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THE EFFECT OF DIFFERENT FERTILIZATION UPON THE GROWTH AND YIELD OF SOME *LAVANDULA ANGUSTIFOLIA* (MILL.) VARIETIES GROWN IN SOUTH EAST ROMANIA

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Abstract

Lavandula angustifolia (Mill.) is a Mediterranean aromatic shrub known since ancient times for its multiple uses. Over the past decade, this species' large-scale cultivation attracted the attention of local farmers, highlighting the necessity of analyzing and improving those crop management practices that can ensure high lavender yields in different growing conditions. Consequently, this paper aimed to analyze the behavior and yield recorded, under the influence of different organo-mineral fertilization levels, by four varieties of Lavandula angustifolia (Mill.), grown during 2017-2019, in the climatic and soil conditions of southeast Romania (Moara Domnească, Ilfov). In the first year of the crop (I), when mineral fertilization $N_{60}P_{60}K_{60}$ was applied, all researched lavender varieties recorded superior values in terms of flower yield and vegetative development compared to other fertilizations. Vera variety obtained the highest yield for this type of fertilization with a value of 798.3 kg/ha. For the second (II) and third-year (III) of the crop, both the perennial character of the species and a longer availability of soil nutrients ensured by organic fertilization determined higher values of the biometric parameters and superior flower yields. Under organic fertilization (manure 30 t/ha), the highest yields were recorded by Vera, with values of 4,877.3 kg/ha in 2018 (II) and 6,411.2 kg/ha in 2019 (III).

Key words*: lavender, flower yield, biometric parameters, mineral fertilization, organic fertilization.*

INTRODUCTION

Lavender (*Lavandula angustifolia* Mill.) is an aromatic shrub with Mediterranean origins, grown for therapeutic, ornamental, or nutritional purposes. Due to its essential oil content and high-quality (Mac and Harris, 2002; Ion et al., 2008; Sönmez et al., 2018; Kara and Baydar, 2018; Giray, 2018), this shrub is mostly used in the cosmetics and perfumes industries.

In the food industry, lavender flowers are used for tea (Yukes and Balick, 2010), as well as for tinctures and infusions (Smetan, 2018). Various extracts from lavender also help preserve the food or give flavor to bakery products (Jianu et al., 2013; Śmigielski et al., 2013).

The literature identifies 48 species of lavender. For commercial purposes, several species, part of the subgenus *Spica*, are used and recognized for their oil production: *L. angustifolia* (*L. angustifolia* Mill., also known as *L. officinalis*), *Lavandula intermedia* (lavandin or *L. hybrida* L.) and *Lavandula latifolia* (*L. spica*) (Yukes and Balick, 2010; Duskova et al., 2016; Sönmez et al., 2018).

The quantity and quality of lavender oil depend mainly on the species and variety but are influenced by both environmental conditions and crop technology applied upon cultivation and by distillation methods (Parkash and Singh, 2013).

Mineral and organic fertilization are the most important factors of lavender's crop technology as it ensures stable and high yields (Maganga, 2004; Silva et al., 2017; Skoufogianni et al., 2017). Fertilization can be applied in both, autumn and spring (Racz et al., 1970).

Macronutrients (N, P, K) are recommended for lavender crops due to their positive influence on plants' development, inflorescence yield and oil quality (Şekeroğlu and Özgüven, 2008; Yukes and Balik, 2010; Chrysagyris et al., 2017). Also, macronutrients can be used in processes such as photosynthesis and transpiration (Camen et al., 2016). Matysiak and Nogowska (2016) recommend crop fertilization management to be established to protect the environment, due to the increased risk of nitrate pollution.

This research aims to enrich scientific data on lavender cultivation in Romania, where research on *L. angustifolia* (Mill.) grown in field conditions is relatively scarce.

MATERIALS AND METHODS

Field experimental design

Lots of field research was carried out in the experimental farm Moara Domnească (Ilfov county), a subunit of UASVM Bucharest. The soil type was a chromic luvisol, with a clay loam texture (TT), a pH of 7.68 (slightly alkaline) and a humus content of 2.49% (0-20 cm depth).

The design of the field experiment was a Latin Rectangle, with four repetitions and the factors displayed as randomized blocks. Lavender (*L. angustifolia* Mill.) plants were provided by local producers in Onești, Bacău county and Bonțida, Cluj-Napoca county.

Lavender varieties: *Sevstopolis* (a_1), *Vera* (a_2), *Hidcote* (a_3), *Buena Vista* (a_4) were treated with the following fertilization types: $N_0P_0K_0$ (**Ct**; b_1), $N_{60}P_{60}K_{60}$ (b_2), CAN: calcium nitrate N_{60}+$CaO_{15,5}$+$Mg_{11,1}$ (b_3), $N_{30}P_{30}K_{30}$+15 t/ha manure (b_4) and 30 t/ha manure (b_5).

To determine plants behavior in terms of vegetative development, biometric measurement as plants' height and vigor were conducted. In terms of yield, data regarding the number of floral stems and the yield of fresh flowers per plant and per hectare.

Crop establishment

Main soil tillage was carried out in autumn by ploughing the soil 30 cm deep. Mineral and organic fertilizers were applied before planting, in the spring of 2017. Fertilizers were incorporated into the soil at seedbed preparation.

Lavender varieties were planted manually on March 29, 2017, at a density of 16,667 plants/ha, using healthy, rooted seedlings, that were trimmed before planting.

A drip irrigation system was installed after planting to complete in the first two years of the crop (2017 and 2018) the amount of water provided by rainfall, with an irrigation volume of 200 m^3/year (average irrigation).

Mechanical weed harrowing (between rows) and manual weed harrowing (along the rows) were carried out each year, with a higher persistence upon crop establishment (2017) on perennial weed species as: *Sorghum halepense*, *Agropyron repens* and *Convolvulus arvensis*, to efficiently control them in the following years.

Climatic conditions

During the growing season of lavender varieties, temperature (Table 1) in each of the three years of research, had higher values than the specific multiannual average

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Table 1. Climatic conditions in research period of the research period (Moara Domnească, 2017-2019)

Cliamatic factor	Year	Months								
		March	April	May	June	July	August	September	October	Average/ Sum
Average monthly temperature (˚C)	2017	15	16.5	18.6	22.4	26.4	24.2	19.1	11.5	19.2
	2018	3.7	16.4	19.7	22.5	23	24.1	19.2	13.8	17.8
	2019	9.5	11.3	17	23.1	22.6	24.3	19.1	12.6	17.4
	1961-2007	4.8	11.1	16.7	20.4	22.3	21.4	16.6	10.7	15.5
Rainfall (mm)	2017	44.5	90	47.3	46.8	105.2	37.1	37	70.9	478.8
	2018	0.2	0	0	53.2	107.6	2	28.9	10.4	202.3
	2019	31.2	78.4	148.2	109.4	76	2.4	4.8	41.1	491.5
	1961-2007	40	46.9	66	77	67.7	57.4	52.9	41.6	449.5

Compared to the multiannual value, average temperature from March to October had an increase between 1.9ºC (2019) and 3.7ºC (2017).

For 2017 and 2019 the amount of rainfalls was similar to the multiannual average of March-October (449.5 mm). In 2018, precipitation amount during the growing season (202.3 mm)

was -247.2 mm lower than the multiannual average. In April and May, there was no rainfall (Table 1).

Statistical analysis

ANOVA (analysis of variance) was carried out for the statistical analysis of data.

RESULTS AND DISCUSSIONS

Lavender varieties development

Of the four lavender varieties grown in South East Romania, Vera had, in each of the three years of crop development, the highest height and number of floral stems per plant (Table 4).

Plants heights (Table 2) from this variety ranged from 41.3 cm (Ct) to 49.1 cm ($N_{60}P_{60}K_{60}$), in the first year of the crop (I), and reached values between 69.2 cm (Ct) and 82.4 cm (Manure30) by the third year (III) of the crop. At the opposite end, Buena Vista variety had the smallest values in terms of plants height with values ranging from 33.6 cm (Ct, Ist year of the crop) to 62.8 cm (Manure30, IIIrd year of the crop). Sevstopolis variety obtained, for the three years of the crop, average heights between 52.7 cm (Ct) and 62.1 cm (Manure30), while for Hidcote the average height of plants varied from 45.5 cm (Ct) to 55.0 cm (Manure30) (Table 2).

The number of floral stems (Table 3), of these two varieties, was between 55.7 stems/plant (Hidcote, Ist year of the crop) and 729.0 stems/ plant (Sevstopolis, IIIrd year of the crop). The highest number of floral stems was recorded by Vera in the IIIrd year of the crop. The lowest number of floral stems was obtained by Buena Vista in each of the three years of the crop.

Upon crop establishment (Ist year), the highest values of the morphological characters (number of floral stems, height) were obtained for the mineral fertilization $N_{60}P_{60}K_{60}$. Thus, for this treatment, plants height was between 39.8 cm (Buena Vista) and 49.1 cm (Vera), and the number of floral stems was between 53.1 stems/plant (Buena Vista) and 122.0 stems/plant (Vera). In the following years of the crop (IInd and IIIrd) a positive influence was observed when organic fertilizers were used, allowing, through slow release of macronutrients, a longer availability of nutrients for plants.

Table 2. Height (cm) of *Lavandula angustifolia* (Mill.) varieties (Moara Domnească, 2017-2019)

Fertilization	Sevstopolis				Vera				Hidcote				Buena Vista			
	2017	2018	2019	**Avg***	2017	2018	2019	**Avg***	2017	2018	2019	**Avg***	2017	2018	2019	**Avg***
$N_0P_0K_0$ (Ct))	38.4	56.3	63.4	**52.7**	41.3	59.1	69.2	**56.5**	34.6	49.3	52.7	**45.5**	33.6	44.6	49.1	**42.4**
$N_{60}P_{60}K_{60}$	45.1	63.2	70.1	**59.5**	49.1	65.4	75.1	**63.2**	42.3	57.7	58.4	**52.8**	39.8	50.3	55.7	**48.6**
CAN	40.6	61.5	68.5	**56.9**	42.7	63.6	72.5	**59.6**	36.5	54.2	56.1	**48.9**	35.7	48.6	52.6	**45.6**
$N_{30}P_{30}K_{30+}$M15**	42.7	64.8	76.3	**61.3**	45.5	67.3	77.2	**63.3**	39.4	58.6	62.6	**53.5**	37.2	52.8	59.3	**49.8**
Manure30***	39.8	66.7	79.8	**62.1**	43.2	71.0	82.4	**65.5**	35.8	61.4	67.8	**55.0**	34.6	57.2	62.8	**51.5**

Avg. - average of the period 2017-2019;15 t/ha bovine manure;***30 t/ha bovine manure*

Table 3. Number of floral stems per plant of *Lavandula angustifolia* (Mill.) varieties (Moara Domnească, 2017-2019)

Fertilization	Sevstopolis				Vera				Hidcote				Buena Vista			
	2017	2018	2019	**Avg***	2017	2018	2019	**Avg***	2017	2018	2019	**Avg***	2017	2018	2019	**Avg***
$N_0P_0K_0$ (Ct))	65.6	323.0	452.0	**280.2**	72.4	484.0	560.0	**372.1**	55.7	303.9	423.5	**261.0**	53.1	280.8	362.6	**232.2**
$N_{60}P_{60}K_{60}$	106.5	390.4	530.8	**342.6**	122.0	538.8	637.7	**432.8**	102.8	364.7	501.7	**323.1**	98.1	333.4	446.5	**292.7**
CAN	76.9	348.0	488.6	**304.5**	86.1	511.6	604.0	**400.5**	70.3	332.9	479.8	**294.3**	66.7	305.3	431.9	**267.9**
$N_{30}P_{30}K_{30+}$M15**	84.8	454.9	599.1	**379.6**	93.0	631.7	702.1	**475.6**	79.5	425.4	560.2	**355.0**	72.4	408.8	510.8	**330.6**
Manure30***	74.6	588.7	729.0	**464.1**	80.1	769.9	813.2	**554.4**	66.6	487.3	618.9	**390.9**	61.8	477.4	541.1	**360.1**

Avg. - average of the period 2017-2019;15 t/ha bovine manure;***30 t/ha bovine manure*

Thus, for organic fertilization with bovine manure (Manure30) plants height ranged between 57.2 cm (Buena Vista, IInd year of the crop) and 82.4 cm (Vera, IIIrd year of the crop).

The number of floral stems varied from 477.4 stems/plant (Buena Vista, IInd year of the crop) to 813.2 stems/plant (Vera, IIIrd year of the crop).

Yield analysis as influenced by fertilization

Along with its contribution to plants vegetative development in the first year of the crop (I), application of different doses and types of fertilizers (mineral and organic) ensured an increase of fresh flowers yields, both upon the establishment of the crop (I) and in the following two years (II, III). Analyzing the average yield obtained during 2017-2019, by the four lavender varieties (Table 4) it was observed that compared to the unfertilized variant (Ct), where fresh flowers yield was 1,933.9 kg/ha, the complex mineral fertilization ($N_{60}P_{60}K_{60}$) determined a significant yield increase ($p < 0.05$) of 392.4 kg/ha, while the use calcium nitrate (CAN) generated a distinctly significant increase ($p < 0.01$) of 675.6 kg/ha. The highest increase of the average yield, very significant in statistical terms ($p < 0.001$), was obtained for the organic fertilization Manure30 (1,590.6 kg/ha). Compared to control, for the organo-mineral treatment ($N_{30}P_{30}K_{30}$ + M15), the average yield also had a very significant increase, by 943.7 kg/ha. In the first year of the crop (I), the four varieties of lavender obtained an average yield of fresh flowers of 563.3 kg/ha (Table 4) for the control treatment ($N_0P_0K_0$). The use of the mineral fertilizer $N_{60}P_{60}K_{60}$ upon crop establishment determined a very significant yield increase of 141.1 kg/ha.

Table 4. Fertilization influence on flower yield (kg/ha) of *Lavandula angustifolia* (Mill.) varieties (Moara Domnească, 2017-2019)

Lavender variety	Fertilization	2017 (I)		2018 (II)		2019 (III)		Avg*	
		Yield (kg/ha)	Diff. (kg/ha)	Yield (kg/ha)	Diff. (kg/ha)	Yield (kg/ha)	Diff. (kg/ha)	Yield (kg/ha)	Diff. (kg/ha)
Sevstopolis	**$N_0P_0K_0$ (Ct)**	**602.4**	**Ct**	**2,316.2**	**Ct**	**3,239.0**	**Ct**	**2,052.5**	**Ct**
	$N_{60}P_{60}K_{60}$	751.1	148.7***	2,727.3	411.1ns	3,827.9	588.9 ns	2,435.4	382.9 ns
	CAN	683.8	81.4**	3,261.7	945.5***	4,277.9	1,038.9**	2,741.1	688.6***
	$N_{30}P_{30}K_{30+}$M15	708.9	106.5***	3,513.4	1,197.2***	4,750.1	1,511.1	2,990.8	938.3***
	Manure30	667.7	65.3*	4,157.3	1,841.1***	6,194.6	2,955.6	3,673.2	1,620.7***
Vera	**$N_0P_0K_0$ (Ct)**	**638.6**	**Ct**	**2,808.4**	**Ct**	**3,339.0**	**Ct**	**2,262.0**	**Ct**
	$N_{60}P_{60}K_{60}$	798.3	159.7***	3,240.1	431.7 ns	3,950.1	611.1 ns	2,662.8	400.8*
	CAN	715.2	76.6**	3,790.1	981.7***	4,575.1	1,236.1***	3,026.8	764.8***
	$N_{30}P_{30}K_{30+}$M15	740.0	101.4***	4,043.4	1,235.0***	5,027.9	1,688.9***	3,270.4	1,008.5***
	Manure30	702.7	64.1*	4,877.3	2,068.9***	6,411.2	3,072.3***	3,997.1	1,735.1***
Hidcote	**$N_0P_0K_0$ (Ct)**	**551.4**	**Ct**	**2,065.7**	**Ct**	**2,838.9**	**Ct**	**1,818.7**	**Ct**
	$N_{60}P_{60}K_{60}$	673.9	122.5***	2,477.8	412.1 ns	3,455.6	616.7 ns	2,202.4	383.8 ns
	CAN	623.9	72.5**	2,778.9	713.2**	3,922.3	1,083.4**	2,441.7	623.0**
	$N_{30}P_{30}K_{30+}$M15	651.7	100.3***	3,440.1	1,374.4***	4,233.4	1,394.5***	2,775.1	956.4***
	Manure30	615.4	64.0*	3,725.6	1,659.9***	5,794.6	2,955.6***	3,378.5	1,559.9***
Buena Vista	**$N_0P_0K_0$ (Ct)**	**460.6**	**Ct**	**1,916.7**	**Ct**	**2,430.5**	**Ct**	**1,602.6**	**Ct**
	$N_{60}P_{60}K_{60}$	593.9	133.3***	2,344.5	427.8 ns	3,075.4	644.9 ns	2,004.6	402.0*
	CAN	527.8	67.2*	2,627.8	711.1**	3,530.3	1,099.8**	2,228.6	626.0**
	$N_{30}P_{30}K_{30+}$M15	546.6	86.0**	3,016.7	1,100.0***	3,859.9	1,429.4***	2,474.4	871.8***
	Manure30	531.3	70.7**	3,550.1	1,633.4***	5,066.9	2,636.4***	3,049.4	1,446.8***
Avg. varieties	**$N_0P_0K_0$ (Ct)**	**563.3**	**Ct**	**2,276.7**	**Ct**	**2,961.8**	**Ct**	**1,933.9**	**Ct**
	$N_{60}P_{60}K_{60}$	704.3	141.1***	2,697.4	420.7 ns	3,577.2	615.4 ns	2,326.3	392.4*
	CAN	637.7	74.4**	3,114.6	837.9**	4,076.4	1,114.6**	2,609.6	675.6**
	$N_{30}P_{30}K_{30+}$M15	661.8	98.6***	3,503.4	1,226.7***	4,467.8	1,506.0***	2,877.7	943.7***
	Manure30	629.3	66.0*	4,077.6	1,800.8***	5,866.8	2,905.0***	3,524.6	1,590.6***
*Avg. - average of the period 2017-2019		*LSD 5%: 51.5 kg/ha; LSD 1%: 67.8 kg/ha; LSD 0.1%: 88.1 kg/ha*		*LSD 5%: 504.3 kg/ha; LSD 1%: 670.2 kg/ha; LSD 0.1%: 870.7 kg/ha*		*LSD 5%: 649.9 kg/ha; LSD 1%: 863.7 kg/ha; LSD 0.1%:1,122.1 kg/ha*		*LSD 5%: 392.4 kg/ha; LSD 1%: 521.5 kg/ha; LSD 0.1%: 677.5 kg/ha*	

For the second (II) and third (III) of the crop, this treatment generated yield growths compared to the control of 420.7 kg/ha and 615.4 kg/ha respectively, but the differences were not statistically assured.

Compared to control, a very significant yield increase, of 98.6 kg/ha ($p<0.001$), was generated in the first year of the crop (I) by the organo-mineral treatment $N_{30}P_{30}K_{30}$ + M15. For this treatment, in the following years (II,

III), yield growths were also significant, with values of 1,226.7 kg/ha for the IInd and 1,506.0 kg/ha for the IIIrd. Calcium nitrate treatment (CAN) has statistically ensured increases of the average yield obtained by the four lavender varieties, in each of the three years of the crop (Table 4).

Organic fertilization with manure 30 t/ha determined a significant increase (66.0 kg/ha) of the average yield, compared to the unfertilized variant. Longer availability of soil nutrients was provided when applying manure that has generated the growth of the average yield obtained in the IInd and IIIrd year of the crop, with very significant values, of 1,800.8 kg/ha, and 2,905.0 kg/ha, respectively.

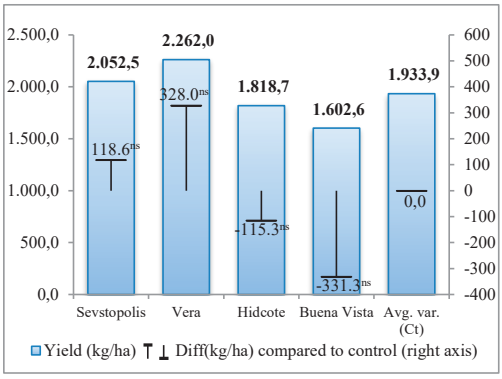
The highest fresh flowers yield growth, due to fertilization, was obtained by Vera variety for the treatment Manure30. This yield increase, of 3,072.3 kg/ha, was obtained in the IIIrd year of the crop and was very significant in statistical terms. The smallest yield increase was generated by the same treatment but in the Ist year of the crop, for the variety Hidcote, with a statistically ensured value of 64.0 kg/ha.

Yield analysis as influenced by variety

Lavender variety influenced the average flowers yield for each of the five fertilization treatments. For the control treatment (Figure 1), compared to the average yield of the four varieties, yield growths of 118.6 kg/ha and 328.0 kg/ha were obtained for the varieties Sevstopolis and Vera.

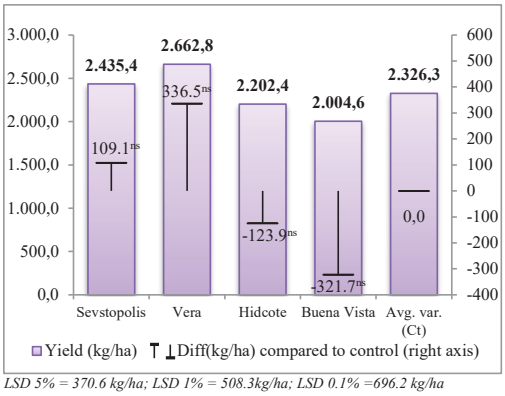
Buena Vista recorded a smaller yield (-331.3 kg/ha) compared to the average yield of the four varieties, and Hidcote also had a smaller yield (-115.3 kg/ha). Both differences were not statistically ensured (Figure 1). When mineral fertilization $N_{60}P_{60}K_{60}$ was applied, Vera obtained a significant yield increase of 417.2 kg/ha compared to the average yield of the varieties, while Buena Vista had a significant yield decrease of -380.9 kg/ha (Figure 2). For Sevstopolis and Hidcote, yield differences were not statistically ensured.

For calcium nitrate (CAN) treatment, Sevtopolis and Vera varieties obtained yield growths of 131.6 kg/ha, and 417.2 kg/ha respectively, only the latter being statistically ensured (Figure 3). Hidcote and Buena Vista varieties had smaller flower yields compared to the average of the four varieties, but only for Buena Vista the difference (-380.9 kg/ha) was significant ($p<0.05$).



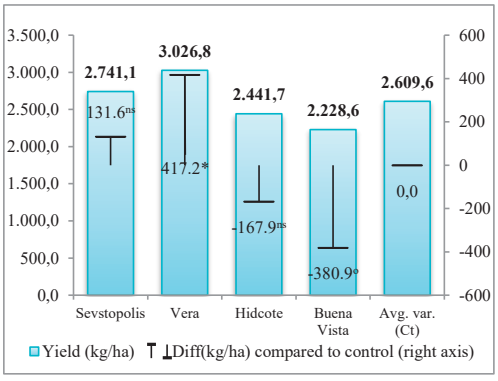
LSD 5% = 370.6 kg/ha; LSD 1% = 508.3kg/ha; LSD 0.1% =696.2 kg/ha

Figure 1. Variety influence on lavender flower yield (kg/ha) for **$N_0P_0K_0$** fertilization, average 2017-2019



LSD 5% = 370.6 kg/ha; LSD 1% = 508.3kg/ha; LSD 0.1% =696.2 kg/ha

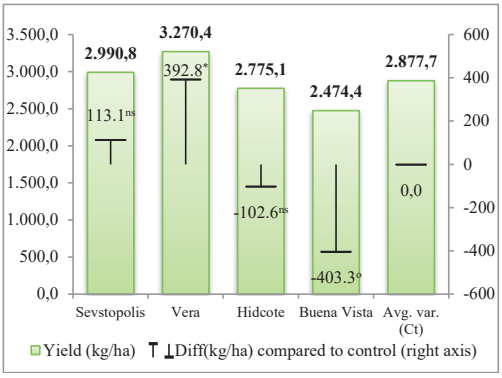
Figure 2. Variety influence on lavender flower yield (kg/ha) for **$N_{60}P_{60}K_{60}$** fertilization, average 2017-2019



LSD 5% = 370.6 kg/ha; LSD 1% = 508.3kg/ha; LSD 0.1% =696.2 kg/ha

Figure 3. Variety influence on lavender flower yield (kg/ha) for **CAN** fertilization, average 2017-2019

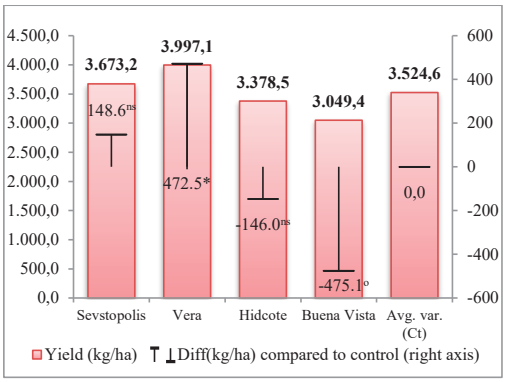
When organo-mineral fertilizer $N_{30}P_{30}K_{60+}M15$ was applied (Figure 4), yield differences were statistically visible for Vera (with a yield increase of 392.8 kg/ha) and Buena Vista (with a yield decrease of -403.3 kg/ha) varieties. For Sevtopolis and Hidcote, yield varied compared to the average of the four varieties, but differences were not significant (p>0.05).



LSD 5% = 370.6 kg/ha; LSD 1% = 508.3kg/ha; LSD 0.1% =696.2 kg/ha

Figure 4. Variety influence on lavender flower yield (kg/ha) for **$N_{30}P_{30}K_{60+}$M15** fertilization, average 2017-2019

For the organic treatment Manure30 (Figure 5), both Sevstopolis and Hidcote obtained yield differences compared to the average yield of the varieties, which were insignificant in statistical terms. On the other hand, Vera and Buena Vista have statistically ensured differences of 472.5 kg/ha and -475.0 kg/ha.



LSD 5% = 370.6 kg/ha; LSD 1% = 508.3kg/ha; LSD 0.1% =696.2 kg/ha

Figure 5. Variety influence on lavender flower yield (kg/ha) for **Manure30** fertilization, average 2017-2019

Analyzing differences among varieties (Table 5) it is observed that, for each fertilization treatment, Vera variety (a_2) had higher fresh flower yields compared to Sevstopolis (a_2), but the differences were not significant (p>0.05). Compared to Hidcote (a_3) and Buena Vista (a_4), Vera also obtained higher yields, and the differences were distinctly and significant.

The same trend was observed for Sevtopolis when compared to Hidcote and Buena Vista. The yield differences between Sevtopolis and Hidcote were not significant, while the increases compared to Buena Vista were statistically ensured.

Hidcote variety obtained higher yields compared to Buena Vista, but the increases were not statistically significant.

Table 5. Yield differences (kg/ha) between *Lavandula angustifolia* (Mill.) varieties (Moara Domnească, average 2017-2019)

Fertilization	**a_2-a_1**	**a_1-a_3**	**a_1-a_4**	**a_2-a_3**	**a_2-a_4**	**a_3-a_4**
$N_0P_0K_0$ (Ct))	209.5^{ns}	233.8 ^{ns}	449.9**	443.3**	659.4**	216.1 ^{ns}
$N_{60}P_{60}K_{60}$	227.4 ^{ns}	233.0 ^{ns}	430.8**	460.4**	658.2**	197.9 ^{ns}
CAN	285.7 ^{ns}	299.4 ^{ns}	512.5**	585.1**	798.1***	213.1 ^{ns}
$N_{30}P_{30}K_{30+}M15$	279.6 ^{ns}	215.7 ^{ns}	516.4**	495.4**	796.0***	300.6 ^{ns}
Manure30	323.9^{ns}	247.7^{ns}	623.8**	618.6**	947.7***	329.1 ^{ns}

LSD 5% = 370.6 kg/ha; LSD 1% = 508.3kg/ha; LSD 0.1% =696.2 kg/ha

Yield correlation to plants development

The average fresh flowers yield of the four lavender varieties was closely related to plants' vegetative development.

The strongest correlation, with a coefficient $r = 0.9390$, was observed between the fresh flower yield and the number of floral stems (Figure 6), and the regression coefficient $R^2 = 0.8817$ highlights that 88% of the yield depends on the number of floral stems.

Analyzing yield as a dependent variable in relation to plants' height reflects a close dependence, supported by a correlation coefficient $r = 0.8594$ (Figure 7).

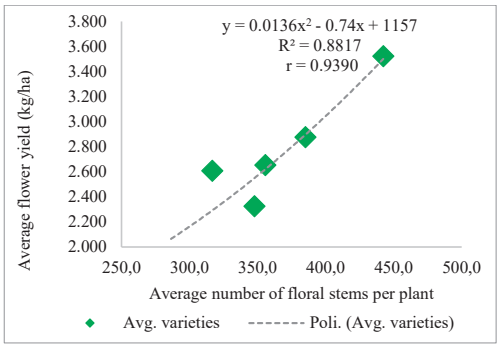


Figure 6. Correlation of lavender flower yield to the number of floral stems, average 2017-2019

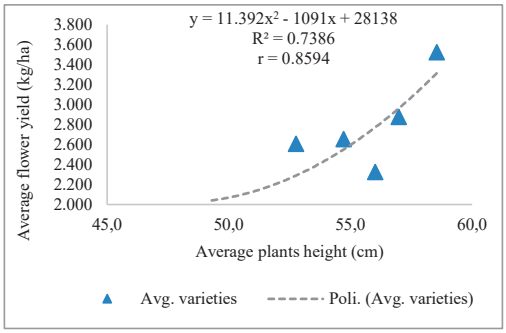


Figure 7. Correlation of lavender flower yield to the height of plants, average 2017-2019

CONCLUSIONS

The results of the research on *Lavandula angustifolia* grown in South East Romania show that both, plants development and fresh flowers yield were influenced by fertilizer's type and amount, but also by the lavender variety.

While in the first year of the crop (I), mineral fertilization generated higher values in terms of plants growth, crop development and yield, for the IInd and IIIrd years, the highest results were obtained when organic fertilization was applied. On crop establishment (I), flower yields were increased due to mineral fertilization by 13.2% (CAN) and 25.7% ($N_{60}P_{60}K_{60}$). Organo-mineral fertilization $N_{30}P_{30}K_{30}$+M15 generated a yield increase of 17.5%, while organic treatment (Manure30) ensured a yield growth of 11.7%. In the following years of crop development, the yield obtained for organic treatment were 4,077.6 kg/ha (II) and 5,866.0 (III), higher by 79.1% and 98.1%, respectively compared to the unfertilized.

Vera was the variety with the most developed plants. This variety also obtained the highest flower yields, in each of the three years of crop development, with values of 798.3 kg/ha (Ist).

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