**Journal of Medicinal Plants and By-products (2014) 1: 85-87**

**Short communication**

# The Effect of Chemical and Biological Fertilizers on Flower Yield, Leaf Yield and Essential Oil of Lavender (*Lavandula angustifolia*)

**Hadis Mirrabi[1*], Bohloul Abbaszadeh[2] and Mehrdad Akbarzadeh[1]**

[1]*Department of Horticulture, Miyaneh Branch, Islamic Azad University, Miyaneh, Iran*
[2]*Research Institute of Forests and Rangelands, Tehran, Iran*

Article History: Received: 16 September 2013/Accepted in revised form: 21 April 2014


## Abstract

To study the effect of chemical and biological fertilizers on growth and essential oil content of lavender (*Lavandula angustifolia* Mill.), the present work was conducted in 2012-2013 at the experimental field of Alborz Research Station of the Research Institute of Forests and Rangelands, Karaj, Iran. The experiment was conducted in factorial in the form of a randomized complete block design with three replications and two treatments: chemical nitrogen and phosphorus fertilizers in four levels ($N_0P_0$, $N_0P_{150}$, $N_{300}P_0$, and $N_{300}P_{150}$) and biological fertilizers in four levels (non inoculated control, double inoculation with *Glomus mosseae* + *G. intraradices*, inoculation with *Pseudomonas fluorescens*, and triple inoculation of *G. mosseae* + *G. intraradices* + *P. fluorescens*). Results indicated that chemical and biological fertilizer significantly affected flower yield, flower essential oil content, flower essential oil yield and flower + leaf essential oil yield ($P\leq0.01$). The interaction of the two factors had also a significant effect on flower yield, flower essential oil content (percentage), flower essential oil yield and flower + leaf essential oil yield ($P\leq0.01$). Mean comparison showed that flower yield was the highest in $N_0P_{150}$ × the triple inoculation (3932.5 kg/ha). The highest flower essential oil yield was achieved in N0P150 × the double inoculation with mycorrhiza fungi (114.27 kg/ha). The total essential oil yield of flower + leaf was the highest in $N_0P_{150}$ × the double inoculation with mycorrhizal fungi (144.6 kg/ha) and $N_0P_{150}$ × *P. fluorescens* (134.73 kg/ha). Generally, results indicated that the triple inoculation of *G. mosseae* + *G. intraradices* + *P. fluorescens* gave the best results of essential oil.

**Key words**: Mycorrhiza, Nitrogen, Phosphorus, *Pseudomonas*.

## Introduction

Lavender (*Lavandula angustifolia* L.) is a perennial woody medicinal plant. Its origin is South Europe and Mediterranean area [1,2]. To obtain high yield and quality in lavender production, nutrient management is highly important. A study of the effect of different N fertilizer on yield and quality of basil (*Ocimum basilicum* L.) showed that the highest essential oil content and yield were achieved when 100 kg N/ha was applied [3]. Afkhami [4] found that application of phosphate solubilizing bacteria increased morphological traits and yield of balm (*Melissa officinalis* L.). Koochaki *et al.* [5] also found the significant effect of biofertilizers on shoot yield and essential oil yield of hyssop (*Hyssopus officinalis* L.). Banchio *et al.* [6] inoculated basil with *Bacillus* bacteria and found a significant improvement in shoot yield and essential oil yield. So, the objective of this experiment was to study the effect of different chemical and biological fertilizers on lavender (*L. angustifolia*).

## Material and Methods

This experiment was conducted in 2012-2013 at the experimental field of Alborz Research Station of the Research Institute of Forests and Rangelands, Karaj, Iran. The experiment was conducted in

*****Corresponding author: Department of Horticulture, Miyaneh Branch, Islamic Azad University, Miyaneh, Iran
E-mail Address: hmirrabi@yahoo.com

factorial in the form of a randomized complete block design with three replications and two treatments:

Chemical fertilizer

Chemical nitrogen and phosphorus fertilizers in four levels including $N_0P_0$ ($A_1$), $N_0P_{150}$ ($A_2$), $N_{300}P_0$ ($A_3$), and $N_{300}P_{150}$ ($A_4$). N was provided from urea source and P from triple-superphosphate. Because soil K content was high, no chemical K fertilizer was considered in the treatments (Table 1). Chemical fertilizers were added to the root development depth (0-30 cm) at the field preparation stage.

Biofertilizer

Biological fertilizers were in four levels including: $B_1$: non-inoculated control. $B_2$: double inoculation with *Glomus mosseae* + *G. intraradices* (50:50 ratio). At the time of transplanting in the main field, 10 g of the inoculants was poured under each plant. $B_3$: inoculation with *Pseudomonas fluorescens* strain 187. Before transplanting, plant roots were soaked in the inoculants for 20 minutes and were then transplanted. $B_4$: triple inoculation of *G. mosseae* + *G. intraradices* + *P. fluorescens*. Before transplanting, roots were soaked in the *Pseudomonas* inoculants for 20 minutes and at the time of transplanting, 5 g of the mycorrhiza inoculants were poured under each plant.

For field preparation, a deep moldboard plow, disk and then a leveler was used.

**Table 1** Analysis of variance of the effect of treatments on the measured traits.

| SOV | df | Mean Squares (MS) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Flower yield | Leaf yield | Flower essential oil content | Flower essential oil yield | Leaf essential oil content | Leaf essential oil yield | Flower + Leaf essential oil yield |
| Block | 2 | ** | ns | ** | ns | ns | ns | ns |
| Chemical fertilizer | 3 | ** | ** | ** | ** | ns | ns | ** |
| Biological fertilizer | 3 | ** | ns | ** | ** | ** | ** | ** |
| Chemical × Biological | 9 | ** | ns | ** | ** | ns | ns | ** |
| Error | 30 | 9634.13 | 282569.6 | 0.03 | 50.38 | 0.02 | 47.12 | 76.26 |
| CV (%) | - | 4.8 | 12.83 | 6.67 | 12.68 | 22.54 | 24.13 | 10.34 |

ns, nonsignificant; *, significant at $P\leq0.05$; **, significant at $P\leq0.01$.

**Table 2** The effect of interaction of the two factors on the measured traits.

| Treatment | Flower yield (kg/ha) | Leaf yield (kg/ha) | Flower essential oil content (%) | Flower essential oil yield (kg/ha) | Leaf essential oil content (%) | Leaf essential oil yield (kg/ha) | Flower + leaf essential oil yield (kg/ha) |
|---|---|---|---|---|---|---|---|
| $A_1B_1$ | 1329.17h | 4379.1a-d | 3.24c | 42.81e | 0.56de | 24.6cd | 67.4cd |
| $A_1B_2$ | 1749f | 4474.8abc | 2.44def | 42.4e | 084abcd | 38.11ab | 80.52c |
| $A_1B_3$ | 2181.6de | 3699.3cde | 2.34def | 50.87de | 0.6de | 22.38cd | 73.25cd |
| $A_1B_4$ | 23.57.6c | 4781.7ab | 2.19ef | 51.51de | 0.58de | 28.34bcd | 79.85c |
| $A_2B_1$ | 2134e | 4549.1abc | 2.32def | 49.35de | 0.53e | 24.03cd | 73.38cd |
| $A_2B_2$ | 2440.5c | 4395.6a-d | 4.13a | 100.77b | 1ab | 43.81a | 144.6a |
| $A_2B_3$ | 3140.5b | 4024.4b-e | 3.65b | 114.27a | 0.51e | 20.45cd | 134.73a |
| $A_2B_4$ | 3932.5a | 5195.9a | 2.23def | 87.67c | 0.64cde | 32.08abc | 119.75b |
| $A_3B_1$ | 991.6i | 4248.8a-e | 2.09f | 20.8f | 0.66cde | 27.65bcd | 48.45e |
| $A_3B_2$ | 1530.8g | 4093.7b-e | 2.58d | 39.08e | 1.06a | 43.43a | 82.51c |
| $A_3B_3$ | 1799.05f | 3988.1b-e | 2.34def | 41.81e | 0.73bcde | 29.75bcd | 71.57cd |
| $A_3B_4$ | 2108.33e | 3413.9de | 4.3a | 90.7bc | 0.71bcde | 24.41cd | 115.1b |
| $A_4B_1$ | 1005.95i | 4217.4a-e | 2.26def | 22.63f | 0.55de | 23.31cd | 45.95e |
| $A_4B_2$ | 1782f | 3641.6vde | 2.32def | 41.06e | 0.92bc | 33.64abc | 74.71cd |
| $A_4B_3$ | 1906.67f | 3831.3b-e | 2.19ef | 41.6e | 0.44e | 17.02d | 58.62de |
| $A_4B_4$ | 2326.5cd | 3331.4e | 2.52de | 58.23d | 0.66cde | 22.06cd | 80.3c |

Means in column followed by the same letter are not significantly different at $P\leq0.01$.

$A_1$, $N_0P_0$; $A_2$, $N_0P_{150}$; $A_3$, $N_{300}P_0$; $A_4$, $N_{300}P_{150}$, kg N and P/ha.

$B_1$, non-inoculated; $B_2$, *Glomus mosseae* + *G. intraradices*; $B_3$, *Pseudomonas fluorescens*; $B_4$, *G. mosseae* + *G. intraradices* + *P. fluorescens*.

Plot size was 3 × 3 m, inter-row spacing was 45 cm and on-row spacing was 40 cm. The field was irrigated using drip irrigation system. Before planting lavender transplants to the main field, they were held in frames outside the greenhouse for 14 days. After field preparation, transplants were inoculated with the biofertilizers and were planted. Irrigation was conducted two times a week during the growth season, and weeds were controlled manually four times. The harvest was conducted at the full flowering stage. Essential oil was produced from flowers and leaves (dried under shadow), by hydrodistillation using a Clevenger for two hours. Data were analyzed using SAS 9.1 and means were compared according to the Duncan's multiple range test at P≤0.05, after the normality test was conducted.

## Results and Discussion

Analysis of variance indicated that the chemical fertilizer significantly affected some traits (Table 1).

Mean comparison of the interaction of the two factors (Table 2) indicated that flower yield was the highest (3932.5 kg/ha) in $N_0P_{150}$ × the triple inoculation of mycorrhizae + *Pseudomonas*. Flower essential oil content was the highest in $N_{300}P_0$ × the triple inoculation of mycorrhiza + *Pseudomonas* (4.3%) and in $N_0P_{150}$ × mycorrhizal inoculation (4.13%).

Determining the correlation of the traits indicated that leaf yield was significantly correlated to leaf essential oil yield (Table 3).

**Table 3** The correlation of the measured traits.

| | Leaf yield | Leaf essential oil content | Leaf essential oil yield | Flower essential oil content | Flower essential oil yield |
|---|---|---|---|---|---|
| Leaf yield | 1 | | | | |
| Leaf essential oil content | -0.10ns | 1 | | | |
| Leaf essential oil yield | 0.31* | 0.90** | 1 | | |
| Flower essential oil content | -0.14ns | 0.11ns | 0.06ns | 1 | |
| Flower essential oil yield | 0.01ns | 0.01ns | 0.01ns | 0.72** | 1 |

ns, nonsignificant; *, significant at P≤0.05; **, significant at P≤0.01.

Mean comparison indicated that the highest flower yield was achieved in P fertilizer among chemical treatments, and in the triple inoculation (*G. mosseae* + *G. intraradices* + *P. fluorescens*) among the biological treatments; the interaction of these two treatments had also the highest flower yield which represents that phosphorus has key role in lavender flowering. It seems that in plants with slow growth rate, application of biological fertilizers and organic fertilizers which slowly release nutrients to soil, can increase plant yield and prevent environmental pollutions caused by fast-release chemical fertilizers such as urea.

## References

1. Baytop T. Therapy with Medicinal Plants in Turkey (Past and Present) 3255. Publications of the Istanbul University, Istanbul, Turkey, 1984.
2. Omidbeigi R. Approaches to Production and Processing of Medicinal Plants, Vol. 3. Fekr-e-Ruz Publications, Tehran, Iran, 2006.
3. Dadvand Sarab MR, Naghdi Badi HA, Nasri M, Makki Zadeh M, Omidi H. The variation in basil (*Ocimum basilicum* L.) yield and essential oil as affected by planting interval and nitrogen fertilizer. Journal of Medicinal Plants. 2008;27:60-70.
4. Afkhami S. Effect of phosphate solubilizing bacterial and sulfur on yield and quality of balm (*Melissa officinalis* L.). M.Sc. thesis, Islamic Azad University, Karaj branch, Iran, 2013.
5. Koochaki A, Tabrizi L, Ghorbani R. Effect of biofertilizers on growth and yield of *Hyssopus officinalis*. Iranian Journal of Agronomy Research. 2008;6:127-137.
6. Banchio E, Bogino PC, Zygadlo J, Giordano W. Plant growth promoting rhizobacteria improve growth and essential oil yield in *Organum majorana* L. 2009;36:766-771.