

EFFECT OF VESICULAR-ARBUSCULAR MYCORRHIZAL FUNGI ON
THE NUTRIENT UPTAKE OF ZEA MAYS L.

BY

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Received : 30 - 7 - 1987

ABSTRACT

Mycorrhizal (M) and non-mycorrhizal (NM) Zea mays plants were grown for 60 days in pots containing sterilized sandy soil under greenhouse conditions. Results showed that the fungus Glomus fasciculatum has been successfully established and maintained in pot cultures of Zea mays roots. As a consequence of the mycorrhizal infection growth as well as mineral content and uptake of N, P, K, Mn, Na and Ca were increased , but decreased root-Fe content .

INTRODUCTION

It is well established that vesicular-arbuscular mycorrhiza (VAM) can increase phosphate uptake and growth in a number of agricultural crops, especially in soils low in available phosphorous [15,5,21] . It is also found that VAM can increase uptake of copper and Zinc

Delta J.Sci. 12 (2)1988

Effect of Vesicular- Arbascular

[13], sulphur [7], nitrogen [19], potassium and calcium [18] and manganese [10].

Numerous researchers have reported beneficial results when VAM were applied to roots of plants [20, 8] , by extending the absorptive area of the plant's root system [1].

The aim of this present study is to investigate the effect of VAM on growth and nutrient uptake of Zea mays plant.

MATERIALS AND METHODS

Zea mays L. (Giza 202) grains were sown in pots each holding 1-7 kg washed sterilized sandy soil with 4 plants per pot (20 pots per replicate). After 7 days growth , each pot was inoculated with approximately 25 ml sterile (non-mycorrhizal treatment) or viable (mycorrhizal treatment G. fasciculatum spores collected from the rhizosphere of wheat field by wet-sieving and decanting technique [6]. The pots were supplied with full strength Long Ashton nutrient solution (modified from Hewitt [11]) at the rate of 25 ml per pot twice weekly. Maize seedlings, VA mycorrhizal and uninoculated controls, were grown for 60 days in the greenhouse with a diurnal temperature range from 20°C to 32°C . At harvest, the percentage of infected root tissue

Delta J. Sci. 12 (2)1988

Bahia A. Abdel-Ghaffar et al.

was estimated by examining random samples (more than 20 segments of root per replicate). The roots were cleared and stained [16] and examined for VAM formation.

Samples were taken at intervals 15, 30 and 60 day-old plants. Shoots and roots were separated, weighed and dried at 70°C for 48 h. Dry weight and % of moisture content were recorded and the dry samples were analysed for mineral content. The mixed acid digestion method was used in preparing the sample solution for element content determinations. Mg, Mn, Ca, K, Fe and Na were determined by using Shimadzu Atomic Absorption Flame Spectrophotometer Model AA-640-12. Phosphorous was determined by the Molybdenum Blue method. The micro-Kjeldahl method was used to determine total N. All these procedures are according to Allen et al. [2].

RESULTS

The fungus G. Fasciculatum has been successfully established and maintained in pot cultures of Zea mays roots with $18\% \pm 3.2$ root length infection. All the uninoculated plants remained uninfected (0%). Plants inoculated with VAM weighed more, but it had no difference in percentage of moisture than did uninoculated plants (Table 1).

Effect of Vesicular- Arbuscular

Table 1: Biomass (mg/plant) and percentage of Zea mays plants inoculated or not with VA mycorrhizal fungi for 15,30 and 60 days.

Day-old	Biomass(mg/plant)		Water content	
	NM	M	NM	M
15	182±6	224±5	87.5±2.1	88.5±1.5
30	273±7	331±7	90.7±1.4	89.9±2.3
60	528±6	634±5	89.1±1.9	89.6±2.3

The concentration of N,P,Mg,Ca Na and Fe were increased in shoots and roots of infected plants of 15,30 and 60 day-old , exacept root-Fe. (Fig.1). N and P in roots and shoots were increased gradually by time, so they reached the maximum concentration at the end of the growth period (60 days old). The concentration of Mg,Ca, and Mn reached their maximum levels in roots of infected plants at 30 day-old and in shoot of 60 day-old. That is probably due to the transport of these elements from roots to plant shoots. Shoot-Fe reached its maximum in the 60 day-old plant. Mycorrhizal infection affected more or less Na content of shoot.

The mycorrhizal infection increased the nutrient uptake of Zea mays plants (Table 2) and decreased the N/P

Delta J.Sci. 12 (2)1988

Bahia A. Abdel-Ghaffer et al.

ratio of shoot and root (Table 3). This was associated with the increased plant phosphorous concentration.

Table 2: Nutrient uptake of Zea mays plants after 2 months old(mg/plant)

	N	P	Mg	k	Ca	Na	Fe	Mn
NM	11.5	4.1	4.4	2.4	9.5	3.2	0.4	0.05
M	15.5	5.9	6.3	3.3	11.5	4.3	0.7	0.06

Table 3: N/P ratios

Treatment	15 day-old		30 day-old		60 day-old	
	Root	Shoot	Rood	Shoot	Root	Shoot
NM	3.5	2.8	2.8	2.1	2.1	1.5
M	3.1	2.2	2.6	1.5	1.7	1.4

DISCUSSION

In this investigation VAM-inoculation increased the biomass and the concentration of macronutrients (P,N, Ca,

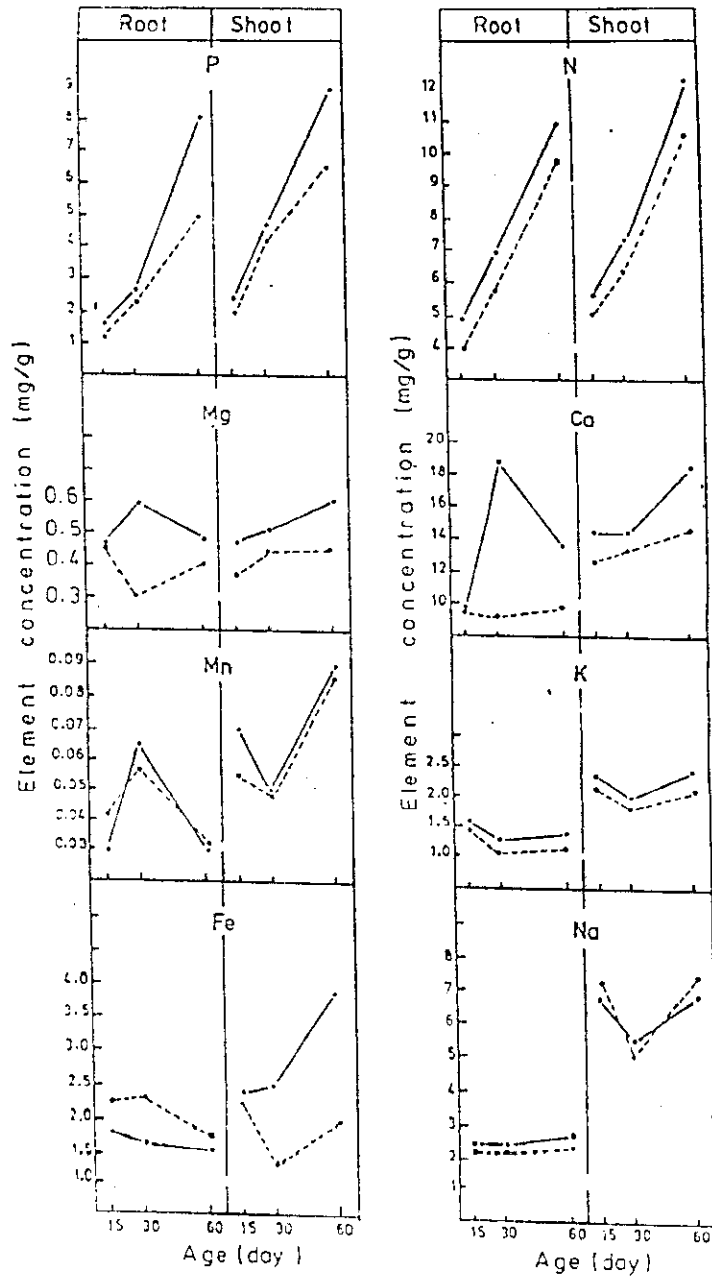


Fig. 1. Nutrient concentration (mg/g) in shoot and root of *Zea mays* plants (60-day-old).

—•— VAM inoculated plants
 - - - - - ○ - - - - - Uninoculated plants

Delta J. Sci. 12 (2)1988
Bahia A. Abdel-Ghaffer et al.

Mg, K, Na) and micronutrients (Mn & Fe) and their uptake in Zea mays plants. The explanation for the increased nutrient consequently the uptake following VAM-inoculation probably is that nutrients are absorbed by VAM-hyphae and transported across roots to plant shoots. The concentration of P and N in roots and shoots increased gradually during the growth period. Smith et al. [19] demonstrated that mycorrhizal infection increased the activity of glutamate synthetase. This activity would be important in increased uptake of N which is an inevitable prerequisite for increased growth. Also the increased uptake of P in many mycorrhizal plant species has been cited as a major factor contributing to increase biomass [15, 14, 9] . Ruey-Shyang et al. [18] However , found that mycorrhizal plants had greater P,K and Ca uptake than non-mycorrhizal plants. Bloss and Pfeiffer [4] recorded that infection of Guayale plant with G. fasciculatum was increased the concentrations of Ca, Fe, Mg, Mn and Zn but decreased that of Na. Jensen [12] found that inoculated Barley with VA mycorrhizal fungi had increased the total uptake of P, Cu and Zn.

This paper agrees with other experiments reporting an increase in growth and uptake of nutrients by VAM fungi [17,3,10] .

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Delta J. Sci. 12.(2)1988

Bahia A. Abdel-Ghaffar et al.

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Effect of Vesicular - Arbuscular

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Bahia A. Abdel-Ghaffar et al.

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تأثير الفطريات الجذرية ذات التركيبات
الكيسيه الشجرية على امتصاص العناصر فى
نبات الذرة الشاميه

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تمت زراعة الذرة الملقحه بالفطريات الجذرية وغير الملقحة فى

تربه رملية معقمه وتروى النباتات بمحلول مغلغل كامل لمدته ٦٠ يوما فى

صوبه زجاجيه .

أوضحت النتائج أن القطره جلوماس فاسيكيولاتم أستطاعت أن تنتج

فى أصابه جذور نباتات الذره وصاحب ذلك زياده فى نمو النبات ممثلا فى

الوزن الجاف . كما زاد محتوى النبات من العناصر المعدنيه ممثله فى

النيتروجين والفوسفور والبوتاسيوم والمنجنيز والماغنسيوم والصوديوم وقد

زاد عنصر الحديد فى المجموع الخضرى بينما تناقص فى الجذور .