method of Singh (1988).

E.Storability; after curing, random samples (each of 10 kg) were taken from every treatment, stored at normal room conditions and weight loss percentage was recorded monthly during six monthes of storage period. Average air temperature and relative humidity in store room were recorded in Table 2.

F. Statistical analysis;: all obtained data were subjected to statistical analysis of variance, and the least significant differences (L.S.D)at 5% level of probability were calculated as mentioned by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Vegetative growth:

1.Plant height:

Results of Table 3 revealed that N-fertilizer application ,significantly, increased plant height at the three sampling dates as compared with control plants. The increase in nitrogen level, markedly, increased plant height at different growth stages in both seasons. Biofertilizer treatments (2 or 4 kg/*fed*) markedly increased

Table 3: Plant height after 60, 90 and 120 days of planting as affected by N-levels, biofertilizer "Rhizobacterin" and their interactions during 1999/ 2000(S1) and 2000/2001 (S2) seasons

Character		plant height (cm)					
Treatments		at 60 days		at 90 days		at 120 days	
		S1	S2	S1	S2	S1	S2
N- levels (kg/ *Fed)*							
0		27.97	29.65	41.97	44.48	53.29	57.38
40		31.70	33.72	47.55	50.58	60.25	63.50
80		35.70	36.55	53.55	54.83	64.17	67.75
120		37.91	37.73	57.05	56.59	65.50	69.50
160		39.24	38.45	58.97	57.67	66.50	70.58
L.S.D.(5 %)		0.61	0.96	1.02	1.46	1.40	1.73
Rhizobacterin (kg/*fed*)							
0		33.35	34.28	50.15	51.42	60.45	64.28
2		34.57	35.30	51.90	52.96	61.95	65.90
4		35.58	36.07	53.40	54.11	63.43	67.05
L.S.D.(5 %)		0.44	0.51	0.65	0.76	0.72	1.69
Interactions							
N- levels	Rhizo.						
	0	27.00	27.23	40.55	40.85	49.75	53.63
0	2	28.03	30.22	42.05	45.33	53.38	58.25
	4	28.86	31.50	43.30	47.25	56.75	60.25
	0	29.54	32.43	44.30	48.65	58.13	61.50
40	2	31.69	33.67	47.55	50.50	60.25	63.50
	4	33.87	35.05	50.80	52.58	62.38	65.50
	0	34.70	35.93	52.05	53.90	63.00	66.75
80	2	35.53	36.55	53.30	54.83	64.25	67.75
	4	36.87	37.17	55.30	55.75	65.25	68.75
	0	36.99	37.55	56.05	56.33	65.38	69.25
120	2	38.20	37.72	57.30	56.58	65.50	69.50
	4	38.53	37.92	57.80	56.88	65.63	69.75
	0	38.55	38.25	57.80	57.38	66.00	70.25
160	2	39.41	38.37	59.30	57.55	66.38	70.50
	4	39.77	38.72	59.80	58.08	67.13	71.00
L.S.D.(5 %)		0.98	1.13	1.44	1.68	1.61	1.81

this parameter and 4 kg/ *fed* was more useful than 2kg /*fed* The interaction effect of nitrogen and bio-fertilizer showed that all levels of nitrogen were, generally, more effective in the presence than in the absence of biofertilizer. For instance, plants received 160kg/ *fed* with 4 kg/fed. biofertilizers gave the highest values at the different growth stages. The obtained results are compatible with those of Lewis *et al.*1995), Wange(1998) ; Ali *et al.*(2001).

2.Number of leaves and leaves area / plant:

As shown in Tables 4 and 5 nitrogen fertilizer at different levels increased both the number of leaves and leaves area / plant after 60, 90 and 120 days planting. The increments were, gradually corresponded with the increase of nitrogen dose. The biofertilizer application increased both leaves number and leaves area. It seemed that plants inoculated with 4 g/ fed. biofertilizers had significant increase in their leaves area than those treated with 2 kg/fed. although these differences were not significant for the number of leaves. These results are confirmed with those obtained by Thabet *et al.*(1994) ,Wange (1995) ;Dibut *et al.*(1996)all on garlic; Mahmoud *et al.*(2000) on onion and Ali *et al.*(2001) on garlic.

3.Dry weight and crop growth rate (CGR):

Data in Tables 6 and 7 indicate that both leaves dry weight and CGR at different growth periods was, generally, better with N-fertilizer application than with the control and the increments were corresponding with the nitrogen level. Results showed also that application of biofertilizer to garlic plants, significantly, increased each of dry weight and CGR at the different growth periods, the increase was much higher with 4 kg./fed than with 2kg/fed. Those results are in agreement with those of Selvaraj *et al.*(1997) on garlic, El-Moursi (1999) on garlic, Mahmoud *et al.*(2000) on onion ;Gouda (2002) on garlic. However plants received 120 or 160 kg N/ *fed* with biofertilizer at 4 kg/ *fed* gave the highest values of both dry weight and CGR in both seasons.

Generally, the enhancing effect of N-fertilization on plant growth may be due to the positive effects of N-element on activation of photosynthesis and metabolic processes of organic compounds in plants which in turn, encourage the plant vegetative growth (Gardener *et al* . 1985). The increases in plant growth ascribed to

Table 4: Number of leaves/ plant at 60, 90 and 120 days after planting as affected by N- levels, biofertilizer "Rhizobacterin" and their interactions during 1999 / 2000 (S1) and 2000/2001 (S2) seasons

Character		Number of leaves					
Treatments		at 60 days		at 90 days		at 120 days	
		S1	S2	S1	S2	S1	S2
N- levels (kg/ *Fed*)							
0		5.50	5.08	6.67	6.42	8.40	9.40
40		6.50	6.33	7.75	7.58	9.30	10.30
80		7.33	7.08	8.50	8.33	10.20	11.20
120		7.83	7.50	8.83	8.75	10.70	11.70
160		8.17	8.08	9.17	9.33	11.30	12.20
L.S.D.(5 %)		0.16	0.52	0.25	0.60	0.53	0.55
Rhizobacterin (kg/*fed*)							
0		6.8	6.45	7.95	7.75	9.70	10.70
2		7.05	6.90	8.15	8.15	10.10	11.00
4		7.35	7.10	8.45	8.35	10.30	11.20
L.S.D.(5 %)		0.37	0.40	0.37	0.37	0.43	0.41
Interactions							
N- levels	Rhizo.						
	0	5.00	4.50	6.25	6.00	8.00	9.00
0	2	5.50	5.25	6.50	6.50	8.50	9.50
	4	6.00	5.50	7.25	6.75	8.80	9.80
	0	6.25	5.73	7.50	7.00	9.00	10.00
40	2	6.50	6.50	7.75	7.75	9.30	10.30
	4	6.75	6.75	8.00	8.00	9.80	10.80
	0	7.00	7.00	8.25	8.25	9.80	10.80
80	2	7.25	7.00	8.50	8.25	10.30	11.30
	4	7.75	7.25	8.75	8.50	10.50	11.50
	0	7.75	7.25	8.75	8.50	10.50	11.50
120	2	7.75	7.50	8.75	8.75	10.80	11.80
	4	8.00	7.75	9.00	9.00	10.80	11.80
	0	8.00	7.75	9.00	9.00	11.00	12.00
160	2	8.25	8.25	9.25	9.50	11.50	12.30
	4	8.25	8.25	9.25	9.50	11.50	12.30
L.S.D.(5 %)		N.S	N.S	N.S	N.S	N.S	N.S

Table 5: Leaves area after 60, 90 and 120 days of planting as affected by N - levels, biofertilizer "Rhizobacterin" and their interactions during 1999 / 2000 (S1) and 2000/ 2001 (S2 seasons.

Characters		Leaves area (cm) / plant					
		at 60 days		at 90 days		at 120 days	
Treatments		S1	S2	S1	S2	S1	S2
N- levels (kg/ *fed*.)							
0		240.61	215.48	313.84	312.10	417.63	417.48
40		324.23	260.18	435.90	410.97	573.57	555.73
80		374.75	300.14	508.61	480.80	761.50	716.31
120		408.33	341.99	536.63	545.40	884.17	829.12
160		414.73	350.80	537.96	547.72	885.48	829.69
L.S.D.(5%)		4.18	3.01	53.70	51.46	24.01	19.87
Rhizobacterin (kg/ *fed)*							
0		333.11	281.30	441.17	435.27	664.66	632.20
2		349.14	291.74	463.39	451.84	692.62	660.09
4		375.34	308.12	495.21	491.09	756.13	716.71
L.S.D. (5 %)		3.68	2.36	39.18	36.76	17.01	12.59
Interactions							
N-levels	Rhizo.						
	0	188.00	194.83	245.22	254.13	373.48	367.53
0	2	234.50	215.47	305.87	299.78	387.83	404.10
	4	299.33	236.13	390.43	382.39	491.58	480.80
	0	304.81	247.49	399.58	394.38	514.73	506.18
40	2	322.72	258.31	433.54	403.54	570.03	545.53
	4	345.15	274.74	474.58	435.00	635.95	615.48
	0	352.88	279.62	487.50	436.20	666.25	628.95
80	2	365.76	289.63	502.92	463.40	735.65	691.95
	4	405.61	331.17	535.40	542.80	882.60	828.03
	0	406.38	337.93	535.80	544.00	883.78	828.85
120	2	408.03	342.68	536.65	544.80	884.02	829.15
	4	410.58	345.39	537.44	547.40	884.70	829.35
	0	413.48	346.63	537.76	547.63	885.05	829.48
160	2	414.70	352.64	537.95	547.69	885.58	829.73
	4	416.03	353.14	538.18	547.85	885.82	829.88
L.S.D. (5 %)		8.23	5.26	87.52	81.68	41.140	28.12

Table 6: Dry weight of leaves/plant after 60, 90 and 120 days of planting as affected by N-levels, biofertlizer "Rhizobaterin" and their interactions during 1999 / 2000 (S1) and 2000/2001 (S2)

Characters		Dry weight of leaves/ plant (gm)					
Treatments		at 60 days		at 90 days		at 120 days	
		S1	S2	S1	S2	S1	S2
N- levels (kg/ *fed.*)							
0		2.19	2.10	3.41	3.40	6.89	6.75
40		2.81	2.67	4.27	4.42	8.64	8.74
80		3.33	3.11	5.51	5.48	10.57	10.52
120		3.70	3.53	6.21	6.39	12.45	12.60
160		3.81	3.60	6.50	6.57	12.90	12.97
L.S.D. (5%)		0.04	0.06	0.08	0.02	0.37	0.47
Rhizobacterin (kg/ *fed*)							
0		2.99	2.86	4.87	4.90	9.72	9.74
2		3.16	2.97	5.17	5.26	10.20	10.17
4		3.36	3.17	5.50	5.59	10.96	11.04
L.S.D.(5 %)		0.03	0.04	0.06	0.04	0.24	0.26
Interactions							
N-levels	Rhizo.						
	0	1.77	1.82	2.85	2.82	5.89	5.90
0	2	2.22	2.07	3.41	3.21	6.80	6.48
	4	2.59	2.41	3.97	3.94	7.90	7.88
	0	2.60	2.56	3.99	4.03	8.05	8.13
40	2	2.76	2.63	4.17	4.40	8.68	8.73
	4	3.08	2.82	4.64	4.83	9.20	9.38
	0	3.16	2.84	5.03	4.84	9.60	9.40
80	2	3.29	3.04	5.60	5.50	10.20	10.08
	4	3.53	3.45	5.91	6.08	11.90	12.08
	0	3.64	3.52	6.05	6.24	12.15	12.33
120	2	3.69	3.54	6.15	6.39	12.38	12.68
	4	3.77	3.55	6.43	6.45	12.83	12.90
	0	3.77	3.58	6.43	6.56	12.83	12.95
160	2	3.83	3.60	6.52	6.58	12.93	12.98
	4	3.83	3.61	6.55	6.58	12.98	12.98
L.S.D.(5 %)		0.06	0.08	0.14	0.10	0.53	0.57

Table 7: Crop growth rate of garlic plants after 60 - 90 days and 90 - 120 days of planting as affected by N- levels, biofertilizers "Rhizobacterin"and their interactions during 1999/ 2000 (S1) and 2000/ 2001 (S2) seasons.

Characters		Crop growth rate(mg/ g dry weight/ day)			
Treatments		at 60-90 days		at 90- 120 days	
		S1	S2	S1	S2
N- levels (kg/ *fed*.)					
0		0.400	0.042	0.116	0.117
40		0.048	0.058	0.146	0.144
80		0.073	0.079	0.168	0.169
120		0.084	0.095	0.208	0.207
160		0.090	0.099	0.214	0.213
L.S.D. (5%)		0.003	0.002	0.012	0.016
Rhizobacterin (kg/ *fed*)					
0		0.063	0.068	0.162	0.163
2		0.067	0.067	0.167	0.166
4		0.071	0.080	0.182	0.182
L.S.D. (5 %)		0.002	0.001	0.007	0.009
Interactions					
N-levels	Rhizo.				
	0	0.036	0.033	0.104	0.109
0	2	0.039	0.046	0.113	0.111
	4	0.046	0.048	0.131	0.131
	0	0.046	0.049	0.135	0.136
40	2	0.047	0.059	0.150	0.144
	4	0.052	0.067	0.152	0.152
	0	0.062	0.067	0.152	0.152
80	2	0.077	0.082	0.153	0.155
	4	0.079	0.088	0.200	0.199
	0	0.080	0.091	0.203	0.202
120	2	0.082	0.095	0.206	0.206
	4	0.089	0.099	0.213	0.212
	0	0.089	0.099	0.213	0.213
160	2	0.090	0.099	0.214	0.214
	4	0.091	0.098	0.214	0.214
L.S.D. (5 %)		0.004	0.002	0.013	0.020

contributing some hormone substances, such as gibberellins, auxins and cytokinins (Tien *et al.*1979, Bouton *et al.*1985 ; Cacciari *et al.* 1989). These phytohormones may stimulate the cell elongation and division and hence plant growth (Paleg, 1985). Moreover, the increment in bacteria population and its activity in the absorption zone of plant roots might improve soil fertility and plant development by N_2-fixation and due to releasing of certain other nutrients i.e. Fe, Zn and Mn (Bhonde *et al.* 1997).

The positive interactions between the applied N-fertilizer levels and biofertilizers "Rhizobacterin" on plant vegetative growth may be due to the promoting effects of both N-element and biofertilizers together on the established plant roots and nutrient uptake (Wange, 1995). Increasing N fertilizer increase the population of bacteria and this in turn increase nitrogen fixation and release of phytohormones and trace elements for that interaction increase plant growth.

Total Yield and Its Components:

Results outlined in Table 8 declare that the highest total yield; i.e.9.901 and 10.159 tons/ *fed* was obtained from the treatment received 80 kg N/ *fed* in the first and second seasons, respectively, followed by that of 80 kg/fed. However, increasing N-fertilizer level gradually from 0 up to 120kg N/ fed. led to a gradual increases in yield of bulb>5 cm. Moreover, there was a significant reduction in yield of bulbs <5 cm in both seasons. On the other hand, application of 160 kg N /*fed* had no further advantage on bulb yield. Concerning the effect of biofertilizer, data showed that its application at 4 kg/ *fed* achieved the highest total yield; i.e., 8.7 and 9.0 tons/*fed* as well as yield of bulbs >5 cm (5.4 and 5.5 tons/ fed) in the first and second seasons, respectively. The favorable effect of N- fertilizer and biofertilizers on total yield and its components could be explained through the great role of N-element in enhancing plant growth rate, which exert direct effect on the yield. These results are in accordance with those of Lewis *et al.*(1995) , Patel *et al.*(1996) ; Selvaraj *et al.*(1997) and Gomez and Munoz (1998) all on garlic. The interaction effect of N-fertilizer and biofertilizer indicated that all levels of nitrogen were more effective in the presence rather than in the absence of biofertilizer. However, plants receiving N at the rate of 80 kg/ *fed* with biofertilizer at the rate of 4 kg/*fed.* produced the highest yields, in both seasons of study.

Table 8: Total yield and its components as affected by N - levels, biofertilizer "Rhizobacterin"and their interactions during 1999/ 2000 (S1) and 2000 / 2001 (S2) seasons.

Characters		Yield (ton/ fed)					
Treatments		Total yield		Yield of bulbs >5 cm		Yield of bulbs < 5 cm	
		S1	S2	S1	S2	S1	S2
N- levels (kg/ *fed.*)							
0		5.830	6.093	1.714	1.756	4.121	4.337
40		7.721	7.979	3.797	3.955	3.924	4.008
80		9.162	9.420	6.135	6.276	3.026	6.143
120		9.846	10.104	7.418	7.598	2.429	2.506
160		8.855	9.113	5.290	5.408	3.559	3.705
L.S.D.(5%)		0.762	0.459	0.371	0.487	0.312	0.302
Rhizobacterin (kg/ *fed)*							
0		7.867	8.125	4.294	4.403	3.573	3.722
2		8.280	8.538	4.897	5.021	3.383	3.517
4		8.704	8.962	5.425	5.572	3.279	3.381
L.S.D.(5 %)		0.213	0.207	0.114	0.141	N.S	N.S
Interactions							
N-levels	Rhizo.						
	0	5.422	5.680	0.949	0.976	4.473	4.703
0	2	5.803	6.061	1.706	1.839	4.097	4.223
	4	6.279	6.537	2.487	2.453	3.793	4.084
	0	6.943	7.201	2.986	3.106	3.957	4.094
40	2	7.824	8.082	3.912	3.998	3.911	4.085
	4	8.397	8.655	4.492	4.760	3.905	3.847
	0	8.428	8.686	4.888	4.952	3.540	3.734
80	2	9.155	9.413	6.043	6.257	3.113	3.157
	4	9.901	10.159	7.476	7.620	2.426	2.540
	0	9.786	10.044	7.437	7.589	2.349	2.455
120	2	9.853	10.112	7.390	7.602	2.464	2.510
	4	9.899	10.157	7.427	7.605	2.475	2.552
	0	8.757	9.015	5.211	5.391	3.547	3.623
160	2	8.764	9.023	5.434	5.411	3.331	3.612
	4	9.044	9.302	5.246	5.421	3.798	3.880
L.S.D.(5 %)		0.575	0.458	0.453	0.316	N.S	N.S

Bulb and Clove Traits:

Data in Tables 9 and 10 elucidate that increasing applied N- fertilizer to growing plants from 0 up to 120 kg/ *fed* led to constant increases in bulb weight, diameter and clove weight. There were no further increases with 160 kg N/*fed* .However, bulbing ratio and number of cloves and clove circles/ bulb were significantly affected. The increase in bulb and clove weights and bulb diameter due to N- application at moderate levels could be the result of increasing the dry matter in plant foliage, which is diverted to the bulb felling. These results are in harmony of Abdel-Hameid *et al.*(1991) and Wange (1995) both on garlic. Biofertilizers either at 2 or 4 kg/ *fed* increased bulb weight, diameter and clove weight over the control, but the level of 4 kg/ *fed* was more useful than 2 kg/ *fed* in both seasons. However, biofertilizer treatments did not reflect significant variations on bulbing ratio or number of clove and circles/ bulb. Similar results were reported by Lewis *et al.*(1995) and Ali *et al.*(2001) on garlic. The interaction effect demonstrated that biofertilizers at 4-kg/ *fed* in combination with 80 or 120 kg N/ *fed* achieved the highest mean values on bulb and clove weight in the two seasons of the study. On the contrary, there were no significant effects on bulb diameter, bulbing ratio and both number of cloves or clove circles/ bulb. The obtained results were similar to those of Bhonde *et al.*(1997) , Gomez and Munoz (1998) ; Gouda (2002)on garlic.

Chemical Constituents:

Increasing the applied N- levels to plants from 40 up to 120 kg/ *fed,* progressively, increased concentration of N and K Table 11 as well as carotenoid and volatile oils Table 12, although application of 160 kg N/fed, had no further increases except NO_3 which was higher in the second season . The necessity of N. as a plant nutrient is emphasized by the fact that it is a main constituent of many organic compounds in plant (Tyler *et al.*1988). Similar results were obtained by EL-Moursi (1999). Concerning the effect of biofertilizer treatments results revealed that concentrations of N and K Table 11 as well as carotenoids and volatile oils Table 12 were higher and NO_3 ,significantly, decreased with biofertilizer than with untreated ones, in both seasons. Bashan and Holguin (1997) reported that the beneficial effect of biofertilizer on chemical constituents of garlic bulb may be due to the fact that non-symbiotic bacteria (N_2-fixation) have the ability to supply the growing plants with N, certain micronutrients and phytohormones

Table 9: Bulb traits as affected by N - levels, biofertilizer "Rhizobacterin" and the interactions during 1999/ 2000 (S1) and 2000/ 2001 (S2) seasons.

Characters		Yield (ton/ fed)					
Trearments		Weight (gm)		Diameter (cm)		Bulbing ratio	
		S1	S2	S1	S2	S1	S2
N- levels (kg/ *fed*.)							
0		46.53	44.83	3.97	4.27	0.276	0.267
40		64.32	62.62	5.00	5.30	0.241	0.235
80		83.23	81.53	5.88	6.18	0.188	0.180
120		89.36	87.66	6.29	6.43	0.166	0.159
160		81.83	82.13	5.57	5.87	0.232	0.225
L.S.D. (5%)		3.60	3.61	0.25	0.26	N.S	N.S
Rhizobacterin (kg/ *fed*)							
0		68.66	67.36	5.16	5.36	0.229	0.222
2		73.35	72.05	5.32	5.62	0.219	0.213
4		77.15	75.85	5.55	5.85	0.211	0.203
L.S.D.(5 %)		2.34	2.36	0.14	0.13	N.S	N.S
Interactions							
N-levels	Rhizo.						
	0	39.30	37.60	3.55	3.85	0.287	0.280
0	2	47.48	45.78	3.90	4.20	0.760	0.269
	4	52.83	51.13	4.45	4.75	0.258	0.251
	0	57.40	55.70	4.75	5.05	0.253	0.246
40	2	63.98	62.28	5.00	5.30	0.239	0.235
	4	71.58	69.88	5.25	5.55	0.230	0.223
	0	76.50	74.80	5.45	5.75	0.215	0.208
80	2	83.75	82.15	6.00	6.30	0.185	0.178
	4	89.43	87.73	6.20	6.50	0.163	0.154
	0	89.33	87.63	6.15	6.45	0.165	0.158
120	2	89.35	87.65	6.08	6.38	0.166	0.159
	4	89.40	87.70	6.15	6.45	0.165	0.158
	0	80.78	81.08	5.40	5.70	0.277	0.221
160	2	82.20	82.50	5.60	5.90	0.230	0.223
	4	82.50	82.80	5.70	6.00	0.238	0.231
L.S.D.(5 %)		5.23	5.22	N.S	N.S	N.S	N.S

Table 10 : Clove traits and bulbing ratio as affected by N -levels, biofertilizer "Rhizobacterin" and their interactions during 1999/ 2000 (S1) and 2000/ 2001 (S2) seasons.

Characters		Traits of clove					
Treatments		Weight (gm)		No. of cloves/ bulb		No. of cloves circles/ bulb	
		S1	S2	S1	S2	S1	S2
N- levels (kg/ *fed.*)							
0		2.96	2.90	9.50	15.58	5.08	4.82
40		4.69	4.47	13.83	14.08	4.33	4.75
80		7.98	7.13	10.58	11.58	3.50	4.20
120		8.96	7.99	10.00	11.00	3.41	4.35
160		6.64	6.01	12.33	13.33	4.42	4.37
L.S.D. 5%		0.46	0.42	N.S	N.S	0.41	0.33
Rhizobacterin (kg/ *fed*)							
0		5.74	5.25	12.95	13.50	4.40	4.58
2		6.24	5.69	12.50	13.10	4.10	4.51
4		6.75	6.17	12.10	12.75	3.95	4.40
L.S.D. (5 %)		0.29	0.26	N.S	N.S	N.S	N.S
Interactions							
N-levels	Rhizo.						
	0	2.38	2.32	16.50	16.25	5.75	5.00
0	2	3.02	2.97	15.75	15.50	5.00	4.70
	4	3.47	3.42	15.25	15.00	4.50	4.75
	0	3.89	3.79	14.75	14.75	4.50	4.85
40	2	4.66	4.45	13.75	14.00	4.25	4.85
	4	5.51	5.18	13.00	13.50	4.25	4.55
	0	6.66	5.99	11.50	12.50	3.75	4.35
80	2	7.81	6.98	10.75	11.75	3.50	4.15
	4	9.45	8.42	9.50	10.50	3.25	4.10
	0	9.17	8.17	9.75	10.75	3.50	4.40
120	2	9.98	9.97	10.00	11.00	3.25	4.40
	4	8.74	7.83	10.25	11.25	3.50	4.25
	0	6.58	5.97	12.25	13.25	4.50	4.30
160	2	6.73	6.08	12.25	13.25	4.50	4.45
	4	6.61	5.99	12.50	13.50	4.25	4.25
L.S.D.(5 %)		0.66	0.59	N.S	N.S	N.S	N.S

Table 11: Concentrations of N, P and K in t he bulbs as affected by N - levels, biofertilizer "Rhizobacterin" and their interactions during 1999 / 2000 (S1) and 2000/ 2001 (S2) seasons.

Characters		N %		P %		K %	
Treatments		S1	S2	S1	S2	S1	S2
N- levels (kg/ *fed.*)							
0		1.344	1.335	0.340	0.328	0.680	0.675
40		1.661	1.643	0.294	0.309	0.756	0.752
80		2.105	2.075	0.281	0.285	0.880	0.883
120		2.324	2.352	0.276	0.276	0.971	0.966
160		2.165	2.141	0.284	0.283	0.945	0.951
L.S.D. (5%)		0.001	0.012	N.S	N.S	0.009	N.S
Rhizobacterin (kg/ *fed*)							
0		1.809	1.871	0.300	0.303	0.815	0.813
2		1.929	1.899	0.295	0.295	0.847	0.848
4		2.022	2.010	0.290	0.291	0.877	0.875
L.S.D.(5 %)		0.012	0.008	N.S	N.S	0.011	0.005
Interactions							
N-levels	Rhizo.						
	0	1.232	1.260	0.351	0.337	0.640	0.636
0	2	1.344	1.316	0.335	0.324	0.680	0.676
	4	1.456	1.428	0.333	0.323	0.720	0.713
	0	1.484	1.512	0.300	0.320	0.728	0.717
40	2	1.680	1.652	0.296	0.312	0.760	0.758
	4	1.820	1.764	0.286	0.296	0.780	0.782
	0	1.904	1.848	0.284	0.294	0.800	0.804
80	2	2.142	2.044	0.280	0.282	0.880	0.887
	4	2.268	2.332	0.278	0.279	0.960	0.957
	0	2.296	2.344	0.277	0.278	0.968	0.962
120	2	2.324	2.355	0.276	0.276	0.972	0.968
	4	2.352	2.357	0.275	0.274	0.972	0.969
	0	2.128	2.122	0.288	0.285	0.940	0.947
160	2	2.156	2.131	0.286	0.283	0.944	0.950
	4	2.212	2.170	0.279	0.282	0.952	0.955
L.S.D.(5 %)		0.026	0.018	N.S	N.S	N.S	N.S

Table 12: Concentrations of carotenoids, volatile oils and NO_3 in the bulbs as affected by N-levels, biofertilizer "Rhizobacterin" and their interactions during 1999/ 2000 (S1) and 2000/ 2001 (S2) seasons.

Characters		Carotenoids (mg/kg)		Volatiles oil (cm/L		NO_3 ppm	
Treatments		S1	S2	S1	S2	S1	S2
N- levels (kg/ *fed.)*							
0		0.233	0.232	0.556	0.555	0.089	0.103
40		0.261	0.263	0.625	0.633	0.115	0.118
80		0.316	0.317	0.753	0.752	0.196	0.199
120		0.357	0.356	0.787	0.785	0.205	0.213
160		0.326	0.326	0.700	0.716	0.174	0.227
L.S.D.(5%)		0.031	0.005	0.003	0.007	0.008	0.009
Rhizobacterin (kg/ *fed*)							
0		0.286	0.286	0.660	0.663	0.177	0.184
2		0.299	0.299	0.687	0.690	0.166	0.171
4		0.311	0.311	0.705	0.708	0.156	0.161
L.S.D.(5 %)		0.023	0.005	0.006	0.008	0.008	0.002
Interactions							
N-levels	Rhizo.						
	0	0.216	0.219	0.529	0.526	0.105	0.112
0	2	0.239	0.237	0.556	0.558	0.089	0.103
	4	0.243	0.241	0.584	0.582	0.092	0.095
	0	0.251	0.252	0.599	0.595	0.125	0.132
40	2	0.258	0.260	0.627	0.632	0.118	0.115
	4	0.274	0.276	0.648	0.651	0.103	0.105
	0	0.289	0.287	0.707	0.711	0.205	0.212
80	2	0.315	0.316	0.768	0.761	0.198	0.196
	4	0.343	0.347	0.783	0.785	0.186	0.189
	0	0.353	0.352	0.785	0.784	0.218	0.226
120	2	0.355	0.357	0.788	0.785	0.204	0.214
	4	0.363	0.359	0.788	0.786	0.193	0.198
	0	0.320	0.322	0.682	0.698	0.230	0.238
160	2	0.327	0.325	0.694	0.714	0.212	0.226
	4	0.332	0.330	0.724	0.735	0.204	0.218
L.S.D.(5 %)		0.052	0.012	0.014	0.018	N.S	N.S

Table 13: Weight loss percentage of stored garlic (six monthes) as affected by N-levels, biofertilizer "Rhizobacterin" and their interactions in the first storage season.

Characters		Weight loss percentage					
Treatments		at 30 days	at 60 days	at 90 days	at 120 days	at 150 days	at 180 days
N- levels (kg/ *fed.*)							
0		15.80	27.70	35.37	39.17	41.80	43.20
40		16.40	28.90	36.83	41.17	43.90	45.60
80		17.00	30.17	38.60	43.57	46.57	48.37
120		17.50	31.17	39.90	45.13	48.43	50.37
160		17.97	31.83	40.97	46.40	48.93	51.47
L.S.D. (5%)		N.S	0.17	0.23	0.11	0.07	0.04
Rhizobacterin (kg/ *fed*							
0		17.12	30.30	38.84	43.70	46.60	48.42
2		16.92	29.96	38.32	43.06	45.88	47.78
4		16.76	29.60	37.84	42.50	45.30	47.20
L.S.D. (5 %)		N.S	0.18	0.14	0.15	0.06	0.04
Interactions							
N-levels	Rhizo.						
	0	16.00	28.00	35.80	29.70	42.40	43.80
0	2	15.80	27.70	35.40	39.20	41.80	43.20
	4	15.60	27.40	34.90	38.60	41.20	42.60
	0	16.60	29.30	37.30	41.80	44.70	46.30
40	2	16.40	28.90	36.80	41.10	43.60	45.50
	4	16.20	28.50	36.40	40.60	43.40	45.00
	0	17.20	30.60	39.20	44.30	47.50	49.30
80	2	17.00	30.20	38.70	43.70	46.60	48.40
	4	16.80	29.70	37.90	42.70	45.60	47.40
	0	17.60	31.40	40.20	45.50	48.90	50.80
120	2	17.50	31.20	39.90	45.10	48.40	50.30
	4	17.40	30.90	39.60	44.80	48.00	50.00
	0	18.20	32.20	41.70	47.20	49.50	51.90
160	2	17.90	31.80	40.80	46.20	49.00	51.50
	4	17.80	31.50	40.40	45.80	48.30	51.00
L.S.D. (5 %)		N.S	0.23	0.32	0.25	0.160	0.09

Table 14: Weight loss percentage of stored garlic (six monthes) as affected by N-levels, biofertilizer "Rhizobacterin" and their interactions in the second storage season.

Characters		Weight loss percentage					
Treatments		at 30 days	at 60 days	at 90 days	at 120 days	at 150 days	at 180 days
N- levels (kg/ *fed*.)							
0		15.53	26.77	33.00	38.10	41.20	42.80
40		16.27	27.87	34.97	40.17	43.00	45.09
80		17.23	29.57	36.40	42.77	45.50	46.67
120		17.90	30.87	38.57	44.53	47.37	48.43
160		18.60	32.10	39.46	45.53	47.93	49.43
L.S.D. (5%)		N.S	0.05	0.04	0.08	0.05	0.06
Rhizobacterin (kg/ *fed*)							
0		17.40	29.92	36.80	42.80	45.68	47.08
2		17.10	29.38	36.48	42.18	44.94	46.52
4		16.82	29.00	36.16	41.68	44.38	45.86
L.S.D. (5 %)		N.S	0.06	0.03	0.09	0.05	0.04
Interactions							
N-levels	Rhizo.						
	0	15.80	27.30	33.20	38.60	41.70	43.30
0	2	15.50	26.70	33.00	38.10	41.20	42.80
	4	15.30	26.30	32.80	37.60	40.70	42.30
	0	16.50	28.20	35.30	40.70	43.90	45.80
40	2	16.30	27.90	35.00	40.10	42.70	45.30
	4	16.00	27.40	34.60	39.70	42.40	44.20
	0	17.50	30.00	36.80	43.30	46.50	47.60
80	2	17.20	29.50	36.40	42.80	45.50	46.80
	4	17.00	29.20	36.00	42.20	44.50	43.60
	0	18.20	31.50	38.90	44.90	47.80	48.90
120	2	18.00	30.80	38.60	44.50	47.30	48.40
	4	17.50	30.30	38.20	44.20	47.00	48.00
	0	19.00	32.50	39.80	465.00	48.50	49.80
160	2	18.50	32.00	39.40	45.40	48.00	49.30
	4	18.30	31.80	39.20	44.70	47.30	49.20
L.S.D. (5 %)		N.S	0.12	0.08	0.22	0.12	0.09

that could stimulate nutrients absorption and photosynthesis and thereby increase chemical contents in different plant tissues. The obtained results are in compatible with those of Lewis *et al.* (1995) , Wange (1998) ;Gouda (2002) on garlic.

The interaction effects of applied N-levels and biofertilizer treatments showed that application of 120 kg N/ *fed* with biofertilizer at 4 kg/ *fed* gave the highest concentration of N, carotenoids and volatile oils, while 160 kg N/ *fed* with biofertilizer at 2 kg N/ *fed* gave the highest P levels in the two seasons. On the other hand, there were no significant effects on K or NO_3 contents in both seasons. These results coincide with those of Gomez and Munoz (1998) and Gouda (2002).

Storability:

Data illustrated in Tables 13 and 14 proved that N fertilization treatments significantly increased weight loss percentage of stored garlic for six months in both seasons. Increasing the storage period from 30 to 180 days constantly reduced stored garlic weight in both seasons. Moreover, increasing the applied N-fertilizer levels to grown plants led to linear increases in weight loss percentage during the storage period. Leilah and Mostafa (1993) suggested that N-nutrition at higher rates may encourage plant growth at the expense of some organic compounds formation and total soluble solids in storage parts. These results agreed to such extent with those of El-Beheidi *et al.* (1985) on garlic.

Concerning the effect of biofertilization treatments, the most interesting observation was the reduction of weight loss percentage in stored garlic by biofertilizer treatments of either at 2 or 4 kg/ *fed* compared with untreated plants in both seasons. The highest level gave lower percentage of weight loss during the storage period. Similar results were obtained by Mahendran and Kumar (1996) and Gomez and Munoz (1998) on garlic. The interaction effect indicated that application of biofertilizer at 4 kg/ *fed* with 80 kg N/ *fed* gave acceptable values in both seasons. These results are in harmony with those obtained by Ali *et al.* (2001) and Gouda (2002) on garlic.

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تأثير مستويات الأسمدة الحيوية(ريزوباكتيرين) و النيتروجينية علي إنتاجية وصفات الثوم الصيني تحت ظروف الأراضي الرملية

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أجريت تجربتان حقليتان في أرض رملية بمزرعة بحوث التجارب بكلية الزراعة جامعة قناة السويس بالإسماعيلية, خلال موسمي ١٩٩٩/ ٢٠٠٠, ٢٠٠٠/٢٠٠١ علي صنف الثوم الصيني" سلالة سدس" ٤بهدف تقييم تأثير التسميد الأرضي بالنيتروجين الكيميائي منفردا علي صورة نترات أمونيوم ٣٣،٥ % بمستويات صفر , ٤٠ , ٨٠, ١٢٠ و ١٦٠ كجم أزوت/ فدان, أو في توليفات مع المخصب الحيوي ريزوباكتيرين بمعدل ٢, ٤ كجم / فدان علي كل من النمو الخضري , المحصول الكلي, مكوناته, كذلك علي جودة الأبصال, قابليتها للتخزين تحت ظروف الغرفة.

و يمكن تلخيص النتائج المتحصل عليها فيما يأتي:

١-أدت زيادة مستويات سماد النيتروجين المضاف بمفرده من صفر – ١٦٠ كجم أزوت/ فدان إلى حدوث زيادة معنوية في كل صفات النمو الخضري المختبرة.

٢-أدت زيادة مستويات السماد النيتروجيني من ٤٠ حتى ١٢٠ كجم أزوت / فدان إلى حدوث زيادة معنوية في المحصول الكلي, مكوناته كذلك تحسين معظم المحتويات الكيميائية المختبرة في الأبصال , قابليتها للتخزين.

٣-أدت زياد المخصب الحيوي بمفردة بمعدل ٢ كجم أو ٤ كجم للفدان إلى حدوث زيادات معنوية في نمو النباتات, المحصول الكلي , مكوناته, كما أدت إلى تحسين المحتوي الكيماوي للأبصال , كذلك قابليتها للتخزين مقارنة بغير المعاملة وكانت المعاملة ٤كجم / فدان هي الأكثر فاعلية عن المعاملة ٢ كجم/ فدان.

٤- وجد أن أحسن معاملة لانتاج الثوم الصيني تحت ظروف الأراضي الرملية في منطقة الإسماعيلية هي استخدام ٨٠ كجم أزوت للفدان مع ٤ كجم سماد حيوي " ريزوباكتيرين".