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The Effect of Mycorrhizal Inoculation on Growth Characteristics, Phenolic Compounds and Antioxidant Activity of *Nepeta Binaludensis* Jamzad

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Introduction

Nepeta Binaludensis Jamzad is a species of *Laminasea* family, which is an annual and rare plant and is distributed in limited areas of northeastern of Iran (Ghahreman, 1999). Due to its many healing properties, this plant has been exploited excessively and unfortunately, it is one of the plants in danger of extinction (Walter et al., 1968). Mycorrhiza fungi are soil microorganisms that able to establish a symbiotic relationship with plant roots and effect plant growth (Khan, 2005). Micorrhizal plants often increase their photosynthesis rate in different ways, such as increasing leaf area, increasing the amount of carbon dioxide fixation, and changing water and hormonal relationships (Valentine et al., 2006). In an experiment with *Rosmarinus officinalis* L, mycorrhizal plants had more root and aerial biomass than non-mycorrhizal plants in drought stress condition (Sanchez et al., 2004).

In general, many successes have been achieved in the symbiosis of plants with mycorrhizal fungi, which include the improvement of the absorption of nutrients such as phosphorus and nitrogen (Javaid, 2009), the synthesis of secondary metabolites (Nell et al., 2009), the revitalization of vegetation (Smith, 2010), and the improvement of tolerance to biotic and abiotic stresses (Franken, 2012). Considering the unique characteristics of mycorrhizal fungi as a result of creating a symbiotic relationship with host plants, the present study was conducted with the aim of investigating the effect of inoculation of mycorrhizal fungi on morphological characteristics, phenolic compounds and antioxidant capacity of *Nepeta binaludensis*.

Material and Methods

In this experiment, the effects of three species mycorrhiza, including to: *Glomus hoi*, *Glomus interaradis*, *Glomus mossea* and control (without of fungi) on growth characteristics and morphological characteristics in a period of 20 weeks was investigated. This experiment was conducted as a factorial experiment based on completely randomized design with three replications. Each pots were filled with a ratio of 1:2 (sand and garden soil) and were considered as experimental units. In order to inoculate mycorrhizal fungi, for each 1 Kg of soil, 100 g of fungi powder was added to the top 3 cm of the soil.

Collect the seeds in autumn, then washing with water and they were planted in six parts of the pot at a depth of 1 cm. The plants were grown for 20 weeks at 25°C and under phytotron conditions with a photoperiod of 16 / 8 hours of light and darkness, respectively. After of growth of the plants, they were taken out of the pot and divided into two parts, the aerial part and the root part. Morphological traits including height of aerial part, weight of aerial part, leaf area and root related traits including length, diameter and root area were measured. Also, after preparing the methanolic extract, the amount of phenol, flavonoids and antioxidant capacity were measured. Inductively coupled plasma spectrometry was used to investigate the accumulation of potassium, calcium, phosphorus, magnesium and iron elements in the aerial part.

Result and Discussion

The results of this study showed that the highest plant height and dry weight of plants were related to inoculation with *G. interaradis* species. Also, all three species of mycorrhizal had a significant effect on root dry weight gain compared to control. In this study, the highest root surface and leaf area were related to the application of mycorrhizal *G. mossea* species and the highest increase in root diameter was observed in plant inoculated with *G. hoi* species. Generally, mycorrhizal fungi increases the amount of water absorption and food elements due to increasing root contact surface with soil and thus improves plant growth (James et al., 2008).

The highest content of total phenol and flavonoids was related to plants inoculated with *G. interaradis* species that had a significant difference with other treatments and control. Increasing phenol and flavonoid compounds can be related to absorbing more nitrogen in mycorrhizal plants, seeking the development of the root system (Toussaint, 2004). The inoculated plants with *G. mossea* and *G. interaradis* species were superior than to other in terms of antioxidant compounds.

Most magnesium, potassium and phosphorus content belonged to the plants inoculated with *G. intradices* and *G. hoi* species. The highest content of iron and calcium was related to the plants inoculated with *G. intradices* and *G, mossea* species, respectively.

Conclusions

In general, mycorrhizal fungi in a symbiotic relationship with plants had positive effects on morphological and biochemical traits. In this study, the highest content of total phenol, flavonoids and antioxidant capacity were related to plants inoculated with *G. intraradices*. It seems that mycorrhizal fungi have increased the absorption of nutrients and the content of nutrients such as calcium, potassium, iron, magnesium and phosphorus in plant tissues through the development of the root system and possibly facilitating their transfer to the vascular cylinder.

Keywords: Nepeta binaludensis, Morphological traits, Compounds phenol, Mycorrhiza fungi.

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Declaration of conflict of interest

The authors of this study declare that they have no conflict of interest.