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EFFECT OF ARBUSCULAR MYCORRHIZAL FUNGI ON GROWTH AND NUTRIENTS ABSORPTION OF ACCLIMATIZED DATE PALM PLANTLETS

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ABSTRACT

This work was done in 2008 and 2009 to study the positive effects of Arbuscular mycorrhizal fungi on growth and absorption of macro and micro elements by date palm (*Phoenix dactylifera* L.cv Bartomouda) plantlets. Plantlets were produced via tissue culture technique. One year after acclimatization stage, the roots of potted plantlets were inoculated with arbuscular mycorrhizal fungi (Glomus spore) in the greenhouse, they were fertilized with NPK (Krestalon) complete fertilizers (19-19-19) with three different levels, i.e. 1.5, 2.0 and 2.5 g/l, in addition to control treatment. Plantlets were weekly fertilized for eight month during two seasons. The results of both seasons indicated that inoculation of mycorrhizal fungi induced positive effects of growth and minerals content. The addition of 2.5 g/l NPK had the highest significant values of plant height (cm), number of leaves/ plantlet, length of root (cm), and number of roots/plantlet as compared to control treatment. Arbuscular mycorrhizal fungi showed a network of hyphae around roots which might increase water, macro and micro nutrients the absorption through increasing the absorption surface area. The results also revealed that there were significant differences among different NPK treatments on various growth parameters and minerals contents. Nitrogen, phosphorus, potassium, Fe, Zn, Mn and Cu, were significantly increased with the three applications all studied fertilized levels. The addition of 205g / l was brought about the highest significant increase in total sugars0 These data showed that the inoculation of mycorrhizal had positive effects on absorption of macro and micro minerals which could be reflected

on photosynthesis and thus was appeared in the form of new leaves and roots of the plants.

Key word: Mycorrhizal fungi, date palm, growth, minerals.

INTRODUCTION

Many investigators demonstrated that Arbuscular mycorrhizal increased the absorbtion of nutrient elements through its hypha and transport them to the plant, Egertone *et al.* on grass land (2009), Mona on banana and guava (2001), George *et al.* (1992), Thingstrup *et al*. on *Linum usitatissimum*(1999) and Bakhshipour *et al.* on tea seedlings (2008) indicated that Arbuscular mycorrhizal enhanced plant uptake of inorganic nutrients particularly phosphorus and nitrogen. This incessant uptake resulted in better growth. Eliopoulos *et al.* on potato(2007), Chen *et al*. (2007), Gergon *et al*. on *Allium cepa*(2008), Schubert *et al*. on *Actinidia deliciosa*(2009), Peter *et al*. on *Pinus muricata*(2009) and Ahmed *et al*. on *cucumber* (2009) found that mycorrhizal inoculation and NPK fertilizers (120- 240- 120 kg NPK/ha) and (60-120-60 kg/ha NPK) increased growth. Since the date palm is economically very important in Egypt and their growth is very slow especially produced through micropropagation and since the most date palm orchards did not take enough care. thus the principal objective of this investigation is to evaluate in the greenhouse the growth and the absorption of NPK under soil in which mycorrhizal fungus inoculation of date palm plantlets .

MATERIALS AND METHODS

This investigation was conducted during 2008 and 2009 seasons in the greenhouse of the Horticultural Research Institute, Giza, Egypt. The plantlets (*Phoenix dactylifera* L. cv Bartomouda) which produced through tissue culture after they passed rooting stage (1/4 MS + 0.1 IBA) for one month, one year after acclimatization stage, plantlets were selected with same characterized (3-4 leaves, 20-25 cm of shoot length 15-18 cm for root length) and were cultivated in peat moss and sand 2:1 in the plastic bags (40x 20 cm). Three NPK levels, i.e. 1.5,2.0 and 2.5 g/l of complete fertilizers (krestalon 19-19-19), in addition to control treatment (water only). Each treatment was replicated three times, and each one contained three plantlets. These plantlets were

weekly for efertigated eight months during the two seasons of this experiment.

Mycorrhizal treatment:

Mycorrhizal spores were originally extracted from the Egyptian soil spores of arbuscular mycorrhizal (VAM) fungi including the following genera (Glomus Giga spora and Acaulo spora) and were added after planting. Extraction and method was described by (Massoud 1999) 0Fifty grams (250 spores/gram) per pot of mixed spores of arbuscular mycorrhizal genera were prepared after extraction and the roots of plantlets of each pot were immersed in sugary solution then coated with Mycorrhizal spores carried on sterilized sand soil was modified by (Massoud 2005). The following parameters were estimated at the end of the experiment (eight months).

1- Number of leaves /plantlet 2- Plant height (cm) 3- Root length (cm) 4- Number of roots /plantlet 5- Fresh and dry weights of leaves 0The fresh leaves sampl was cut into small parts and dried at 60-65 c^0 for 48 h to obtain the dry matter content according to Dowson and Aten (1962)0

Chemical analysis:-

1-Total sugars0Were determined according to Dubois et al0 (1956)and calculated by means of the standard curve of glucose0

2- Mineral content (N, P,K, Fe, Zn, Mn and Cu)

N,P and K contents :

Were determined as described by (Jackson *et al.* 1973).Iron, manganese, zinc and copper concentrations were determined by using Atomic absorbtion spectrophotometer (Perkin Elmer 3300) according to (A.O.A.C. 1980).

Anatomical study:

Transverse cross sections were taken from the middle part of the main root (3-5 cm behind apex of the main root). Samples were killed and fixed in formalin, acetic acid and ethyl alcohol, at a ratio of 90:5:5, dehydrated in ascending concentrations of ethyl alcohol, then cleared by soaking in a series of absolute alcohol and xylene and imbedded in paraffin wax (M.P. 55-58 oC). Using a rotary microtome, a serial cross-sections (15-20 microns) were taken. Samples were then stained with safraneen and light green combination

and mounted in Canada balsam. Examination and observations were carried out by Nikon light Microscope and photographed by Nikon Camera FX-35.

Statistical analysis:-

The complete randomized design was adopted for the experiment according to Snedecor and Chocran (1980). The means were compared using L.S.D. values at 5 % level.

RESULTS AND DISCUSSION

Growth parameters of date palm *Phoenix dactylifera* l. i.e. plant height, number of leaves, root length and numbers of roots were presented in Table (1).

As for the number of leaves data in Table (1) and fig (1) illustrated that number of leaves of the plantlets were significant raised with 2.5 g/l NPK (19-19-19) and inoculated with mycorrhizal fungi gaving 7.2 and 7.8 leaves/plantlet for the first and second season respectively, as compared to control treatment (3.6 and 4.0 leaves/plantlet for the first and second season respectively). The treatment 1.5 NPK with mycorhiza produced the lowest value of number of leaves/ plantlet (6.1 and 6.3 for the first and second season, respectively) as compared to control treatment. Significant differences were obtained from 2.0 and 2.5 treatments of complete NPK fertilizer on the number of leaves in which mycorrhiza was added.

Concerning t VAM, he effect of complete fertilizer NPK (1.5,2.0 and 2.5 g/l) and soil i it was noculation of arbuscular mycorrhizal fungi, on plantlet height, found it was found significant increase with the three levels of NPK (89.9,92.6 and 96.5) and (91.1,94.6 and 98.7) for first and second season, respecti vely with 1.5, 2.0 and 2.5 g/l of complete NPK fertilizer as compared to control or with VAM treatment 0T he highly significant increase was obtained from addition of 2.5 g/l NPK (89.1 and 91.0) with mycorrhiza for first and second season, respectively.

Regarding the root length and number of roots, results in Table (2) and fig (1) indicated that treatment 1.5 g/l NPK with mycorrhiza induced significant enhancement on root length 50.5 and 52.6 cm for the first and second seasons, respectively, for the while the treatment 2.5 g/l NPK resulted in the greatest root length 65.2 and 66.3 cm for the first and second seasons, respectively, as compared to control.

treatment (water only). Highly significant interaction was found between root length and mycorrhiza under all complete fertilizer levels.

Table (1): Effect of mycorrhiza and different levels of complete fertilizers on number of leaves /plantlet and plant height (cm) of *Phoenix dactylifera* L. cv. Bartomouda

A \ B	Leaves number						Plant height					
	First season			Second season			First season			Second season		
	con	mycorrh	mean	con	mycorrh	mean	con	mycorrh	mean	Con	Mycorrh	Mean
Con	3.6	4.8	4.2	4	5.6	4.8	70.6	79.5	75.1	74.5	77.8	76.2
1.5	4.9	6.1	5.5	5.3	6.3	5.8	76.3	89.9	83.1	77.7	91.1	84.4
2.0	5.2	6.4	5.8	5.8	6.8	6.3	79.3	92.6	86	80.7	94.6	87.7
2.5	5.7	7.2	6.5	6.5	7.8	7.2	81.6	96.5	89.1	83.2	98.7	91.0
Mean	4.9	6.1		5.4	6.6		77.0	89.6		79.0	90.6	
l.s.d. (0.05%)	A= 0.3	B=0.2	AB=0.4	A=0.4	B=0.3	AB=0.6	A=1.5	B=1.0	AB=2.0	A=1.4	B=1.0	AB=1.9

From the Table (2) and fig (1) the number of roots were took the same trend of the root length. Interaction between VAM and the treatment 2.5 g/l NPK produced the highest significant values of roots number (7.6 and 8.5 roots/plantlet for first and second season respectively) compared to control treatment (water only) which was gave the lowest values 4.8 and 5.1 roots/plantlet for the first and second seasons, respectively,. In this respect, (Duponnois *et al*. 2007) stated that arbuscular mycorrhizal (Glomus intraradices) was significant enhanced plant growth and plants height of *Acacia holosericea*. Growth and shoot length of *Eucalyptus globules* were increased with saprob and arbuscular mycorrhizal fungi (Arriagada *et al*. 2007). Number of leaves of *Sesamum indicum* L. and root system were higher with addition of arbuscular mycorrhizal fungi to the soil (Boureima *et al*. 2008). Plant growth of Conifers was increased with inoculation with arbuscular mycorrhizal and fertilized with 27 kg N/ha + 39 Pkg/ha (Classen and Zasoski 2009). Three species of arbuscular mycorrhizal (Glomus mosseae, Gigaspora margarita and Gigaspora rosea), the Gigaspora rosea significantly increased internodes number of *Ocimum basilicum* var. Genovese (Copetta *et al*. 2009).

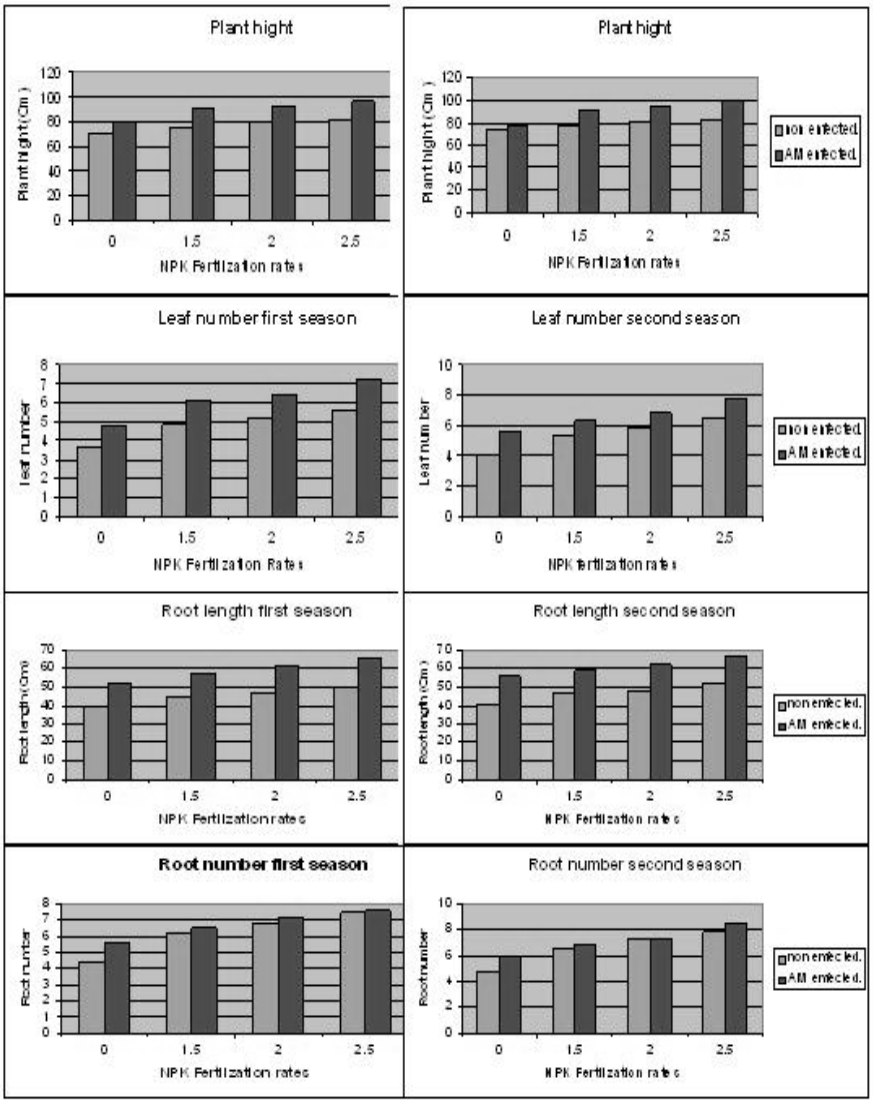

Figure (1) Effect of Arabuscular Mycorrhizal infection and NPK fertilization levels (0. 1.5, 2 and 2.5 gl^{-1}) on vegetative and root characteristics

Table (2): Effect of mycorrhiza and different levels of complete fertilizers on root length (cm) and number of roots /plantlet of *Phoenix dactylifera* L. cv Bartomouda

A \ B	Root length						Root number					
	First season			Second season			First season			Second season		
	con	mycorrh	mean	con	mycorrh	Mean	con	mycorrh	mean	Con	mycorrh	Mean
Con	39.5	52.2	45.9	40.5	53.5	47.0	4.8	5.6	5.2	5.1	5.9	5.5
1.5	44.4	56.5	50.5	46.5	58.7	52.6	6.2	6.5	6.4	6.6	6.8	6.7
2.0	47.1	60.8	54.0	48.4	61.8	55.1	6.8	7.0	7.0	7.4	7.4	7.4
2.5	50.6	65.2	57.9	52.2	66.3	59.3	7.5	7.6	7.6	7.8	8.5	8.2
Mean	45.4	58.7		46.9	60.1		6.3	6.7		6.7	7.2	
l.s.d. (0.05%)	A=1.1 B=0.8 AB=1.6			A=1.4 B=0.9 AB=1.9			A=0.4 B=0.3 AB=0.5			A=0.4 B=0.2 AB=0.5		

Fresh and dry weights of leaves:

Regarding to the effect of inoculation of arbuscular mycorrhizal and three levels of complete fertilizer NPK 19-19-19 (1.5,2.0 and 2.5 g/l) on the fresh and dry weights of leaves of date palm. Data in the Table (3) indicated that all levels of complete NPK and arbuscular mycorrhizal were significantly enhanced fresh and dry weights of leaves for both seasons as compared to control treatment (water only) which was induced the lowest values 8.5, 9.4 and 3.8, 4.3 respectively for fresh and dry weights of leaves in the first and second seasons, while the highest values were obtained by the treatment 2.5 g/l complete fertilizer with mycorrhiza treatment (17.4,18.1 and 8.3, 8.5 respectively for fresh and dry weights of the first and second seasons, respectively). These findings were supported by (Cline *et al*. 2007) who stated that root to shoot biomass ratio of Douglas fir (*Pseudotsuga menziesii* (Mirb).Franco) seedlings were significantly greater with ectomycorrhiza fungi. (Ben *et al*. 2008) found that date palm (*Phoenix dactylifera* L.) dry weights were increased by about 57% with inoculated by arbuscular mycorrhizal fungi. Ail *et al*. (2008) showed that more biomass of *Koeleria pyramidata* and *Poe pratensis* were accumulated with arbuscular mycorrhizal. Recently (Chen *et al.* 2009) cleared that arbuscular mycorrhizal increased plant dry weights of shoots of *Medicago sativa* and *Plantago lanceolata* when fertilized by N fertilizer, (Covacevich *et al* 2009) stated that shoot dry matter of *Triticum aestivum* was increased with VAM. These previous data

Table (3): Effect of mycorrhiza and different levels of complete fertilizers on fresh and dry weights (g) of *Phoenix dactylifera* L. plantlets cv Bartomouda

A \ B	Fresh weight						Dry weight					
	First season			Second season			First season			Second season		
	con	mycorrh	mean	con	mycorrh	Mean	con	mycorrh	mean	Con	mycorrh	Mean
Con	8.5	9.1	4.6	9.4	9.9	9.7	3.8	5.1	4.5	4.3	5.4	4.9
1.5	13.9	13.5	13.7	15.0	14.6	14.8	5.6	6.3	6.0	6.2	6.7	6.5
2.0	15.4	15.2	15.3	16.1	15.9	16.0	6.3	7.0	6.7	6.7	7.1	7.1
2.5	16.7	17.4	17.1	17.1	18.1	17.6	7.4	8.3	7.9	7.6	8.5	8.5
Mean	14.4	14.6		14.4	14.6		5.8	6.7		6.2	7.3	
l.s.d. (0.05%)	A=0.6 B=0.4 AB=0.8			A=1.1 B=0.9 AB=1.7			A=0.3 B=0.2 AB=0.4			A=0.5 B=0.4 AB=0.7		

indicated that the useful effect of mycorrhiza on growth of leaves and roots which were closely related to photosynthesis in the green plants.

Total sugars:

As shown in Table (4) arbuscular mycorrhizal inoculation and addition of complete NPK (1.5,2.0 or 2.5 g/l) were significantly increased the total sugars in the leaves of date palm plantlets, and highly significant interaction between concentration NPK fertilizer levels and mycorrhiza. The treatment 2.5 g/l NPK resulted in the greater concentration of total sugars as compared to control treatment which had the lowest values of total sugars (45.0 and 45.8 mg/g d0wt0 in the two seasons, respectively). The previous results were in agreement with Demir (2004)who showed that pepper plants which were infected with mycorrhizal fungus Glomus increased sucrose and total sugars contents, Recently، Bahadur *et al*. (2009) found that total sugars were increased with arbuscular mycorrhizal and organic manure and phosphate biofertilizer solubilizing in the chinese cabbage (*Brassica pekinensis* (Lour) Rupe).

N,P, K, Fe, Zn,Mn and Cu concentrations :-

Nitrogen (N) and phosphorus (P) were essential nutrients and they represented one of the most limiting in natural habitats as well as in agricultural production world-wide. Data in the Tables (4and 7) and

fig (2 and 3) exhibited that all levels of complete fertilizer (1.5,2.0 or 2.5 g/l) NPK 19-19-19 and in combination with soil inoculation of arbuscular mycorrhizal were significantly increased the concentrations of nitrogen, phosphorus, potassium, and also the micronutrients , i0e0 , Zn, Mn and Cu in the leaves of date palm. Highly significant levels of these minerals N, P, K, Fe , Zn, Mn and Cu which were important for the plants growth. The treatment of 2.5 g/l complete fertilizer were superior as compared to control treatment (water only). The treatment 1.5 g/l had the lowest significant values as compared to control treatment. In this concerning (Bucher 2007) indicated that arbuscular mycorrhizal exhibited improved P acquisition efficiency and thus require lower inputs of P fertilizer for optimal growth. Cartmill *et al.* (2008) stated that N,P , K, Fe and Zn content were higher with arbuscular mycorrhizal of *Rosa multiflora*. Also Joner (2000) and Deguchi *et al.* (2007) on *Trifolium repense*, Al-Agely and Sylvia (2008) on *Sea oats*, and Cavagnaro *et al*. (2009) on *Solanum lycopersicum* found that N,P and Zn were increased with AM. The above results explain the importance role of arbuscular mycorrhizal on fixing nitrogen which had the most favorable effects on the plants metabolism, therefore enhancing the other growth parameters.

Table (4): Effect of mycorrhiza and different levels of comp/lete fertilizers on total sugars concentration (mg/g d.wt.) and nitrogen percentage in leaves of Phoenix dactylifera L.plantlets cv. Bartomouda

A \ B	Total sugars(mg/g d0wt0)						Nitrogen (%)					
	First season			Second season			First season			Second season		
	con	mycorrh	mean	con	mycorrh	mean	con	mycorrh	mean	con	mycorrh	Mean
Con	45.0	69.4	57.2	45.8	69.4	57.6	1.8	2.4	2.1	2.1	2.6	2.4
1.5	72.3	68.5	70.4	73.7	69.4	71.6	2.0	5.1	3.6	2.3	5.3	3.8
2.0	75.6	75.9	75.8	76.6	76.9	76.8	2.2	6.0	4.1	2.5	6.5	4.5
2.5	77.5	80.2	78.9	78.4	81.5	80.0	2.5	6.3	4.4	2.8	6.9	4.9
Mean	67.6	73.5		68.6	74.3		2.1	4.9		2.4	5.3	

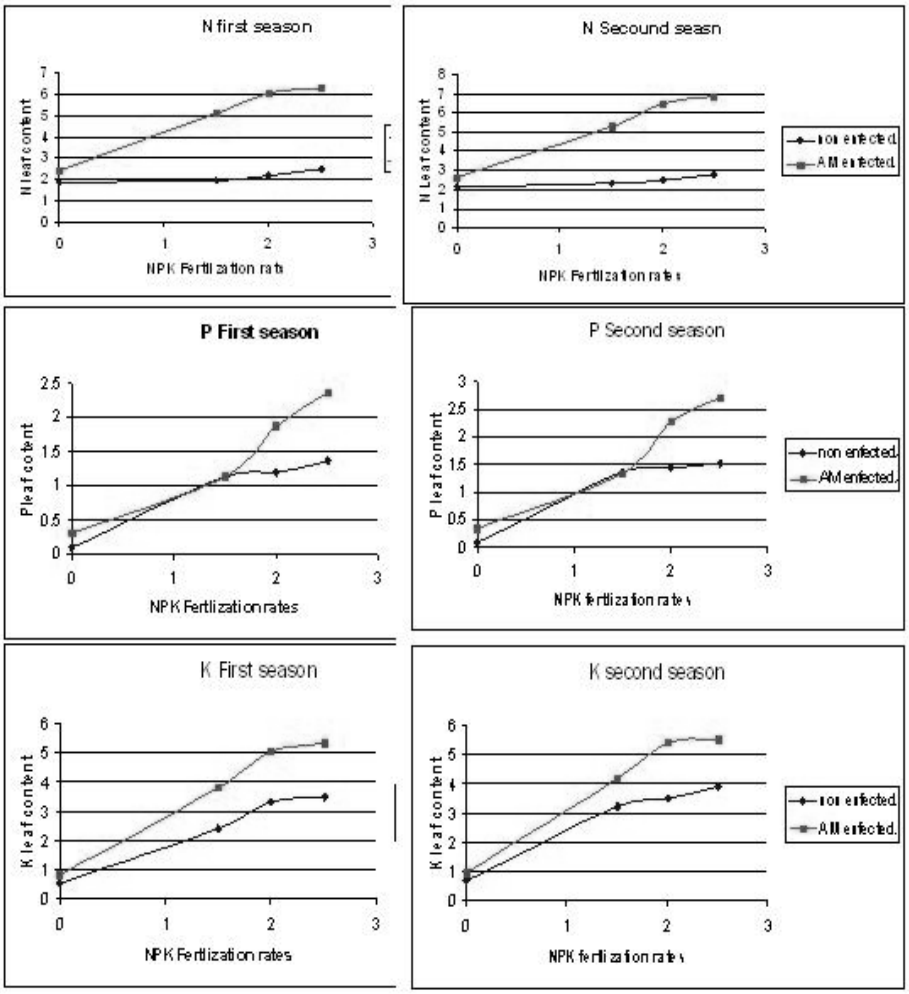

Figure (2) Effect of Arabuscular Mycorrhizal infection and NPK fertilization concentrations (0. 1.5, 2 and 2.5 gl^{-1}) on Macronutrient leaf content mg/100g

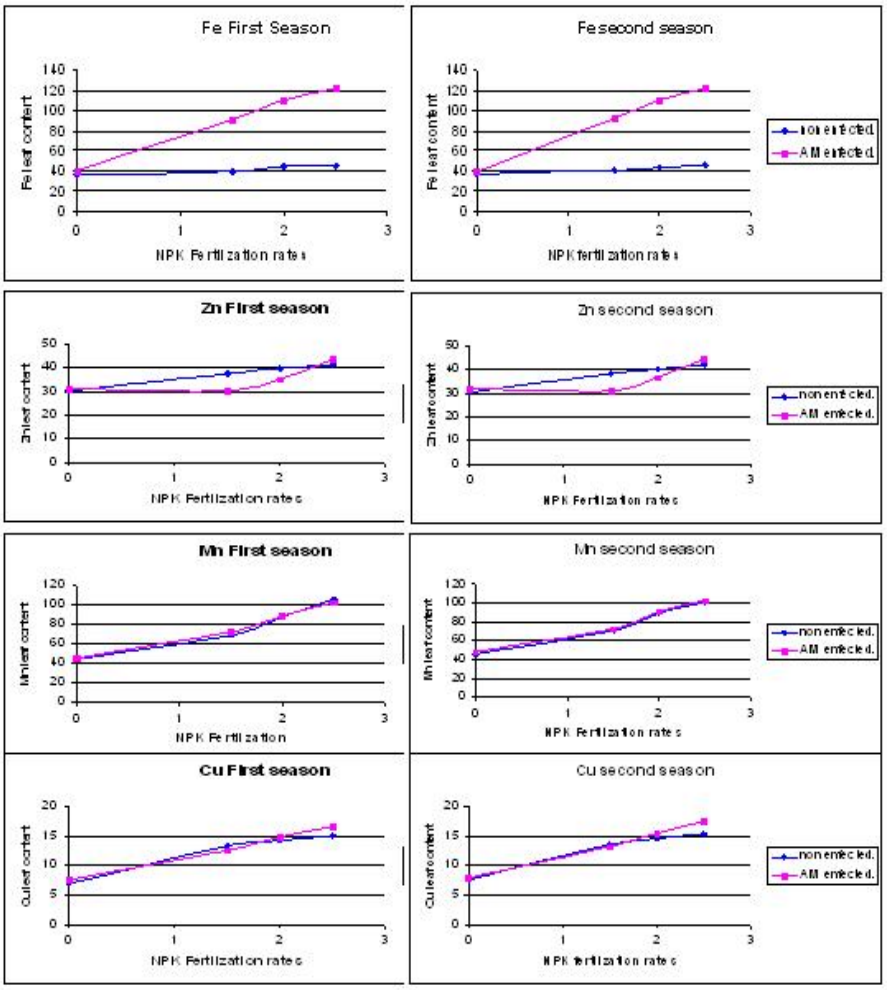

Figure (3) Effect of Arabuscular Mycorrhizal infection and NPK fertilization concentration (0. 1.5, 2 and 2.5 gl^{-1}) on micronutrient leaf content mg/kg

Table (5): Effect of mycorrhiza and different levels of complete fertilizers on P and K percentage of *Phoenix dactylifera* L. cv. Bartomouda plantlets

A \ B	Phosphorus %						Potassium %					
	First season			Second season			First season			Second season		
	Con	mycorrh	mean	con	mycorrh	mean	con	mycorrh	mean	Con	mycorrh	Mean
Con	0.2	0.6	0.4	0.2	0.6	0.4	500	800	700	700	900	800
1.5	202	202	202	1.4	206	208	24	38	31	32	42	37
2.0	204	308	302	1.4	406	308	33	51	42	35	54	45
2.5	308	408	308	1.5	504	402	35	53	44	39	57	48
Mean	109	208		1.1	304		24	38		28	41	
l.s.d. (0.05%)	A=0.2	B=0.2	AB =002	A=0.2	B=0.2	AB=0.4	A=2	B=2	AB=4	A=2	B=2	AB=2

Table (6): Effect of mycorrhiza and different levels of complete fertilizers on Fe and Zn concentrations (ppm). of *Phoenix dactylifera* L.cv. Bartomouda olantlets

B \ A	Fe ppm						Zn ppm					
	First season			Second season			First season			Second season		
	con	mycorrh	mean	con	mycorrh	mean	con	mycorrh	mean	con	mycorrh	Mean
Con	36.4	39.8	38.1	37.5	39.5	38.5	30.5	31.1	30.8	30.5	31.7	31.1
1.5	39.7	91.3	65.5	40.1	92.4	66.3	30.3	37.5	33.9	31.0	38.3	34.7
2.0	42.1	110.3	76.2	43.0	110.6	76.8	35.2	39.8	37.5	36.8	40.2	38.5
2.5	44.8	122.1	83.5	45.5	122.5	84.0	41.2	43.7	42.5	41.9	44.2	43.1
Mean	40.8	90.9		41.5	91.3		34.4	38.0		35.1	38.6	
l.s.d. (0.05%)	A=1.1	B=0.8	AB=1.5	A=0.9	B=0.6	AB=1.2	A=0.6	B=0.5	AB=0.9	A=1.0	B=0.7	AB=1.4

Table (7): Effect of mycorrhiza and different levels of complete fertilizers on Mn and Cu concentrations(ppm) in leaves of *Phoenix dactylifera* L. cv Bartomouda plantlets

B / A	Mn ppm						Cu ppm					
	First season			Second season			First season			Second season		
	con	mycorrh	mean	con	mycorrh	mean	con	mycorrh	mean	con	mycorrh	Mean
Con	44.9	45.4	45.2	45.6	47.9	46.8	6.9	7.5	7.2	7.5	7.9	7.7
1.5	69.3	72.9	71.1	70.6	72.9	71.8	13.3	12.6	13.0	13.5	13.2	13.4
2.0	87.8	89.4	88.6	89.4	90.6	90.0	14.2	14.8	14.5	14.5	15.4	15.0
2.5	106	102.4	104.2	100.8	102.8	101.8	15.0	16.6	15.8	15.3	17.4	16.4
Mean	77.0	77.5		76.6	78.5		12.4	12.9		12.7	13.5	
l.s.d. (0.05%)	A=2.3	B=1.6	AB=3.3	A=0.9	B=0.6	AB=1.2	A=0.2	B=0.1	AB=0.3	A=0.2	B=0.1	AB=0.3

Anatomical study

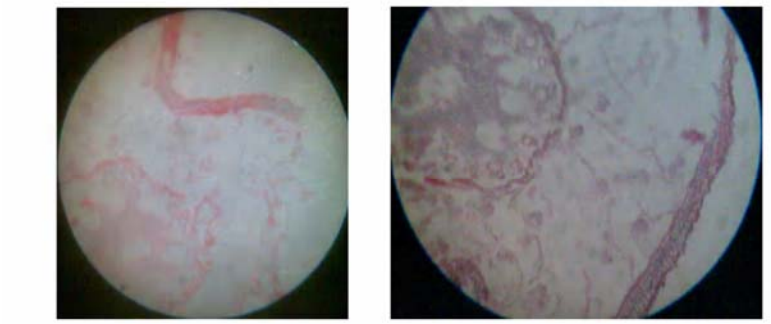

photo (1,2)

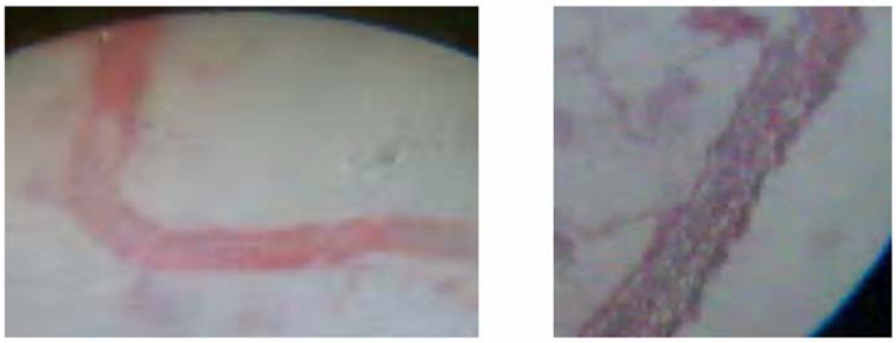

photo (3,4)

The site of penetration is shown at top right of photos (1,2,3 and 4), where the fungus produced a pre-penetration swelling (appressorium, ap), then it grew between the root cells and formed finely branched arbuscules (arb) and swollen vesicles (v).

The hyphae of AM fungi extend into soil, where their large surface area and efficient absorption enable them to uptake mineral nutrients, even if these are in short supply or are relatively immobile. AM fungi seemed to be particularly important for absorption of phosphorus, as a poorly mobile element, and a proportion of the phosphate that they absorbed has been shown to be passed into the plant

When arbuscular mycorrhizal fungal hyphae encounter the root of a host plant an apressorium (an infection structure) is formed on the root epidermis. The apressorium is the structure from which the hyphae can penetrate into the host's parenchyma cortex. The formation of apressoria does not require chemical signals from the plant. AM fungi could form apressoria on the cell walls of "host" cells in which the protoplast had been removed to eliminate signaling between the fungi and the host plant. However, the hyphae did not further penetrate the cells and grew in toward the root cortex which might indicates that signaling between symbionts could be required for further growth once appresoria are formed.

Tillage breaking apart the soil macro structure the hyphae network is rendered non-infective (Miller *et al.* 1995, McGonigle and Miller 1999). The disruption of the hyphae network decreases the absorptive abilities of the mycorrhizae because the surface area spanned by the hyphae is greatly reduced, which in turn ,lowers the phosphorus input to the plants which are connected to the hyphal network, (McGonigle and Miller 1999).

The available phosphorus concentration in the root zone could be increased by mycorrhizal activity. Mycorrhizae lower the rhizosphere pH due to selective uptake of NH_4^+ (ammonium-ions) and release of H^+ ions. Decreased soil pH increased the solubility of phosphorus precipitates. The hyphae uptake of NH_4^+ also increases the flow of nitrogen to the plant.

A decrease in mycorrhizal colonization due to high soil phosphorus level could lead to plant deficiency in other micronutrients that have mycorrhizal mediated uptake such as copper (Timmer and Leyden 1980).

As the soil's phosphorus level was available to the plants increase, the amount of phosphorus also increases in the plant's tissues and carbon drain on the plant by the AM fungi symbiosis become non-beneficial to the plant (Grant *et al*. 2005).

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تأثير الميكروهيزا على نمو و امتصاص العناصر الغذائية لنبيتات نخيل البلح المؤقلمة

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أجرى هذا البحث خلال عامى 2008-2009 و ذلك لدراسة تأثير فطر الميكروهيزا على نمو و امتصاص العناصر الغذائية لنبيتات نخيل البلح. و بعد عام من مرحلة ألاقلمة لنبيتات نخيل البلح عوملت هذة النبيتات بفطر الميكروهيزا مع ثلاث مستويات من السماد الكامل 19-19-19 و هى (1.5 ،2 و 2.5 جم/لتر) بالاضافة لمعاملة الكنترول (ماء فقط)، و تمت اضافة المستويات السمادية مع مياة الرى بمعدل مرة كل اسبوع لمدة ثمانية أشهر خلال الموسمين. أشارت النتائج فى نهاية التجربة الى التأثير الايجابى لفطر الميكروهيزا بلا شتراك مع السماد الكامل على نمو النبات و كذلك امتصاص العناصر. ادت المعاملات السمادية مع فطر الميكروهيزا الى زيادة معنوية فى عدد الاوراق، طول النبيتات، طول الجذور، عدد الجذور، الاوزان الطازجة و الجافة للاوراق كما ادت الى زيادة السكريات الكلية و العناصر مثل النيتروجين، الفوسفور، و البوتاسيوم و ايضا الى زيادة امتصاص العناصر الصغرى مثل الحديد،الزنك،المنجنيز و النحاس. ادت المعاملة 2.5 جم/لتر من السماد الكامل (NP K) الى زيادة معنوية فى الصفات الخضرية و كذالك الى زيادة امتصاص العناصر. و توضح نتائج التشريح الى نمو فطر الميكروهيزا على الجذر مما ساعد على زيادة امتصاص العناصر الهامة لعملية التمثيل الغذائى فى النبات مما ادى الى زيادة نمو النباتات.

الكلمات الدالة: الميكروهيزا، النمو،النيتروجين،الفوسفور و البوتاسيوم