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## Effect of Biofertilizers on Agronomic Criteria of Hyssop (*Hyssopus officinalis*)

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Key words: hyssop, biofertilizer, agronomic criteria, essential oil

### Abstract

An experiment was conducted under field conditions to evaluate the effects of pure or combinations of biofertilizers on agronomic and quality criteria of Hyssop (*Hyssopus officinalis*), a medicinal and aromatic plant from Labiateae family at the Research Station of the Faculty of Agriculture, Ferdowsi University of Mashhad, during 2006 and 2007. A complete randomized block design with three replications was used. Treatments containing *Azospirillum/Azotobacter*(Nitroxin), *Azospirillum/Bacillus subtilis/ Pseudomonas fluorescens* (Super Nitro Plus), *Glomus intraradices* (*Mycorrhizal inoculant*), *Pseudomonas fluorescens*, *Glomus intraradices / Pseudomonas fluorescens*, *Azospirillum/ Azotobacter/ Glomus intraradices / Pseudomonas fluorescens* and a control. The results indicated that in general application of biofertilizers enhanced yield and other plant criteria in this plant. In terms of all plant criteria, the plants performed better with application of Super Nitro Plus and a mixture of *Glomus intraradices* and *Pseudomonas fluorescens*.

### Introduction

Good soil fertility management ensures adequate nutrient availability to plants and increases yields. High above-ground biomass yield is obviously accompanied by an active root system, which releases an array of organic compounds into the rhizosphere (Mandal et al., 2007). It is well known that a considerable number of bacterial and fungal species possess a functional relationship and constitute a holistic system with plants. They are able to exert beneficial effects on plant growth (Vessey, 2003) and also enhance plant resistance to adverse environmental stresses, such as water and nutrient deficiency and heavy metal contamination (Wu et al., 2005).

Biofertilizers are products containing living cells of different types of microorganisms (Vessey, 2003; Chen, 2006) that have an ability to convert nutritionally important elements from unavailable to available form through biological processes (Vessey, 2003) and are known to help with expansion of the root system and better seed germination. Biofertilizers differ from chemical and organic fertilizers in that they do not directly supply any nutrients to crops and are cultures of special bacteria and fungi. Some microorganisms have positive effects on plant growth promotion, including the plant growth promoting rhizobacteria (PGPR) such as *Azospirillum*, *Azotobacter*, *Pseudomonas fluorescens*, and several gram positive *Bacillus* spp. (Chen, 2006). The diazotrophic rhizobioceonosis is an important biological process that plays a major role in satisfying the nutritional requirements of the commercial medicinal plants (Deka et al., 1992). The strong and rapidly stimulating effect of fungal elicitor on plant secondary metabolism in medicinal plants has attracted considerable attention and research efforts (Zhao et al., 2005).

*Azotobacter* and *Azospirillum* are free-living N<sub>2</sub>-fixing bacteria that in the rhizospheric zone have the ability to synthesize and secrete some biologically active substances that enhance root growth. They also increase germination and vigor in young plants, leading to improved crop stands (Chen, 2006). Various *Pseudomonas* species have shown to be effective in controlling pathogenic fungi and stimulating plant growth by a variety of mechanisms, including production of siderophores, synthesis of antibiotics, production of phytohormones, enhancement of phosphate uptake by the plant, nitrogen fixation, and synthesis of enzymes that regulate plant ethylene levels (Abdul Jaleel et al., 2007). Arbuscular mycorrhizal fungi (AMF) are a major component of rhizosphere microflora in natural ecosystems and have been reported to form obligate symbiotic associations with most angiospermic plants, including several medicinal species (Venkateshwar Rao et al., 2000). The ability of AMF to enhance host plant uptake of relatively immobile nutrients, in particular P, and several micronutrients, has been the most recognized beneficial effect of mycorrhiza. Therefore, mycorrhizas are multifunctional in (agro)ecosystems, potentially improving physical soil quality (through the external hyphae), chemical soil quality (through enhanced nutrient uptake), and biological soil quality (through the soil food web) (Cardoso and Kuyper, 2006).

Hyssop (*Hyssopus officinalis*), which belongs to the family Labiateae, is a perennial, branched semi-shrub and one of the most important pharmaceutical herbs. Since efficient plant nutrition management should ensure both enhanced and sustainable agricultural production and safeguard the environment, the objective of the present investigation was to evaluate the effects of different biofertilizers on growth and productivity of *H. officinalis*.

### Materials and methods

This experiment was conducted over two years (2006-2007) with a complete randomized block design with three replications. Treatments containing N-fixing *Azospirillum/Azotobacter* (Nitroxin), *Azospirillum/Bacillus subtilis/ Pseudomonas fluorescens* (Super Nitro Plus), *Glomus intraradices* (*Mycorrhizal inoculant*), *Pseudomonas fluorescens* (P solubilizer), *G. intraradices /P. fluorescens*, *Azospirillum/ Azotobacter/G. intraradices /P. fluorescens*, and a control. A few months before the experimental practices were introduced, all plots were given 20 t ha<sup>-1</sup> of cow manure. In April seeds of hyssop were mixed with different biofertilizers on the basis of 21 ha<sup>-1</sup> for Nitroxin, Super Nitro Plus, and *P. fluorescens* and for *Mycorrhizal inoculant* the seeds were inoculated with a proper amount of powder. Arabic gum was used as surfactant. Seeds were planted in early April in plots of 2x2 m in rows 50 cm apart with 40 cm separation between plants in rows. The field was managed organically, with no application of chemicals including fertilizers and pesticides. In the flowering stage, morphological parameters such as plant height and plant diameter were measured in the samples from 1 m<sup>2</sup> of each plot, then the plants were cut at a height of 10 cm above soil level and dried in a shaded area. Dry weight of aerial parts and essential oil content were determined. The essential oil content of the dry herbage was determined by hydro-distillation for 3 h, using a Clevenger-type apparatus. Since this investigation was to compare the treatments' effects in two years, the analysis was done as a split plot design in time, using SAS statistical software (SAS Institute, 2002).

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## Results

Table 1 shows that as expected, although there were some differences in plant height among different biofertilizer sources, the differences were not considerable. However, a pronounced difference could be seen between the control and biofertilizers. This was also true for plant diameter, where the trend was almost the same as with plant height. In other words biofertilizers affected plant height and plant diameter in the same manner.

Although dry weight showed no significant difference in response to biofertilizers, the yield in biofertilized plots were 2-3 times higher than the control. In addition, applications of Super Nitro Plus and a mixture of *G. intraradices* and *P. fluorescens* were more effective in terms of all these plant criteria. A similar trend as with dry matter yield was also observed for essential oil yield. However, no significant effect was observed between control and biofertilizers in terms of percent of essential oil.

**Tab. 1: Mean values for agronomic criteria of hyssop grown under different biofertilizers**

Treatment	Height (cm)	Diameter (cm)	Dry Weight (gm <sup>2</sup> )	Essential Oil (%)	Essential Oil Yield (gm <sup>2</sup> )
B1	54 ab	35 c	566 a	0.7 a	4 a
B2	59 a	44 a	629 a	0.8 a	4 a
B3	52 ab	37 bc	470 a	0.7 a	3 a
B4	52 ab	39 b	558 a	0.7 a	4 a
B5	55 a	39 b	591 a	0.8 a	4 a
B6	53 ab	38 bc	586 a	0.7 a	4 a
Control	48 b	28 d	279 b	0.8 a	2 b

B1: Azospirillum/Azotobacter, B2: Azospirillum/B. subtilis/ P. fluorescens, B3: G. intraradices, B4: P. fluorescens, B5: G. intraradices /P. fluorescens, B6: Azospirillum/Azotobacter/ G. intraradices /P. fluorescens. Means in each column followed by the same letter are not significantly different (P<0.05) using Duncan's Multiple Range Test.

## Discussion

Productivity in an ecosystem is influenced by several factors, such as availability of nutrients and water. In the present study, increases in agronomic criteria were observed following inoculation with biofertilizers. This may be due to better utilization of nutrients in the soil through inoculation of efficient microorganisms. A positive effect of biofertilizers on plant height and diameter has been reported in the literature (Migahed *et al.*, 2004).

In addition, higher dry matter production by the inoculated plant might be because of the augmented uptake of N and P, which in turn was a consequence of the root proliferation. Also, the increased growth parameters in hyssop might be due to the production of growth hormones by the bacteria. Ratti *et al.* (2001) found that a combination of the arbuscular mycorrhizal fungi (*G. aggregatum*), the PGPR (*B.*

*polymyxa*) and *A. brasilense* maximized biomass and P content of the aromatic grass palmarosa (*Cymbopogon martinii*) when grown with an insoluble inorganic phosphate. In general it appears that as expected, application of biofertilizers improved yield and other plant criteria; this has also been reported elsewhere (Venkateshwar Rao *et al.*, 2000). Therefore, it appears that application of these biofertilizers could be promising in production of medicinal and aromatic plants.

## References

- Abdul Jaleel C., Manivannan P., Sankar B., Kishorekumar A., Gopi R., Somasundaram R., Panneerselvam R. (2007). *Pseudomonas fluorescens* enhances biomass yield and almalaine production in *Catharantus roseus* under water deficit stress. Colloids Surf. B: Biointerf. 60:7-11.
- Cardoso I.M., Kuyper T.W. (2006). Mycorrhizas and tropical soil fertility. Agric. Ecosys. and Environ. 116:72-84.
- Chen J (2006). The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility. International Workshop on Sustained Management of the Soil-Rhizosphere System for Efficient Crop Production and Fertilizer Use. 16 - 20 October, Thailand.
- Deka B.C., Bora G.C., Shadique A. (1992). Effect of Azospirillum on growth and yield of chilli (*Capsicum annuum* L.) cultivar Pusa Jawala, Haryana. J. Hort. Sci. 38:41-46.
- Mandal A., Patra A.K., Singh D., Swarup A., Ebin Mastro R. (2007). Effect of long-term application of manure and fertilizer on biological and biochemical activities in soil during crop development stages. Biores. Technol. 98: 3585-3592.
- Migahed H.A., Ahmed A.E., Abd El-Ghany B.F. (2004). Effect of different bacterial strains as biofertilizer agents on growth, production and oil of *Apium graveolense* under Caccareous soil. J. of Agric. Sci. 12: 511-525.
- Ratti N., Kumar S., Verma H.N., Gautams S.P. (2001). Improvement in bioavailability of tricalcium phosphate to *Cymbopogon martinii* var. motia by rhizobacteria, AMF and Azospirillum inoculation. Microbio. Res. 156: 145-149.
- Venkateshwar Rao G.C., Manoharachary C., Kurwan I.K., Rajeshwar Rao B.R. (2000). Arbuscular mycorrhizal fungi associated with some economically important spices and aromatic plants. Philippine J. Sci. 129:1-5.
- Vessey J.K. (2003). Plant growth promoting rhizobacteria as biofertilizers. Plant Soil. 255: 571-586.
- Wu S.C., Caob Z.H., Lib Z.G., Cheung K.C., Wong M.H. (2005). Effects of biofertilizer containing N-fixing, P and K solubilizers and AM fungi on maize growth: a greenhouse trial. Geoderma. 125:155-166.
- Zhao J., Lawrence T., Davis C., Verpoorte R. (2005). Elicitor signal transduction leading to production of plant secondary metabolites. Biotechnol. Advances 23:283-333.