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EFFECT OF N_2-FIXING BACTERIA, DIFFERENT LEVELS FROM MINERAL NITROGEN AND FOLIAR APPLICATION OF POTASSEIN ON GROWTH AND PRODUCTIVITY OF GARLIC PLANTS

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ABSTRACT: ***Two field experiments were carried out during two successive winter seasons of 2007/2008 and 2008/2009 at the Experimental Farm, El Kassasein Research Station, Ismailia Governorate, to investigate the effect of partially substituting of N fertilizer with N_2-fixing Azospirilla and Azotobacter spp. and foliar application of potassein as well as their interaction on growth, dry weight, leaf pigments, yield and chemical constituents of Garlic (Allium sativum L.) cv. Chinese.***

Fertilization of garlic plants with 100% mineral N (120kg N/fed.) or 75% mineral N plus 1kg N_2-fixers recorded the highest values of plant height, number of leaves per plant, both neck and bulb diameter, bulbing ratio, total dry weight per plant, average bulb weight, average clove weight and total yield / fed. as well as bulbs content of nitrogen and total protein in garlic bulbs, while, treated garlic plants with biofertilizer only at 8kg/ fed. gave the highest values of photosynthetic pigments i.e., chlorophyll a , b and total chlorophyll (a+b) in leaf tissue as compared to other treatments. Spraying garlic plants with potassein at a rate of 6 ml /L recorded the highest values of both neck and bulb diameters, dry weight of leaves and bulbs, total plant dry weight, average bulb weight, total yield per feddan and relative yield, as well as content of potassium in bulbs.

The interaction treatments between 100% mineral N (120kg N/fed.) or 75% mineral N plus 1kg N_2-fixers and foliar application of potassein at a rate of 6ml / L gave the maximum vegetative growth parameters, total plant dry weight, yield and its components as well as N, P and total protein in bulbs, meanwhile, the interaction between N_2-fixers biofertilizer only at rate 8 kg/ fed. and foliar application of 6ml/l potassein recorded the best values of photosynthetic pigments i.e., chlorophyll a , b and total chlorophyll (a+b) in leaf tissue as well as K% content in bulbs as compared to other treatments.

Key Words: ***Mineral nitrogen, Potassein, Azospirilla, Azotobacter, Garlic.***

INTRODUCTION

Garlic (*Allium sativum* L.) is one of the oldest and very important vegetable crops grown in Egypt, due to its wide local consumption as a spice or condiment, exportation and food, as well as medicinal industries.

Using mineral fertilizers (NPK) without rationalization may cause environmental pollution as well as contaminate the underground water. Therefore, there was a great attention to use biofertilizers in the production of garlic in order to reduce the contamination of plant and soil with different elements, to reduce the usage of mineral fertilizers, to produce clean crop and also to improve the soil properties. Biofertilizer (microbial inoculation), which contain efficient strains of nitrogen fixing Azospirillum lipoferum and Azotobacter chrococcoum, could be used partially instead of chemical fertilizers. Moreover, these N_2 fixing bacteria increase the availability of fixing Atmospheric nitrogen in form that can be easily assimilated or to make them absorbable by plants (Subba Rao, 1993).

Nitrogen is one of the essential mineral elements for plant growth and one nutrient that is the most frequently in short supply in cultivated soils around the world. The use of biofertilizer such as the nitrogen fixing bacteria may reduce the amount of nitrogen application and consequently reduces production cost Saad *et al.* (1999). In this respect, Fertilization of garlic plants with N at 100 Kg / fed. significantly increased plant height, leaf number, dry weight of leaves, bulb and total / plant, N P and K content in bulb as well as total and exportable yield (Abou El-Magd *et al.* 1998).

In addition, inoculation of 100 Kg garlic cloves with 1 Kg biogen increased number of leaves / plant, total dry weight / plant, total yield, marketable yield and the content of N, P and K in bulb tissues compared with the control (Ali *et al.* 2001), or using 7 Kg nitrobein (Nr) or applying mineral nitrogen fertilizer at 100 Kg / fed. increased plant height, diameter of both neck and bulb, dry weight of bulb and leaves, total yield and uptake of N, P and K by plant compared with the control (EL-Shabasi *et al.* 2003).Moreover, fertilizing garlic plants with 100% mineral N combined with 3 Kg Nr/ fed. gave the highest length and recorded maximum values of leaf number, neck and bulb diameter, total dry weight / plant, average bulb weight and total yield (Bardisi, et *al.* 2004 a and b).

Addition of 100% mineral N and 3 Kg Nr/ fed. alone or in combination had significant effect on chlorophyll a, b, and total (a+b) as well as carotenoids in leaf tissues (Abou El-Khair 2004).

Among the essential nutrients needed by the plant is potassium, which plays a highly recognized role in plant life, an adequate supply of potassium for plant improves the quality and productivity. There are some problems which prevent the garlic plants from using sufficient amounts of potassium to obtain high productivity, such as potassium ions are adsorbed by clay minerals in the clay soils (Schouwenburg and Schuffelen, 1963).

Several investigators reported that growth, yield and storability of garlic plants were generally markedly enhanced by potassium fertilization (Mohd *et al*, 1994). Mansour *et al,* (2002) found that when artichoke treated with foliar spray of potassein at a rate of 2500ppm plus 50% from the recommended mineral dose of K increased vegetative growth, produced the higher value of

early yield with the highest value of receptacle weight and increased the percentage of both nitrogen and potassium in the receptacle. Also, El-Morsy *et al*, (2004) indicated that foliar application of potassium at 2% significantly increased the almost of growth parameters of the garlic plants. Therefore, this study aimed to qualify the effect of N_2-fixing Azospirillum lipoferum and Azotobacter chrococcoum and foliar application of potassein on plant growth, yield and chemical constituents of garlic bulbs grown under sandy soil conditions.

MATERIALS AND METHODS

The present investigation was conducted at the Experimental Farm, El Kassasein Horticultural Research Station, Ismailia Governorate, during two successive winter seasons of 2007-2008 and 2008-2009. to clarify the effects of partial substitution of chemical N fertilizer by the inoculation with Azospirillum lipoferum and Azotobacter chrococcoum and foliar application of potassein on growth, bulb quality and yield of garlic plants (*Allium sativum* L.) under sandy soil conditions. Microorganisms, Azospirillum lipoferum and Azotobacter chrococcoum were obtained from microbiology department, Soil Water and Environment Research Institute, Agric. Res., Center (ARC), Giza, Egypt.

Inoculum preparation:

Azospirillum lipoferum culture was prepared on semi-solid malate medium (Dobereiner, 1978) for 48h at 30 ^{0}C. Whereas, Azotobacter chrococcoum culture was prepared on modified Ashby's medium (AbdEl-Malak and Ishac, 1968) the mixture of bacterial cultures (1:1) containing (1×10^7 cells / ml) injected into sterilized beatmoss (50 ml culture / 250 gm) per bag and then each bag mixed thoroughly to be ready for use as an inoculum for application.

Physical and chemical properties of the experimental soil are presented in Table (1).

This experiment included 15 treatments, which were the combinations between five of mineral and biofertilizer nitrogen rates, and foliar application with three levels of potassein. The treatments were arranged in a split plot design with three replicates, mineral and biofertilizer N treatments were randomly assigned in the main plots, while potassein treatments were randomly distributed in the sub-plots as follows:-

A- Mineral and bio- N fertilizer.

1- 100 % of the recommended dose of mineral N (120 Kg N/ fed.).

2- 75 % mineral N (90Kg N/ fed.) + 1Kg N_2-fixers.

3- 50 % mineral N (60Kg N/ fed.) + 2 Kg N_2-fixers.

4- 25 % mineral N (30Kg N/ fed.) + 4 Kg N_2-fixers.

5- 0 % mineral N + 8 Kg N_2-fixers.

B- Spry treatments.
1- Control (spraying plants with tap water).
2- Potassein 3 ml / L.
3- Potassein 6 ml / L.

Table 1: Physical and chemical properties of the tested soil during2007/2008 and 2008/2009 seasons.

Physical properties			Chemical properties		
	2007/2008	2008/2009		2007/2008	2008 /2009
Sand (%)	96.5	95.6	Organic matter (%)	0.03	0.08
Silt (%)	1.7	1.6	Available K (ppm)	52	64
Clay (%)	1.8	2.8	Available P (ppm)	5.5	6.2
F C (%)	6.5	6.8	Available N (ppm)	5.4	6.9
W P (%)	2.4	2.5	Calcium carbonate %	0.18	0.26
Available water	4.5	4.5	pH	8.1	8.1
Water holding capacity (%)	13.8	14.5			

Cloves of Chinese cultivar garlic were selected for uniformity in shape and size. N_2-fixers inoculum was mixed with weted cloves by adding Arabic gum solution, then the cloves coated with the inoculum before sowing then the treated cloves were, directly, sown in the same day. The biofertilizer used was a mixture of *Azotobacter chrococcoum* and *Azospirillum lipoferum* which consider a nitrogen fixing bacteria, Potassein is a chemical product containing 30% K_2O and 8% P_2O_5. The source of potassein was the General Organization for Agriculture Equalization Foundation (GOAEF), Ministry of Agriculture, Egypt. While, garlic bulbs Chinese cv. were obtained from Horticultural Research Institute, Agriculture Research Center, Egypt.

Treated cloves were sown on two sides of the dripper line at distance of 15 cm apart. Sowing was done on September 21st and 26th in 2007/2008 and 2008/2009, respectively. The experimental unit area was 10.8 m^2 it contained three dripper lines with 6 m in long and 60 cm in width. In addition, one row was left between each two experimental units without spraying as a guard row to a void the overlapping of spraying solution.

Nitrogen was applied as ammonium sulfate (20.6 %N), at four equal portions after 30, 45, 60and 75 days from sowing. All treatments received 50% of the recommended dose of potassium i.e., 100 kg/ fed. as potassium sulfate (48%-52% K_2O) during soil preparation.

Treatments of potassein were sprayed three times i.e., 30, 60 and 90 days from sowing. Each plot received 2 L. /solution for each level and using spreading agent (Super Film 1ml / L.), the untreated plants were sprayed with tap water. The other agriculture practices were carried out as commonly followed in the district.

Data recorded:

Growth parameters:

A random sample of nine plants was taken from each sub-plot at 150 days after sowing, in both seasons of study, for measuring the growth characters of garlic plants expressed as: Plant height, leaf number / plant, neck diameter and bulb diameter, as well as bulbing ratio according to the equation of Mann (1952).

$$\text{Bulbing ratio} = \frac{\text{Neck diameter}}{\text{Bulb diameter}}$$

Dry weight:

The different parts of garlic plant, i.e., leaves and bulb were oven dried at 70 ^{0}C till constant weight and then the following data were recorded: Bulb dry weight / plant, leaves dry weight / plant and total plant dry weight (bulb and leaves).

Photosynthetic pigments:

Disk samples from the fourth upper leaf were taken at 150 days after sowing (in the second season only) to determine chlorophyll a, b and total chlorophyll as well as carotenoidis according to Wettestein (1957).

Yield and its components:

At proper maturity stage of bulbs (200 days after sowing), bulbs in every plot were harvested and the following data were recorded: Average bulb weight (g), bulb diameter, number of cloves / bulb and average clove weight (g).

Chemical analysis in garlic bulbs:

Dried cloves were finely ground and digested with sulfuric acid and percholoric acid (3:1).Total Nitrogen, phosophorus and potassium percentage were determined according to the method described by Kock and Mc-Meekin (1924), Murphy and Riley (1962) and Brown and Lilliland (1946), respectively.

Total crude protein %: **It was calculated by multiplying total nitrogen × 6.25.**

Nitrate content:

It was determined on the basis of dry weight according to the method described by Cafado *et al.* (1975).

Statistical analysis:

All data of this experiment were subjected to the analysis of variance according to Snedecor and Cochran (1980). Duncan`s multiple range test was used for the comparison among treatments (Duncan, 1955).

RESULTS AND DISCUSSION

Vegetative Characters:

Effect of mineral nitrogen plus N_2-fixers levels:

The effect of mineral nitrogen plus N_2-fixers levels on vegetative characters of garlic plants; i.e., plant height, leaves number, neck diameter, bulb diameter and bulbing ratio are shown in Table 2. It is obvious from data that application of nitrogen fertilizer at recommended dose as 100% mineral N or 75 % mineral nitrogen plus 1 Kg N_2-fixers significantly increased all studied vegetative characters as compared to other tested fertilization treatments, without significant differences between their effects. Such effects of the above mentioned treatments could be attributed to the role of added nitrogen fertilizer and the activity of nitrogen fixing bacteria in the absorption zone of plant roots which improving soil fertility and consequently plant development by N_2- fixation and due also to releasing of certain other nutrients; i.e., Fe, Zn and Mn (Bhonde *et al.,* 1997) through the breaking down of organic materials in the soil and make these elements in available forms. These results are in harmony with those obtained by Abou El-Magd *et al.* 1998, Ali *et al.* 2001, EL-Shabasi *et al.* 2003 and Bardisi *et al.* 2004a, whose confirmed these results of their researches on garlic.

Effect of foliar application of potassein:

It is evident from the data in Table 2 that, spraying garlic plants with potassein at different concentrations had a promoting effect on all studied vegetative growth characters and significantly increased neck diameter, bulb diameter and bulbing ratio, these results are emphasized in both growing seasons. The highest values were recorded by foliar spray with potassein three times during the growth season at rate 6 ml /l, while the lowest values of all the above mentioned characters of vegetative growth were recorded in case of the control treatment.

This promotion effect of potassein may be attributed to the fact that K nutrient play an active role in building new merestematic cells, cell elongation and increasing photosynthesis activity which lead to increase the vegetative growth. Obtained results are agreeable with those reported by Mohd *et al*, 1994 and El-Morsy *et al*, 2004 on garlic and Mansour *et al,* 2002 on artichoke.

Table 2

Effect of the interactions between mineral nitrogen plus N_2-fixers levels and foliar application of potassein:

The results in Table 3 illustrate effect of the interactions between mineral nitrogen plus N_2-fixers levels and foliar application of potassein on vegetative characters of garlic plants. It is obvious from the data that there were significant differences among most of the interaction treatments on all studied vegetative characters. These results are recorded in both growing seasons. In general, the interactions between potassein at rate of 6ml/Land 100 % mineral N only or 75 % mineral N + 1kg N_2-fixers gave the highest values of plant height, leaves number, bulb diameter and bulbing ratio as compared to other treatments which recorded the lowest values in both seasons.

Dry weight and Photosynthetic Pigments:

Effect of mineral nitrogen plus N_2-fixers levels:

The results listed in Table 4 clearly show the effect of mineral nitrogen plus N_2-fixers levels on dry weight and photosynthetic pigments of garlic plants, the results indicate that fertilization garlic plants with 100 % mineral N only or 75 % mineral N plus 1kg N_2-fixers led to significant increase in dry weight of leaves, bulb and total dry weight as compared to other treatments.

The effect of mineral N and biofertilizers on dry weight of garlic might owe much to the increase in plant growth (Table2). These results are in the accordance with those reported by Abou El-Magd *et al.* 1998, Ali *et al.* 2001, EL-Shabasi *et al.* 2003 and Bardisi et *al.* 2004a.

As for the effect of mineral nitrogen levels and N_2-fixers biofertilizer on photosynthetic pigments, the same results in Table 4 show also that fertilization of garlic plants with biofertilizers only recorded the highest values of chlorophyll a, b and total chlorophyll, while the minimum values of chlorophyll a, b and total chlorophyll were recorded by 75 % mineral N + 1 kg N_2-fixers. On the other hand, all treatments did not reflect any significant effect on carotenoids.

The promoting effect of biofertilizer treatments on chlorophyll pigments content may be related to the role of the same symbiotic and non symbiotic N_2-fixing in producing of phytohormones or improving the availability and acquisition of nutrients or both which promoted the vegetative growth. These results are in harmony with those obtained by Abou El-Khair 2004 on garlic.

Effect of foliar application of potassein:

It is clear from the data in Table 4 that foliar application of potassein had significant effect on dry weight of leaves, bulb and total dry weight of garlic plant, the highest values were recorded from plants which sprayed with 6ml / L potassein, while the minimum values were recorded by the control.

Table 3

Table 4

These results may be referred to the beneficial effect of the applied K as a foliar beside the soil application during plant growth periods is available by plants. These results agree with those reported by Mohd *et al*, 1994 and El-Morsy *et al*, 2004 on garlic and Mansour *et al,* 2002 on artichoke.

Regarding the effect of potassein on photosynthetic pigments, the same results in Table 4 show also that spraying garlic plants with potassein did not reflect any significant effect on photosynthetic pigments.

Effect of the interactions between mineral nitrogen plus N_2-fixers levels and foliar application of potassein:

Data in Table 5 illustrate the effect of the interactions between nitrogen plus diazotorophs (N_2-fixers) levels and foliar application of potassein on dry weight and photosynthetic pigments of garlic plants. It is obvious that all the interaction treatments had a promotive effect on all parameters of dry weight; these positively results are obtained in both seasons. In general, the interactions between 100 % mineral N and 6 ml / L potassein gave the highest values of dry weight of leaves, bulb and total dry weight followed by 75 % mineral N + 1 kg N_2-fixers and 6ml potassein, while the interactions between biofertilizers only without potassein recorded the lowest values in both seasons.

As for the effect of the interactions between nitrogen plus N_2-fixers levels, and foliar application of potassein on photosynthetic pigments, data in Table 5 show that all the interaction treatments significantly affected on chlorophyll a, b and total chlorophyll as well as carotenoids. It is obvious from this data that the highest values of chlorophyll a, b and total chlorophyll were obtained by the interactions between biofertilizers only and 6ml /l potassein, whereas the interactions between 25 % mineral N + 4kg N_2-fixers without potassein recorded the highest values of carotenoids.

Yield and Its Components:

Effect of mineral nitrogen plus N_2-fixers levels:

Data in Table 6 clearly show the effect of mineral nitrogen plus N_2-fixers levels on yield and its components of garlic plants; i.e., average bulb weight, number of cloves/bulb, average clove weight, total yield and relative yield %. It is obvious from such data that, fertilization garlic plants with mineral N only at 100 % of the recommended dose or with 75% mineral N + 1 kg N_2-fixers gave the highest values of all studied characters with non significant differences between the two treatments, whereas the lowest values were recorded from the plants which received bio-fertilizer N_2-fixers only at 8 kg / fed.

The favorable effect of mineral nitrogen fertilizer and biofertilizer on total yield and its components could be explained through the great role of these fertilizers in enhancing plant growth rate, which exert direct effect on the yield and its components. These results are in a harmony with those obtained by Abou El-Magd *et al.* 1998, Ali *et al.* 2001, EL-Shabasi *et al.* 2003 and Bardisi et *al.* 2004b all worked on garlic.

Table 5

Table 6

Effect of foliar application of potassein:

It is clear from the data in Table 6 that spraying garlic plants three times during the growing season with potassein at rate of 3ml/L or 6ml/L significantly increased average bulb weight, total yield/ fed. and relative yield % as compared to the control treatment. The improving effect of potassein fertilization on these characters may be attributed to the role of potassium in plants as an enzyme activation for water and energy relations, translocations of assimilates, N uptake and protein as well as syntheses starch which led to form more weight.

In addition, potassium improved the rates of photosynthesis, biosyntheses of garlic plants and translocation of carbohydrates from source to sink. These results are in accordance with those obtained by Mohd *et al*, 1994 and El-Morsy *et al*, 2004 on garlic and Mansour *et al,* 2002 on artichoke.

Effect of the interactions between mineral nitrogen plus N_2-fixers levels and foliar application of potassein:

According to the effect of the interactions between mineral nitrogen plus N_2-fixers levels and foliar application of potassein on yield and yield components expressed as average bulb weight, number of cloves per bulb, average clove weight, total yield / fed. and relative yield % , it is obvious from data in Table 7 that the interaction treatments reflected significant effect on all yield components, these results were matched during both seasons of study. It is noticed that the interactions between 100% mineral N and 6ml/L potassein was the superior interaction followed by 75% mineral N + 1kg N_2-fixers and 6ml/L potassein. On the other side, the interactions between N_2-fixers biofertilizer only without potassein foliar application recorded the lowest values of yield and yield components.

Bulbs chemical constituents:

Effect of mineral nitrogen plus N_2-fixers levels:

The results listed in Table 8 clearly show the effect of mineral nitrogen plus N_2-fixers levels on chemical constituents of garlic bulbs; i.e., N, P, K and protein % as well as nitrate content. It is seen that mineral and biofertilizer nitrogen treatments had significant effect on N, K and protein content. The data show also that 100% mineral N or 75% mineral N +1kg N_2-fixers gave the highest values of N% and protein content, while N_2-fixers biofertilizer only recorded the highest values of K content in the first season only.

For nitrate content (Table 8) show that the lowest values of nitrate were obtained by application of nitrogen fertilize in bio from N_2-fixers only at 8 kg/fed. while, the maximum value (1102.1 and 1042.0 mg/kg FW) was obtained by mineral fertilizer only (100% N). It is important to note that, these values did not ever reach to 2500 mg/kg of the maximum allowable for EU countries (Cameria *et al.,* 2000) on lettuce. The maximum tolerant dose is 10 to 15 mg NO_3 and 4mg NO_2 / kg daily (Ahmed *et al.,* 1997). These results agree with those reported by Ali *et al.* 2001, EL-Shabasi *et al.* 2003 and Bardisi et *al.* 2004b all worked on garlic.

Table 7

Table 8

Effect of foliar application of potassein:

Presented data in Table 8 indicate the effect of potassein foliar application on chemical constituents of garlic bulbs. The results reveal that spraying garlic plants with potassein did not reflect any significant effect on N, P% and protein content, while using potassein at rate of 6 ml / L obtained a promotive effect on K %, but such increment did not reaching to the statistical level.

Regarding the effect of potassein on nitrate content, the same results in Table 8 show also that spraying garlic plants with potassein had significant effect on nitrate content, the highest values were recorded from plants which sprayed with 6ml / L potassein, while the minimum values were recorded by the control.

These results matched with those reported by Mansour *et al,* 2002on artichoke and El-Morsy *et al*, 2004 on garlic.

Effect of the interactions between mineral nitrogen plus N_2-fixers levels and foliar application of potassein:

The data listed in Table 9 clearly show the effect of the interactions between mineral nitrogen plus N_2-fixers levels and foliar application of potassein on chemical constituents of garlic bulbs. It is obvious from such data that the interaction treatments significantly increased N, P, K and protein % as well as nitrate content, the highest increases in N, P and protein content were obtained by the interaction betweens 100% mineral N or 75% mineral N + 1kg N_2-fixers and potassein with different rates, while the interactions between 25% mineral N +4kg N_2-fixers or 8 kg N_2-fixers only and different rates of potassein gave the highest values of K content.

As for the effect of the interactions between mineral nitrogen plus N_2-fixers levels and foliar application of potassein on nitrate content, data in Table 9 show that all interaction treatments significantly affected nitrate content. It is obvious from the same data that the highest values of nitrate content were obtained by the interaction between 100% mineral N without potassein, while the interactions between 8 Kg N_2-fixers and 6ml / L potassein recorded the lowest values.

CONCLUSION

From the previous results of this investigation, it could be conciuded that substituting the inorganic N fertilizer with 75% mineral N +1 kg N_2-fixers and foliar application of potassein three times after 30, 60 and 90 days from planting at rate 6ml /L was sufficient to produce the highest vegetative growth parameters, leaf pigments and yield and its components as well as chemical constituents of garlic. This substituting of the inorganic N may help in overcoming the problems of high prices of chemical fertilizers by decreasing the total cost of production as well as lowering environmental pollution.

Table 9

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تأثير البكتريا المثبتة للنيتروجين ومعدلات مختلفة من النيتروجين المعدنى والرش الورقى بالبوتاسين على النمو والإنتاجية لنباتات الثوم

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أقسام بحوث الخضر – معهد بحوث البساتين – مركز البحوث الزراعية

الملخص العربي

أجريت تجربتان حقليتان خلال الموسم الشتوى لعامى ٢٠٠٧ / ٢٠٠٨و ٢٠٠٨ /٢٠٠٩ فى مزرعة التجارب البحثية بمحطة بحوث البساتين بالقصاصين ، محافظة الأسماعيلية ،وذلك لدراسة تأثير استبدال واحلال التسميد الحيوى الذى يحتوى على سلالتين من مثبتات النيتروجين (أزوتوباكتر كروكوكم و أزوسبيريلم ليبوفيرم) بمعدلات مختلفة بدلا من السماد النيتروجينى المعدنى بالاضافة إلى الرش الورقى بالبوتاسين والتفاعل بينهم ، على النمو ،الوزن الجاف ،الصبغات النباتية ،المحصول و مكوناته و المحتوى الكيماوى لنباتات الثوم الصينى تحت ظروف الأراضى الرملية.

سجلت كلا من معاملة التسميد النيتروجينى المعدنى بمعدل ١٠٠% ومعاملة التسميد النيتروجينى المعدنى بمعدل ٧٥% + ١كجم من مثبتات النيتروجين أعلى القيم بالنسبة لإرتفاع النبات ، عدد الأوراق/نبات ،قطركلا من العنق و البصلة، نسبة التبصيل، الوزن الجاف الكلى للنبات ، ومتوسط وزن البصلة ، متوسط وزن الفص والمحصول الكلى للفدان وكذلك محتوى الأبصال من النيتروجين والبروتين الكلى ، بينما أعطت معاملة التسميد الحيوى فقط بمعدل ٨ كجم من مثبتات النيتروجين / فدان أعلى القيم بالنسبة لصبغات التمثيل الضوئى متمثلة فى كلوروفيل أ ، ب والكلوروفيل الكلى (أ+ب) فى نسيج الورقة بالمقارنة بباقى المعاملات.

سجلت معاملة الرش الورقى لنباتات الثوم بالبوتاسين بمعدل ٦سم^{٣} / لتر أعلى القيم بالنسبة لكل من قطرالعنق والبصلة ،الوزن الجاف للأوراق ، الأبصال وكذلك الوزن الجاف الكلى للنبات ، متوسط وزن البصلة ،المحصول الكلى للفدان، المحصول النسبى هذا بالاضافة إلى محتوى الأبصال من البوتاسيوم.

أعطت معاملات التفاعل بين التسميد النيتروجيني المعدني بمعدل ١٠٠% أو ٧٥ % + ١كجم من مثبتات النيتروجين والرش الورقي بالبوتاسين بمعدل ٦سم[٣] / لتر أعلى القيم بالنسبة لقياسات النمو الخضرى ، الوزن الجاف ،المحصول الكلى ومكوناته وأيضا محتوى الأبصال من النيتروجين ، الفوسفور والبروتين الكلى بينما سجلت معاملة التفاعل بين التسميد الحيوى فقط بمعدل ٨كجم من مثبتات النيتروجين /فدان والرش الورقى بالبوتاسين بمعدل ٦سم[٣] / لتر أعلى القيم بالنسبة لصبغات التمثيل الضوئى متمثلة فى كلوروفيل أ ،ب والكلوروفيل الكلى (أ+ب) ومحتوى الأبصال من البوتاسيوم .

Table 2. Effect of mineral nitrogen plus N_2-fixing levels and potassine on vegetative growth of garlic plants during 2007/2008 and 2008/2009 seasons.

Treatments	Growth characters / plant									
	2007/2008 Season					2008/2009 Season				
Nitrogen + N_2 – fixing	Plant height (cm)	Leaves No.	Neck diameter (cm.)	Bulb diameter (cm.)	Bulbing ratio	Plant height (cm)	Leaves No.	Neck diameter (cm.)	Bulb diameter (cm.)	Bulbing ratio
100% N+ 0Kg N_2-fixing	72.3^{a}	12.2^{a}	1.60^{a}	6.77^{a}	0.236^{a}	69.4^{a}	12.1^{a}	1.62^{a}	6.83^{a}	0.236^{ab}
75% N + 1Kg N_2-fixing	68.7^{ab}	11.6^{b}	1.46^{b}	6.49^{a}	0.228^{ab}	69.6^{a}	11.6^{ab}	1.54^{b}	6.40^{a}	0.239^{ab}
50% N + 2Kg N_2-fixing	66.4^{b}	10.5^{c}	1.22^{c}	5.82^{b}	0.210^{b}	65.1^{b}	11.3^{ab}	1.40^{c}	5.73^{b}	0.244^{a}
25% N + 4Kg N_2-fixing	60.9^{c}	10.4^{c}	1.25^{c}	5.64^{b}	0.222^{ab}	61.7^{bc}	10.6^{bc}	1.26^{d}	5.50^{b}	0.230^{ab}
0% N + 8Kg N_2-fixing	57.5^{c}	9.8^{d}	0.92^{d}	5.09^{c}	0.182^{c}	58.5^{c}	10.0^{c}	1.06^{e}	4.85^{c}	0.218^{b}
Potassine ml/ L.										
Control (Without)	63.5^{a}	10.6^{a}	1.13^{b}	5.56^{b}	0.206^{a}	62.6^{a}	10.9^{a}	1.19^{c}	5.59^{b}	0.212^{b}
3 ml / L	64.7^{a}	10.9^{a}	1.24^{b}	5.97^{ab}	0.207^{a}	64.7^{a}	11.1^{a}	1.31^{b}	5.80^{ab}	0.226^{b}
6 ml / L	67.3^{a}	11.2^{a}	1.50^{a}	6.35^{a}	0.233^{a}	67.3^{a}	11.4^{a}	1.63^{a}	6.19^{a}	0.263^{a}

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 3. Effect of the interactions between mineral nitrogen plus N_2-fixing levels and potassein on vegetative growth of garlic plants during 2007/2008 and 2008/2009 seasons.

Treatments		Growth characters / plant									
		2007/2008 Season					2008/2009 Season				
Nitrogen $+N_2$ – fixing level	Potassein	Plant height (cm)	Leaves No.	Neck diameter (cm.)	Bulb diameter (cm.)	Bulbing ratio	Plant height (cm)	Leaves No.	Neck diameter (cm.)	Bulb diamete r (cm.)	Bulbing ratio
100% N+ 0Kg Nf*	Control	68.1^{b-d}	12.0^{a}	1.35^{d}	6.52^{bc}	0.207^{de}	66.1^{b-d}	11.9^{ab}	1.40^{e}	6.58^{b}	0.213^{a}
	3 ml/L	71.5^{b}	12.3^{a}	1.48^{c}	6.76^{ab}	0.219^{cd}	68.8^{b}	11.9^{ab}	1.51^{d}	6.83^{ab}	0.221^{b-e}
	6 ml /L	77.3^{a}	12.3^{a}	1.97^{a}	7.03^{a}	0.281^{a}	73.4^{a}	12.6^{a}	1.93^{a}	7.08^{a}	0.273^{a}
75% N + 1Kg Nf	Control	67.3^{cd}	11.2^{bc}	1.24^{e}	6.19^{cd}	0.213^{de}	65.7^{b-d}	11.4^{b-d}	1.32^{f}	6.19^{c}	0.214^{c-e}
	3 ml/L	67.6^{b-d}	11.7^{ab}	1.36^{d}	6.53^{bc}	0.208^{de}	69.5^{b}	11.5^{bc}	1.45^{de}	6.23^{c}	0.234^{bc}
	6 ml /L	71.2^{bc}	11.9^{ab}	1.76^{b}	6.76^{ab}	0.261^{b}	73.4^{a}	11.8^{ab}	1.82^{b}	6.76^{ab}	0.269^{a}
50% N + 2Kg Nf	Control	66.1^{d}	10.3^{de}	1.11^{f}	5.47^{fg}	0.203^{de}	63.4^{de}	11.2^{b-e}	1.23^{g}	5.50^{efg}	0.224^{b-d}
	3 ml/L	66.3^{d}	10.4^{c-e}	1.23^{e}	5.79^{ef}	0.214^{de}	64.5^{cd}	11.2^{b-e}	1.32^{f}	5.62^{e}	0.236^{b}
	6 ml /L	66.7^{d}	10.8^{cd}	1.32^{d}	6.19^{cd}	0.214^{de}	67.4^{bc}	11.5^{bc}	1.64^{c}	6.06^{cd}	0.272^{a}
25% N + 4Kg Nf	Control	59.4^{ef}	10.1^{d-f}	1.10^{f}	5.24^{g}	0.211^{de}	59.8^{e-f}	10.4^{d-f}	1.05^{h}	5.19^{g}	0.203^{e}
	3 ml/L	61.2^{e}	10.3^{de}	1.22^{e}	5.61^{f}	0.217^{de}	62.5^{d-f}	10.6^{c-e}	1.24^{g}	5.52^{ef}	0.225^{b-d}
	6 ml /L	62.1^{e}	10.8^{cd}	1.43^{c}	6.07^{de}	0.237^{c}	62.8^{d-f}	10.9^{b-e}	1.50^{d}	5.77^{de}	0.261^{a}
0% N + 8Kg Nf	Control	56.4^{f}	9.4^{f}	0.86^{h}	4.36^{h}	0.198^{e}	57.7^{g}	9.5^{f}	0.92^{i}	4.50^{h}	0.205^{de}
	3 ml/L	56.8^{f}	9.9^{ef}	0.91^{h}	5.17^{g}	0.176^{f}	58.2^{g}	10.2^{ef}	1.01^{h}	4.77^{h}	0.212^{de}
	6 ml /L	59.3^{ef}	10.2^{de}	0.99^{g}	5.72^{f}	0.173^{f}	59.5^{fg}	10.2^{ef}	1.25^{g}	5.28^{fg}	0.239^{b}

Nf = N_2 – fixing

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 4. Effect of mineral nitrogen plus N_2-fixing levels and potassein on dry weight and photosynthetic pigments of garlic plants during 2007/2008 and 2008/2009 seasons

Treatments	Dry weight (g/plant)						Photosynthetic pigments			
	2007/2008 Season			2008/2009 Season			2008/2009 Season			
Nitrogen +N_2 – fixing	Leaves	Bulb	Total	Leaves	Bulb	Total	Chl.a mg/g D.W.	Chl.b mg/g D.W.	Total(a+b) mg/g D.W.	Carotenoids mg/g D.W.
100% N+0Kg N_2 – fixing	17.16^{a}	38.39^{a}	55.55^{a}	14.86^{a}	39.84^{a}	54.69^{a}	3.46^{c}	2.26^{cd}	5.71^{ab}	3.91^{a}
75% N + 1Kg N_2 – fixing	16.54^{a}	35.53^{b}	52.07^{b}	14.28^{ab}	38.25^{a}	52.53^{a}	3.50^{bc}	2.03^{d}	5.53^{b}	3.64^{a}
50% N + 2Kg N_2 – fixing	15.30^{b}	33.05^{c}	48.35^{c}	12.76^{bc}	32.68^{b}	45.44^{b}	4.01^{a}	2.61^{b}	6.62^{a}	4.04^{a}
25% N + 4Kg N_2 – fixing	13.71^{c}	32.32^{c}	46.03^{d}	11.54^{cd}	31.42^{b}	42.96^{c}	3.88^{ab}	2.40^{bc}	6.27^{ab}	4.08^{a}
0% N + 8Kg N_2 – fixing	13.45^{c}	36.46^{c}	44.91^{d}	11.15^{d}	32.11^{b}	43.30^{bc}	3.96^{a}	3.05^{a}	6.67^{a}	3.98^{a}
Potassine ml / L.										
Control (Without)	13.79^{b}	32.03^{b}	45.83^{b}	11.34^{b}	30.40^{b}	41.74^{c}	3.73^{a}	3.73^{a}	6.04^{a}	3.94^{a}
Potassine 3 ml / L	15.38^{ab}	34.23^{ab}	49.61^{a}	13.10^{a}	35.40^{a}	48.52^{b}	3.82^{a}	3.82^{a}	6.33^{a}	3.98^{a}

Potassine 6 ml / L	16.53^{a}	36.18^{a}	52.72^{a}	14.31^{a}	38.77^{a}	53.09^{a}	3.73^{a}	3.73^{a}	6.12^{a}	3.87^{a}

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 5. Effect of the interactions between mineral nitrogen plus N_2-fixing levels and potassein on dry weight photosynthetic pigments of garlic plants during 2007/2008 and 2008/2009 seasons

Treatments		Dry weight (g/plant)						Photosynthetic pigments			
		2007/2008 Season			2008/2009 Season			2008 /2009 Season			
Nitrogen +N_2 – fixing level	Potassein	Leaves	Bulb	Total	Leaves	Bulb	Total	Chl.a mg/g D.W.	Chl.b mg/g D.W.	Total(a+b) mg/g D.W.	Carotenoids mg/g D.W.
	Control	15.13^{c}	36.35^{cd}	51.48^{cd}	13.91^{c-e}	33.35^{ef}	47.25^{e}	3.37^{cd}	2.09^{de}	5.46^{cd}	3.89^{ab}
100% N+ 0Kg Nf*	3 ml/L	18.00^{ab}	38.55^{b}	56.54^{b}	15.01^{ab}	40.88^{bc}	55.89^{bc}	3.59^{a-d}	2.40^{c}	5.99^{a-d}	3.97^{ab}
	6 ml /L	18.37^{a}	40.27^{a}	58.64^{a}	15.65^{a}	45.28^{a}	60.93^{a}	3.41^{b-d}	2.28^{c-e}	5.69^{b-d}	3.85^{b}
	Control	14.53^{cd}	34.13^{e}	48.66^{e}	13.29^{d-f}	32.88^{ef}	46.17^{ef}	3.67^{a-d}	1.67^{f}	5.34^{cd}	3.47^{c}
75% N + 1Kg Nf	3 ml/L	17.11^{ab}	35.12^{de}	52.23^{c}	14.06^{cd}	39.69^{cd}	53.75^{cd}	3.64^{a-d}	2.38^{c}	6.02^{a-d}	3.97^{ab}
	6 ml /L	17.99^{ab}	37.34^{bc}	55.33^{b}	15.49^{a}	42.18^{b}	57.67^{b}	3.19^{d}	2.05^{e}	5.24^{d}	3.48^{c}
	Control	13.98^{c-e}	29.69^{g}	43.67^{fg}	10.45^{hi}	27.87^{g}	38.33^{g}	4.02^{ab}	2.45^{c}	6.47^{ab}	4.06^{ab}
50% N + 2Kg Nf	3 ml/L	15.19^{c}	34.39^{e}	49.59^{de}	13.42^{d-f}	32.03^{f}	45.44^{ef}	4.08^{a}	2.48^{c}	6.56^{ab}	4.05^{ab}
	6 ml /L	16.74^{b}	35.07^{de}	51.81^{c}	14.41^{bc}	38.15^{d}	52.56^{d}	3.94^{a-c}	2.88^{b}	6.83^{a}	4.01^{ab}
	Control	12.84^{ef}	30.45^{g}	43.29^{g}	9.70^{ij}	28.73^{g}	38.43^{g}	3.70^{a-d}	2.35^{cd}	6.05^{a-d}	4.27^{a}
25% N + 4Kg Nf	3 ml/L	13.30^{d-f}	32.39^{f}	45.69^{f}	11.84^{g}	31.76^{f}	43.60^{f}	3.91^{a-c}	2.33^{c-e}	6.24^{a-c}	3.93^{ab}
	6 ml /L	15.01^{c}	34.11^{e}	49.12^{e}	13.07^{ef}	33.76^{ef}	46.84^{e}	4.02^{ab}	2.51^{c}	6.53^{ab}	4.05^{ab}
0% N + 8Kg Nf	Control	12.50^{f}	29.55^{g}	42.05^{g}	9.35^{j}	29.19^{g}	38.54^{g}	3.88^{a-c}	2.98^{ab}	6.86^{a}	4.00^{ab}

3 ml/L	13.30^{d-f}	30.68^{g}	43.98^{fg}	11.15^{gh}	32.65^{ef}	43.92^{f}	3.88^{a-c}	2.98^{ab}	6.86^{a}	4.00^{ab}
6 ml /L	14.56^{cd}	34.14^{e}	48.70^{e}	12.95^{f}	34.50^{e}	47.45^{e}	4.10^{a}	3.21^{a}	7.31^{a-c}	3.93^{ab}

Nf = N_2 – fixing

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 6. Effect of mineral nitrogen plus N_2-fixing levels and potassein on yield and its components of garlic plants during 2007/2008 and 2008/2009 seasons.

Treatments	Yield and its components									
	2007/2008 Season					Season 2008/2009				
Nitrogen + N_2 – fixing	Average bulb weight (g)	No. of cloves/ bulb	Average clove weight (g)	Total yield (ton/fed.)	Relative yield (%)	Average bulb weight (g)	No. of cloves/ bulb	Average clove weight (g)	Total yield (ton/fed.)	Relative yield (%)
100% N+0Kg N_2–fixing	92.3^{a}	15.3^{a}	6.03^{a}	8.611^{a}	100.0	87.4^{a}	15.7^{a}	5.58^{a}	8.154^{a}	100.0
75% N +1Kg N_2 – fixing	88.5^{a}	15.3^{a}	5.79^{a}	8.260^{a}	95.9	83.1^{b}	16.2^{a}	5.12^{ab}	7.756^{b}	95.1
50% N + 2Kg N_2 – fixing	75.7^{b}	15.9^{a}	4.78^{b}	7.066^{b}	82.1	74.6^{c}	16.0^{a}	4.67^{bc}	6.963^{c}	85.4
25% N + 4Kg N_2 – fixing	67.1^{c}	16.3^{a}	4.12^{c}	6.260^{c}	72.7	69.3^{d}	15.8^{a}	4.40^{cd}	6.469^{d}	79.3
0% N + 8Kg N_2 – fixing	62.2^{c}	15.7^{a}	3.98^{c}	5.800^{c}	67.4	63.8^{e}	15.8^{a}	4.05^{d}	5.949^{e}	73.0
Potassine ml / L.										
Control (Without)	72.4^{b}	15.5^{a}	4.74^{a}	6.753^{b}	100.0	70.0^{b}	15.6^{a}	4.50^{a}	6.531^{b}	100.0

3 ml / L	76.3^{ab}	15.7^{a}	4.88^{a}	7.116^{ab}	105.4	75.8^{ab}	16.1^{a}	4.72^{a}	7.074^{ab}	108.3
6 ml / L	82.9^{a}	15.9^{a}	5.20^{a}	7.729^{a}	114.5	81.1^{a}	16.0^{a}	5.07^{a}	7.570^{a}	115.9

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 7. Effect of the interactions between mineral nitrogen plus N_2-fixing levels and potassein on yield and its components of garlic plants during 2007/2008 and 2008/2009 seasons

Treatments		Yield and its components									
		2007/2008 Season					2008/2009 Season				
Nitrogen +N_2 – fixing level	Potassein	Average bulb weight (g)	No. of cloves/ bulb	Average clove weight (g)	Total yield (ton/fed.)	Relative yield (%)	Average bulb weight (g)	No. of cloves/ bulb	Average clove weight (g)	Total yield (ton/fed.)	Relative yield (%)
	Control	85.7^{b}	14.3^{c}	5.98^{a}	7.996^{b}	100.0	78.6^{de}	15.3^{b}	5.13^{c}	7.333^{de}	100.0
100% N+ 0Kg Nf*	3 ml/L	90.5^{b}	15.7^{abc}	5.78^{ab}	8.450^{b}	105.6	89.1^{b}	16.0^{ab}	5.59^{b}	8.313^{b}	113.4
	6 ml /L	100.6^{a}	16.0^{abc}	6.31^{a}	9.389^{a}	117.5	94.5^{a}	15.7^{ab}	6.04^{a}	8.817^{a}	120.2
	Control	80.3^{c}	14.7^{bc}	5.52^{abc}	7.492^{c}	93.8	76.3^{ef}	15.3^{b}	4.98^{c}	7.118^{ef}	97.1
75% N + 1Kg Nf	3 ml/L	88.3^{b}	15.3^{bc}	5.77^{ab}	8.238^{b}	103.2	82.5^{c}	16.3^{ab}	5.05^{c}	7.697^{c}	105.0
	6 ml /L	97.0^{a}	16.0^{abc}	6.07^{a}	9.050^{a}	113.2	90.6^{b}	17.0^{a}	5.33^{bc}	8.453^{b}	115.3
	Control	72.6^{d}	16.3^{ab}	4.45^{def}	6.774^{d}	84.8	69.8^{g}	16.0^{ab}	4.37^{de}	6.512^{g}	88.8
50% N + 2Kg Nf	3 ml/L	75.2^{cd}	15.0^{bc}	5.03^{bcd}	7.016^{cd}	87.8	74.0^{f}	16.3^{ab}	4.53^{de}	6.904^{f}	94.2
	6 ml /L	79.4^{c}	16.3^{ab}	4.87^{cd}	7.408^{c}	92.7	80.1^{cd}	15.7^{ab}	5.12^{c}	7.473^{cd}	101.9
	Control	64.6^{fg}	16.0^{abc}	4.05^{ef}	6.027^{fg}	75.4	64.1^{hi}	15.0^{b}	4.27^{de}	5.981^{hi}	81.6
25% N + 4Kg Nf	3 ml/L	66.3^{ef}	17.3^{a}	3.83^{ef}	6.186^{ef}	77.4	69.7^{g}	16.0^{ab}	4.37^{de}	6.503^{g}	88.7
	6 ml /L	70.4^{de}	15.7^{abc}	4.49^{de}	6.568^{de}	82.1	74.2^{f}	16.3^{ab}	4.55^{d}	6.923^{f}	94.4

	Control	58.7^{h}	16.0^{abc}	3.68^{f}	5.477^{h}	68.6	61.2^{i}	16.3^{ab}	3.75^{f}	5.710^{i}	77.9
0% N + 8Kg Nf	3 ml/L	61.0^{gh}	15.3^{bc}	3.98^{ef}	5.691^{gh}	71.3	63.8^{hi}	15.7^{ab}	4.08^{ef}	5.953^{hi}	81.1
	6 ml /L	66.8^{ef}	15.7^{abc}	4.27^{def}	6.232^{ef}	78.0	66.3^{gh}	15.3^{b}	4.33^{de}	6.186^{gh}	84.4

Nf = N_2 – fixing

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 8. Effect of mineral nitrogen plus N_2-fixing levels and potassein on chemical constituents of garlic bulbs during 2007/2008 and 2008/2009 seasons

Treatments	Chemical constituents									
	2007/2008 Season					2008/2009 Season				
Nitrogen + N_2 – fixing	N %	P %	K %	Protein%	Nitrate mg/kg FW	N %	P%	K%	Protein%	Nitrate mg/kg FW
100% N+ 0Kg N_2 – fixing	1.79^{a}	0.484^{a}	1.73^{c}	11.17^{a}	1102.1^{a}	1.80^{a}	0.474^{a}	1.67^{a}	11.23^{a}	1042.0^{a}
75% N + 1Kg N_2 – fixing	1.77^{a}	0.463^{a}	1.85^{b}	11.06^{a}	1045.7^{b}	1.78^{ab}	0.467^{a}	1.74^{a}	11.12^{ab}	977.9^{b}
50% N + 2Kg N_2 – fixing	1.63^{b}	0.441^{a}	1.85^{b}	10.18^{b}	1005.3^{c}	1.58^{ab}	0.453^{a}	1.71^{a}	9.88^{ab}	872.3^{c}
25% N + 4Kg N_2 – fixing	1.57^{b}	0.441^{a}	1.87^{b}	9.76^{b}	856.6^{d}	1.40^{ab}	0.472^{a}	1.72^{a}	8.77^{ab}	773.4^{d}
0% N + 8Kg N_2 – fixing	1.33^{c}	0.450^{a}	1.94^{a}	8.31^{c}	666.2^{e}	1.34^{b}	0.479^{a}	1.69^{a}	8.38^{b}	620.4^{e}

Potassine ml / L.										
Control (Without)	1.60^{a}	0.456^{a}	1.77^{a}	9.99^{a}	956.2^{a}	1.59^{a}	0.465^{a}	1.61^{a}	9.91^{a}	883.2^{a}
3 ml / L	1.61^{a}	0.457^{a}	1.87^{a}	10.07^{a}	942.1^{b}	1.58^{a}	0.469^{a}	1.70^{a}	9.89^{a}	856.1^{b}
6 ml / L	1.64^{a}	0.454^{a}	1.90^{a}	10.23^{a}	907.3^{c}	1.57^{a}	0.474^{a}	1.82^{a}	9.83^{a}	832.4^{c}

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 9. Effect of the interactions between mineral nitrogen plus N_2-fixing levels and potassein on chemical constituents of garlic plants during 2007/2008 and 2008/2009 seasons

Treatments		Chemical constituents									
		2007/2008 Season					2008 /2009Season				
Nitrogen +N_2 – fixing level	Potassein	N%	P %	K%	Protein %	Nitrate mg/kg FW	N %	P %	K%	Protein %	Nitrate mg/kg FW
	Control	1.76^{ab}	0.476^{a-c}	1.66^{g}	11.04^{ab}	1125.0^{a}	1.80^{a}	0.466^{b-f}	1.58^{d}	11.19^{ab}	1056.0^{a}
100% N+ 0Kg Nf*	3 ml/L	1.78^{ab}	0.481^{ab}	1.75^{f}	11.13^{ab}	1111.6^{b}	1.81^{a}	0.481^{a-c}	1.66^{b-d}	11.31^{a}	1028.3^{c}
	6 ml /L	1.82^{a}	0.494^{a}	1.79^{ef}	11.35^{a}	1069.7^{c}	1.79^{ab}	0.475^{a-d}	1.77^{ab}	11.19^{ab}	1041.8^{b}
	Control	1.74^{ab}	0.457^{a-c}	1.74^{fg}	10.88^{ab}	1055.9^{d}	1.79^{ab}	0.455^{d-g}	1.66^{b-d}	11.17^{ab}	1000.8^{d}
75% N + 1Kg Nf	3 ml/L	1.77^{ab}	0.486^{a}	1.85^{c-e}	11.06^{ab}	1048.0^{e}	1.76^{abc}	0.476^{a-c}	1.72^{a-c}	11.00^{abc}	978.0^{e}
	6 ml /L	1.80^{a}	0.445^{a-c}	1.96^{ab}	11.25^{a}	1033.1^{f}	1.79^{ab}	0.473^{a-e}	1.85^{a}	11.19^{ab}	955.1^{f}
	Control	1.61^{cd}	0.414^{c}	1.82^{d-f}	9.96^{cd}	1029.9^{g}	1.63^{abc}	0.446^{g}	1.61^{cd}	10.19^{abc}	909.7^{g}
50% N + 2Kg Nf	3 ml/L	1.60^{d}	0.450^{a-c}	1.85^{c-e}	10.00^{cd}	1008.2^{h}	1.57^{abc}	0.461^{c-g}	1.69^{b-d}	9.81^{abc}	864.0^{h}
	6 ml /L	1.69^{bc}	0.458^{a-c}	1.87^{b-e}	10.56^{bc}	977.9^{i}	1.54^{abc}	0.454^{e-g}	1.83^{a}	9.63^{abc}	843.2^{i}

	Control	1.55^{d}	0.471^{a-c}	1.74^{fg}	9.59^{d}	886.8^{j}	1.38^{abc}	0.474^{a-e}	1.59^{d}	8.63^{abc}	818.7^{j}
25% N + 4Kg Nf	3 ml/L	1.56^{d}	0.420^{bc}	1.92^{a-c}	9.75^{d}	864.1^{k}	1.40^{abc}	0.452^{fg}	1.74^{a-c}	8.75^{abc}	773.3^{k}
	6 ml /L	1.59^{d}	0.432^{a-c}	1.93^{a-c}	9.94^{cd}	818.9^{l}	1.43^{abc}	0.489^{a}	1.83^{a}	8.94^{abc}	728.3^{l}
	Control	1.36^{e}	0.463^{a-c}	1.90^{a-d}	8.50^{e}	683.3^{m}	1.34^{bc}	0.486^{ab}	1.58^{d}	8.38^{bc}	630.9^{m}
0% N + 8Kg Nf	3 ml/L	1.34^{e}	0.448^{a-c}	1.96^{ab}	8.38^{e}	678.3^{n}	1.37^{abc}	0.476^{a-c}	1.67^{b-d}	8.56^{abc}	637.0^{m}
	6 ml /L	1.29^{e}	0.439^{a-c}	1.97^{a}	8.06^{e}	636.9^{o}	1.31^{c}	0.476^{a-c}	1.83^{a}	8.19^{c}	593.4^{n}

Nf = N_2 – fixing

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.