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# The Effects of Growth Regulatory Agents in Varying doses on *Lavandula angustifolia* and *Lavandula × intermedia* Species in Different Rooting Media

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**HIGHLIGHTS**

- Rooting *Lavandula* species in different media.

**Abstract**

Lavender is a valuable ornamental and aromatic plant species with several applications, including food additives, cosmetics, perfumes, medicine, and aromatherapy, owing to its antimicrobial, antibacterial, antiviral, and antioxidant properties, as well as its pleasant odor. The purpose of this study was to determine the rooting capability of lavender species (*Lavandula angustifolia* and *Lavandula × intermedia*) in different media (peat, perlite, peat+perlite) and different doses of indole-3-butyric acid (IBA) (1000, 1500, and 2000 ppm) on cuttings. After 5 seconds in the (IBA) solution, the cuttings were planted in various rooting media in the greenhouse environment. The highest rooting rate, 93%, was obtained from 2000 ppm IBA application in peat+perlite (1:1) medium, whereas the lowest rooting rate, 13%, was obtained from *Lavandula angustifolia* species from control application in peat media. In a peat+perlite (1:1) medium with 1500 ppm, the longest root length was 13.16 cm. IBA application *Lavandula angustifolia* species, the lowest root length in *Lavandula × intermedia* cuttings were 2.7 cm from control application in perlite medium. *Lavandula × intermedia* cuttings in peat medium produced the best results in terms of root number (3.36 pcs/cuttings), while *Lavandula × intermedia* cuttings in perlite medium produced the lowest root number in the control application. In terms of viability rate, both species received high values, with the lowest viability rate obtained from the control application in perlite medium with 80% in *Lavandula angustifolia* species.

**Keywords:** Indol-3-butyric acid (IBA); *Lavandula angustifolia*; *Lavandula X intermedia*; Peat; Perlite; Rooting

## 1. Introduction

Plants are extremely important in nutrition. Medicinal and fragrant plants have been utilized since the dawn of time for a variety of purposes including food, medicine, cosmetics, and spices. Essential oils derived from medicinal and aromatic plants are in great demand due to their antioxidant, antidepressant, antiseptic, antibacterial, analgesic, anti-inflammatory, antifungal, antispasmodic, and sedative characteristics, as well as their relaxing effects (Bousta and Farah 2020). Furthermore, medicinal, and aromatic plants have very powerful organic plant chemicals that, due to the scent molecules they contain, purify the surroundings of illnesses, bacteria, and fungi (Dapkevicius et al. 1998; Klaochanpong et al. 2015; Schippmann et al. 2006). It is

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known that the essential oil and aroma molecules in the lavender plant protect it from many kinds of bacteria. It is used to make medicines for headaches and to boost the immune system. It is also used in the pharmaceutical industry to give some medicines a smell and taste (Hay et al. 1998; Nikolaevskiĭ et al. 1990; Romine et al. 1999).

Lavender (*Lavandula angustifolia* Mill.), and lavender (*Lavandula* × *intermedia* Emeric ex Loisel.) a fragrant herb, has been used since antiquity for both medicinal and essential oil purposes (Jianu et al. 2013; Upson and Andrews 2004). Lavender includes anthocyanins, phytosterols, sugars, minerals, coumaric acid, glycolic acid, valeric acid and its esters, ursolic acid, heparin, coumarin, and tannins in addition to essential oils. In addition, lavender flowers are gathered and utilized in the dried flower industry, and in recent years, they have also been used as bouquet flowers. Lavender is a plant that can yield even in poor soil conditions, has the almost minimal disease and harmful factors in its agriculture, and requires less effort in terms of labor (Anonymous, 2020). The genus *Lavandula* contains 39 wild species (Arabaci et al. 2007). In Turkey, there are two prevalent species of lavender (*L.* × *intermedia* and *L. angustifolia*) (Korkunc 2018).

Today, it is grown in large amounts in Southern Europe, Australia, the USA, French and Bulgaria (Karakas and Scout 2021). According to 2021 statistics, our country produces 6.108 tons of lavender on an area of 35.386 decares. Isparta (1.436 tons) accounts for 23% of total output. This is followed by the provinces of Afyonkarahisar (1.110 tons), Antalya (438 tons), Ankara (403 tons), Denizli (349 tons), and Burdur (320 tons) (Tuik, 2022). Lavender has been traded for the last 40 years in the Lakes Region, where lavender cultivation is intense, and in this process, it has provided an important cultural and agricultural benefit and an additional source of income to the existing rose oil industry. In the region, lavender oil is produced on a small, medium, and large scale. In recent years, due to the interest in lavender flowers and lavender oil, it has become the product of choice for many producers (Anonymous, 2020).

Lavender is a semi-shrub and perennial herb in the *Lamiaceae* family. The lavender plant, which is commonly used for decorative and landscaping purposes, grows to a height of 40-60 cm. The lowest portion of the stem is woody, while the upper portion is green with lance-shaped leaves. Lavender flowers grow on spikes organized in circles at the top of the stalk (3-5 flowers per circle). Although white-flowered (Alba and Nana Alba) and pink-flowered (Rosea) cultivars have been developed, they are pale violet (Góra et al. 2005). The lavender plant can be propagated both vegetatively and generatively. Because the foreign-pollinated lavender plant will exhibit genetic expansion, it can be reproduced vegetatively for seedling production also, the seed germination rate is very low. Certain lavender species can only be propagated through seeds, while others can be grown through shoot cuttings vegetatively, and some lavender species and variants can be propagated more readily and swiftly using both methods. Some research on rooting in lavender cuttings has revealed that there are variances in the type of cuttings taken and the varied rooting media utilized to eliminate these difficulties (Bona et al. 2012).

Many experiments have been conducted to improve rooting, root length, and root number percentages in various rooting media and IBA concentrations, however, it is well-recognized that these studies are quite restricted to lavender. As a result, the goal of this study is to assess the rooting capability of cuttings of high-value *Lavandula* species (*Lavandula angustifolia* and *Lavandula* × *intermedia*) in different habitats (peat, perlite, and peat+perlite) and IBA concentrations (0, 1000, 1500 and 2000 ppm).

## 2. Materials and Methods

This study was carried out in the Research and Application Greenhouse of the Department of Horticulture, Faculty of Agriculture, Selcuk University, between the years 2021-2022. The lavender species *Lavandula angustifolia* and *Lavandula* × *intermedia* were employed in the experiment. *Lavandula angustifolia* and *Lavandula* × *intermedia* species were cut into 15-20 cm long cuttings. To reduce water loss in the cuttings, all the leaves

were cleaned so that 2-3 leaves remained on each cutting and the cuttings obtained from these varieties; practice, in the form of sheaves of cutting, 1-2 cm of the bottom parts were dipped in IBA solution (control, 1000 ppm, 1500 ppm, and 2000 ppm) for five seconds and we waited for the alcohol to release for a short period.

The cuttings were then planted in peat, perlite, and peat+perlite media in three replications, with 15 plants in each replication, using a randomized plot design. To prevent water loss in cuttings, the leaves that grew during the development stage were harvested. Bordeaux slurry was used to prevent the growth of fungal diseases caused by excessive moisture. The viability and rooting rates (%), average root number (pcs/cuttings), and root length (cm) of cuttings were determined in this study. The Duncan's multiple range test (DMTR) was Duncan's multiple range test (DMTR) was used to compare mean values at $p < 0.05$ by SPSS 23.0 software.

## 3. Results

The effects of various rooting media and IBA doses on rooting and several parameters of cuttings of two lavender species were studied in this study (Table 1-2). The effects of different rooting mediums and IBA doses on the rooting rate of cuttings of *Lavandula angustifolia* species are shown in Table 1, and the effects of *Lavandula* × *intermedia* on the viability rate, average root length, average root number, and rooting rate are shown in Table 2. Vitality levels: In both species, the effects of hormone doses and varied rooting media were statistically significant ($p<0.01$). The maximum viability rate (100%) was obtained in *Lavandula angustifolia* species from peat and perlite rooting media and 1000 to 1500 ppm IBA doses. Cuttings administered at 1500 and 2000 ppm in perlite media and 2000 ppm IBA in peat+perlite (1:1) media resulted in the maximum survival rate (100%) in *Lavandula* × *intermedia* species.

The effects of hormone doses and different rooting media on the root length of both species' cuttings were statistically significant ($p<0.01$). When hormone doses were tested, the peat/perlite (1:1) media produced the longest root length (13.16 cm). The control (3 cm) application in perlite media yielded the shortest root length. The longest root length (9.6 cm) was observed in *Lavandula* × *intermedia* species at 1500 ppm IBA dose from perlite media. The control application in perlite media yielded the shortest root length (2.7 cm). Among the species, peat+perlite (1:1) media (13.16 cm) and 1500 ppm IBA dosage produced the best root length findings. When the effects of three different rooting media on some rooting parameters of *Lavandula angustifolia* cultivars (Hemus, Sevtopolis and Drujba) and Super A cultivars of *Lavandula* × *intermedia*, with the lowest root length of 2.34 cm, was obtained from *Lavandula angustifolia* Hemus cultivar in soil (Karakas and Izci 2021). In a study on various aromatic plants, root lengths of 18.89 cm for oil rose, 14.32 cm for berberis, 25.58 cm for rosemary, and 17.26 cm for lavender were obtained in perlite rooting media and treatments of 4000 and 5000 ppm IBA doses, respectively. Perlite medium as a rooting medium has been reported to produce the greatest results (İzgi 2020).

When the root count values in *Lavandula* species were examined, the effect of IBA applications and different rooting media was statistically significantly affected in peat+perlite (1:1) media ($p<0.01$). It was statistically significantly affected in terms of root numbers in peat and perlite media ($p<0.05$). The best root count results were obtained in 2000 ppm IBA application with *Lavandula angustifolia* (3 pcs/cutting) and *Lavandula* × *intermedia* (3.36 pcs/cutting) in peat media the best root number was determined. *Lavandula* × *intermedia* was obtained in peat+perlite (1:1) media (2.5 pcs/cutting). Furthermore, the greatest results in *Lavandula angustifolia* species were achieved in 1500 IBA treatments (2.7 pcs/cutting) in perlite medium and both 1500 (2.76 pcs/cutting) and 2000 (2.46 pcs/cutting) ppm IBA applications in peat+perlite media. The lowest root numbers were found in *Lavandula angustifolia* perlite media (pcs/cutting) and *Lavandula* × *intermedia* peat+perlite media (1.5 pcs/cutting) from 1000 ppm IBA applications.

**Table 1** The effect of different rooting media and IBA doses on the rooting of *Lavandula angustifolia* cuttings

| IBA (ppm) | Rooting medium | | |
|---|---|---|---|
| | **Peat** | **Perlite** | **Peat+Perlite** |
| **Vitality Rate (%)** | | | |
| **0** | 83.0 e | 80.0 e | 90.1 c |
| **1000** | 100.0 a | 100.0 a | 90.0 c |
| **1500** | 100.0 a | 100.0 a | 95.2 c |
| **2000** | 97.0 b | 95.5 c | 100.0 a |
| **Average Root length (cm)** | | | |
| **0** | 3.50 c | 3.0 e | 4.83 d |
| **1000** | 5.50 c | 7.8 cd | 8.90 c |
| **1500** | 6.23 bc | 9.4 a | 13.16 a |
| **2000** | 6.70 b | 8.3 bc | 9.50 c |
| **Average Root number (pcs/cutting)** | | | |
| **0** | 3.0 A | 2.0 BC | 1.70 b |
| **1000** | 2.5 AB | 1.7 C | 2.03 b |
| **1500** | 2.4 AB | 2.7 A | 2.76 a |
| **2000** | 3.0 A | 2.2 ABC | 2.46 a |
| **Rooting Rate (%)** | | | |
| **0** | 13.00 e | 20.0 f | 47.0 d |
| **1000** | 41.00 c | 47.2 d | 40.1 d |
| **1500** | 33.50 b | 47.0 d | 40.0 d |
| **2000** | 27.13 c | 33.5 e | 93.0 a |

A, B P <0.05; a,b P<0.01. There is no difference between the averages indicated with the same letter. (p<0.05)

The influence of rooting material on the rooting rate is statistically significant (p<0.01) in terms of *Lavandula angustifolia* rooting rate. The perlite+peat (1:1) 2000 ppm IBA application resulted in the highest rooting rate of 93%, while in the peat, control application resulted in the lowest rooting rate of 13%. *Lavandula × intermedia* had the highest rooting rate in perlite media (80.1%), followed by control (27.06) and 1000 ppm (27.04) IBA in perlite (33.5%) and peat+perlite (1:1) media. The applications in peat medium yielded the lowest rooting rates. One study found that *L. angustifolia* var. Silver the number of roots, root length, and rooting rate of Silver variety cuttings were determined to be different, and the best rooting rate (95.13%) was determined at a 4000 ppm IBA dose (Kara and Baydar 2011). When lavender and rosemary cuttings were compared to control cuttings in terms of rooting rate, all of the cuttings (100%) were rooted at 6000 ppm, 2000, and 4000 ppm IBA doses in rosemary stem cuttings. The maximum rooting rate (98.33%) was seen in 2000 and 4000 ppm IBA treatments (Arslanoğlu and Albayrak 2011). In one study, the highest rooting rate was achieved from the *Lavandula × intermedia* Super A cultivar in cocopeat media (62%), whereas the lowest rooting rate was obtained from the *Lavandula angustifolia* Sevtopolis and Drujba cultivars in soil (60%). (Karakas and Izgi 2021). Izgi (2020), in the research that different media and in the study in which the effects of different IBA doses on some rooting parameters were investigated, the cuttings were treated with IBA Control-0, 1000, 2000, 3000, 4000 and 5000 ppm doses and then planted in peat, perlite, peat and perlite mixture (1:1) and cocopeat media. Rooting rates were 95.00% for oil rose, 81.67% for berberis, 88.33% for rosemary and 82.50% for lavender.

In terms of quality rooting and root cutting rate, different IBA doses can be used in rooting studies of lavender plants. Three different rooting media were used, including perlite, peat, and field soil, as well as 500, 1000, 2000, and 4000 ppm IBA doses on lavender (*Lavandula hybrida*) cuttings. Although there was no

significant difference in rooting rate between the media and the doses, 2000 and 4000 ppm IBA doses and commercial rooting rates in lavender were seen when compared to the control cuttings. The majority of the cuttings (76.25%, 87.50%, and 83.75%, respectively) were rooted in the rooting powders, according to the results.

**Table 2** The effect of different rooting media and IBA doses on the rooting of *Lavandula × intermedia* cuttings

| | Rooting medium | | |
|---|---|---|---|
| **IBA (ppm)** | **Peat** | **Perlite** | **Peat +Perlite** |
| | **Vitality Rate (%)** | | |
| **0** | 87.0 d | 90.5 d | 87.1 d |
| **1000** | 93.0 c | 97.7 b | 87.1 d |
| **1500** | 93.3 c | 100.0 a | 90.0 b |
| **2000** | 97.3 b | 100.0 a | 100.0 a |
| | **Average Root length (cm)** | | |
| **0** | 7.30 d | 2.7 e | 5.33 d |
| **1000** | 9.00 ab | 4.9 d | 9.33 c |
| **1500** | 8.43 bc | 9.6 a | 11.60 b |
| **2000** | 8.20 c | 7.3 b | 11.30 b |
| | **Average Root number (pcs/cutting)** | | |
| **0** | 2.0 B | 1.63 C | 2.03 b |
| **1000** | 2.0 B | 2.13 ABC | 1.50 c |
| **1500** | 2.5 AB | 2.00 BC | 2.00 b |
| **2000** | 3.4 A | 2.53 AB | 2.50 a |
| | **Rooting Rate (%)** | | |
| **0** | 20.00 d | 33.5 e | 27.06 e |
| **1000** | 27.03 c | 60.0 c | 27.04 e |
| **1500** | 27.30 c | 73.3 b | 40.33 d |
| **2000** | 40.20 d | 80.1 a | 54.00 b |

A,B P <0.05; a,b P<0.01. There is no difference between the averages indicated with the same letter. (p<0.05).

IBA doses were found to enhance rooting, with the maximum rooting (70%) attained with a 4000 ppm IBA treatment (Özcan et al. 2013). In their study titled determination of the appropriate cutting type and IBA dose for cuttings in lavender (*Lavandula angustifolia* Mill.), they obtained a rooting rate of 34.17%-56.67%, the highest rooting rate from 8000ppm IBA dose, and the lowest rooting rate in the control group reported that they obtained (Çiçek and Abdulhabip 2017).

When applied to cuttings of rosemary and sage, commercial preparations containing IBA promoted healthy root formation, the researchers found. Rosemary seedlings grew by a total of 22.68% in length, 18.95% in root length, 21.74% in fresh seedling weight, and 10.29% in dry seedling weight. Sage growth rates outpaced rosemary rates. The findings from experiments including rosemary corroborate our own (Parađiković et al. 2013).

## 4. Discussion

Based on the results of studies conducted with *Lavandula stoechas* (Ayanoğlu et al. 2000), *Lavandula officinalis* (Bhat et al. 2008; Kumar and Sreeja 1996), L. *Salvia indica* L. (Ayanoğlu et al. 2002), *Salvia officinalis* L. (Arslan

et al. 1995; Ayanoğlu and Özkan 2000; Nicola et al. 2003), *Sideritis ssp.* (Gümüşçü and Gümüşçü 2014), *Origanum onites*, (Sarıhan et al. 2003), *Thymus ssp*. (*T. capitatus, T. serpyllum, T. vulgaris* (Lapichino et al. 2006), *T. satureioides*, (Karimi et al. 2014), *Origanum vulgare* L., *Mentha piperita* L. and *Melissa officinalis* (Kuris et al. 1980) plant cuttings, it was determined that IBA applications improved the rooting rate and rooting related features compared to control applications, and that different doses had an effect, although this varied with the species. These broad conclusions corroborate the information we gathered during our study.

Previous research on different IBA doses and rooting media of plant cuttings in several lavender species, as well as the values obtained from lavender cuttings in this study, reveal that rooting values in parallel increase with increasing IBA doses (up to a maximum of 4000 ppm). All factors tested among the species differed according to the different habitats used. Lavender, which has been attempted to be produced primarily in small regions, has increased interest in lavender agriculture in recent years because of its increasing economic relevance.

## 5. Conclusions

One of the most significant constraints to the production of the lavender plant, which is not native to our nation but stands out in terms of essential oil quality, is a lack of saplings. Lavender sapling production from seed is not recommended because of germination problems and genetic expression. For this reason, sapling production is made by cutting, which is one of the vegetative propagation methods. However, the low rooting rate is one of the most important problems in the propagation of lavender by cuttings. In our study, we aimed to determine the effects of different doses of growth regulators on the rooting of *L. angustifola* and *L.* × *intermedia* cuttings in different media. According to these data, the best rooting parameters for *L. angustifolia* species were peat+perlite medium and 2000 ppm IBA dose, whereas the best rooting parameters for *L.* × *intermedia* species were perlite medium and 2000 ppm IBA dose.

**Author Contributions:** The authors have an equal contribution. All authors have read and agreed to the published version of the manuscript.

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