

Research on the influence of biostimulants and rooting substrate on the production of *Lavandula angustifolia* Mill. seedlings the 'HIDCOTE' variety.

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Abstract

Lavandula angustifolia Mill., belongs to the Lamiaceae family, genus *Lavandula*. This genus includes about 30 species with many subspecies, varieties, local populations and hundreds of hybrids selected for cultivation. The species are widespread in the Mediterranean area, Southern Europe, North-East Africa, Middle Eastern countries, South-West Asia, South-East India. It is a subshrub, with gray-green leaves and purple flowers, fragrant, aromatic, also considered a medicinal plant. It reaches a height of 30 to 70 cm, very well adapted to drier weather and higher altitudes (over 1800 m), but has been cultivated in various regions with temperate climates around the world. The biological material was represented by heel and ring cuttings of the species *Lavandula angustifolia* Mill. variety 'Hidcote'. The cuttings were harvested and made on 15.03.2023 from healthy and vigorous mother plants from their own lavender crop in Manaștur, Arad County. From the analysis of experimental data, it was observed that the substrate variants with the best results in terms of rooting are Peat TS4 Plus medium with perlite and clay, TS4 raw with Greenfibre, and the worst yield is given by Baltic Peat. The most effective biostimulator is the Quik-Link solution, followed by Razormin.

Keywords: lavender, heel cuttings, with ring, substrate and rooting biostimulator

Introduction

Lavandula angustifolia Mill., belongs to the Lamiaceae family, genus *Lavandula*. This genus includes about 30 species with many subspecies, varieties, local populations and hundreds of hybrids selected for cultivation. The species are widespread in the Mediterranean area, Southern Europe, N-E Africa, Middle Eastern countries, South-West Asia, South-East India [8,16]. It is a subshrub, with gray-green leaves and purple flowers, fragrant, aromatic, also considered a medicinal plant. It reaches a height of 30 to 70 cm, very well adapted to drier weather and higher altitudes (over 1800 m), but has been cultivated in various temperate climate regions around the world [1, 2,18]. *Lavandula angustifolia* Mill., has many varieties and horticultural forms, but also genotypes with different provenances, which leads to a different percentage of rooting. That is why the need to apply auxin and the necessary dose at the base of the cutting for rooting cannot be generalized [3]. From *Lavandula angustifolia* Mill., the flowers and leaves are used in the cosmetics, aromatherapy, food industry. Due to the importance of this species, research has been done on the production and growth of lavender seedlings using shading net, and the result has confirmed that lavender can be a crop with great productive potential in the northwestern area of Mexico [12]. The propagation of horticultural plants by cuttings is profitable because it allows the large-scale production of plants genetically identical to the mother plant, from [7,9,13,14]. Very good results are obtained by using artificial mist when watering rooting substrates, hormones and rooting biostimulants [4,19]. The percentage of rooting of lavender cuttings depends on the level of atmospheric humidity and the substrate [17]. Insufficient or excess moisture in the substrate can lead to drying out of the cuttings. Excessive irrigation can lead to a lack of aeration inside the rooting substrate, thus affecting

the rooting processes of the cuttings. The artificial mist system ensures the supply of water in the form of fine particles through nozzles to keep the humidity high for the biological material [15]. A study was carried out on the commercial genotype of lavender (*Lavandula angustifolia* Mill.) on the influence of phosphorus (P) and potassium (K) fertilization on the main physiological processes that take place in lavender and the biochemical characterization of the essential oil obtained [5]. Environmental factors and variety are the factors that influence the compounds of essential oils. [6]. Another study on the influence of organic and mineral fertilizers on the growth and flowering of young lavender plants highlights the fact that organic fertilizer can be used in lavender cultivation, but it is not superior from the perspective of mineral fertilizer yield, but research will continue [1].

Material and Method

The biological material was represented by heel-and-ring cuttings (fig. 1) of the species *Lavandula angustifolia* Mill. 'Hidcote' variety (fig. 2). The cuttings were harvested and made on 15.03.2023 from healthy and vigorous mother plants from their own lavender crop in Manaștur, Arad County (fig.3). The size of both types of cuttings was 12-15 cm in length and 1.5-1.7 mm in diameter. The ring cuttings were cut to 5 mm below the bud, and in the heel cuttings, it was shortened. The leaves were removed from the base on a 5 cm portion using five types of nutrient substrates: TS 3 Medium Basic (Standard) peat - Control, TS 4 Plus peat medium with perlite and clay, TS4 Brut peat plus Greenfibre, Baltic peat, TS 4 medium peat plus clay + Greenfibre and two types of rooting biostimulators: Razormin and Quik-Link, the experiment was multifactorial with three repetitions, 10 cuttings per repetition and 30 cuttings per variation. Randomization resulted in 15 variants for each type of cutting (Fig. 4). The experiment took place in our own solarium, the cuttings were put to root in honeycomb trays filled with the substrate corresponding to each variant and watered every 7 days with rooting biostimulators. The seedlings were obtained after 90 days, on 15.06.2023 and biometric measurements were made using the ruler and the electronic underscore (fig. 5). The characters taken into account were: plant height (cm), plant diameter (mm), number of roots and length of the main root (cm), number of stems. Before starting the measurements, the bale of earth was removed at each seedling. From the analysis of experimental data, it was observed that the substrate variants with the best results in terms of rooting are Peat TS4 Plus medium with perlite and clay, TS4 raw with Greenfibre, and the worst yield is given by Baltic Peat. The most effective biostimulator is the Quik-Link solution, followed by Razormin.



Fig. 1 Types of cuttings



Fig. 2 *Lavandula angustifolia* Mill. variety 'Hidcote'



Fig. 3. Land cultivated with different varieties of *Lavandula angustifolia* Mill. (original)



Fig. 4 Rooting cuttings in honeycomb trays



Fig. 5 Seedlings with substrate bale *Lavandula angustifolia* Mill. 'Hidcote' (original)

Results and Discussion

The nutrient substrate and biostimulants used for the propagation of the cuttings of *Lavandula angustifolia* Mill. variety 'Hidcote', have the role of ensuring the percentage of rooting, by ensuring the level of fertility necessary for the rooting and growth of the plant. The evaluation of the influence of the substrate composition and biostimulants on the physiological and biochemical processes in the plant, on the growth and development of the species was quantified by making biometric measurements on some morphological characters, namely: the height of the seedling, the diameter of the stem at the parcel, the number of roots, the length of the main root, respectively the number of stems as branching of the seedling after rooting, the length and diameter of the first five seedlings Dial. The experimental results obtained in the case of ring cuttings, using the five types of substrate, in the control version without biostimulants, are presented in tables 1, 2 and 3.

Analyzing the experimental results presented in Table 1, regarding the influence of the substrate used for rooting the seedlings of *Lavandula angustifolia* Mill. variety 'Hidcote', without biostimulants, it is observed that, in the ring cuttings, the best degree of rooting is obtained on the substrate of TS4 Brut Peat plus Greenfibre the stems of the seedlings are more vigorous, the root system is developed, the brood has a higher number of saplings, compared to the Baltic peat, a substrate for which low results were observed in terms of the morphological characters analyzed.

Table 1. Average values of morphological characters in seedlings of *Lavandula angustifolia* Mill., variety 'Hidcote' from ring cuttings control version

Type of substrate	Variability	Height (cm) sapling	Stem diameter (mm)	No. of roots (pcs.)	Length of the main root (cm)	No. of branches (branching) (pcs.)
Peat TS 3 Medium Basic (Standard)	X±sX	12,17±6,89	1,63±0,31	3,56±1,92	5,67±3,29	2,11±1,71
	s ²	2,61	0,55	1,38	1,81	1,31
	s%	56,62	18,81	53,90	58,06	81,06
Peat TS 4 Plus medium with perlite and clay	X±sX	9,82±6,14	1,43±0,33	3,00±1,84	2,88±1,9	2,35±1,11
	s ²	2,48	0,57	1,36	1,38	1,06
	s%	62,47	22,84	61,24	65,92	47,38
Peat TS4 Brut plus Greenfibre	X±sX	13,00±8,25	1,92±0,86	3,85±2,51	5,54±3,13	2,46±1,56
	s ²	2,87	0,92	1,58	1,77	1,25
	s%	63,43	44,54	65,30	56,43	63,40
Baltic peat	X±sX	4,52±2,63	1,26±0,12	1,48±0,79	1,83±1,15	1,22±0,74
	s ²	1,62	0,35	0,89	1,07	0,86
	s%	58,08	9,84	53,46	63,20	60,45
TS 4 peat medium plus clay and Greenfibre	X±sX	14,35±7,4	1,86±0,7	3,4±1,67	5,2±3,76	2,3±1,38
	s ²	2,71	0,84	1,28	1,94	1,17
	s%	51,12	37,72	49,03	72,39	60,01

Analyzing the experimental results presented in table 2, regarding the influence of the substrate used for rooting the seedlings of *Lavandula angustifolia* Mill. 'Hidcote' variety, using Razormin solution as a biostimulator for rooting, it is observed that, in ring cuttings, the best degree of rooting is obtained on substrate of TS 4 peat medium plus clay and Greenfibre, the seedling is developed in height and number of stalks, on TS 4 Plus peat substrate medium with perlite and clay compared to those from the Baltic peat substrate.

Table 2. Average values of morphological characters in seedlings of *Lavandula angustifolia* Mill. variety 'Hidcote' from ring cuttings the version with Razormin biostimulator

Type of substrate	Variability	Height (cm) sapling	Stem diameter (mm)	No. of roots (pcs.)	Length of the main root (cm)	No. of branches (branching) (pcs.)
Peat TS 3 Medium Basic (Standard)	X±sX	27,40±2,76	3,00±0,33	5,45±0,69	8,90±2,10	2,95±1,70
	s ²	1,67	0,58	0,83	1,45	1,30
	s%	10,08	11,17	12,59	23,60	57,65
Peat TS 4 Plus medium with perlite and clay	X±sX	29,28±6,89	3,72±0,38	9,36±2,27	7,32±1,28	2,64±1,85
	s ²	2,62	0,61	1,51	1,13	1,36
	s%	23,53	10,12	24,26	17,51	69,92
Peat TS4 Brut plus Greenfibre	X±sX	35,24±5,79	3,68±0,32	10,92±1,66	8,76±0,97	6,96±0,98
	s ²	2,42	0,56	1,29	0,98	0,99
	s%	16,43	8,65	15,18	11,07	14,05
Baltic peat	X±sX	15,86±8,17	1,94±0,21	3,14±1,77	2,86±1,42	2,29±1,35
	s ²	2,86	0,46	1,33	1,19	1,16
	s%	51,51	10,86	56,28	49,85	58,93
TS 4 peat medium plus clay and Greenfibre	X±sX	36,74±2,85	3,62±0,25	9,26±1,51	10,33±1,42	6,19±1,24
	s ²	1,69	0,50	1,23	1,19	1,11
	s%	7,76	6,97	16,29	13,69	20,07

Analyzing the experimental results presented in table 3, regarding the influence of the substrate used for rooting the seedlings of *Lavandula angustifolia* Mill. 'Hidcote' variety, using Quik-Link solution as a biostimulant for rooting, it is observed that, in ring cuttings, the best degree of rooting and branching of the shoots is obtained on substrate of raw TS 4 peat plus Greenfibre, compared to those from the Baltic peat substrate.

Table 3. Average values of morphological characters in seedlings of *Lavandula angustifolia* Mill. variety 'Hidcote' from ring cuttings the version with Quik-Link biostimulator

Type of substrate	Variability	Height (cm) sapling	Stem diameter (mm)	No. of roots (pcs.)	Length of the main root (cm)	No. of branches (branching) (pcs.)
Peat TS 3 Medium Basic (Standard)	X±sX	27,40±2,76	3,00±0,33	5,45±0,69	8,90±2,10	2,95±1,70
	s ²	1,67	0,58	0,83	1,45	1,30
	s%	10,08	11,17	12,59	23,60	57,65
Peat TS 4 Plus medium with perlite and clay	X±sX	29,28±6,89	3,72±0,38	9,36±2,27	7,32±1,28	2,64±1,85
	s ²	2,62	0,61	1,51	1,13	1,36
	s%	23,53	10,11	24,26	17,51	69,91
Peat TS4 Brut plus Greenfibre	X±sX	35,24±5,79	3,68±0,32	10,92±1,66	8,76±0,97	6,96±0,98
	s ²	2,41	0,56	1,29	0,98	0,99
	s%	16,43	8,65	15,17	11,07	14,05
Baltic peat	X±sX	15,86±8,17	1,94±0,21	3,14±1,77	2,86±1,42	2,29±1,35
	s ²	2,86	0,46	1,33	1,19	1,16
	s%	51,51	10,86	56,28	49,85	58,93
TS 4 peat medium plus clay and Greenfibre	X±sX	36,74±2,85	3,62±0,25	9,26±1,51	10,33±1,41	6,19±1,24
	s ²	1,69	0,50	1,23	1,19	1,11
	s%	7,77	6,97	16,29	13,69	20,07

Analyzing the experimental results presented in Table 4, regarding the influence of the substrate used for rooting the seedlings of *Lavandula angustifolia* Mill. variety 'Hidcote', without biostimulants, it is observed that the best degree of rooting in heel cuttings is obtained on substrate of Peat TS4 Plus medium with perlite and clay, the stems of the seedlings have large diameters, are more rigorous, the root system is well branched and developed, with large lengths of the main root, the sapling develops a relatively large number of saplings, compared to the Baltic peat substrate.

Table 4. Average values of morphological characters in seedlings of *Lavandula angustifolia* Mill. variety 'Hidcote' from cuttings with heel control variant

Type of substrate	Variability	Height (cm) sapling	Stem diameter (mm)	No. of roots (pcs.)	Length of the main root (cm)	No. of branches (branching) (pcs.)
Peat TS 3 Medium Basic (Standard)	X±sX	22,57±1,63	2,13±0,24	10,43±0,93	11,33±1,68	5,29±0,90
	s ²	1,28	0,49	0,96	1,30	0,95
	s%	7,22	11,43	8,88	14,85	17,07
Peat TS 4 Plus medium with perlite and clay	X±sX	26,70±1,49	5,85±8,75	13,45±1,99	12,30±1,03	7,25±2,15
	s ²	1,23	2,96	1,41	1,02	1,47
	s%	5,58	149,53	14,77	8,38	29,64
Peat TS4 Brut plus Greenfibre	X±sX	31,77±3,44	3,00±0,21	10,96±1,66	10,88±1,28	3,77±1,14
	s ²	1,86	0,46	1,29	1,13	1,07
	s%	10,84	7,13	15,15	11,72	30,30
Baltic peat	X±sX	10,44±4,73	1,57±0,29	3,52±1,66	3,28±2,53	1,96±1,51

	s ²	2,17	0,54	1,29	1,59	1,23
	s%	45,27	18,71	47,20	76,99	77,21
TS 4 peat medium plus clay and Greenfibre	X±sX	28,83±4,91	2,84±0,78	9,7±2,34	10,52±2,11	11,26±2,93
	s ²	2,21	0,88	1,53	1,45	1,71
	s%	17,02	27,53	24,18	20,03	25,99

Table 5. Average values of morphological characters in seedlings of *Lavandula angustifolia* Mill. variety 'Hidcote' from cuttings with heel version with Razormin biostimulator

Type of substrate	Variability	Height (cm) sapling	Stem diameter (mm)	No. of roots (pcs.)	Length of the main root (cm)	No. of branches (branching) (pcs.)
Peat TS 3 Medium Basic (Standard)	X±sX	33,28±1,51	3,98±0,46	9,84±0,85	10,52±0,92	6,28±1,34
	s ²	1,23	0,68	0,92	0,96	1,16
	s%	4,55	11,50	8,64	8,73	21,32
Peat TS 4 Plus medium with perlite and clay	X±sX	31,11±1,76	3,80±0,27	20,67±1,69	11,15±1,06	9,41±0,57
	s ²	1,33	0,52	1,30	1,03	0,76
	s%	5,66	7,01	8,16	9,54	6,08
Peat TS4 Brut plus Greenfibre	X±sX	27,76±4,21	2,07±0,17	6,60±0,82	9,24±0,66	9,92±0,49
	s ²	2,06	0,42	0,90	0,81	0,70
	s%	15,15	8,38	12,37	7,18	4,97
Baltic peat	X±sX	12,67±7,58	1,59±0,25	4,00±1,00	5,20±1,37	2,33±1,76
	s ²	2,75	0,50	1,00	1,17	1,33
	s%	59,88	15,99	25,00	26,41	75,40
TS 4 peat medium plus clay and Greenfibre	X±sX	35,38±5,19	3,51±0,54	8,46±2,04	9,29±2,84	12,42±2,78
	s ²	2,28	0,73	1,43	1,68	1,67
	s%	14,68	15,25	24,15	30,52	22,39

Analyzing the experimental results presented in table 5, regarding the influence of the substrate used for rooting the seedlings of *Lavandula angustifolia* Mill. 'Hidcote' variety, using Razormin solution as a biostimulator for rooting, it is observed that, in heel cuttings, the best degree of rooting is obtained on substrate of TS 4 peat medium plus clay and Greenfibre, the brood is very well developed in height and number of buds, on TS 4 Plus peat substrate medium with perlite and clay the brood has the best developed root system, with the longest length of the main root, while on Baltic peat substrate, low results have been observed in terms of morphological characters.

Table 6. Average values of morphological characters in seedlings of *Lavandula angustifolia* Mill. variety 'Hidcote' from heel cuttings with the Quik-Link biostimulator variant

Type of substrate	Variability	Height (cm) sapling	Stem diameter (mm)	No. of roots (pcs.)	Length of the main root (cm)	No. of branches (branching) (pcs.)
Peat TS 3 Medium Basic (Standard)	X±sX	31,56±2,06	4,37±1,08	10,07±2,00	8,56±0,97	9,89±1,31
	s ²	1,44	1,04	1,41	0,99	1,14
	s%	6,55	24,76	19,84	11,38	13,25
Peat TS 4 Plus medium with perlite and clay	X±sX	40,47±1,43	4,84±0,24	26,47±2,43	19,23±1,45	12,77±1,74
	s ²	1,20	0,49	1,56	1,21	1,32
	s%	3,54	4,94	9,19	7,56	13,60
Peat TS4 Brut plus Greenfibre	X±sX	38,07±2,09	3,69±0,30	10,04±0,59	9,37±1,96	10,48±1,16
	s ²	1,45	0,54	0,77	1,40	1,08

	s%	5,50	8,00	5,85	20,96	11,03
Baltic peat	X±sX	17,20±5,94	1,91±0,28	7,05±2,70	5,20±1,06	2,90±1,71
	s ²	2,44	0,53	1,64	1,03	1,31
	s%	34,56	14,80	38,36	20,31	59,09
TS 4 peat medium plus clay and Greenfibre	X±sX	44,08±2,60	3,59±0,31	14,20±1,83	14,20±1,63	8,84±1,21
	s ²	1,62	0,56	1,35	1,28	1,10
	s%	5,89	8,70	12,86	11,50	13,73

Analyzing the experimental results presented in Table 6, regarding the influence of the substrate used for rooting the seedlings of *Lavandula angustifolia* Mill. 'Hidcote' variety, using as a biostimulator for rooting Quik-Link solution, it is observed that, in heel cuttings, the best degree of rooting and branching of the stems is obtained on the substrate of TS 4 Peat Plus medium with perlite and clay and TS 4 peat medium plus Greenfibre clay, while on Baltic peat substrate, the degree of rooting is very low.

As a synthesis of the data presented in tables 1 to 6, it can be seen that for rooting *Lavandula angustifolia* Mill. 'Hidcote' variety, the heel cuttings variants give superior results compared to ring cuttings, and the substrate variant with the best results in terms of rooting is TS4 Plus peat medium with perlite and clay, and the most effective biostimulator is the Quik-Link solution.

In the following, in order to have a better picture of the biometric data recorded and to be able to evaluate the results, the values obtained for the analyzed morphological characters have been centralized, taking into account the absolute average values, both for the table 7 ring cuttings and for the table 8 heel cuttings.

Table 7. Average values of the quantitative traits analyzed in the seedlings of *Lavandula angustifolia* Mill. variety 'Hidcote' 90 days after cutting in the experimental period March 15 - June 15, 2023 starting from ring cuttings

Type of substrate/ Biostimulator	Height (cm) sapling			Stem diameter (mm)			No. of roots (pcs.)			Length of the main root (cm)			No. of branching branches (pcs.)		
	Control	Razormin	Quik-Link	Control	Razormin	Quik-Link	Control	Razormin	Quik-Link	Control	Razormin	Quik-Link	Control	Razormin	Quik-Link
Peat TS 3 Medium Basic (Standard)	22,57	33,28	31,56	2,13	3,98	4,37	10,43	9,84	10,07	11,33	10,52	8,56	5,29	6,28	9,89
Peat TS 4 Plus medium with perlite and clay	26,70	31,11	40,47	5,85	3,80	4,84	13,45	20,67	26,47	12,30	11,15	19,23	7,25	9,41	12,77
Turbă TS4 Brut plus Greenfibre	31,77	27,76	38,07	3,00	2,07	3,69	10,96	6,60	10,04	10,88	9,24	9,37	3,77	9,92	10,48
Baltic peat	10,44	12,67	17,2	1,57	1,59	1,91	3,52	4,00	7,05	3,28	5,20	5,20	1,96	2,33	2,90
TS 4 peat medium plus clay and Greenfibre	28,83	35,38	44,08	2,84	3,51	3,59	9,70	8,46	14,20	10,52	9,29	14,20	11,26	12,42	8,84

Table 8. Average values of the quantitative traits analyzed in the seedlings of *Lavandula angustifolia* Mill. variety 'Hidcote' 90 days after cutting in the experimental period March 15 - June 15, 2023 starting from heel cuttings

Type of substrate/ Biostimulator	Height (cm) sapling			Stem diameter (mm)			No. of roots (pcs.)			Length of the main root (cm)			No. of branching branches (pcs.)		
	Control	Razormin	Quik-Link	Control	Razormin	Quik-Link	Control	Razormin	Quik-Link	Control	Razormin	Quik-Link	Control	Razormin	Quik-Link
Peat TS 3 Medium Basic (Standard)	12,1 7	19,8 3	27,4 0	1,63	1,67	3,00	3,56	6,50	5,45	5,67	5,67	8,90	2,11	2,5	2,95
Peat TS 4 Plus medium with perlite and clay	9,82	30,8 2	29,2 8	1,43	3,35	3,72	3,00	6,73	9,36	2,88	6,05	7,32	2,35	4,32	2,64
Turbă TS4 Brut plus Greenfibre	13	24,1 5	35,2 4	1,92	2,68	3,68	3,85	6,37	10,9 2	5,54	7,63	8,76	2,46	5,04	6,96
Baltic peat	4,52	9,89	15,8 6	1,26	1,99	1,94	1,48	5,16	3,14	1,83	6,68	2,86	1,22	2,58	2,29
TS 4 peat medium plus clay and Greenfibre	14,3 5	32,1 21	36,7 5	1,86	3,18	3,62	3,40	5,85	9,26	5,20	6,81	10,3 3	2,30	5,23	6,19

Conclusions

Of the two variants subjected to the experiment, heel cuttings develop well-rooted seedlings, with many branches and considerably longer main root lengths, compared to the homologous variant of ring cuttings. It allows a much more efficient absorption of nutrients from the soil and allows the development of the aerial part by growing more shoots.

From the analysis of experimental data, it was observed that the substrate variants with the best results in terms of rooting are Peat TS4 Plus medium with perlite and clay, TS4 raw with Greenfibre, and the worst yield is given by Baltic Peat.

The most effective biostimulator is the Quik-Link solution, followed by Razormin. Rooting is also observed without biostimulants, but the results in terms of crop quality and seedling production yield are lower, compared to their use.

The seedlings obtained from this experiment represented a young crop of *Lavandula angustifolia* Mill., 'Hidcote' variety (fig.5).



Fig. 4 Seedlings transplanted into the field (original)

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