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Short Communication

Arbuscular Mycorrhizal Fungi Affect Seedling Growth of Melon Hybrid Cultivars

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Abstract

Hybrid melon cultivars (Super Magnum F_1, Extra Early Galia F_1, Rambo F_1 and Sempati F_1) were inoculated with 3 different AMF (Arbuscular Mycorrhizal Fungi) [*Gigaspora margarita (Gm)*, *Glomus intraradices* (*Gi*), and *G. etunicatum (Ge)*] in order to examine the effects of AMF on seedling growth in melon. The seedling traits, nutrient uptake, colonization, and relative mycorrhizal dependency (RMD) were assessed in the experiment. Mycorrhizal colonization of melon cultivars ranged from 38.9 to 54.9%. The nitrogen, phosphorous, potassium, magnesium, and manganese contents were affected by melon cultivars, AMF, or their combinations. Relative mycorrhizal dependency also varied widely; only half of the melon cultivar-mycorrhizae combinations showed positive mycorrhizal dependencies. The *Gi* inoculations had higher positive RMDs, while the *Gm* inoculations had lower negative RMDs. © 2013 Friends Science Publishers

Keywords: AM fungi; Inoculation; Melon; Nutrient uptake; Seedling growth

Introduction

Due to its eligible ecological conditions, Turkey is among the countries, where many vegetables species and cultivars can be grown. Approximately 40% of vegetable production in Turkey is melon, watermelon, cucumber, and summer and winter squashes belonging to Cucurbitaceae. Melon is one of the main Cucurbit crops in Turkey (1.61 million tons of production on 95 thousands ha) (Anonymous, 2010).

The Arbuscular Mycorrhizal Fungi (AMF) is among the most effective components of rhizosphere in terms of plant health and plant growth. Mycorrhiza is a mutual symbiotic life between plant roots and some of fungi in a continuous manner. It has been identified that this symbiosis increases the resistance of plants against environmental and cultural stress factors (Smith and Read, 2008).

Cucurbits generally take place within the families of cultivated plants (melon, watermelon, cucumber, summer and winter squashes etc.) with mycorrhizal dependency (Demir, 2002). Different researchers determined diverse AMF colonization, nutrient uptake, and RMDs on the studied cucurbit crops. Tüfenkçi *et al.* (2012) studied the efficacy of different AMF on different hybrid cucumber (*Cucumis sativus* L.) cultivars. These researchers found that there was significant mycorrhizal effect on the iron content of cucumber shoots and the mycorrhizal colonization rate in cucumber roots. Sensoy *et al.* (2011) investigated the various AMF on several hybrid summer squash (*Cucurbita pepo* L.) cultivars. These researchers found that *Gigaspora margarita* inoculations had higher positive RMDs, while *Glomus intraradices* inoculations had lower negative RMDs in *C. pepo*.

The effectiveness of different AMF on different melon hybrids has not been well documented. Therefore, the present study aimed to assess colonization, nutrient uptake, responsiveness and some seedling traits of four melon hybrids inoculated by three different AMF.

Materials and Methods

Four melon hybrids Super Magnum F_1, (Beta Seed Company), Extra Early Galia F_1, (Beta Seed Company), Rambo F_1 (Zeraim Gedera Seed Company) and Sempati F_1 (Hazera Seed Company) used in protected cultivation in Turkey were studied. Three AMF [*G. etinucatum (Ge)*, *G. margarita* (*Gm*), and *G. intraradices* (*Gi*)] inocula consisted of spores, extraradical mycelium and mycorrhizal roots were employed in the study.

The experimental conditions, inoculations, the colonization, nutrient uptake, responsiveness and some seedling traits were determined and employed as similarly described in Sensoy *et al.* (2011) and Tüfenkçi *et al.* (2012): Growth medium comprised of an autoclaved mixture of perlite and peat moss (1:1 *v/v*) in seedling trays covered by vermiculite. The experiment used a 4×4 factorial design (four melon hybrids, three AMF plus one control) with three random replications. One seed was sown per cell, each of which contained 80 cm^3 of sterilized growth medium. In the AMF-inoculated samples, five g (25 spores g^{-1}) of inoculums were placed in the growth medium before the

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seeds were sown. Seedling trays were placed in a growth chamber at a temperature of 22±2^{o}C with 12 h fluorescent illumination (8,000 lux light intensity), and irrigated with distilled water. Each seedling was fertilized twice with a 5 mL of nutrient solution (for 1 L: 720 mg $MgSO_4$ $7.H_2O$, 12.2 mg KH_2PO_4, 295 mg $Ca(NO_3)_2.4H_2O$, 240 mg KNO_3, 0.75 mg $MnCl_2.4H_2O$, 0.75 mg KI, 0.75 mg $ZnSO_2.H_2O$, 1.5 mg H_3BO_3, 0.001 mg $CuSO_4.5H_2O$, 4.3 mg FeNaEDTA, and 0.00017 mg $Na_2MoO_4.2H_2O$).

Plants were harvested 9 weeks after seed sowing and inoculation. Samples were then oven-dried at 68ºC for 48 h, ground, and mineral matter contents (other than N and P) of shoots measured using atomic absorption spectrophotometer; nitrogen (N) contents of shoots measured using Kjeldahl method; phosphorous (P) contents of shoots measured using the vanadate-molybdate-yellow procedure with spectrophotometer (Kacar and Inal, 2008).

Melon roots were dyed to detect AMF presence, and the percentage and intensity of mycorrhizal colonization was estimated using the gridline intersect method (Giovanetti and Mosse, 1980).

Relative mycorrhizal dependency (RMD) of melon hybrids was expressed as the difference between the total dry weight of the mycorrhizal plant and the total dry weight of the non-mycorrhizal plant as a percentage of the total dry weight of the mycorrhizal plant (Sensoy *et al.*, 2007).

The SAS statistical program (SAS Software 1997) was employed in the analysis of data and Duncan's Multiple Range Test used to determine the differences between treatments.

Results and Discussion

Although six combinations of melon cultivar and mycorrhiza showed negative mycorrhizal dependencies, the other six combinations had positive mycorrhizal dependencies (Fig. 1). Interactions showing positive mycorrhizal dependency were Super Magnum x *Gi*, Rambo x *Gi*, Extra EG x *Gi*, Sempati x *Gi*, Rambo x Ge, and Sempati x Ge (Fig. 1).

The significant differences ($P < 0.05$) were determined among melon cultivars for mycorrhizal colonization: The cv. Rambo had the highest root mycorrhizal colonization (54.9%), while cv. Extra Early Galia had the lowest colonization (38.9%) (Table 1). The some macro and micro nutrient contents (insignificant ones were not presented) were affected by various AMF species in various melon cultivars' seedlings are also presented in Table 1. The *Gm* had the highest seedling N content (2.22%), while the *Ge* had the lowest N content (1.76%) (Table 1). The cv. Rambo had the highest seedling P content among the melon cultivars (Table 1). The *Gm* and the control application had the highest seedling K content, while the *Gi* had the lowest K content (Table 1). The Ge x Rambo combination had the highest seedling K content (2.30%) (Table 1).

Table 1: The effects of different AMF species on mycorrhizal colonization, nitrogen (N), phosphorous (P), potassium (K), magnesium (Mg), and manganese (Mn) contents in various melon cultivars' seedlings

Applications	Mycorrhizal Colonization (%)	N (%)	P (%)	K (%)	Mg (%)	Mn (ppm)
Melon Cultivars						
1. Super Magnum F_1	52.8 ab*	1.82 b*	1.80 b *	3.14 (NS)	1.19 (NS)	70.9 b ***
2. Extra Early Galia F_1	38.9 b*	1.72 b	1.91 b	2.95	1.16	55.7 b
3. Rambo F_1	54.9 a	2.30 a	2.89 a	3.34	1.64	98.5 a
4. Sempati F_1	47.9 ab	2.04 ab	1.79 b	3.35	1.49	10.5 a
Mycorrhiza						
1. Control (-AMF)	- (NS)	2.00 ab*	2.42 (NS)	3.54 a*	1.27 (NS)	75.2 b ***
2. *Glomus eticunatum (Ge)*	47.9	1.76 b	2.03	3.00 ab	1.53	99.2 a
3. Glomus intraradices(Gi)	51.0	2.00 ab	2.11	2.77 b	1.40	103 a
4. Gigaspora margarita (Gm)	47.1	2.22 a	1.84	3.49 a	1.26	47.8 c
Cultivar-mycorrhiza combinations						
1. Super M x Control (-AMF)	- (NS)	1.90 (NS)	1.93 (NS)	4.50 a**	1.12 bc*	85.1 bcd**
2. Super M x *(Ge)*	53,3	1.53	1.76	2.93 abc	1.50 abc	86.9 bcd
3. Super M x *(Gi)*	54,7	2.03	1.98	2.64 bc	1.26 bc	72.5 cd
4. Super M x *(Gm)*	50,5	2.13	1.55	2.52 bc	0.87 c	38.9 d
5. Extra EG x Control(-AMF)	-	1.56	1.77	2.07 c	0.94 c	44.9 d
6. Extra EG x *(Ge)*	37,3	1.30	1.92	3.19 abc	1.01 bc	65.5 cd
7. Extra EG x *(Gi)*	40.0	1.90	2.05	2.96 abc	0.95 c	70.4 cd
8. Extra EG x *(Gm)*	39.5	1.96	1.91	3.60 abc	1.74 abc	42.0 d
9. Rambo x Control (-AMF)	-	2.06	4.12	3.68 abc	1.69 abc	55.7 d
10. Rambo x *(Ge)*	68.2	2.50	2.85	2.74 abc	2.30 a	154.0 a
11. Rambo x *(Gi)*	51	2.66	2.44	2.89 abc	1.33 abc	136.0 ab
12. Rambo x *(Gm)*	45.5	2.00	2.16	4.05 ab	1.23 bc	47.3 d
13. Sempati x Control (-AMF)	-	1.90	1.87	3.91 ab	1.34 abc	115.0 abc
14. Sempati x *(Ge)*	32.7	2.25	1.58	3.14 abc	1.30 abc	89.6 bcd
15. Sempati x *(Gi)*	58.3	2.10	1.97	2.60 bc	2.06 ab	136.0 ab
16. Sempati x *(Gm)*	52.7	2.18	1.72	3.97 ab	1.17 bc	70.3 cd

NS: Not Significant; *: $P<0.05$; **: $P<0.01$; ***: $P<0.001$

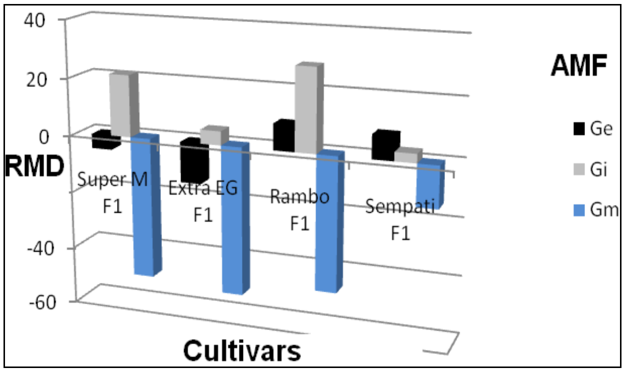

Fig. 1: The relative mycorrhizal dependencies (RMD) of melon hybrid cultivars to various Arbuscular Mycorrhizal Fungi (AMF)

The Gi and Ge had higher Mn contents in seedlings than those of the control and Gm applications. The Ge x Rambo combination had also the highest seedling Mn content (154 ppm) (Table 1).

AMF have positive effects on various crops, but there are variations in response of the genotypes, varieties or cultivars to various AMF species (Sensoy *et al.,* 2007; Meghvanski *et al.,* 2008; Miyauchi *et al.,* 2008; Wang *et al.,* 2008; Long *et al.,* 2010; Sensoy *et al.,* 2011; Tüfenkçi *et al.,* 2012). There was a lack of correlation between mycorrhizal colonization and RMD, which was similar to the findings of Linderman and Davis (2004), Sensoy *et al.* (2007, 2012) and Tüfenkçi *et al.* (2012). Tüfenkçi *et al.* (2012) found out that RMDs ranged widely among the tested cucumber hybrid cultivars. In *Cucurbita pepo* L., the *Gm* inoculations had higher positive RMDs, while the *Gi* inoculations had lower negative RMDs Sensoy *et al.* (2011). However, in melon an opposite situation occurred: the *Gi* inoculations had higher positive RMDs than those of *Gm* ones.

Mycorrhiza inoculated cucurbits had some higher macro and micro nutrients than those of non-inoculated ones (Wang *et al.,* 2008; Rouphael *et al.,* 2010; Sensoy *et al.,* 2011; Tüfenkçi *et al.,* 2012). In the present study, some mycorrhiza species had ameliorative effects on some macro and micro nutrients.

In conclusion, AMF could improve seedling traits in melon. In the studied mycorrhiza species, *Gi* was the best for melon hybrid cultivars' seedlings followed by *Ge* based on the RMD.

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