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EFFECT OF SOME NITROGEN LEVELS AND BIOFERTILIZERS ON PRODUCTIVITY OF GARLIC AND PEA INTRCROPPED

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ABSTRACT

Two field trials were conducted on garlic clone Sids-40 and Pea cv. Master-B as a companion crop, in the vegetable private farm at Kafr Hassan, near El-Mansoura, during 2002/2003 and 2003/2004 seasons to study the effect of some nitrogen fertilizer levels at 30, 60, 90 and 120 kg N/fed, biofertilizers (Control, nitrobien and rhizobacterin) and their interactions on the plant growth, yield and its quality of garlic and pea as well as chemical constituents of garlic and pea plants foliage and garlic bulbs.

Generally, results showed that the growth and yield of garlic and pea plants were enhanced with increases N-levels. Most studied characteristics of garlic plants i.e., plant height, shoot dry weight, bulbing ratio, yield, bulb weight and diameter as well as clove weight were significantly increased with increasing N-levels up to 120 kg N/fed. On the other hand, the growth, yield and yield components of pea plants was increased with increasing N-level from 30 up to 60 kg N/fed. While, all studied characters of pea were not responded to high N-levels above 60 kg N/fed. Whereas, the increases of application-N significantly increased concentration of N, P, K, in garlic and in pea foliage, TSS and volatile oils in garlic cloves.

On the other hand, biofertilizers had a significant effect on growth and yield of garlic and pea plants. In this respect, inoculation of garlic cloves or pea seeds by rhizobacterin pre-sowing significantly increased most studied characteristics of garlic and pea plants compared with the untreated ones.

The combined treatments of N-levels and biofertilizers were generally more effective than with single ones. The best results were obtained by using 90 kg N/fed for garlic or 60 kg N/fed for pea in the presence of rhizobacterin. Besides, these interactions resulted in the best net income from unit area.

From the foregone it is evident that, inoculation garlic cloves or pea seeds by rhizobacterin as a biofertilizer pre-sowing rising their efficiency and reduce application rate of N-fertilizer about 25 %, thereby reducing costs and environmental pollution problems. Therefore, this treatment could be recommended for raising garlic and pea yields, improving their qualities and raising the mean of net income per unit area under similar conditions to this work.

INTRODUCTION

Garlic (*Allium sativum* L.) is one of the most important bulb vegetable crops and is next to onion in importance. It is commonly used as a spice or in many medicinal purposes. Also, pea (*Pisum sativum* L.) is one of the most important and popular winter vegetable crops, it is intercropping in the middle of garlic rows as a one of local cultivated systems to raising the productivity from land unit area, that add a new early income for growers. In Egypt, garlic and pea have been generally cultivated for both local consumption and export. Therefore, increasing garlic or pea yields and improving their qualities are essential aims for both growers and consumers, but it usually depends on many factors especially that affect the plant growth throughout the growth period.

Nitrogen nutrition is one of major factor affecting growth, yield and quality of garlic or pea. It is a main constituent of many organic compounds in plants, such as proteins, enzymes, pigments, hormones and vitamins, (Gardener *et al.*, 1985).

Up to now, several investigations have been carried out to evaluate the effects of N fertilization on growth and productivity of garlic plants. In this respect, several researchers found that plant height, number of leaves, neck thickness, bulb size, number of cloves/bulb and total yield were increased with increasing N-fertilizer level (Pal and Pandey, 1986., Setty *et al.*, 1989; Abd El-Hamid *et al.*, 1991 and 1996; Silva *et al.*, 2000 and Nadiu *et al.*, 2000). Furthermore, contents of N, P and K in leaf and bulbs of garlic and volatile oils in bulbs were much increased by increasing N-level (Hilman and Noordiyati, 1988; Bertoni *et al.*, 1988; Verma *et al.*, 1996; El-Moursi, 1999 and Naruka, 2002).

Also, several researchers reported that increasing nitrogen levels gave a significant increases in growth characters of pea plants, i.e., plant height, number of leaves and branches/plant and dry weight of leaves and branches, pod green yield and chemical composition (Amer, 1998; Hanefy *et al.*, 1999; Shokr 2000 and Uddin *et al.*, 2000).

On the other hand, the continuous increase in the costs of chemical fertilizers and environmental pollution problems limits application of sufficient amount for plants by many farmers. Thus, it has become essential to use of untraditional fertilizers as substitutes or supplements for chemical fertilizers. Fortunately, El-Haddad *et al.* (1993) indicated that using bio-fertilizers is considered a promising alternative for chemical fertilizers under Egyptian soil conditions.

Many studies pointed out that inoculation of garlic plants with N_2-fixing bacteria of *Azospirillum* or *Azotobacter* either single or in combinations markedly increased plant shoot growth, bulb size, total yield and chemical compositions in plant, especially with their mixtures compared with the untreated plants (Mahendran and Kumar, 1996; Gomez and Munoz, 1998; Wange, 1998 and Ali *et al.*, 2001). Recently, Gouda (2002) and Mohamad (2003) found that application of 75% recommended rate of chemical N-fertilizers in the presence of biofertilizers i.e., nitrobien or rhizobacterin significantly increased vegetative growth characteristics, yield and yield components

Likewise, some studies have been carried out to clear and-explain the efficiency of N-biofertilizers on growth and yield of pea plants. In this direction, seeds germination, plant growth rate, yield and chemical constituents in leaves were generally increased by using N-biofertilizers as compared with the untreated ones (Hanafy *et al.*, 1999; Vimala and Natarajan, 1999 & 2000 and Abdalla *et al.*, 2000 a & b) on pea. Also, Safia (2002) found that growth characters, yield and yield characters of broad been were improved with application of nitrobein.

For this reason, it is evident that the present work is a very important to study the effects of chemical N-levels, either single and/or in combinations with the some local bio-fertilizers (Nitrobein or Rhizobacterin) on plant growth, yield and its components as well as chemical constituents of garlic (clone Sids-40) and Pea (Cv. Master-B) intercropped under the local conditions of Dakahlia District.

MATERIALS AND METHODS

Two field experiments were carried out in vegetable private Farm at Kafr Hassan, near El-Mansoura, during the two growing seasons of 2002/2003 and 2003/2004, to study the effects nitrogen application levels and some N-biofertilizers on garlic (Sids-40) and Pea (Master-B) intercropped growth, yield and its components, as well as chemical constituents in foliage of garlic and pea and on garlic cloves.

The experiment included 12 treatments resulting from the combinations of four nitrogen levels; 30, 60, 90 and 120 kg N/fed (later level was recommended N-rate for garlic) and three biofertilizers treatments; control (untreated), nitrobein and rhizobacterin.

The experimental design was a split plot system with three replications. The four levels of N occupied the main plots, while the three biofertilizers treatments were assigned to the sub-plots. The sub-plot area was 17.5 m^2 which contained 5 rows, 5 m length and 0.7 m width.

A randomized samples were obtained from the experiment soils to determine the physical and chemical contents according to the standard method described by Wilde *et al.* (1985).

Table (1) : Soil analysis of the experimental soil.

Depth (cm)	Clay %	Silt %	Sand %	Texture class	O.M %	$CaCo_3$ %	E.C. (mm hos/ cm/25°C)	pH (1 : 2.5 ext.)	Total N ppm	Avail. P ppm	Avail. K ppm
0-60	25.0	47.0	24.2	Loam	1. 7	1.7	1.1	8.0	48.5	7.5	360

Garlic cloves were planted on 3rd and 7th of October in the first and second seasons, respectively. While pea seeds were sown on 7th of Novmber in both seasons.

Nearly uniform garlic cloves were soaked in running water for 24 h and inoculated by dipping for five minutes in thick pastes of carrier based inoculants prior to sowing and hand-planted at 10 cm apart on two sides of each ridge, the companion crop (pea) was sown (after inoculated by biofertilizers) in hills in the middle of ridge at 15 cm apart, the plants were thinned to two plants per hill before the first irrigation. The nitrogen levels were applied as the three equal doses 30, 60 and 90 days after planting garlic cloves. All plants were fertilized with 90 kg P_2O_5/fed (super-phosphate, 15.5% P_2O_5) and 96 kg K_2O/fed (potassium sulphate 48% K_2O) which added in three equal doses in the same times of nitrogen application. The other cultural practices for garlic and pea commercial production were used according to the instructions laid down by the Ministry of Agriculture, Egypt.

Pods green of pea were harvested at the proper maturity stage. The harvesting time of garlic was in the first week of April, for both seasons.

Data recorded:

1- Growth parameters:

A random sample of ten garlic plants was taken from each plot after 120 days from planting to estimate plant height, number of leaves/plant, foliage dry weight and bulbing ratio. For pea, random representative samples of five plants from each plot were chosen at 55 days after sowing in both seasons to determine the plant height, number of leaves/plant, number of branches/plant and plant dry weight.

2- Yield and its components:

At harvest time, marketable garlic plants in the three central rows of each plot were cured , 15 days after harvest, weighted in kg and converted to record as total yield (ton/fed). A random sample (10 bulbs) was taken from each treatment to determine bulb weight and diameter, as well as the number of cloves/bulb and clove weight. For pea, green pods of three rows of each plot were harvested at the proper maturity stage, weighted in each harvested in kg and converted to record as fresh pod yield (ton/fed), a random sample (20 pods) was taken from each treatment to determine pod weight, pod length and number of green seeds/pod.

3- Mean of net income per feddan:

Mean of net income was calculated as follows:-

Net income = total income - total costs

Total net income was counted according to the local price of garlic and pea (L E./ton), the price of garlic was 1200 L.E./ton in both seasons, while the price of pea was 1500 L.E./ton in two seasons of study.

4- Chemical analysis:

Samples of the dried foliage of garlic or pea were ground, wet digested as described by Hesse (1971) and their nitrogen (N), phosphorus (P) and potassium contents were determined according to the methods described by Pregl (1945), John (1970) and Brown and Lilleland (1946) respectively. Percentage of total soluble solids (TSS%) and volatile oils (cm^3/kg cloves fresh weight) in garlic cloves were determined according to A.O.A.C. (1970) and Guenther (1961), respectively.

All obtained data were subjected to statistical analysis of variance according to the procedure outlined by Snedecor and Cochran (1967). The treatment means were compared using Duncan's Multiple Range Test as published by Duncan (1955).

RESULTS AND DISCUSSION

1- Plant growth parameters:

1.1- Effect of mineral N-levels:

Data presented in Tables (2 a and b) show that mean values of all studied characteristics of vegetative growth for garlic plants were generally increased with increasing N-levels from 30 up to 120 kg N/fed. The differences in greater parameters was not significantly when comparing with

90 kg N/fed and 120 kg N/fed in both seasons. except bulbing ratio in the first season only. On the other hand, all vegetative growth characteristics of pea plants were increased with increasing N-levels from 30 up to 60 kg N/fed. These parameters were not responded to increases of nitrogen application level above 60 kg N/fed. The increase in plant growth might be attributed to the favorable effects of nitrogen on stimulating the meristematic activity for producing more tissues and organ, since nitrogen plays an important role in protein and nucleic acids synthesis as well as protoplasm formation (Yagodin, 1984), The obtained results are in harmony with those of (Setty *et al.*, 1989; Abd El-Hamid *et al.*, 1991 and 1996; Silva *et al.*, 2000 and Nadiu *et al.*, 2000) on garlic and (Amer, 1998; Hanefy *et al.*, 1999; Shokr 2000 and Uddin *et al.*, 2000) they found that all plant growth characters studied were significantly increased with increasing of application N.

1.2- Effect of biofertilizers:

In Tables (2 a and b), it is noticed that all studied of vegetative growth parameters of garlic and pea were significantly affected by biofertilizers in both seasons. Garlic cloves or pea seeds inoculated with rhizobacterin gave increased plant height, number of leaves, foliage dry weight of garlic or pea plants, bulbing ratio in garlic and number of branches/pea plant comparing with those of the plants uninoculated in both seasons of study. These increases in plant growth may be due to the great role of biofertilizer bacteria in enhancing plant growth by N_2-fixing in cultivated soils and/or contributing some growth hormones, such as gibberellins, auxins and cytokinins (Tien *et al.*, 1979; Bouton *et al.*, 1985 and Cacciari *et al.*, 1989). The obtained results are in accordance with those of (Wange, 1998; Gomez and Munoz, 1998 and Ali *et al.*, 2001) on garlic and (Hanafy *et al.*, 1999; Abdalla *et al.*, 2000 a & b and Safia, 2002) on pea or broad bean plants.

1.3- Effect of interaction between N-levels and biofertilizers

Data in Tables (2 a and b) show the effect of the interaction between mineral N-levels and biofertilizers on garlic and pea plants growth. It is clear from the data that, in general, plants received 90 or 120 kg N/fed in the presence of rhizobacterin gave the maximum plant height, number of leaves and shoot dry weight in garlic or pea. Moreover, these treatments improved the bulbing ratio of garlic and increased number of shoots/plant of pea. Such results previously were explained by Reynders and Vlassak (1982), who suggested that chemical N addition with biofertilizers may activate N_2-fixing bacteria in the soil, these bacteria have the ability to supply the plants with fixed-N and release plant growth promoting substances (GA, IAA and cytokinins). The obtained results are in harmony with those of (Gouda, 2002 and Mohamad, 2003) on garlic and (Vimala and Natarajan, 1999 & 2000 and Safia, 2002) on pea and broad been plants.

2- Yield and its components:

2.1- Effect of nitrogen levels:

Data presented in Tables (3 a and b) reveal that all the studied characteristics of garlic yield and its components were generally increased with increasing nitrogen level

Table (2 a): Vegetative growth characters of garlic and pea plants as affected by Nitrogen levels, biofertilizers and their interactions during 2002/2003 and 2003/2004 seasons.

Characters / Treatments		Garlic				Pea			
		Plant height (cm)		Number of leaves/plant		Plant height (cm)		Number of leaves/plant	
		2002/2003	2003/2004	2002/2003	2003/2004	2002/2003	2003/2004	2002/2003	2003/2004
N- levels									
30 kg N/fed		66.59 c	71.07 b	10.1 a	11.0 a	50.47 b	41.73 b	12.1 a	13.0 a
60 kg N/fed		70.78 b	77.48 ab	10.8 a	11.1 a	53.26 a	44.36 a	13.8 a	13.7 a
90 kg N/fed		73.71 ab	80.78 a	11.2 a	11.4 a	51.71 ab	44.91 a	12.6 a	13.7 a
120 kg N/fed		75.19 a	82.00 a	11.3 a	11.6 a	53.26 a	44.64 a	12.5 a	13.7 a
Biofertilizers									
Control		67.82 b	73.55 b	10.3 a	10.4 a	51.24 a	42.37 b	12.3 a	12.7 a
Nitrobien		69.10 b	78.11 a	10.8 a	11.0 a	52.05 a	43.79 b	12.8 a	13.7 a
Rhizobacterin		77.78 a	81.83 a	11.4 a	11.5 a	52.71 a	45.65 a	13.1 a	14.3 a
Interactions:									
N-levels	**Biofertilizer**								
30 kg N/fed	Control	63.33 f	68.10 h	9.7 c	9.3 d	50.68 bc	39.60 d	11.7 b	12.3 c
	Nitrobien	64.33 f	70.67 gh	10.0 bc	9.7 cd	49.60 c	41.40 c	12.1 ab	13.2 abc
	Rhizobacte	72.10 c	74.43 efg	10.7 abc	10.3 bcd	51.13 b	44.20 b	12.6 ab	13.7 abc
60 kg N/fed	Control	66.67ef	72.23 fgh	10.3 abc	10.3 bcd	51.87 b	41.73 c	13.3 ab	13.4 abc
	Nitrobien	68.10 de	69.20 cd	10.7abc	11.3 ab	53.60 a	44.33 b	14.0 a	13.5 abc
	Rhizobacte	77.57 b	81.00 bc	11.3 abc	11.7 ab	54.30 a	47.00 a	14.1 a	14.3 a
90 kg N/fed	Control	69.80 cde	76.00 def	10.7 abc	11.0 abc	51.73 b	44.40 b	12.8 ab	12.5 bc
	Nitrobien	71.33 cd	81.00 bc	11.3 abc	11.3 ab	51.60 b	45.00 b	12.3 ab	14.1 ab
	Rhizobacte	80.00 ab	85.33 ab	11.7 ab	12.0 a	51.80 b	45.33 b	12.8 ab	14.5 a
120 kg N/fed	Control	71.47 cd	77.87 cde	10.7 abc	11.0 abc	51.87 b	44.67 b	11.7 b	12.5 bc
	Nitrobien	72.63 c	81.57 bc	11.3 abc	11.7 ab	53.60 a	44.33 b	12.8 ab	14.1 ab
	Rhizobacte	81.47 a	86.57 a	12.0 a	12.0 a	54.30 a	44.93 b	13.0 ab	14.5 a

Means followed by the same letters within each column do not differ significantly according to Duncan's Multiple Range Test at the 5% level.

Table (2 b): Vegetative growth characters of garlic and pea plants as affected by Nitrogen levels, biofertilizers and their interactions during 2002/2003 and 2003/2004 seasons.

Treatments / Characters		Garlic				Pea			
		Foliage dry weight (gm)		Bulbing ratio		Number of .branches/ plant		Shoot dry weight (gm)	
		2002/2003	2003/2004	2002/2003	2003/2004	2002/2003	2003/2004	2002/2003	2003/2004
N- levels									
30 kg N/fed		09.81 b	7.85 a	0.35 a	0.35 a	1.3 b	1.2 a	2.44 b	2.20 b
60 kg N/fed		11.70 a	8.65 a	0.34 b	0.34 b	1.8 a	1.3 a	2.67 a	2.41 a
90 kg N/fed		12.05 a	9.00 a	0.32 d	0.33 c	1.5 b	1.4 a	2.57 a	2.40 a
120 kg N/fed		11.92 a	9.05 a	0.33 c	0.33 c	1.4 b	1.3 a	2.62 a	2.37 a
Biofertilizers									
Control		10.82 b	8.10 b	0.35 a	0.35 a	1.4 b	1.2 c	2.55 c	2.32 a
Nitrobien		11.32 ab	8.61 ab	0.33 b	0.34 b	1.5 b	1.3 b	2.58 b	2.34 a
Rhizobacterin		11.98 a	9.20 a	0.32 c	0.32 c	1.7 a	1.4 a	2.60 a	2.37 a
Interactions:									
N-lvels	**Biofertilizers**								
30 kg N/fed	Control	09.47 f	7.62 de	0.37 a	0.36 a	1.3 d	1.1 e	2.38 l	2.09 c
	Nitrobien	10.76 e	8.51 bc	0.34 c	0.36 a	1.3 d	1.3 cd	2.47 k	2.25 b
	Rhizobacterin	09.20 f	7.42 e	0.33 d	0.34 c	1.5 c	1.3 cd	2.49 j	2.27 b
60 kg N/fed	Control	11.97 abc	8.81 ab	0.35 b	0.35 b	1.6 bc	1.1 e	2.63 d	2.40 a
	Nitrobien	12.00 abc	9.30 ab	0.34 c	0.34 c	1.7 b	1.3 bc	2.69 b	2.42 a
	Rhizobacterin	11.15 de	7.85 cde	0.32 e	0.32 e	2.0 a	1.5 a	2.70 a	2.41 a
90 kg N/fed	Control	12.04 abc	9.01 ab	0.34 c	0.35 b	1.3 d	1.3 c	2.56 i	2.39 a
	Nitrobien	12.62 a	9.53 a	0.32 e	0.33 d	1.5 bc	1.4 b	2.57 h	2.40 a
	Rhizobacterin	11.51 cd	8.46 bcd	0.31 f	0.32 e	1.7 b	1.4 b	2.58 g	2.41 a
120 kg N/fed	Control	11.80 bcd	9.01 ab	0.34 c	0.34 c	1.3 d	1.2 de	2.61 f	2.40 a
	Nitrobien	12.55 ab	9.47 a	0.32 e	0.32 e	1.5 c	1.2 de	2.62 e	2.33 ab
	Rhizobacterin	11.42 cd	8.67 abc	0.32 e	0.31 f	1.5 bc	1.5 a	2.64 c	2.40 a

Means followed by the same letters within each column do not differ significantly according to Duncan's Multiple Range Test at the 5% level.

Increasing the supplied N-level from 30 to 90 or 120 kg N/fed significantly increased total yield, bulb weight and diameter and clove weight in both seasons. Yield increases may be due to the increases in plant growth characteristics (Tables 2 a & b), i.e, plant height, number of leaves and shoot dry weight which increase photosynthesis rate and this in turn increased the total yield and its components. The obtained results are in harmony with those reported by (Pal and Pandey, 1986., Setty *et al.*, 1989; Abd El-Hamid *et al.*, 1991 and 1996; Silva *et al.*, 2000 and Nadiu *et al.*, 2000). On the other hand, yield of pea and its components were increased with increasing N-level up to 60 kg N/fed then reduced with increased N-level above this level. This result is in agreement with those of (Amer, 1998; Hanefy *et al.*, 1999; Shokr, 2000 and Uddin *et al.*, 2000).

2.2- Effect of biofertilizers:

In Tables (3 a and b), data show that inoculation of garlic cloves or pea seeds with biofertilizer (rhizobacterin) exerted significant increases in the total yield and its components of garlic and pea as compared with untreated ones. However, the number of seeds/pod of pea was not significantly influenced by inoculation with biofertilizers in both seasons. Such results may suggest that beneficial effects of biofertilizer (rhizobacterin) on total yield and its components of garlic or pea might be due to one or more from following mechanisms: N-fixation, production of plant growth promoting substances or organic acids, enhancing nutrient uptake or protection against plant pathogens (EL-Haddad *et al.*, 1993). The obtained results were confirmed by (Mahendran and Kumar, 1998; Gomez and Munoz, 1998 and Ali *et al.*, 2001) on garlic and (Hanafy *et al.*, 1999 and Abdalla *et al.*, 2000 a & b) on pea.

2.3- Effect of interaction between nitrogen levels and biofertilizers:

Data illustrated in Tables (3 a and b) show that the interaction between N-levels and biofertilizers had more superior effect than single ones, this is true for both seasons. Total yield of garlic, bulb weight, bulb diameter and average clove weight were increased significantly with combined of 90 or 120 kg N/fed and biofertilizer rhizobacterin in both seasons.

It is notable that garlic plants fertilized with 90 kg N/fed in the presence of rhizobacterin achieved abundant yield which was nearly similar to that produced by using 120 kg N/fed with rhizobacterin or superior on the later level without biofertilizers. Therefore, 90 kg N with inoculation by rhizobacterin is considered superior treatment and sufficient for supplying the garlic plants with their nitrogen needs. These results may be due to beneficial effect of both nitrogen and rhizobacterin on plant growth (Tables 2 a and b). Similar results were obtained by Gouda (2002) and Mohamad (2003). On the other hand, pod green yield of pea was significantly affected by the interaction in the first season only. But, pea yield components were not affected in both seasons. Generally, the high records in this respect were produced at plants fed 60 kg N/fed combined with rhizobacterin in both seasons. These results are in accordance with those reported by Vimala and Natarajan (1999 and 2000) on pea and Safia (2002) on broad been.

Table (3 a): Total yield and its components of garlic and pea as affected by nitrogen levels, biofertilizers and their interactions during 2002/2003 and 2003/2004 seasons.

Characters / Treatments		Garlic				Pea				Net incom	
		Total yield (ton/fed)		Bulb weight (gm)		pod green yield (ton/fed)		Pod wt. (gm)		(L.E)	
		002/2003	003/2004	002/2003	003/2004	2002/2003	2003/2004	2002/2003	2003/2004	2002/2003	2003/2004
N- levels											
30 kg N/fed		5.041 c	4.509 c	52.9 b	47.4 c	1.709 c	1.408 a	8.5 a	9.1 a	4313 b	3223 b
60 kg N/fed		5.777 b	5.204 b	60.7 a	54.3 b	2.696 a	1.901 a	9.1 a	8.9 a	6476 a	4539 a
90 kg N/fed		6.376 a	5.570 a	66.1 a	59.0 a	2 296 b	1.875 a	8.6 a	8.8 a	6535 a	4913 a
120 kg N/fed		6.307 a	5.689 a	66.2 a	59.7 a	2.122 b	1.742 a	8.3 a	9.0 a	6052 a	4783 a
Biofertilizers											
Control		5.695 b	4.906 b	59.8 a	51.5 c	2.077 b	1.683 a	8.5 a	8.6 a	5647 b	4003 b
Nitrobien		5.892 ab	5.307 a	61.9 a	55.5 b	2.212 ab	1.675 a	8.4 a	8 9 a	5665 b	4239 ab
Rhizobacterin		6.039 a	5.515 a	62.8 a	58.3 a	2.328 a	1.836 a	8.9 a	9.3 a	6221 a	4852 a
Interactions:											
N-levels	Biofertilizers										
30 kg N/fed	Control	4.920 g	4.178 e	51.7 f	43.9 f	1.619 h	1.258 d	8.5 abcd	8.8 ab	4149 e	2795 f
	Nitrobien	5.015 fg	4.590 d	52.7 f	48.2 e	1.724 gh	1.388 cd	8.0 cd	9.0 ab	4189 de	3095 ef
	Rhizobacteri	5.187 f	4.759 d	54.5 ef	50.0 e	1.785 g	1.578 bcd	9.1 ab	9.6 a	4601 d	3780 de
60 kg N/fed	Control	5.657 e	4.686 d	59.4 de	49.2 e	2.440 c	1.950 ab	9.3 a	8.7 ab	6069 bc	4089 cd
	Nitrobien	5.759 de	5.306 c	60.5 cd	54.7 d	2.724 b	1.645 bcd	9.0 ab	8.8 ab	6373 b	4124 cd
	Rhizobacteri	5.917 d	5.619 ab	62.1 bcd	59.0 b	2.924 a	2.108 a	9.1 ab	9.1 ab	6985 a	5404 a
90 kg N/fed	Control	6.203 bc	5.263 c	65.1 abc	55.3 cd	2.191 ef	1.883 abc	8.5 abcd	8.2 b	6348 b	4531 bcd
	Nitrobien	6.368 ab	5.670 ab	66.9 ab	59.5 ab	2.267 de	1.868 abc	8.5 abcd	8.7 ab	6326 b	5047 ab
	Rhizobacteri	6.558 a	5.778 ab	66.2 ab	52.1 a	2.429 cd	1.873 abc	8.8 abc	9.4 a	6933 a	5163 ab
120 kg N/fed	Control	5.999 cd	5.498 c	63.0 bcd	57.7 bc	2.057 f	1.640abc	7.8 d	8.8 ab	6095 bc	4597
	Nitrobien	6.425 ab	5.663 ab	67.5 a	59.5 ab	2.134 ef	1.800 abc	8.2bcd	9.1 ab	5699 c	4690 abc
	Rhizobacteri	6.495 a	5.904 a	68.2 a	62.0 a	2.175 ef	1.785 abc	8.8 abc	9.2 ab	6363 b	5062 ab

Means followed by the same letters within each column do not differ significantly according to Duncan's Multiple Range Test at the 5% level.

Table (3 b): Yield components of garlic and pea as affected by nitrogen levels, biofertilizers and their interactions during 2002/2003 and 2003/2004 seasons.

Treatments / Characters		Garlic						Pea			
		Bulb diameter (cm)		No. of cloves/bulb		Clove weight (gm)		Pod length		No. of seeds/pod	
		002/2003	003/2004	002/2003	003/2004	002/2003	003/2004	2002/2003	2003/2004	2002/2003	2003/2004
N- levels											
30 kg N/fed		4.4 b	4.3 b	18.8 a	18.1 a	2.5 b	2.4 b	11.6 a	11.0 a	9.1 a	7.9 a
60 kg N/fed		5.2 a	4.8 ab	17.8 ab	17.0 a	3.1 a	2.9 a	12.3 a	11.1 a	9.4 a	7.9 a
90 kg N/fed		5.4 a	5.1 ab	17.4 b	17.2 a	3.4 a	3.1 a	11.9 a	10.9 a	9.1 a	7.7 a
120 kg N/fed		5.6 a	5.4 a	16.7 b	17.3 a	3.6 a	3.1 a	11.8 a	10.8 a	9.1 a	7.8 a
Biofertilizers											
Control		4.8 b	4.4 b	18.2 a	17.8 a	3.0 a	2.6 b	11.7 a	10.7 a	9.0 a	7.8 a
Nitrobien		5.0 b	4.7 b	15.6 a	17.5 a	3.2 a	2.9 ab	11.9 a	10.9 a	9.3 a	7.7 a
Rhizobacterin		5.7 a	5.6 a	17.2 a	16.9 a	3.3 a	3.1 a	12.0 a	11.2 a	9.1 a	8.2 a
Interactions:											
N-levels	**Biofertilizers**										
30 kg N/fed	Control	3.9 f	3.9 f	19.3 a	18.7 a	2.4 f	2.2 g	11.4 a	11.0 a	8.8 a	8.0 a
	Nitrobien	4.4 ef	4.2 ef	18.7 ab	18.3 ab	2.5 f	2.4 fg	11.6 a	10.8 a	9.2 a	7.6 a
	Rhizobacterin	5.0 cde	5.0 bcd	18.3 abc	17.3 ab	2.7 ef	2.6 def	11.7 a	11.3 a	9.4 a	8.1 a
60 kg N/fed	Control	4.9 de	4.4 def	18.3 abc	17.3 ab	2.9 de	2.6 ef	12.1 a	10.8 a	9.1 a	7.6 a
	Nitrobien	4.9 de	4.7 cde	17.7 abc	17.0 ab	3.2 cd	2.9 bcde	12.5 a	11.1 a	9.3 a	8.0 a
	Rhizobacterin	5.7 abc	5.5 ab	17.3 abc	16.7 b	3.3 bcd	3.2 ab	12.2 a	11.3 a	9.5 a	8.1 a
90 kg N/fed	Control	5.0 cde	4.6 cde	18.3 abc	17.7 ab	3.3 bcd	2.8 cde	11.6 a	10.4 a	8.8 a	7.7 a
	Nitrobien	5.3 cd	4.8 cde	17.3 abc	17.3 ab	3.4 bc	3.1 abc	11.9 a	10.9 a	8.9 a	7.7 a
	Rhizobacterin	6.0 ab	6.0 a	16.7 bc	16.7 b	3.6 ab	3.3 a	12.2 a	11.4 a	9.5 a	7.8 a
120 kg N/fed	Control	5.2 cd	4.8 cde	17.0 bc	17.7 ab	3.3 bc	2.9 bcd	11.6 a	10.6 a	9.0 a	7.8 a
	Nitrobien	5.4 bcd	5.2 bc	16.7 bc	17.3 ab	3.6 ab	3.1 abc	11.7 a	10.7 a	9.1 a	7.6 a
	Rhizobacterin	6.2 a	6.1 a	16.3 c	17.0 ab	3.9 a	3.3 a	12.1 a	11.1 a	9.2 a	8.1 a

Means followed by the same letters within each column do not differ significantly according to Duncan's Multiple Range Test at the 5% level.

3- Mean of net income per feddan:

3.1- Effect of nitrogen levels:

Data presented in Table (3 a) show that the mean of net income was increased with increasing nitrogen level up to 90 kg N/fed in both seasons.

3.2- Effect of biofertilizers:

The results in Table (3 a) showed that there was a significant increase in the main of net income with inoculate by biofertilizers compared with control treatment (uninoculate) in both seasons. The highest record was obtained by rhizobacterin inoculums.

3.3- Effect of interaction between nitrogen levels and biofertilizers:

Data in Table (3 a) showed that the mean of net income was significantly affected by the interaction. The highest net income/fed was obtained from the application of 60 or 90 kg N/fed combined with rhizobacterin biofertilizers.

4- Chemical analysis:

4.1- Effect of nitrogen levels:

Data in Table (4) indicate that increasing the applied nitrogen level from 30 to 120 kg N/fed significantly increased N, P and K concentrations in garlic foliage. Values of TSS and volatile oils in garlic cloves were increased. These results are in agreement with those of (Hilman and Noordiyati, 1988; Bertoni *et al.*, 1988; Verma *et al.*, 1996; El-Moursi, 1999 and Naruka, 2002) who found that values of N, P, K, TSS and volatile oils in cloves were increased by increasing of nitrogen levels.

On the other hand, data in Table (5) show that the concentrations of P and K in pea leaves were significantly increased with increasing nitrogen level up to 60 kg N/fed in both seasons. The concentration of N was increased with increasing N-level up to 90 or 120 kg N/fed in the second season.

4.2- Effect of biofertilizers:

Concerning to the effect of biofertilizers application on chemical constituents in garlic and pea foliage and garlic cloves, data in Tables (4 and 5) show that N, P and K concentrations in garlic and pea foliage and TSS and volatile oils in garlic cloves were increased significantly with application of biofertilizers. Concentration of N in the first season and K in the second season in garlic foliage were not affected. These results concerted with those of (Ali *et al.*, 2001; Gouda, 2002 and Mohamad, 2003) on garlic and (Hanafy *et al.*, 1999 and Abdalla *et al.*, 2000 a & b) on pea.

4.3- Effect of interaction between nitrogen levels and biofertilizers:

Data in Table (4) show that N-levels with biofertilizers interaction had significant influences on N, P, and K concentrations in garlic or pea foliage and TSS and volatile oils in garlic cloves. Garlic plants treated with 90 or 120 kg N/fed and inoculated with rhizobacterin gave the highest values of N, P and K in foliage and TSS and volatile oils in cloves. Similar results were found by Gouda (2000) and Mohammed (2003). Whereas, the highest values of N, P and K in pea leaves were obtained from plants received 60 kg N/fed combined with biofertilizer rhizobacterin in both seasons

Table (4): Chemical constituents in foliage and cloves of garlic as affected by nitrogen levels, biofertilizers and their interactions during 2002/2003 and 2003/2004 seasons.

Characters		Garlic foliage						Garlic cloves			
		N %		P %		K %		TSS %		Volatile oils	
Treatments		2002/2003	2003/2004	2002/2003	2003/2004	2002/2003	2003/2004	2002/2003	2003/2004	2002/2003	2003/2004
N- levels											
30 kg N/fed		2.28 d	2.37 c	0.55 c	0.55 d	2.20 d	2.17 b	4.40 c	4.37 b	0.32 d	0.33 d
60 kg N/fed		2.45 c	2.56 b	0.63 b	0.63 c	2.32 c	2.34 a	5.49 b	5.67 a	0.35 c	0.39 c
90 kg N/fed		2.65 b	2.64 ab	0.63 b	0.67 b	2.38 b	2.40 a	5.90 ab	5.89 a	0.38 b	0.41 b
120 kg N/fed		2.74 a	2.72 a	0.66 a	0.68 a	2.42 a	2.44 a	6.22 a	6.02 a	0.39 a	0.42 a
Biofertilizers											
Control		2.38 c	2.49 b	0.56 a	0.59 c	2.23 c	2.30 a	5.17 b	5.14 b	0.33 c	0.36 c
Nitrobien		2.55 b	2.55 b	0.62 a	0.63 b	2.32 b	2.32 a	5.47 ab	5.53 ab	0.36 b	0.40 b
Rhizobacterin		2.67 a	2.67 a	0.66 a	0.67 a	2.43 a	2.39 a	5.87 a	5.79 a	0.38 a	0.41 a
Interactions:											
N-levels	**Biofertilizers**										
30 kg N/fed	Control	2.14 l	2.28 e	0.53 d	0.52 k	2.13 l	2.17 f	4.30 f	4.10 f	0.29 i	0.32 k
	Nitrobien	2.34 j	2.34 e	0.55 cd	0.53 j	2.17 k	2.15 f	4.30 f	4.30 ef	0. 33 h	0.34 j
	Rhizobacteri	2.37 i	2.49 d	0.57 bcd	0.59 h	2.30 g	2.18 f	4.60 f	4.70 e	0.33 h	0.34 i
60 kg N/fed	Control	2.48 k	2.56 d	0.57 cd	0.62 i	2.23 j	2.30 e	5.20 e	5.30 d	0.33 h	0.37 h
	Nitrobien	2.67 h	2.61 cd	0.64 ab	0.67 f	2.33 f	2.33 de	5.50 de	5.80abcd	0.35 g	0.41 f
	Rhizobacteri	2.81 f	2.76 bc	0.68 a	0.71 d	2.38 d	2.38bcde	5.80 cd	5.90 abc	0.38 d	0.42 e
90 kg N/fed	Control	2.27 g	2.49 cd	0.62 bcd	0.57 g	2.28 i	2.35 cde	5.40 de	5.47 cd	0.36 f	0.37 h
	Nitrobien	2.46 d	2.56 c	0.67 abc	0.64 e	2.37 e	2.39bcde	5.90 bcd	5.90 abc	0.37 e	0.42 d
	Rhizobacteri	2.62 b	2.63 a	0.61 a	0.68 b	2.48 b	2.45 ab	6.40 ab	6.30 a	0.40 b	0.44 a
120 kg N/fed	Control	2.63 e	2.63 bc	0.64 a	0.64 f	2.29 h	2.39 bcd	5.80 cd	5.70 bcd	0.37 e	0.38 g
	Nitrobien	2.71 c	2.72 ab	0.69 abc	0.69 c	2.41 c	2.43 abc	6.20 abc	6.10 ab	0.39 c	0.43 c
	Rhizobacteri	2.89 a	2.81 a	0.72 a	0.72 a	2.56 a	2.50 a	6.67 a	6.27 a	0.42 a	0.44 b

Means followed by the same letters within each column do not differ significantly according to Duncan's Multiple Range Test at the 5% level.

Table (5): Chemical constituents in foliage of pea as affected by nitrogen levels, biofertilizers and their interactions during 2002/2003 and 2003/2004 seasons.

Characters / Treatments		Pea foliage					
		N %		P %		K %	
		002/2003	003/2004	002/2003	003/2004	002/2003	003/2004
N- levels							
30 kg N/fed		3.16 d	2.84 c	0.28 d	0.26 d	2.06 c	2.10 d
60 kg N/fed		3.58 a	3.19 b	0.32 a	0.30 a	2.23 a	2.21 a
90 kg N/fed		3.41 c	3.21 a	0.30 c	0.27 c	2.23 b	2.20 b
120 kg N/fed		3.43 b	3.20 a	0.32 b	0.28 b	2.21 b	2.11 c
Biofertilizers							
Control		3.37 c	3.07 c	0.29 c	0.26 c	2.14 c	2.14 c
Nitrobien		3.39 b	3.11 b	0.31 b	0.27 b	2.17 b	2.15 b
Rhizobacterin		3.43 a	3.15 a	0.32 a	0.29 a	2.23 a	2.17 a
Interactions:							
N-levels	Biofertilizers						
30 kg N/fed	Control	3.14 l	2.79 k	0.27 j	0.25 h	2.02 j	2.09 k
	Nitrobien	3.16 k	2.84 j	0.29 i	0.26 f	2.06 i	2.10 i
	Rhizobacterin	3.19 j	2.90 i	0.30 fg	0.28 d	2.11 h	2.11 g
60 kg N/fed	Control	3.52 c	3.11 h	0.30 gh	0.28 c	2.13 g	2.20 d
	Nitrobien	3.55 b	3.20 d	0.32 bc	0.30 b	2.20 f	2.21 b
	Rhizobacterin	3.65 a	3.25 a	0.35 a	0.31 a	2.36 a	2.23 a
90 kg N/fed	Control	3.41 g	3.19 f	0.30 h	0.26 g	2.21d	2.19 e
	Nitrobien	3.39 i	3.20 d	0.30 f	0.26 ef	2.23 c	2.20 d
	Rhizobacterin	3.42 f	3.22 c	0.32 d	0.29 c	2.25 b	2.21 c
120 kg N/fed	Control	3.40 h	3.19 g	0.31 e	0.26 e	2.20 f	2.09 g
	Nitrobien	3.45 e	3.20 e	0.32 c	0.28 d	2.20 e	2.11h
	Rhizobacterin	3.46 d	3.23 b	0.32 b	0.28 c	2.21 d	2.14 f

Means followed by the same letters within each column do not differ significantly according to Duncan's Multiple Range Test at the 5% level.

These results coincide with Vimala and Natarajan (1999 and 2000) on pea and Safia (2002) on broad been.

Finally, it may be concluded that garlic and pea plants intercropped fertilized by 90 kg N/fed was specific in combination with garlic cloves or pea seeds inoculated by biofertilizer rhizobacterin were the most supperior treatments for enhancing the garlic or pea plant growth, yield and its components, as well as bulb or pod quality. Thus, the inoculation of rhizobacterin with 90 kg N/fed was sufficient to produce the good quantity and quality of garlic and pea, in addition, reducing the need for chemical N-fertilizer by about 25%, could lead to reduce costs and environmental pollution. Therefore, this treatment could be recommended under similar conditions to this work.

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تأثير بعض مستويات الآزوت والمخصبات الحيوية على إنتاجية الثــوم والبســلة المحملين

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نُفذت تجربتان حقليتان على محصولى الثوم (سلالة سدس- ٤٠) والبسلة (صنف ماستر- ب) المحملين فى مزرعة خضر خاصة بكفر حسان بالقرب من المنصورة خلال موسمى الزراعة ٢٠٠٢/٢٠٠٣ و ٢٠٠٣ / ٢٠٠٤ لدراسة تأثير التسميد الأرضى بمستويات مختلفة من الآزوت وهى: ٣٠ ، ٦٠ ، ٩٠ و ١٢٠ كجم ن /فدان كلٌ منها منفرداً أو مع تلقيح التقاوى ببعض المخصبات الحيوية (كنترول ، نتروبين وريزوباكترين) على نمو النباتات والمحصول ومكوناته لكلا المحصولين وكذلك أيضاً المحتويات الكيماوية فى أوراق الثوم وأوراق البسلة وفى فصوص الثوم. وقد وزعت المعاملات فى قطع منشقة مرة واحدة فى ثلاثة مكررات. ويمكن تلخيص النتائج المتحصل عليها فيما يلى:-

أدى زيادة مستوى السماد الآزوتى من ٣٠ إلى ٩٠ أو ١٢٠ كجم ن/فدان إلى حدوث زيادات مصاحبة فى معظم صفات النمو الخضرى والمحصول ومكوناته لنبات الثوم وكانت الزيادة معنوية فى كل القياسات عدا عدد الأوراق فى كلا الموسمين والوزن الجاف لعرش النبات وعدد الفصوص/بصلة فى الموسم الثانى فقط. وجدير بالملاحظة أن الزيادة لم تكن معنوية بين المستويات المرتفعة من الآزوت (٩٠ و١٢٠ كجم ن/فدان) فى معظم الصفات المدروسة. ومن جهة أخرى زادت صفات النمو الخضرى لنبات البسلة وكذا المحصول ومكوناته بزيادة مستوى الآزوت من ٣٠ إلى ٦٠ كجم ن/فدان، ولم تستجب كل القياسات المدروسة معنويا لزيادة مستوى الآزوت عن ٦٠ كجم/ن فدان.

أدى تلقيح تقاوى الثوم والبسلة بالمخصبات الحيوية (نتروبين وريزوباكترين) قبل الزراعة إلى حدوث زيادات معنوية فى ارتفاع نبات الثوم، والوزن الجاف لعرش النبات، نسبة التبصيل وكذلك المحصول الكلى ومتوسط وزن وقطر البصلة، كما أدى إلى زيادة تركيزات النيتروجين والفوسفور والبوتاسيوم فى كلا من أوراق الثوم والبسلة وكذا زيادة محتوى فصوص الثوم من المواد الصلبة الكلية والزيوت الطيارة مقارنة بمعاملة الكنترول. أيضا زاد معنويا ارتفاع النبات وعدد الفروع لنبات البسلة فى كلا موسمى الدراسة بينما كانت الزيادة فى الوزن الجاف للنبات ومحصول القرون الخضراء معنوية فى الموسم الأول فقط مقارنة مع معاملة الكنترول.

التفاعلات بين المستويات المضافة من الآزوت والمخصبات الحيوية (نتروبين وريزوباكترين) لوحظت فى حالات كثيرة ، ولقد كانت كل القيم المتحصل عليها باستخدام مستويات الآزوت فى وجود المخصبات الحيوية بصفة عامة أفضل من تلك الناتجة بدون استخدام المخصبات الحيوية. ولقد أدى استخدام ٩٠ كجم ن/فدان فى وجود المخصب الحيوى ريزوباكترين إلى انتاج محصول جيد من الثوم كان متشابه تقريبا مع ذلك المتحصل عليه باستخدام ١٢٠ كجم ن/فدان فى وجود المخصب الحيوى ويزيد على الأخير بدون المخصيب الحيوى. ومن جهة أخرى فقد أدى استخدام ٦٠ كجم ن/فدان مع المخصب الحيوى ريزوباكترين إلى الحصول على أعلى إنتاج من محصول البسلة، وفى نفس الوقت كان صافى الدخل من كلا المحصولين أفضل فى كلا من تفاعل ٦٠ كجم ن/فدان للبسلة أو ٩٠ كجم ن/فدان للثوم مع المخصب الحيوى ريزوباكترين ولم يكن الفرق بينهما معنويا.

وبناء على ماتقدم، يمكن القول أن استخدام ملقح الريزوباكترين أدى إلى نقص المعدل المطلوب من السماد الآزوتى لمحصول الثوم بمقدار ٢٥٪ من المعدل الموصى به ؛ وبذلك يمكن تخفيض تكاليف الإنتاج وتلوث البيئة ، لذلك يمكن التوصية باستخدام هذه المعاملة لرفع إنتاجية الثوم وتحسين جودة الأبصال، وكذلك زيادة صافى الدخل من وحدة المساحة تحت نظام زراعة البسلة محملة على الثوم.