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RESPONSE OF GARLIC PLANTS TO THE APPLICATION OF TWO BIO-FERTILIZERS AND FOUR MINERAL NITROGEN LEVELS

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ABSTRACT

Two field experiments were conducted during the two successive winter seasons of ٢٠٠٨/٢٠٠٩ and ٢٠٠٩/٢٠١٠ at the Experimental Farm, Sids Horticulture Research Station, Agriculture Research Center, Giza, Egypt. aims to study the effect of four nitrogen levels (٠, ١٠٠, ١٥٠ and ٢٠٠kg N/fed.) in the form of ammonium nitrate ٣٣.٥٪ and two bio-fertilizers sources (Minia-azoten and Biogen) on growth, yield and quality of garlic c.v "Balady". Results showed that the vegetative growth of garlic plant, as well as yield and yield quality were enhanced with increasing the level of nitrogen fertilizers and were affected by the application of bio-fertilizers. Using Minia-azoten gave the highest values for all parameters followed by Biogen. Also, with increasing the levels of N- fertilizer, the weight loss % after four and/or seven months was increased. The results for the interaction effects N-fertilizer levels and Bio-fertilizers application showed that adding ١٥٠kg N/fed. with Minia-azoten gave the highest vegetative growth, yield and yield quality and decreased the weight loss % after four and seven months of storage followed by the Biogen. The chemical analysis of the cured garlic bulbs for the nitrate content declared that nitrate accumulation was increased with increasing the N-level. Using Bio- fertilizer (Biogen) decreased the values for

the accumulation of NO^{3}-N followed by Minia-azoten and it was less than the critical level for human healthy.

Response of garlic plants to bio-fertilizers

INTRODUCTION

Garlic (*Allium sativum* L.) is one of the most important vegetable crops grown in Egypt, not only for local consumption but also for exportation. Mineral fertilizers play an important role in garlic plant growth and productivity. The use of nitrogen fertilizer is the major cost in plant production. But nitrogen one of the causes of the environmental pollution as well as contamination of the underground water (Fisher and Richter,١٩٨٤). In the meantime, it is essential for synthesis of chlorophyll, enzymes and proteins.

Many investigations reported that the vegetative growth of garlic plants and nitrogen uptake were increased with increasing the level of N fertilizers (Abd El-Hameid *et al.*, ١٩٩٦; El- Moursi ١٩٩٩, Gad El-Hak and Abd El- Mageed ٢٠٠٠, Foly *et al*., ٢٠٠٢ and Mohamed, ٢٠٠٤). As regard to bulb quality and yield, some reportes indicated that N fertilization was considered to be very important for improvement of bulb quality (Selvaraj *et al*., ١٩٩٣; Patel *et al*., ١٩٩٦; El-Moursi ١٩٩٩; Gad El- Hak and Abd El- Mageed ٢٠٠٠; Foly *et al*., ٢٠٠٢ and Mohamed ٢٠٠٤). Although, the nitrogen fertilizers application is essential for plant growth, development and yield production, high level of nitrogen fertilizers may (lead) to increase in nitrate accumulation in garlic bulb which is very dangerous on human health as reported by Tantawey (٢٠١٠). Burden (١٩٦١) reported that the fatal dose is about ١٥-٧٠ mg $NO_٣$-N and ٢٠ mg $NO_٢$-N per kilogram of adult body weight. Moreover, the World Health Organization (WHO) has tentatively fixed the acceptable daily intake of nitrate at ٣.٦٥ mg/kg body weight and for nitrite at ٠.١٣ mg/kg body weight.

Bio-fertilizers i.e. Minia-azoten and Biogen had greater amount of bacteria which are responsible for nitrogen fixation. Application of bio-fertilizers led to decreasing the amount of mineral–N by ٢٥٪ and increasing the availability of various nutrients by plants as reported by (Subba- Rao, ١٩٨٨) on onion; El-Ghinbihi and Ali (٢٠٠١) on potato and Foly *et al*, (٢٠٠٢) and Mohamed (٢٠٠٤) on garlic. Moreover, many researchers reported that using bio-nitrogen–fertilizers with

adding minerals or organic fertilizers led to improve the vegetative growth, yield and quality of garlic (Wange, ١٩٩٨; Ali *et al*., ٢٠٠١ and on onion El- Desuki ٢٠٠٦). Garlic contains nitrites and it ranged from ٠.٦ mg to ٢.٢٥ mg/kg (Chung *et al.,* ٢٠٠٣ and Tantawy, ٢٠١٠). This work aims to study the response of garlic to utilization of bio and nitrogen fertilization treatments in order to reduce the amount of mineral nitrogen fertilizers.

MATERIALS AND METHODS

Two main field experiments were conducted during the two successive winter seasons of ٢٠٠٨/٢٠٠٩ and ٢٠٠٩/٢٠١٠ in a clay loam soil at the Experimental Farm of Sids Horticulture Research Station, Agriculture Research Center, Giza, Egypt. Garlic cultivar "Balady" was used in this study. The experimental soil was ploughed and pulverized. Twenty soil samples every season were randomly taken from the experiment area before planting at the depth of ٠-٣٠ cm. Physical and Chemical characteristics were determined according to Jakson, (١٩٥٨) at Soil laboratories of Sids Agric. Res. Station (Table ١).

Table ١: Physical and chemical properties of the experimental soil in the two winter season of ٢٠٠٨/٢٠٠٩ and ٢٠٠٩/٢٠١٠

Particle size distribution	Sand%	Silt%	Clay%	Texture	Organic Matter %	Available . N(ppm)	E.C. mm hos/ cm.
First season	١٧.٨١	٢٤.٦٠	٥٧.٥٩	Clay loam	٢.٤	٩٠.٠	٠.٠٦
Second season	١٤.٤٥	٢٨.٥٨	٥٦.٩٧	Clay loam	٢.٢	٨٨.٠	٠.٠٨

The soil of experiments was divided to experimental unit**s**. The area of each experimental unit was ١٠.٥ $m^{٢}$ and consisted of ٥ rows (٠.٦ m width and ٣.٥ m long). The chosen garlic cloves **(**free from all defects) were planted on both sides of the rows, ١٠ cm apart in the first week of October in both seasons. Normal agricultural practices for garlic production were followed. The different treatments used

were as follows:-Four nitrogen levels (٠,١٠٠,١٥٠ and ٢٠٠ kg N/fed.) in the form of ammonium nitrate ٣٣.٥٪ which were divided to three equal doses and applied after ٤٠, ٧٠ and ١١٠ days from planting. Two bio-fertilizers Minia-azoten and Biogen were used. These bio-fertilizers are the commercial products contains active micro-organisms were obtained from Faculty of Agriculture, Minia University. Solution were used at the rate of one kg/١٠٠ kg wetted cloves. The cloves were soaked in an aqueous with ٢٠٪ Arabic gum. Also, at the first and the second irrigation from planting the two microbial products were added at the rate of five liters per feddan. A split- plot design with four replicates was used in this experiment. N rates were placed in the main plot, and bio-fertilizers treatments were randomly arranged in the sub plot.

Recorded data

Two weeks before harvesting, ten plants were randomly taken from each experimental plot to determine I-Vegetative growth parameters (١-Plant height ٢- Fresh weight of whole plant ٣- dry matter % of vegetative growth). The samples were dried at ٧٠^{O} C up to constant weight to determine the dry matter % of vegetative part. Fresh bulb characters (١ bulb fresh weight g ٢ dry matter % of bulb) then bulb slices were oven dried at ١٠٥ C^{O} up to constant weight to determine dry matter % then stored for chemical analysis.

At the harvest time

Garlic plants were harvested on the first week of April in both seasons. Fresh yield (kg/plot) was recorded. All data was converted to ton/fed.

Cured yield and bulb quality

The harvested garlic plants were left to be cured for ٢١ days and cured plants were then weighted. Cured yield (ton/fed) were calculated. The weight loss % as a results of curing was recorded. After curing, ten plants from each experimental plot were randomly taken to determine the cured bulb diameter.

Storage ability

The cured yield was used to determine the percentage of weight loss during storage period. On the ١٥th May, four samples (two kgs) of cured bulbs were randomly taken from each plot and stored into plastic net under normal room condition. The samples were weighted after four and seven months and the percentage of weight loss was calculated.

Bulb chemical analysis

Nitrate content (ppm) was determined in the bulb dry matter according to the method described by Jones *et al.*, (١٩٩١).

Statistical analysis

The recorded data was statistically analyzed according to MSTAT-C program (١٩٨٥) using two factors Randomized Complete Block Design Model ٩. The differences among means were tested using the least significant difference test L.S.D. at ٠.٠٥ probability level.

RESULTS AND DISCUSSION

Vegetative growth

Main effect of nitrogen fertilizers levels

Results in Table ٢ show the effect of nitrogen fertilizers levels on garlic growth parameters i.e. plant height, fresh weight of whole plant and dry matter % of vegetative part. Data cleared that these parameters were significantly increased with increasing N level from ٠ up ٢٠٠ kg N/fed. The high values were obtained when nitrogen fertilizer was applied **at** ١٥٠ kg N/fed. These results were obtained in both growing seasons. This increase may be due to the role of nitrogen on chlorophyll, enzyme and protein synthesis (Millard and Marshal ١٩٨٦). These results are in harmony with those reported by Gad El – Hak and Abd El-Mageed (٢٠٠٠); Foly *et al.*, (٢٠٠٢); Momamed (٢٠٠٤) on garlic and El- Desuki *et al.*, (٢٠٠٦) on onion.

Table ٢: Vegetative growth of garlic plants as affected by nitrogen fertilizer application

N-Fertilizer levels (Kg/fed.)	Plant height (cm)		Fresh weight of whole plant (g)		Dry matter % of Vegetative Part	
	First Season	Second Season	First Season	Second Season	First Season	Second Season
٠	٧٤.١	٨٠.٠٥	٦٤.٨٩	٧٢.٣٢	١١.٩٤	١١.٤٤
١٠٠	٨١.٢٧	٨٤.٠٨	٧٨.٧٢	٧٩.٤٢	١٢.٤٣	١٢.٦٨
١٥٠	٩٢.٦٢	٩٢.١٧	٩١.٢٧	٩٢.٣٢	١٣.٥٤	١٤.٣٨
٢٠٠	٩٣.٥١	٩٣.٤١	٩١.٣٣	٩٢.٣٣	١٣.٨٣	١٤.٣٩
L.S.D.	٢.٩٤	٢.٩٠	٣.٥٣	٣.١٠	٠.٢٨	٠.٥٩

Main effect of bio-fertilizers application

Data in Table (٣) showed that all vegetative growth parameters were significantly affected by using bio-fertilizers. Results cleared that using Minia-azoten gave the highest values of the studied vegetative growth characters (plant height, fresh weight of whole plant and dry matter % of vegetative part) followed by using Biogen compared to the control treatment (without bio-fertilizers application) which gave the lowest values as shown in both seasons. these results may be due to the role of bio-fertilizers i.e. Minia-azoten and Biogen on the N-fixation which increasing the availability of nitrogen to plant absorption (Subba–Rao, ١٩٨٨). This results are in harmony with those reported by, Wange (١٩٩٨), Ali et al., (٢٠٠١), on garlic; Amer et al ., (٢٠٠٣) on tomato; Mohamed (٢٠٠٤) on garlic and El- Desuki et al., (٢٠٠٦) on onion.

Table ٣: Vegetative growth of garlic plants as affect by bio-fertilizers application in the ١st and ٢nd seasons.

Bio-Fertilizers	Plant height (cm)		Fresh weight of whole plant (g)		Dry matter % of vegetative part	
	١st	٢nd	١st	٢nd	١st	٢nd
Minia-azoten	٩٠.٩٤	٩١.٢٢	٨٨.٠٥	٩٠.٦٣	١٣.٩٤	١٤.١٠
Biogen	٨٤.٤٩	٨٨.٠٤	٨١.٢٢	٨٣.٣٨	١٢.٧٣	١٣.٤٢
Without	٨٠.٦٨	٨٣.٠١	٧٥.٧٦	٧٨.٢٤	١٢.١٤	١٢.١٦
L.S.D.	٣.٣٣	٣.٧١	٢.٩٨	٤.٧٠	٠.٣١	٠.٦٠

Effects of interaction treatments

Data in Table (٤) showed the effect of the interaction treatments between nitrogen fertilizers and bio-fertilizers application on vegetative growth of garlic plants. Results cleared that all vegetative growth parameters (plant height, fresh weight of whole plant and dry weight % of vegetative growth) were significantly affected by the interaction treatments in both seasons.

Table ٤: Vegetative growth characters of garlic plants as affected by the interaction treatments between nitrogen fertilizer levels and bio- fertilizers application in the ١st and ٢nd seasons.

N-Fertilizer levels(Kg/fed.)	Bio-fertilizers	Plant height (cm)		Fresh weight of whole plant(g)		Dry matter % of veg. part	
		١st	٢nd	١st	٢nd	١st	٢nd
٠	Minia-azoten	٧٩.٢٠	٨٥.٢٠	٦٨.٧٥	٧٥.٣٢	١٢.٨٥	١٢.٣٢
	Biogen	٧٥.٠٥	٨٣.٠٥	٦٥.١٢	٧٤.٢٢	١١.٨٠	١١.٤٥
	Without	٦٨.٠٥	٧١.٩٠	٦٠.٨٠	٦٧.٤٢	١١.١٧	١٠.٥٥
١٠٠	Minia-azoten	٨٦.١٥	٨٨.٩٧	٨٣.٥٢	٨٥.٢٥	١٣.٣٠	١٣.٩٥
	Biogen	٨١.٨٢	٨٦.٠٧	٧٧.٦٧	٨٠.١٥	١٢.٤٠	١٢.٨٢
	Without	٧٥.٨٢	٧٧.٢٠	٧٤.٩٧	٧٢.٨٧	١١.٦٠	١١.٢٧
١٥٠	Minia-azoten	١٠٠.٧٧	٩٧.٤٠	١٠٠.٤٢	١٠٣.٠٧	١٥.١٥	١٥.٥٧
	Biogen	٩٣.٥٠	٩٣.١٥	٩٢.٠٠	٩٢.٦٠	١٣.٤٧	١٥.٣٠
	Without	٨٣.٥٧	٨٥.٩٧	٨١.٣٧	٨١.٣٠	١٢.٠٠	١٢.٢٧
٢٠٠	Minia-azoten	٩٧.٦٥	٩٣.٣٢	٩٩.٥٠	٩٨٩٠	١٤.٤٥	١٤.٥٥
	Biogen	٨٧.٦٠	٨٩.٩٠	٩٠.١٠	٨٦.٥٥	١٣.٢٥	١٤.١٠
	Without	٩٥.٢٧	٩٧.٠	٨٥.٩٠	٩١.٣٥	١٣.٨٠	١٤.٥٢
L.S.D. (٠.٠٥)		٢.٦٨	٢.٧٨	١٢.٣٢	٣.٣٠	٣.٣٠	٠.٦٣

These highest values of various vegetative growth parameters were recorded with plants received nitrogen fertilizers at ١٥٠ kg N/fed. addition to the bio-fertilizers Minia-azoten. However, the lowest values of vegetative growth were recorded with control treatment.

These results may be due to the efficiency of nitrogen – fertilizers on promotion of vegetative growth of garlic plants as discussed in Table ٢ and the role of bio-fertilizers Minia-azoten on increasing the availability of soil nutrients to those recorded. These results are simila to those recorded by Wange (١٩٩٥), Foly *et al*.,

(٢٠٠٢), Mohamed (٢٠٠٤) on garlic, Mahmoud *et al.*, (٢٠٠٢) on tomato and onion and El-Desuki (٢٠٠٦) on onion.

Bulb quality and yield component:

Effect of nitrogen fertilizer levels on bulb quality and yield component

Results in Table ٥ showed the effect of nitrogen fertilizers on garlic bulb parameters i.e. (bulb fresh weight (g), cured bulb diameter (cm) and bulb dry weight %). Data cleared that all bulb characteristics were significantly increased with increasing N level from ٠ up to ٢٠٠ kg N/fed.

Table ٥: Yield component of garlic plants as affected by nitrogen fertilizers application in the ١st and ٢nd seasons..

N-Fertilizer levels (Kg/fed.)	Bulb fresh weight(g)		Cured bulb diameter (cm)		Bulb dry matter %	
	١st	٢nd	١st	٢nd	١st	٢nd
٠	٣٩.٥٢	٤١.٧٣	٣.٨٣	٤.٣٧	٢٦.٧٥	٢٨.٨٦
١٠٠	٤١.٣٢	٤٤.٢٦	٤.٤١	٤.٧٢	٢٦.٨٣	٣٠.٤٢
١٥٠	٥٢.٤٤	٥١.٦٠	٥.٣٦	٥.٧٠	٢٨.٧٩	٣٢.٨٢
٢٠٠	٥٢.٦٥	٥١.٧٣	٥.٣٧	٥.٧٢	٢٨.٢٩	٣٢.٦٢
L.S.D. (٠.٠٥)	١.١٤	١.٣٣	٠.٤٢	٠.٢٣	٠.٩٨	٠.٨٠

The highest values were obtained when nitrogen fertilizer was applied at ١٥٠ kg N/fed. These results were quite similar in both seasons. Nitrogen is used in large amount by plants to build many compounds essential for plant growth and development such as proteins, and chlorophyll (Millard and Marshal, (١٩٨٦). Similar findings were reported by Abd El-Hamied *et al.*, (١٩٩١), Pandy and Singh (١٩٩٣); Seno *et al.*, (١٩٩٤) and Mohamed (٢٠٠٤) on garlic and El- Desuki *et al.*, (٢٠٠٦) on onion.

Effect of bio-fertilizers application on bulb quality

Data in Table (٦) showed that all bulb quality and yield component parameters were significantly affected by using bio-fertilizers application. Using Minia-azoten gave the highest values followed by using Biogen but the lowest values of bulb quality of

garlic plants were recorded with the control treatment (without bio-fertilizers) as shown in both seasons. These results may be due to the positive role of bio-fertilizers i.e. Minia-azoten and Biogen on nitrogen fixation which increase the availability of nitrogen to plant absorption Subba – Rao (١٩٨٨). These results are in harmony with those reported by Wange (١٩٩٨), Ali *et al.,* (٢٠٠١), Amer *et al.*, (٢٠٠٣) on tomato, Mohamed (٢٠٠٤) on garlic and El- Desuki *et al.*,(٢٠٠٦) on onion.

Table ٦: Yield component of garlic plants as affect by bio-fertilizers application in the ١st and ٢nd seasons.

Bio-Fertilizers	Bulb fresh weight(g)		Cured bulb diameter(cm)		Bulb dry matter Percentage	
	١st	٢nd	١st	٢nd	١st	٢nd
Minia-azoten	٤٨.٩٢	٥٠.٠٣	٥.٢٨	٥.٤٠	٢٨.٢٨	٣٢.٣٤
Biogen	٤٦.٣٥	٤٦.٥٥	٤.٧٣	٥.٠٦	٢٧.٢٢	٣٠.٠١
Without	٤٤.١٧	٤٥.٤١	٤.٢٢	٤.٩٢	٢٧.٥٠	٢٩.٢٥
L.S.D. (٠.٠٥٪):	١.٦٢	١.٠١	٠.٢٠	٠.١٠	٠.٧٧	٠.٦٢

Effects of interaction between N- fertilizer levels and bio-fertilizers application on yield component of garlic plants

Data in Table (٧) showed the effect of the interaction treatments between nitrogen levels and bio-fertilizers application on yield component of garlic plants. Results showed that all bulb quality parameters (bulb fresh weight, cured bulb diameter and bulb dry matter %**)** were significantly affected by the interaction treatments as shown in both seasons. The highest values were recorded with plants received ١٥٠ kg N/ fed. level of nitrogen fertilizers in addition to bio-fertilizers by Minia-azoten. The lowest values were recorded with control treatment. Wange (١٩٩٥), Foly *et al.,* (٢٠٠٢), Mohamed (٢٠٠٤) on garlic**,** Mahmoud *et al.,* (٢٠٠٢) on tomato and onion and El-Desuki *et al.,* (٢٠٠٦) on onion reported that using bio-nitrogen–fertilizers with adding minerals or organic fertilizers lead to improve the vegetative growth, yield and quality of garlic.

Table ٧: Some yield components of garlic plants as affected by the interaction between four levels of nitrogen fertilizer and two bio- fertilizers in the ١st and ٢nd seasons .

N-Fertilizer levels (Kg/fed.)	Bio-fertilizers	Bulb fresh Weight (g)		Cured bulb diameter (cm)		Bulb dry matter %	
		١st	٢nd	١st	٢nd	١st	٢nd
٠	Minia-azoten	٤٠.٦٧	٤٤.٠٥	٤.١٥	٤.٥٠	٢٦.٦٣	٢٩.٥٠
	Biogen	٣٩.٦٠	٤١.١٥	٤.١٥	٤.٣٧	٢٦.٠٠	٢٩.٠٩
	Without	٣٨.٣٠	٤٠.٠٠	٣.٢٠	٤.٢٢	٢٧.٦٣	٢٧.٠٠
١٠٠	Minia-azoten	٤٤.٣٢	٤٦.٩٥	٤.٨٠	٤.٩٠	٢٧.٨٨	٣١.٥٠
	Biogen	٤٠.٤٢	٤٣.٨٠	٤.٣٧	٤.٦٥	٢٦.٥٠	٣٠.٢٩
	Without	٣٩.٢٠	٤٢.٠٢	٤.٠٧	٤.٦٠	٢٦.١٣	٢٩.٤٨
١٥٠	Minia-azoten	٥٧.٧٠	٥٤.٦٧	٦.١٥	٦.١٥	٣٠.١٣	٣٤.٨٠
	Biogen	٥٤.٢٥	٥١.٩٠	٥.٣٧	٥.٨٥	٢٩.١٣	٣٢.٥٦
	Without	٤٥.٣٧	٤٨.٢٢	٤.٥٧	٥.١٠	٢٧.١٣	٣١.٠٩
٢٠٠	Minia-azoten	٥٣.٠٠	٥٤.٤٥	٦.٠٥	٦.٠٤	٢٨.٥٠	٣٣.٣٤
	Biogen	٥١.١٢	٤٩.٣٥	٥.٠٢	٥.٣٧	٢٧.٢٥	٣٢.٠٩
	Without	٥٣.٨٢	٥١.٤٠	٥.٠٥	٥.٧٥	٢٩.١٣	٣٢.٤٤
L.S.D. (٠.٠٥٪):		١.٥٠	١.١٢	٠.٤٣	٠.١١	N.S	١.١٣

Yield:

Effect of nitrogen fertilizer levels on fresh and cured yield (ton/fed.)

Results in Table ٨ showed the efficiency of nitrogen fertilizer levels for increasing garlic yield parameters i.e. [fresh and cured yield (ton/fed.)]. Data cleared that both yield parameters were significantly increased with increasing N levels from ٠ up to ١٥٠ kg N/fed. The highest values from yield were obtained when nitrogen fertilizer was applied at ١٥٠ kg N/fed. with insignificant differences at the level of ٢٠٠ kg N/fed. in both growing seasons. The effect of nitrogen on increasing (fresh and cured yield ton /fed.) could be due to the effect of N on increasing vegetative growth. The important of N in cell division process and the biosynthesis of protein could explain the beneficial effect of the proper rate of N which enhance the uptake of

nutrients to meet the superior in growth and development of bulb These results are quite similar with those obtained by Abd El-Hameid *et al.*,(١٩٩١), Pandy and Singh (١٩٩٣), Seno *et al.*, (١٩٩٤) and Mohamed (٢٠٠٤) on garlic and El- Desuki *et al.*, (٢٠٠٦) on onion.

Table ٨: Yield (ton/fed.) of garlic plants as affected by application of nitrogen fertilizer in the ١st and ٢nd seasons .

N-Fertilizer levels(Kg/fed.)	Fresh yield (ton/fed).		Cured yield (ton/fed).	
	١st	٢nd	١st	٢nd
٠	٦.٨٧	٦.٣٥	٣.٣٢	٣.٣٢
١٠٠	٨.٢٣	٧.٥٧	٤.٠٥	٣.٩٣
١٥٠	١٠.٢١	٩.٦٦	٥.١٢	٥.٠٨
٢٠٠	١٠.١٥	٩.٣٤	٥.٠٢	٥.٠٤
L.S.D.(٠.٠٥٪):	٠.٢٢	٠.٣٥	٠.٢٠	٠.٢٨

Effect of bio-fertilizers application on fresh and cured yield (ton/fed.)

Data in Table ٩ showed that both fresh and cured yield were significantly affected by using bio-fertilizers. However, using Minia-azoten gave the highest values of fresh and cured yield **(**ton/fed.**)** followed by using Biogen but the lowest values were recorded with control treatment (without bio-fertilizers) in both seasons. The effect of bio-fertilizers on increasing fresh yield and cured yield (ton/fed.) could be due to the effect of bio-fertilizers on increasing the available N and the secretion of some growth regulators which increased vegetative growth and yield component as reported by, Wange (١٩٩٥), Ali *et al* (٢٠٠١), Amer *et al.*, (٢٠٠٣), Mohamed (٢٠٠٤) and El-Desuki *et al.*, (٢٠٠٦).

Effect of interaction between nitrogen fertilizer and bio- fertilizers on yield

Data in Table ١٠ showed the effect of the interaction treatments between nitrogen levels and bio-fertilizers application on yield of garlic plants.

Results indicated that fresh and cured yield ton/fed. were significantly affected by the interaction treatments in both seasons.

Response of garlic plants to bio-fertilizers

The highest yield values were recorded when plants received ١٥٠ kg N/fed. in addition to the application bio-fertilizers Minia-azoten. However, the lowest values of yield were recorded with control treatment. These results are in harmony with those reported by Wange (١٩٩٥), Foly *et al*., (٢٠٠٢), Mohamed (٢٠٠٤) and El-Desuki *et al*., (٢٠٠٦).

Table ٩: Yield (ton/fed.) of garlic plants as affected by application of bio-fertilizers in the ١st and ٢nd seasons .

Bio-Fertilizers	Fresh yield (ton/fed.)		Cured yield (ton/fed).	
	١st	٢nd	١st	٢nd
Minia-azoten	٩.٤٦	٨.٥٩	٤.٥٨	٤.٦٣
Biogen	٨.٨٩	٨.٣٩	٤.٣٩	٤.٤٤
Without	٨.٢٥	٧.٧١	٤.١٧	٣.٩٦
L.S.D. (٠.٠٥٪):	٠.٢٩	٠.٢٨	٠.٢٦	٠.١٤

Table ١٠: Yield (ton/fed.) of garlic plants as affected by the interaction of treatments between nitrogen fertilizer levels and bio- fertilizers application in the ١st and ٢nd seasons.

N-Fertilizer levels(Kg/fed.)	Bio-fertilizers	Fresh yield (ton/fed.)		Cured yield (ton/fed.)	
		١st	٢nd	١st	٢nd
٠	Minia-azoten	٧.٦٥	٦.٧٠	٣.٥٢	٣.٧٢
	Biogen	٧.٠٠	٦.٦٢	٣.٣٧	٣.٤٥
	Without	٥.٩٧	٥.٧٢	٣.٠٥	٢.٨٠
١٠٠	Minia-azoten	٨.٨٠	٧.٧٧	٤.٣٠	٤.٢٠
	Biogen	٨.٤٧	٨.١٥	٤.١٥	٤.٠٥
	Without	٧.٤٢	٦.٨٠	٣.٧٠	٣.٥٥
١٥٠	Minia-azoten	١٠.٩٧	١٠.٣٧	٥.٥٠	٥.٥٠
	Biogen	١٠.٣٢	٩.٧٢	٥.٢٠	٥.٣٢
	Without	٩.٣٢	٨.٨٧	٤.٦٧	٤.٤٢
٢٠٠	Minia-azoten	١٠.٤٢	٩.٥٠	٥.٠٠	٥.١٠
	Biogen	٩.٧٥	٩.٠٧	٤.٨٢	٤.٩٥
	Without	١٠.٢٧	٩.٤٥	٥.٢٥	٥.٠٧
L.S.D. (٠.٠٥٪)		٠.٤٣	٠.٤٦	٠.٤٦	٠.٣٦

Nitrate content (ppm)

Effect of nitrogen fertilizers levels on the nitrate content of the dried garlic bulbs and storage ability

The obtained results in Table(١١) cleared that the nitrate content was significantly increased with increasing N level from ٠ up to ٢٠٠ kg N/fed. The height values of nitrate content (ppm) in bulb were obtained from plants fertilized with ٢٠٠ kg N/fed. These recorded levels were within the safe limit and did not cause any toxic effects (Chung *et al.*,٢٠٠٣; Tantawy, ٢٠١٠).

Table ١١: Nitrate content (ppm) and weight loss % of garlic plants as affected by nitrogen fertilizer application in the ١st and ٢nd seasons.

N-Fertilizer levels (Kg/fed.)	Nitrate content (ppm)		Weight loss % during curing		Weight loss % after four months		Weight loss % after seven months	
	١st	٢nd	١st	٢nd	١st	٢nd	١st	٢nd
٠	٣٢١.١٦	٣١٤.٧٥	٥١.٥٤	٤٧.٧٥	١٣.٧٧	١٤.٠٤	٢٨.٢٢	٣٠.٠٠
١٠٠	٣٥٩.٠٠	٣٥٢.٢٩	٥٠.٥٢	٤٧.٩٩	١٤.٧٣	١٤.٨٩	٣٠.١٧	٣١.٨٢
١٥٠	٣٨٤.٣٧	٣٧٦.٩١	٤٩.٧٨	٤٧.٤٠	١٥.٩٣	١٥.٨٨	٣٢.٢٧	٣٣.٢٨
٢٠٠	٤٠٥.٤١	٣٩٩.٠٨	٥٠.٢٥	٤٦.٤٤	١٦.٥٤	١٧.٠٨	٣٤.٢٢	٣٤.٧٧
L.S.D. (٠.٠٥٪):	٣.٠٦	٢.٥٠	N.S	N.S	٠.٢١	٠.١٢	١.٤٠	٠.٥٦

Weight loss%

Concerning the effect of N level on the weight loss % after four and seven months, the obtained results revealed that weight loss % after four and seven months were significantly affected in both seasons. The highest values for weight loss % were obtained from bulbs produced from plants which received ٢٠٠ kg N/fed. in both seasons. These results are in agreement with those reported by Foly *et al.*, (٢٠٠٢) and Mohamed (٢٠٠٤) on garlic.

Effect of bio-fertilizers application on the nitrate content of the dried garlic bulbs

Results in Table (١٢) showed that nitrate content (ppm) was significantly affected by the bio-fertilizers. Results indicated that the highest values of nitrate accumulation were recorded with adding

Biogen followed by Minia-azoten, but the lowest and the best values were recorded with the control treatment.

Table ١٢: Nitrate content (ppm) and weight loss % of garlic plants as affected by bio- fertilizers application in the ١st and ٢nd seasons.

Bio-Fertilizers	Nitrate content (ppm)		Weight loss % during curing		Weight loss % after four months		Weight loss % after seven months	
	١st	٢nd	١st	٢nd	١st	٢nd	١st	٢nd
Minia-azoten	٣٦٧.٥٦	٣٦١.٣١	٥١.٧٣	٤٥.٨٧	١٤.٩١	١٥.٣١	٣٠.١٤	٣١.٥٩
Biogen	٣٧٣.٤٦	٣٦٥.٣٤	٥٠.٧٨	٤٧.٥٣	١٥.١٠	١٥.٣٥	٣١.١٦	٣٢.٤٤
Without	٣٦١.٤٣	٣٥٥.٦٢	٤٩.١٧	٤٨.٧٩	١٥.٤٩	١٥.٧٧	٣٢.٣٦	٣٣.٣٨
L.S.D. (٠.٠٥٪):	٢.٦٧	٢.٩٨	N.S	N.S	٠.١٥	٠.٢١	٠.٩٥	٠.٧٥

Regarding the effect of bio-fertilizers application, the obtained results in Table (١٢) indicated that weight loss % was significantly affected by the bio-fertilizers application after four and seven months in both seasons. Application of Minia-azoten significantly decreased the weight loss % after four and seven months followed by Biogen. It is known that, microorganisms can produce antioxidants as well as suppress pests and diseases, which may be the reason for reducing weight loss during storage.

Effects of interaction between nitrogen fertilizer levels and bio-fertilizers application on the nitrate content of the dried garlic bulbs (ppm)

With respect to the nitrate accumulation of garlic bulbs, results in Table ١٣ declared that the highest values of NO٣-N accumulation were recorded when ٢٠٠ kg N/fed+Biogen and followed by using ٢٠٠kg N/fed. +Minia-azoten. But the lowest values were recorded with adding the low level of nitrogen fertilizers.

Results in Table ١٣ indicated that the interaction effects between nitrogen rates and bio-fertilizers application had significant effect on weight loss % after four and seven months in both seasons. The

highest values of weight loss % after four and seven months were obtained from plants that received ٢٠٠ kg N /fed. without inoculation by bio-fertilizers in both seasons. Also, the results indicated that application of bio-fertilizers significantly decreased weight loss % after four and seven months under storage in both seasons. These results are quite similar to those obtained by Foly *et al.*, (٢٠٠٢) and Mohamed (٢٠٠٤).

Table ١٣: Nitrate content (ppm) and weight loss % of garlic plants as affected the interaction treatments between nitrogen and bio-fertilizers application.

N-Fertilizer levels (Kg/fed.)	Bio-Fertilizers	Nitrate content (ppm)		Weight loss% during curing		Weight loss % after four months		Weight loss % after seven months	
		١st	٢nd	١st	٢nd	١st	٢nd	١st	٢nd
٠	Minia-azoten	٣٢٣.٦٢	٣١٥.٧٥	٥٣.٩٢	٤٤.٣٧	١٣.٦٣	١٣.٥٠	٢٦.٨٧	٢٨.٨٢
	Biogen	٣٣٠.٨٧	٣١٩.٨٧	٥١.٧٥	٤٧.٩٢	١٣.٨٠	١٣.٦٠	٢٨.٥٧	٣٠.١٠
	Without	٣٠٩.٠٠	٣٠٨.٦٢	٤٨.٩٥	٥٠.٩٧	١٤.٠٠	١٤.٢٠	٢٩.٢٠	٣١.٠٧
١٠٠	Minia-azoten	٣٥٩.٢٥	٣٥٤.٠٠	٥١.١٢	٤٥.٩٥	١٤.٨١	١٤.٦٠	٢٩.٢٥	٣١.١٧
	Biogen	٣٦٣.٥٠	٣٥٨.١٢	٥٠.٩٥	٥٠.٢٧	١٤.٦٤	١٤.٧٠	٢٩.٩٧	٣٢.٠٠
	Without	٣٥٤.٢٥	٣٤٤.٧٥	٤٩.٦٥	٤٧.٧٥	١٤.٩٨	١٤.٨٨	٣١.٣٠	٣٢.٣٠
١٥٠	Minia-azoten	٣٨٣.٢٥	٣٦٧.١٢	٤٩.٨٧	٤٦.٩٠	١٥.٣٥	١٥.٣٠	٣١.٤٠	٣٢.٢٧
	Biogen	٣٩٠.٥٠	٣٨٠.٦٢	٤٩.٦٢	٤٥.١٧	١٥.٨٠	١٥.٧٠	٣٢.١٥	٣٣.١٠
	Without	٣٧٩.٣٧	٣٧٤.٠٠	٤٩.٨٥	٥٠.١٢	١٥.٧٥	١٥.٩٠	٣٣.٢٧	٣٤.١٧
٢٠٠	Minia-azoten	٤٠٤.١٢	٣٩٩.٣٧	٥٢.٠٢	٤٦.٢٧	١٦.١٥	١٦.٢٥	٣٣.٠٥	٣٣.٧٧
	Biogen	٤٠٩.٠٠	٤٠٢.٧٥	٥٠.٥٠	٤٦.٧٥	١٦.٣٨	١٦.٤٠	٣٣.٩٢	٣٤.٥٧
	Without	٤٠٣.١٢	٣٩٥.١٢	٤٨.٢٢	٤٦.٣٠	١٦.٧٥	١٦.٩٨	٣٥.٦٧	٣٥.٩٧
L.S.D. (٠.٠٥):		٢.٣٢	٢.٥٤	٢.٥٤	N.S	N.S	٠.١٧	٠.١٧	٠.٩٢

Finally, from the previous results, we could conclude that using ١٥٠ kg N/fed. in the form of ammonium nitrate (٣٣.٥٪) and bio-fertilizers Minia-azoten are recommended to obtain the highest total yield with the best quality. This treatment also reduces both

nitrate accumulation in garlic bulbs and weight loss % during storage period.

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Response of garlic plants to bio-fertilizers

استجابة نباتات الثوم لإضافة اثنين من المخصبات الحيوية وأربع مستويات من التسميد النتروجينى

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أجريت تجربتان حقليتان خلال عامين متتاليين فى الموسم الشتوي ٢٠٠٨/٢٠٠٩ – ٢٠٠٩/٢٠١٠ بمحطة بحوث البساتين بسدس، مركز البحوث الزراعية، الجيزة، مصر بهدف دراسة تأثير أربعة مستويات من النتروجين (صفر و١٠٠و١٥٠و٢٠٠ كجم نتروجين /للفدان) على صورة نترات نشادر ٣٣.٥% واثنين من المخصبات الحيوية هما منيا ازوتين و بيوجين على النمو والمحصول والجودة للثوم البلدى

أظهرت النتائج أنة بزيادة إضافة معدلات التسميد النتروجين ازداد النمو الخضرى والمحصول وجودته. و إضافة المخصبات الحيوية أثرت على النمو والمحصول وجودته أيضا فأعطى المخصب الحيوى منيا ازوتين أعلى القيم فى كل القياسات تحت الدراسة يليه المخصب الحيوى بيوجين.

بالنسبة لتأثير التداخل أوضحت النتائج أنه بإضافة المعدل ١٥٠ كجم نتروجين/للفدان مع المخصب الحيوى منيا ازوتين أعطيا أعلى القيم فى النمو الخضرى والمحصول وجودته.وأما بالسبة للمحتوى النتراتى وجد انه كلما زاد معدل إضافة النتروجين زاد تراكم النترات فى البصلة ووجد ان البيوجين قد أعطى أعلى القيم من النترات المتراكمة يليه المنيا ازوتين.وتوضح النتائج ان المحتوى النتراتى كان اقل من الحد الحرج على صحة الإنسان.

أما بالنسبة للقدرة التخزينية فوجد أن النسبة المئوية للفقد فى الوزن بعد أربعة وسبعة اشهرقد ازدادت بزيادة مستوى النتروجين المضاف واستخدام المخصب الحيوى منيا ازوتين أعطى اقل نسبة مئوية للفقد فى الوزن بعد أربعة وسبعة أشهر يليه المخصب الحيوى بيوجين.

وعلى ذلك يمكن التوصية بالتسميد النيتروجينى للثوم البلدى بمعدل ١٥٠ كحم نترات نشادر (٣٣.٥%) مع إضافة المخصب الحيوى منيا ازوتين للحصول على اعلى انتاجية قليلة المحتوى النتراتى وتقليل الفاقد اثناء التخزين.