Effect of *Glomus intraradices* on the Growth, Chemical Composition and Yield of Garlic Plants under Calcareous Soil

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ABSTRACT

Two field experiments were carried out during the growing seasons 2006/2007 and 2007/2008 under calcareous soil conditions at the farm of Nubaria Agriculture Research Station (Horticulture), to study the positive effect of arbuscular mycorrhizal (AM) fungi under different levels of mineral phosphorus fertilizer on growth, yield and quality content of two garlic cultivars (Balady and Kaha31), and the suitable level of P fertilizer in the presence of AM fungi to achieve the highest quality and quantity of garlic yield to decrease mineral fertilization and chemical pollution. The field experiments were arranged statistically in split-split plot design in randomized complete blocks with four replicates. Results indicated that, inoculated garlic plants with *Glomus intraradices* significantly increased root and shoot dry weights, total yield fresh weight, bulb weight, number of cloves and total bulb yield compared to uninoculated plants. Results also showed that, plants inoculated with *G. intraradices* significantly increased the NPK uptake and the contents of three free amino acids (proline, arginine and phenylalanine) at different levels of mineral phosphorus fertilizer in both seasons compared to uninoculated plants. No significant differences were observed in garlic plants inoculated with AM fungi either in the presence of 75 or 100% of the recommended dose of mineral phosphorus fertilizer.

Key word: arbuscular mycorrhizal fungi; garlic; NPK uptake; yield; calcareous soil

INTRODUCTION

Garlic (*Allium sativum,* L.) is considered as one of the most promising winter crops in Egypt either for local consumption or export (Taalab and Aziz, 2004).Its importance is due to the wide consumption in human daily diet. Moreover, it is considered as an important source of sulfur compounds, several enzymes, 17 amino acids and minerals such as selenium (Newall *et al.*, 1996). The world production of garlic is 15,799,909 ton cultivated on 122,031, 7ha (FAO, 2007). In Africa, the production is 337,212 ton produced from 372,900 ha. While in Egypt, the production is 168,000 ton gained from 7500 ha.

Most Egyptian soils are classified as a second or third degree of fertility. Which contain low content of total and available nutrients as well as organic matter Awad *et al.*, 1996. Under such conditions, the productivity tendencies of different crops decrease markedly .The newly reclaimed lands in West Nubaria are mainly calcareous and sandy soils. Calcareous soils occupy wide areas in the North African countries such as Egypt. The soils have a high percentage of calcium carbonate and are normally basic in reaction. Efficiency of phosphorus and micronutrients specially is an obvious pose problem in highly calcareous soils with alkaline soil pH. In order to increase the productivity of these soils, addition of nitrogen, phosphate, potassium as mineral nutrients and other amendments are recommended (Hilal *et al.*, 1990).

Biological fertilizers help in increasing the production of many crops.One of the most important biological fertilizers are arbuscular - mycorrhizal (AM) fungi (El-Awamy, 2004). Mycorrhizal fungi provide their host plants with a wide range of benefits. They are known to increase the solubility of minerals in soil, improve nutrient uptake of host plants and protect the roots against soil borne phytopathogens with their antagonistic effects. Such beneficial qualities of the mycorrhizae can be well utilized for better crop stand, establishment of high yielding forests, land reclamation and introduction of exotic plant species. Mycorrhizal fungi have greater applicability in enhancing plant growth under unfavorable environmental conditions (Mishra and Mishra, 2004).

The aim of the present work was to study: (1) the positive effects of arbuscular - mycorrhizal fungus (AMF) under different levels of mineral phosphorus fertilizer on the growth, yield and chemical content of garlic plants under calcareous soil conditions; (2) the suitable level of P fertilization in the presence of AMF to achieve the highest quality and quantity of garlic yield and to decrease mineral fertilization and chemical pollution.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive winter seasons 2006/2007 and 2007/2008 at the farm of Nubaria, Agricultural Research Station (Horticulture), Agricultural Research Center, Giza. Egypt. Egyptian garlic (Balady) and Chinese cultivar (Kaha 31) were used in these experiments. Bulbs were provided from the Horticulture Research Institute, Agricultural Research Center, Giza, Egypt. The soil was sandy clay loam was used, its characteristics were: pH 8.25; EC 2.56 dSm^{-1}; $CaCO_3$ 23.59 %; organic matter 3.96 g/kg; available N 50.38 ppm; available P 4.44 ppm and available K 111.99 ppm according to Page *et al.*, (1982) and Klute (1986).

Cloves were planted in the field under drip irrigation system with one clove per hill. Each experimental plot consisted of two rows, three meters long, 70 cm wide with 10 cm distance between each hill. The total area of each plot was 4.2 m^2 and contained 60 plants.

Arbuscular mycorrhizal inoculum

Mycorrhizal strain *Glomus intraradices* , which was isolated from the Experimental Station of Alexandria University at Abies, (Aboul- Nasr, 1993a), was used in both experiments. The inoculum consists of expanded clay aggregates (2-4 mm in diameter, leca), containing chlamydospores and fungus mycelium, which had been produced on *Tagetes erecta* L. (Aboul-Nasr, 2004). The inoculum was added at the rate of 7.0 g / hill under garlic cloves. The control plants received the same amount of heat sterilized expanded clay.

Mineral fertilization

The plants were fertilized at the rate of 720 kg/ha mono-calcium phosphate (15.5% P_2O_5) which were applied before sowing at three different levels (P_{zero}, P_{75} % and P_{100}% of the recommended dose). Nitrogen (ammonium nitrate 33.5%N and potassium (potassium sulphate (48 % K_2O) fertilizers were applied at the recommended doses.

Two field experiments were laid out in a split–split – plot design in randomized complete blocks with four replicates in the presence of the two tested cultivars of garlic which were assigned in the main plot, whereas, the three rates of mineral phosphorus fertilizer (P_0, P_{75} and P_{100} %) were arranged in the compatible biofertilizer in the sub-sub plots.

Measured parameters

The percentage of mycorrhizal root length colonization was estimated three times after sowing, when plants were, 8 and 16 weeks old and at harvest (22 weeks) according to Koske and Gemma (1989). The percentage of AM root colonization was estimated according to the equation of Giovannetti and Mosse, (1980):

$$\text{AM root colonization (\%)} = \frac{\text{Number of segments containing AM}}{\text{Total number of examined segments}} \times 100.$$

Growth and yield parameters

During the vegetative growth period, three samples 8, 16 weeks and at harvest (22 weeks) of garlic plants were taken (3 plants / plot) and the root and shoot dry weights (g/plant) were recorded. At harvest, when the plants were suited to full maturity, 10 random plants per plot were collected to determine the following parameters: total yield fresh weight (t/ha), bulb weight (g/bulb), number of cloves / bulb and total bulb yield (t/ha).

Chemicals analysis

NPK contents of garlic shoots were measured at the end of the experiments during the two seasons. Total nitrogen was determined according to Chapman and Pratt (1978). Total phosphorus and total potassium contents were determined according to Jackson (1958). Nitrogen, phosphorus and potassium uptake was calculated by multiplication the NPK content × plant dry wt. (g). Total soluble carbohydrates and some amino acids were determined according to Umbreit *et al.*, (1972).

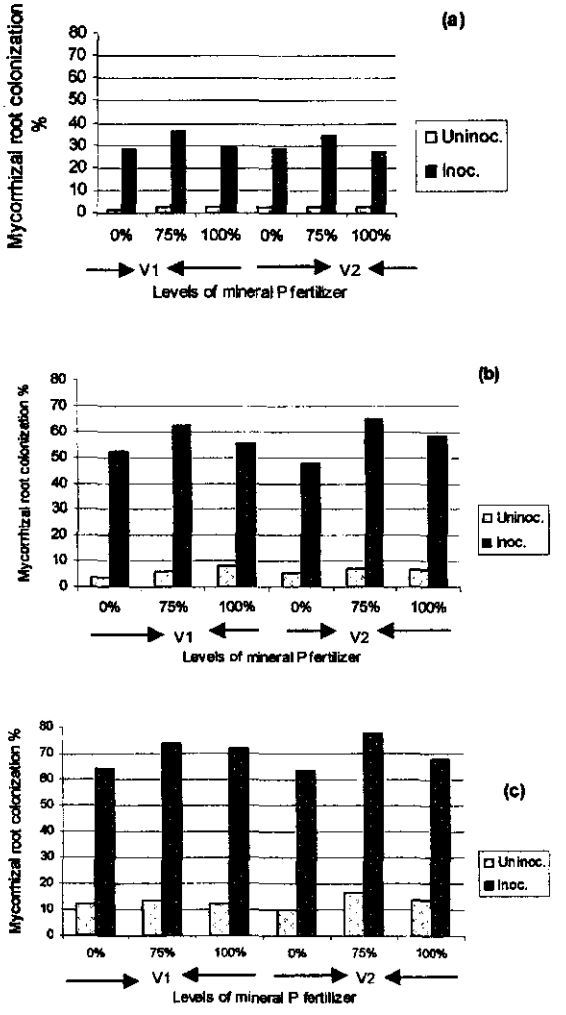
Data were statistically analyzed by the analysis of variance to test the treatments effect on different measured parameters. The differences between the different treatments combinations were tested using the Duncan's Multiple range method outlined by Snedecor and Cochran. (1982). Data for the percentage of root length colonization were analyzed using angular transformation (Steel and Torrie, 1982).

3. Results and discussion

3.1 Arbuscular mycorrhizal root colonization

The effect of *Glomus intraradices* on the development of the percentage of mycorrhizal root length colonization at different plant ages was studied.Figures (1a, b, c) show that, the percentage of mycorrhizal root length colonization in inoculated plants (8, 16 and 22 weeks old), significantly increased at all levels of mineral phosphorus fertilizer compared to uninoculated plants. The proportion of mycorrhizal root colonization in control plants were 1.5% for Egyptian garlic (Balady), and 2.78 % for Kaha 31 due to natural soil AM fungi in both seasons, respectively, in the presence of P_{zero} %. The highest values at three times tested were noticed in case of P_{75}% in inoculated plants for both cultivars, when plants were 22 weeks old; (73.91 and 77.89% for Balady and Kaha 31, respectively). No significant differences were observed between P_{75} and P_{100}% at the recommended dose of mineral phosphorus fertilizer. Similar results were reported by Borde *et al.*, (2009), Goussousi and Mohammad (2009) and Sari *et al.*, (2002), they also showed that, inoculated garlic plant with AM fungi showed significant increase in the percentage of AM colonization

compared to non AM inoculated garlic plants under field conditions.

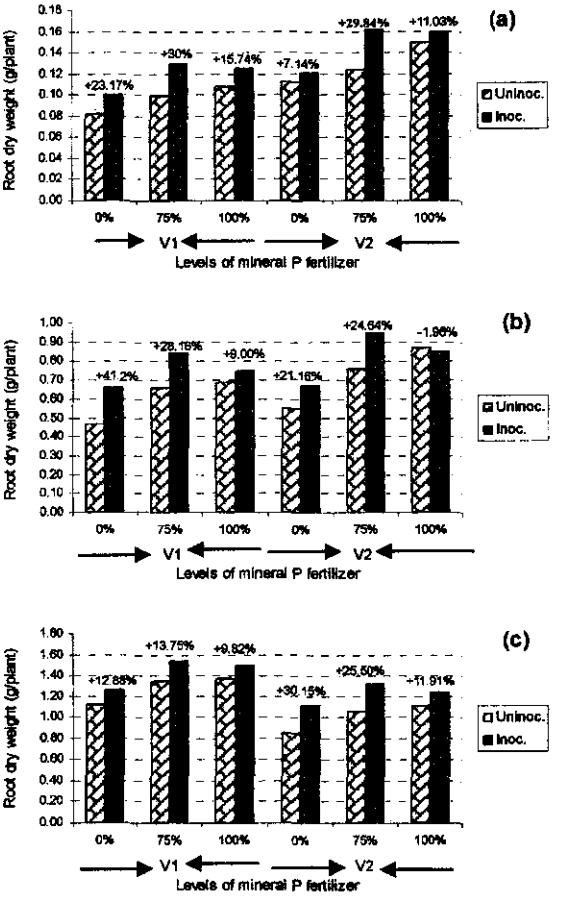


- Plant age was a) 8 b) 16 c) 22 weeks old
- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)

Fig. 1: Effect of the inoculation of *Allium sativum* cvs.; (Balady and Kaha 31) with *G. intraradices* on the % of mycorrhizal root colonization in the presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008).

3.2 Root and shoot dry weights per plant (g)

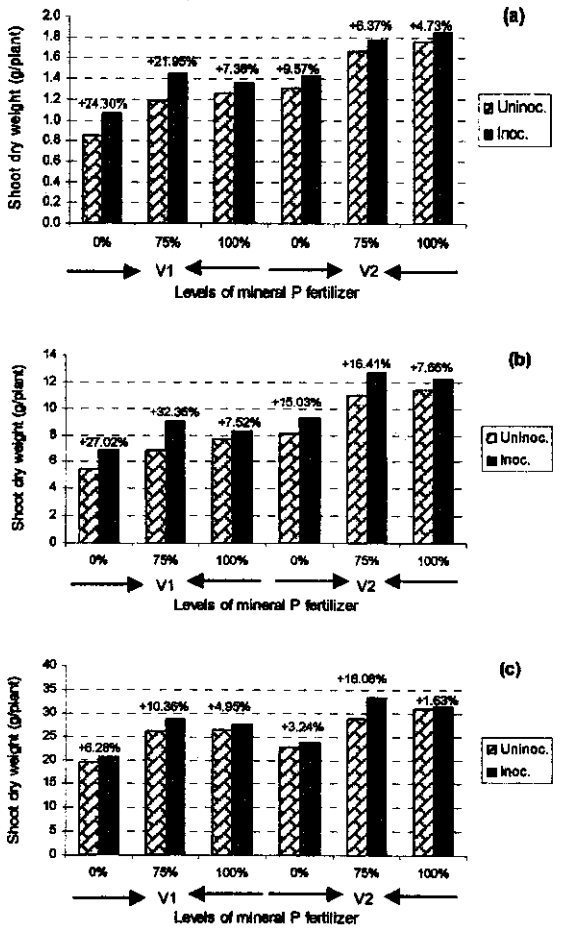
Figures (2a 8 weeks old plants, b, c) show the significant differences in root dry weights (g/plant) between 8 weeks old plants inoculated and uninoculated AM fungi. The percentages increase were 23.17, 30.00 and 15.74% for Balady and 7.14, 29.84 and 11.03% for Kaha 31 in the presence of P_0, P_{75} and P_{100}% of the recommended dose of mineral phosphorus fertilizer, respectively. The same trend in root dry weights (g) was found at 16 and 22 weeks old. Figures (3a, b, c) show that, the shoot dry weights of 8 weeks old plants were significantly increased in case of inoculated plants with *G. intraradices*. The percentages of increase, were 28.76, 27.51 and 10.39% for Balady and 19.52, 15.29 and 5.47 for Kaha 31 in the presence of P_0, P_{75} and P_{100}% of the recommended dose of mineral phosphorus fertilizer. The same trend in shoot dry weight (g) was found at 16 and 22 weeks old. The highest values in case of root and shoot dry weights were noticed in inoculated garlic plants under P_{75}% for the two cultivars. No significant differences were observed in root and shoot dry weights (g/plant) in the presence of either $P_{75\%}$ with mycorrhiza or P_{100}% (recommended dose) of mineral P fertilizer for both cultivars at different plant ages. These results are in harmony with those obtained by Elkhider and Khaliel (1987), who reported that mycorrhizal tomatoes had greater dry weights compared to uninoculated ones. Li *et al.*, (1991) and Aboul - Nasr and El-Fayoumy (2003), reported similar results in case of *zea mays* plants.



- Plant age was a) 8 b) 16 c) 22 weeks old
- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)
- ± % Increase or decrease to uninoculated (control) plants

Fig. 2: Effect of the inoculation of *Allium sativum* cvs.; (Balady and Kaha 31) with *G. intraradices* on root dry weight (g) in the

presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008)



- Plant age was a) 8 b) 16 c) 22 weeks old
- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)
- ±% Increase or decrease to uninoculated (control) plants

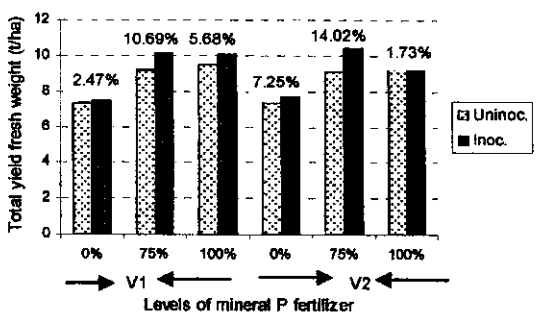
Fig. 3: Effect of the inoculation of *Allium sativum* cvs.;Balady and Kaha 31 with *G. intraradices* on shoot dry weight (g) in the presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008)

3.3 Total yield fresh weight (t/ha)

Total garlic fresh weight (t/ha) was recorded as the weight of garlic leaves and bulb fresh weight. Data in Figure (4) show that, no significant differences were found between the two cultivars. Total yield fresh weight (t/ha) significantly increased in case of plants inoculated with *G. intraradices* compared to uninoculated plants. The highest value of total yield fresh weight (t/ha) was noticed in the case of garlic inoculated with AM fungi at the level case of P_{75}% in both cultivars (10.15 t/ha for Balady; 10.41 t/ha for Kaha 31). The results were in agreement with the findings of Sari *et al.*, (2002), who also showed that, inoculated garlic plants with AMF *Glomus mosseae*, significantly increased the yield compared to uninoculated ones. Bolandnazar *et al.*, (2007) reported similar results in onion *Allium cepa* plants, and Mehraban *et al.*, (2009) in case of *Sorghum bicolor* L. plants.

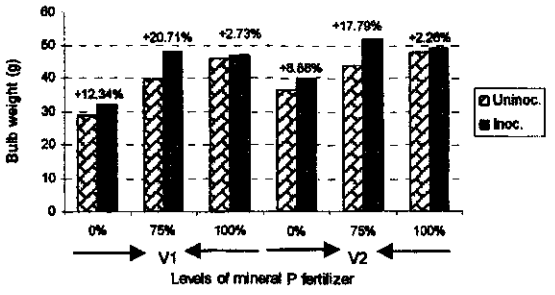
3.4 Bulb weight (g)

Data in Figure (5) shows the significant increases in bulb weight (g) due to mycorrhizal inoculation. The highest values were recorded in the case of Kaha 31 cultivar. The percentage of increase to uninoculated plants was 12.34, 20.71 and 2.73% for Balady and 8.88, 17.79 and 2.26 % for Kaha 31 in the presence of P_{zero}, P_{75} and P_{100}% of the recommended dose of mineral phosphorus fertilizer. The highest values were in case of P_{75}% for the two cultivars (47.91g for Balady and 51.57g for Kaha 31). No significant differences were observed in bulb weight (g) in inoculated garlic in the presence of either P_{75}% or $P_{100\%}$ (recommended dose) of mineral P fertilizer for both cultivars. These results were in agreement with those obtained by Abdaila (2003), who observed that, the mean value of bulb weight were 53 and 57 g for Egyptian garlic and 65 and 72 g for Chinese garlic in the first and second season, respectively. Koch *et al.*, (1997), Al-Karaki (2002a), Al-Karaki (2002b) and Borde *et al.*, (2009)., reported that, inoculated garlic plants with AM fungi significantly increased bulb weight compared to uninoculated garlic plants under field conditions.



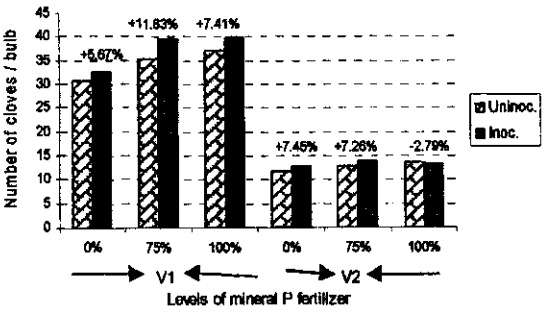
- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)
- ± % Increase or decrease to uninoculated (control) plants

Fig. 4: Effect of the inoculation of *Allium sativum cvs.* with *Glomus intraradices* on the total yield fresh weight (t/ha) in the presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008).



- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)
- ± % Increase or decrease to uninoculated (control) plants

Fig. 5: Effect of the inoculation the *Allium sativum cvs.* with *Glomus intraradices* on bulb weight (g) in the presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008).



- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)
- ± % Increase or decrease to uninoculated (control) plants

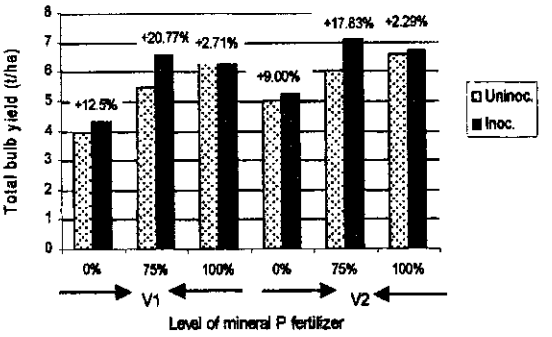
Fig. 6: Effect of the inoculation of *Allium sativum* with *Glomus intraradices* on number of cloves/bulb in the presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008).

3.5 Number of cloves/bulb

Significant differences in the number of cloves per bulb were found between the two garlic cultivars. Egyptian garlic (Balady) recorded higher number of cloves per bulb, compared to the Chinese cultivar (Kaha 31) under the different levels of mineral phosphorus fertilizer (Figure 6). Significant differences were observed in the number of cloves per bulb due to AM inoculation, compared to control plants. The highest values of cloves number per bulb was noticed in case of inoculated garlic with AM fungi at level P_{75}% in both cultivars (39.56 cloves/bulb for Balady; 13.88 cloves/bulb for Kaha 31). Abdaila (2003) observed that the Egyptian garlic recorded higher number of cloves per bulb as compared to Chinese and Elephant garlic. Asfour and Zayed (2005) reported that, the mean value of cloves number/bulb was 15.5 for Kaha 31 cultivar.

3.6 Total bulb yield (t/ha)

Garlic yield was calculated in t/ha as shown in Figure (7).The highest yield was obtained when garlic plants were inoculated with AM in the presence of $P_{75\%}$ at the recommended dose of mineral phosphorus fertilizer for both cultivars. Bulb yield reached 6.57 t/ha for Balady cultivar and 7.07 t/ha for Kaha 31 in the presence of P_{75} %. The percentage increase in bulb yield in inoculated plants was 20.77% for Balady and 17.83 % for Kaha 31 compared to uninoculated ones, in the presence of P_{75} %. No significant differences in bulb yield (t/ha) were observed in inoculated plants between the two levels $P_{75\%}$ and P_{100} % for both cultivars. Al-Karaki (2002a) and Borde *et al.*, (2009) showed that, inoculated garlic plants with AMF *Glomus fasciculatum*, significantly increased fresh bulb yield compared to uninoculated plants. Cimen *et al.*, (2010) reported similar results in onion *Allium cepa* plants.



- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)
- % Increase or decrease to uninoculated (control) plants

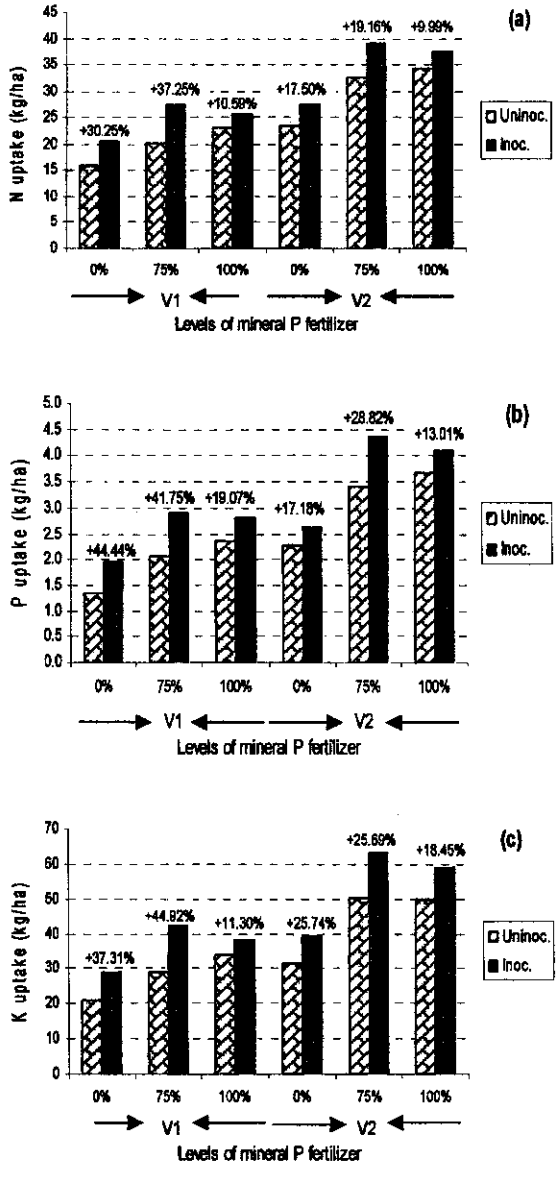
Fig. 7: Effect of the inoculation of *Allium sativum* cvs. with *Glomus intraradices* on the total bulb yield (t/ha) in the presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008).

3.7 Chemical analysis

3.7.1 NPK uptake (kg/ha)

Data in Figures (8a, b, c) revealed that the inoculation of garlic plants with AM fungus significantly increased NPK uptake (kg/ha) when compared to uninoculated ones. The highest values of NPK uptake were recorded in case of inoculated plants in the presence of P_{75} %. N uptake was 27.78 and 39.00 kg/ha, P uptake was 2.92 and 4.38 kg/ha, K uptake was 42.20 and 63.17 kg/ha, in both cultivars Balady and Kaha 31, respectively. The results were agreed with that reported by Sari, *et al.*, (2002), who observed that, inoculated garlic plants with AMF *Glomus mosseae*, significantly increased P uptake compared to uninoculated plants.

Goussousi and Mohammad (2009) showed that, inoculated onion *Allium cepa* with AM fungi significantly increased micro and macronutrients compared to uninoculated plants. Bryla and Koide (1998); David and Knowles (1993); Douds *et al.*, (2005) and Ortas *et al.*, (2001) confirmed that the AM hyphae increase the total absorption surface in infected plants which improve its access of immobile elements such as P, Cu, Zn and Cd.

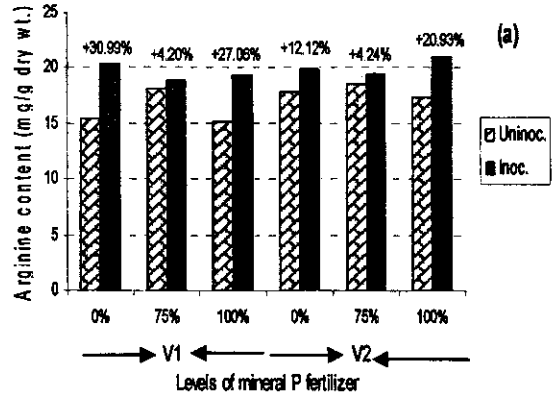


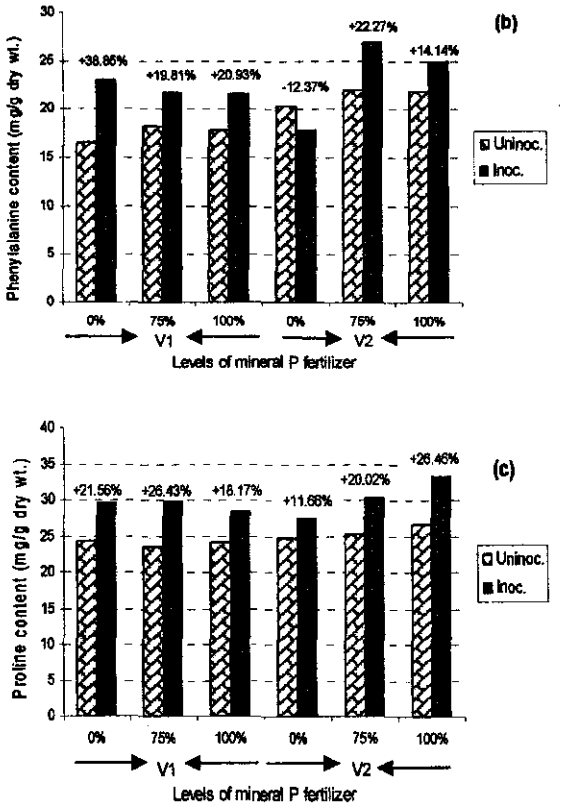
- a) Arginine content b) phenylalanine content c) Proline content
- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)
- ± % Increase or decrease to uninoculated (control) plants

Fig. 8: Effect of the inoculation *Allium sativum* cvs.; (Balady and Kaha 31) with *G. intraradices* on the NPK uptake (kg/ha) in the presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008).

3.7.2 Free amino acids content (mg/g dry wt.)

Figures (9a, b, c) show that, proline and arginine contents (mg/g dry wt.) were significantly increased in case of plants inoculated with *G. intraradices* compared to uninoculated plants of the two tested cultivars. The percentage increase was 21.56, 26.43 and 18.17% for Balady and 11.66, 20.02 and 26.46% for Kaha 31 in case of proline content, and 30.99, 4.203 and 27.06% for Balady and 12.12, 4.24 and 20.93% for Kaha 31 in case of arginine content, in the presence of P_{zero}, P_{75} and P_{100} % of the recommended dose of mineral P fertilizer, respectively, compared to non-inoculated ones. The same trend was found in phenylalanine content (mg/g dry wt.). The percentage increase was 38.85, 19.81 and 20.93% in case of inoculated Balady cultivars in the presence of P_{zero}, P_{75} and P_{100}%, respectively, compared to non-inoculated ones. In case of Kaha 31, significant increase was found in phenylalanine content (mg/g dry wt.) due to AM inoculation in the presence of P_{75}% and $P_{100\%}$ of the recommended dose of mineral phosphorus fertilizer. These results are in agreement with those obtained by Nemec and Meredith (1981), who found that inoculated *Citrus limon* with *G. etunicatum* had higher total amino acids in leaves than control. Ibrahim (2007) reported that the inoculated *Lycopersicon esculentum*, Mill. with *G. intraradices* increased the content of the free amino acids proline, arginine and phenylalanine in the presence of P_{25}, P_{50}, P_{75} and P_{100} of the mineral phosphorus fertilizer.





- a) Arginine content b) phenylalanine content c) Proline content
- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)
- ± % Increase or decrease to uninoculated (control) plants

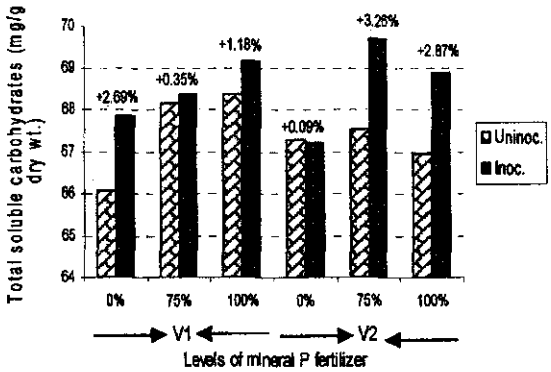
Fig. 9: Effect of the inoculation *Allium sativum* cvs. with *Glomus intraradices* on the content of some free amino acids (mg/g dry wt.) in the presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008).

3.7.3 Total soluble carbohydrates content in garlic leaves (mg/g dry wt)

Data in Figure (10) shows that significant increase was noticed when plants were inoculated with *G. intraradices* ones. The percentages were 2.69, 0.35 and 1.18% for Balady cultivar and 0.09, 3.26 and 2.87% for Kaha 31 cultivar, in the presence of P_{zero}, P_{75} and P_{100}% of the recommended dose of mineral phosphorus fertilizer. Similar results were reported by Messiha *et al.*, (2005) who found that, the mean value of carbohydrate % for Chinese garlic cultivar was 48.26 %. Koch *et al.*, (1997) reported that, garlic inoculated with arbuscular mycorrhizal fungi (*Glomus intraradices*), significantly increased photosynthesis rate, especially at low light intensities. Radwan (1997) reported similar results in mungbean plants. Fouda and Ramadan (2004) reported that inoculated radish plants with AM fungi increased photosynthetic pigment concentrations in leaves and carbohydrates. Ibrahim (2007) reported similar results in tomato plants.

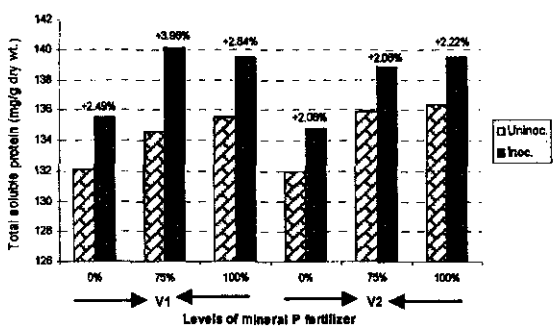
3.7.4 Total soluble protein content in garlic leaves (mg/g dry wt)

Data in Figure (11) shows that significant increase was noticed in case of inoculated plants compared to uninoculated plants, the increase percentages were 2.49, 3.96 and 2.84% for Balady cultivar and 2.08, 2.06 and 2.22% for Kaha 31 cultivar, in the presence of P_{zero}, P_{75} and P_{100}% of the recommended dose of mineral phosphorus fertilizer, compared to non-inoculated ones. Aboul-Nasr (1993b) and Ibrahim (2007) found that inoculated tomato plants with mycorrhizal fungi, increased the total soluble protein content. Aboul-Good (2006) reported similar results in *Nigella sativa* plants. Selvaraj (1998) also reported an increase in the protein content in *Prosopis juliflora*, inoculated with *G. fasciculatum*.



- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)
- ± % Increase or decrease to uninoculated (control) plants

Fig. 10: Effect of the inoculation *Allium sativum* cvs. with *Glomus intraradices* on the content of carbohydrates (mg/g dry wt.) in the presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008).



- V1 mean of Egyptian garlic (Balady)
- V2 mean of Chinese garlic (Kaha 31)
- ± % Increase or decrease to uninoculated (control) plants

Fig. 11: Effect of the inoculation *Allium sativum* cvs. with *Glomus intraradices* on the content of protein (mg/g dry wt.) in the presence of different levels of mineral phosphorus fertilizer (mean value of the two seasons 2006/2007-2007/2008).

CONCLUSION

Finally, it could be concluded that: The inoculation of the two garlic cultivars with *Glomus intraradices* enhances the growth, yield, NPK uptake, content of three free amino acids and carbohydrates and protein. The highest values noticed in the case of inoculated garlic with AM fungi at P_{75}% in both cultivars. No significant differences were observed between P_{75}% with endomycorrhizae and P_{100}% of the recommended dose of mineral phosphorus fertilizer.

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الملخص العربي

تأثير فطر الميكوريزا الداخلية *Glomus intraradices* على نمو ، المحتوى الكيميائى والمحصول لنباتات الثوم تحت ظروف الأراضى الجيرية

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اجريت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بالنوبارية (البساتين) في عامي ٢٠٠٦/ ٢٠٠٧ و٢٠٠٧/٢٠٠٨ لدراسة التأثير الايجابي لفطر الميكوريزا الداخلية علي النمو والمحصول وكذلك المحتوي الكيميائي لصنفي الثوم البلدي وقها ٣١ تحت المستويات المختلفة من السماد الفوسفاتي ، وتحديد المستوي المناسب من السماد الفوسفاتي في وجود فطر الميكوريزا بهدف تقليل التلوث البيئي.

- ادي التلقيح بفطر الميكوريزا إلي احداث زيادة معنوية في كل من الوزن الجاف للمجموع الجذري والمجموع الخضري وكذلك المحصول الطازج الكلي ووزن الأبصال وعدد الفصوص في البصلة والمحصول الكلي للأبصال وذلك بالمقارنة بالنباتات غير الملقحة.
- ادي التلقيح بفطر الميكوريزا الي زيادة معنوية في امتصاص النباتات للنيتروجين ، الفوسفور والبوتاسيوم وكذلك السكريات وبعض الأحماض الأمينية الذائبة عند كل مستويات التسميد الفوسفاتي في كلا موسمي الزراعة.
- لم تكن هناك أي فروق معنوية عند استخدام الميكوريزا مع ٧٥% أو المعدل الموصي به (١٠٠%) من السماد الفوسفاتي.