ESSAI

Volume 8 Article 15

4-1-2011

The Effects of Mycorrhizae on the Growth of the Radish, *Raphanus sativus L.*

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(Honors Biology 1152)

ABSTRACT

Mycorrhizae are known to increase nutrient absorption by plants leading to faster plant growth and increased reproduction. The following study examines the benefits of mycorrhizal interaction with radish, *Raphanus sativus L.* A commercial mycorrhizal inoculate was used as a source of mycorrhizae. Growth parameters, including germination rate, plant height and mass, leaf number, leaf canopy size, and stem diameter, were studied and recorded over a six week period to determine the effect of the fungal relationship. The mycorrhizal inoculum was not found to have a positive effect on the germination and growth of the radish as defined in the previously mentioned parameters. This relationship was not beneficial to the host plant possibly due to the species of mycorrhizae found in the inoculum.

INTRODUCTION

Mycorrhizae and plants can share a mutually beneficial relationship. The mycorrhizal fungi colonize plant roots allowing the plant access to necessary nutrients in the soil in exchange for carbohydrates produced by the plant (Graham et al. 2008, Mack and Rudgers 2008, Smith et al. 2004). Root surface area greatly increases due to mychorrhizal infestation causing a correlative increase in nutrient and water uptake by the host plant and in soil volume available for exploitation (Allen et al. 2003). In addition, mycorrhizae provide resistance to pathogens by direct competition for resources and provide stabilization to environmental stresses (Graham 2001, English 2009, Whitfield 2007). However, there are degrees of mutualism within the plant/fungi relationship mediated by the capabilities of both the plant and fungi (Smith et al. 2004). Under certain conditions, mycorrhizae can become parasitic (Mack and Rudgers 2008).

In the following study, the effects of mycorrhizae on the germination and growth of the radish were investigated. The prediction that mycorrhizae would promote growth was based on the majority of findings of previous studies.

METHODS

OMRI MycoGrow™ Micronized Endo/Ecto Seed Mix inoculum (OMRI, PO Box 11558, Eugene, OR, 97440-3758) was used to inoculate the autoclaved potting soil. Seventy milliliters of potting soil was placed in each of 60 plastic cups. To the soil of 30 of these cups, 5 ml of mychorrhizal inoculum was mixed in to create the mycorrhizal treatment. The 30 remaining cups collectively served as the control treatment. Radish seeds obtained from W. Atlee Burpee and Company (300 Park Ave., Warminster, PA 18974), were placed on the surface of the soil, one seed per pot. Plantings were kept in the Department of Biological Studies greenhouse at College of DuPage (Glen Ellyn, IL 60139) in large plastic pans. Water was added to the pans as the potting soil became dry.

The number of cups having germinating radish was determined after 3 weeks. Differences between mycorrhizal and control treatments were tested using Chi Square Goodness of Fit Test. Homogeneity of variance could not be safely assumed among the various growth measurements. Hence, the Mann-Whitney non-parametric test was used to test for differences in each growth parameter between the control and mycorrhizal treatments.

RESULTS

Table 1 summarizes germination rates according to experimental treatment. The control treatment showed over twice the germination rate as the control group, a significant difference ($\chi^2 = 6.26$; df = 1; $P < 0.05$). Only stem diameter varied significantly between treatments with the tendency for the mycorrhizal treated plants to have a smaller diameter (Table 2). Although not significant, leaf canopy and plant mass proved to be greater in the mychorrhizal group (Table 2).

DISCUSSION

Mycorrhizae appeared to have a negative effect on the germination of the radish. Even after germination, the data indicate little advantage to mycorrhizal associations. Various species of mycorrhizal fungi have different abilities for promoting plant growth (Bever et al. 2001). Possibly the inoculum used did not contain a fungi beneficial to this species of radish resulting reduced germination and growth. Mycorrhizae can become parasitic leading to an imbalance of nutrient exchange in the relationship with the host plant (Mack and Rudgers 2008). As the mycorrhizae take carbohydrates manufactured from the plant without returning the needed nitrogen and phosphorus, the host plant becomes depleted of necessary resources for development (Graham et al. 2008, Mack and Rudgers 2008, Smith et al. 2003).

Plants will only allocate resources to mycorrhizae that support a beneficial relationship (Bever et al. 2009), therefore, the developing radish may not have found a beneficial relationship with the provided inoculum. Competition for available resources between the fungi and plant may have ensued leaving less available nutrients for the seedlings. However, plants can survive when provided with the necessary nutrients and will reduce their association with the fungi accordingly (Allen 2001, Bronstein 1994).

Further studies are needed to identify which mycorrhizae species can benefit this species of radish the most. Increased sample sizes in this study could provide better statistical analysis of the variation of growth parameters. Inoculating the soil samples with only one type of mycorrhizae may determine which fungi is the most beneficial to the radish. Additional experimental parameters could include the differences in germination time between the control and experimental groups. The existing nutrient content of the soil should also be analyzed and recorded.

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Table 1. Summary of number of germinated seeds per group after three weeks.

Group	# of Germinated Seeds
Control	23
Mycorrhize	11

Table 2. Summary (mean ± standard error) of radish growth parameters. Also provided are Mann-Whitney comparisons of Control and Mycorrhizal treatments according to inclusion of all plants or plant with more than 2 leaves. Significance ($P \leq 0.05$) is denoted by *.

	All plants			Plants with > 2 leaves		
Parameter	Control	Mycorrhizae	U	Control	Mycorrhizae	U
Radish height (cm)	6.26 ± 0.19	4.90 ± 0.91	42.4	6.24 ± 0.20	5.86 ± 0.85	40.5
Leaf count/plant	4.39 ± 0.26	3.57 ± 0.75	56	4.60 ± 0.40	4.53 ± 0.23	34.5
Plant weight (g)	5.59 + 2.79	1.23 + 0.38	38.5	1.52 + 0.38	5.69 + 2.96	37.5
Leaf canopy (cm2)	47.72 + 3.10	53.57 + 19.74	55	48.21 + 3.24	74.30 + 21.02	33
Stem diameter (cm)	1.17 + 0.09	0.33 + 0.10	*3.5	1.12 + 0.08	0.42 + 0.11	*3.5
Sample size	18	7		17	5	