Black Sea Journal of Agriculture
doi: 10.47115/bsagriculture.1213642

Open Access Journal
e-ISSN: 2618 – 6578

Research Article
Volume 6 - Issue 2: 113-116 / March 2023

THE EFFECT OF DIFFERENT PLANT GROWTH HORMONES AND CONCENTRATIONS ON THE REPRODUCTION OF *ROSMARINUS OFFICINALIS* L. WITH SEEDLING PRODUCTION

Meryem YEŞİL[1], Emel KARACA ÖNER[1]*

[1]*Ordu University, Vocational School of Technical Sciences, Department of Crop and Animal Production, 52200, Ordu, Türkiye*

Abstract: To evaluate the proper concentration of plant growth hormone and the suitable plant growth hormone in *Rosmarinus officinalis* L., a significant fragrant, medicinal and herbaceous plant, the study was carried out in a greenhouse during the vegetative period of 2022. In the experiment, peat and vermicompost mixture (3 peat / 1 vermicompost) as the rooting medium, Indole-3-acetic acid (IAA), Indole-3-butyric acid (IBA) and 1-Naphthaleneacetic acid (NAA) hormones were used as plant growth regulators and the concentrations of these hormones were 0, 1000, 2000, 3000, 4000 ppm The Randomised Plot Experiment Design were established three times in the Multiple Comparison Test "LSD". In seedlings removed three months after planting, properties such as seedling height (cm), number of roots (pieces), root length (cm), maximum root length (cm), number of laterals (pieces) and lateral length (cm) were examined. The highest seedling length (19.88 cm) and number of shoots (12.60 pcs), 3000 ppm concentration of Indole-3-acetic acid (IAA), root length (16.30 cm), and 3000 ppm concentration of 1-Naphthaleneacetic acid (NAA) at the highest root length (22.82 cm) came to the fore. In terms of root number, the values found at 3000 ppm concentration of indole acetic acid (19.25 pieces) and naphthalene acetic acid (20.09 pcs) were combined into one statistical group and made up the maximum number of roots. The lateral length control seedlings statistically prevented other applications and produced the highest lateral length (1.99 cm). Therefore, it can be said that Indole-3-acetic acid (IAA) and 1-Naphthaleneacetic acid (NAA), both of which have a concentration of 3000 ppm, are the most suited growth hormones.

Keywords: Growth hormones, *Rosmarinus officinalis* L., Vegetative reproduction

***Corresponding author:** Ordu University, Vocational School of Technical Sciences, Department of Crop and Animal Production, 52200, Ordu, Türkiye
E mail: emelkar55@hotmail.com (E. KARACA ÖNER)
Meryem YEŞİL https://orcid.org/0000-0002-9246-2362
Emel KARACA ÖNER https://orcid.org/0000-0002-1714-7426

Received: December 02, 2022
Accepted: January 10, 2023
Published: March 01, 2023

Cite as: Yeşil M, Karaca Öner E. 2023. The effect of different plant growth hormones and concentrations on the reproduction of Rosmarinus officinalis L. with seedling production. BSJ Agri, 6(2): 113-116.

1. Introduction

The rosemary (*Rosmarinus officinalis* L.) plant, known by names such as kusdili, hasalbal, and akpuren according to the regions in Turkish, is an important medicinal, aromatic and herbaceous plant that belongs to the Lamiaceae family (Begum et al., 2013). Rosemary is a coniferous, occasionally leafless shrub that grows in the Mediterranean region's environment (Satya et al., 2017). It is recognized by the European Union as a safe and effective food preservative (E 392) (Andrade et al., 2018) and is a rich source of antioxidants (Nieto et al., 2018). Tea is used in traditional medicine to treat intestinal parasites, coughing, and colds, whereas oil is used to alleviate rheumatism and joint discomfort (Calvo et. al., 2011; Satya et. al., 2017). It is being researched for the treatment of Alzheimer's disease in modern medicine (Habtemariam, 2016).

In medicinal aromatic plants, some species reproduce vegetatively through organs like lateral stems, root parts like rhizome and stolon, onion, tuber, and corm, while some species reproduce generatively through the use of seeds (Baydar, 2019). As a result of the generative reproduction method's prolonged duration from emergence to flowering and maturation in medicinal aromatic plants, slow growth, issues with seed germination, modifications to the plant's morphology, and a change in the amount of active substance content (essential oil composition) are all consequences (Kara et al., 2011, Baydar, 2019). For plants with low seed retention rates, poor germination power, or opening due to foreign fertilization, the vegetative propagation method is widely used (Parađiković et al., 2013; Baydar, 2019). The plant rosemary is also capable of vegetative and generative reproduction. However, seed production is uncommon since the seeds are very hard and small and the germination rate is very low (Baydar, 2019). To produce high-quality seedlings, many growth hormones are used in vegetative production. These hormones are chemical compounds that are used topically to aid in rooting, speed up rooting, increase the quantity of roots and steels, and shorten rooting time (Parlak, 2008; Boyer and Graves, 2009). Gibberellins, and cytokines are classified as growth promoters among these regulators, while abscisic acid (dormines) inhibitors and ethylene

are classified as ripeners (Algül et al., 2016).

Effective rooting hormones from the auxin group include IAA, IBA, and NAA. In today's world, IBA is the hormone most frequently applied and has a long-lasting impact on rooting plants (Boyer and Graves, 2009; Grunewald et al., 2009).

Obtaining quality seedlings depends significantly on the type and concentration of plant growth regulators. The goal of this study was to examine how hormones and concentrations of the auxin class chemicals NAA, IAA, and IBA, which are the most frequently used in aquaculture, affected the growth of the *Rosmarinus officinalis* L plant from cuttings.

2. Materials and Methods

A trial specimen of the *Rosmarinus officinalis* species was taken from the collection garden of the medical and aromatic plants program at Ordu University's Technical Sciences Vocational School, and body steels measuring 12 cm long from the plant were employed. IAA, IBA and NAA concentrations of 0 ppm, 1000 ppm, 2000 ppm, 3000 ppm, and 4000 ppm were utilized as growth regulators of peat and vermicompost mixture (3 peat/1 vermicompost) as rooting medium. On May 16, 2022, the randomized plot experiment design was used to plant the trial in the vials by dipping the hormone concentrations of IAA, IBA, and NAA for 5 seconds with 3 repetitions and 15 sheets of steel in each repetition. According to the needs of the steels, necessary irrigation was made, and the seedlings were removed after three months. The seedling length (cm), the number of roots (pieces), root length (cm), maximum root length (cm), the number of laterals (pieces), and lateral length (cm) were determined.

The study's data were analyzed using the SAS-JMP 10.0 program by the randomized plot experiment design, and one of the multiple comparison test "LSD" was applied.

3. Results and Discussion

Table 1 presents the analysis findings and the standard deviation values demonstrating the impact of hormone administrations on seedling length, root number, root length, maximum root length, number of laterals, and lateral length of steels. The tested characters' responses to different hormone kinds and hormone concentrations were very significant (P<0.01).

3.1. Seedling Length (cm)

The average seedling height was found 19.88 cm for IAA at 3000 ppm and 15.50 cm for NAA at 4000 ppm; this difference was statistically significant (P<0.01). 1000 ppm (17.07 cm), 4000 ppm (18.39 cm) of IAA, 1000 ppm (17.78 cm), 2000 ppm (17.60 cm) and 3000 ppm (18.37 cm) of IBA, and 3000 ppm (16.86 cm) of NAA are in the same group according to the multiple comparison test.

In terms of hormone kinds, the resulting seedling lengths varied between 16.42 (Control) and 19.88 (3000 ppm) cm in IAA, 15.81 cm (4000 pmm) and 18.37 cm (3000 ppm) in IBA application, and 15.50 cm (4000 pmm) and 16.86 cm (3000 ppm) in NAA hormone. The auxin group includes the plant growth regulators employed in the study. These hormones promote growth by boosting cell division and longitudinal extension (Deytieux-Belleau et al., 2007; Algül et al., 2016). According to the study's findings, in line with the results of the researchers, the maximum seedling size was attained at a 3000 ppm concentration of IAA hormone, one of the auxin growth regulators.

3.2. Number of Roots (pcs)

The highest concentration of 20.09 roots and 3000 ppm of NAA also emerged in the control group with the lowest number of 7.28 roots. The highest values, 19.25 roots measured at 3000 ppm IAA hormone concentration and 20.09 roots that emerged at 3000 ppm NAA concentration, were included in the same statistical group. The results of the study showed that, compared to control seedlings, hormone concentrations increased the number of roots.

Table 1. Descriptive statistical values for *Rosmarinus officinalis* L. seedlings

HC (ppm)	SL (cm)	RN (piece)	RL (cm)	LRL (cm)	NL (piece)	LL (cm)
Control	16.42 ± 2.16 ^{b}	7.28 ± 3.48 ^{c}	10.05 ± 2.75 ^{bc}	14.36 ± 4.49 ^{b}	8.28 ± 2.08 ^{c}	1.99 ± 0.54 ^{a}
IAA 1000	17.07 ± 2.58 ^{ab}	16.71 ± 8.42 ^{ab}	13.83 ± 4.965 ^{ab}	17.95 ± 7.14 ^{ab}	9.76 ± 2.98 ^{abc}	1.51 ± 0.38 ^{abc}
IAA 2000	16.55 ± 3.99 ^{b}	12.20 ± 6.36 ^{abc}	12.33 ± 2.95 ^{abc}	15.76 ± 4.48 ^{ab}	10.10 ± 3.16 ^{abc}	1.39 ± 0.38 ^{bc}
IAA 3000	19.88 ± 3.10 ^{a}	19.25 ± 8.33 ^{a}	11.02 ± 4.47 ^{bc}	14.00 ± 5.07 ^{b}	12.60 ± 3.47 ^{a}	1.62 ± 0.46 ^{abc}
IAA 4000	18.39 ± 1.97 ^{ab}	17.00 ± 6.82 ^{ab}	10.68 ± 3.23 ^{bc}	14.44 ± 4.19 ^{b}	10.94 ± 2.94 ^{abc}	1.56 ± 0.58 ^{abc}
IBA 1000	17.78 ± 4.44 ^{ab}	8.22 ± 6.22 ^{bc}	7.77 ± 5.00 ^{c}	11.94 ± 6.72 ^{b}	8.89 ± 1.76 ^{abc}	1.39 ± 0.265 ^{bc}
IBA 2000	17.60 ± 3.75 ^{ab}	15.10 ± 7.59 ^{ab}	12.94 ± 4.73 ^{abc}	17.53 ± 5.98 ^{ab}	11.40 ± 3.17 ^{ab}	1.28 ± 0.33 ^{c}
IBA 3000	18.37 ± 3.24 ^{ab}	14.40 ± 8.22 ^{abc}	11.57 ± 4.50 ^{abc}	15.87 ± 8.60 ^{ab}	10.53 ± 2.59 ^{abc}	1.49 ± 0.80 ^{abc}
IBA 4000	15.81 ± 2.76 ^{b}	15.88 ± 6.44 ^{ab}	10.58 ± 3.85 ^{bc}	15.34 ± 4.12 ^{ab}	9.56 ± 1.86 ^{abc}	1.42 ± 0.39 ^{abc}
NAA 1000	15.90 ± 2.26 ^{b}	12.85 ± 4.56 ^{abc}	8.97 ± 4.56 ^{c}	13.75 ± 4.11 ^{b}	9.15 ± 2.32 ^{bc}	1.38 ± 0.39 ^{bc}
NAA 2000	16.00 ± 3.17 ^{b}	13.81 ± 7.17 ^{abc}	12.32 ± 7.17 ^{abc}	17.03 ± 3.53 ^{ab}	11.38 ± 3.34 ^{abc}	1.88 ± 0.98 ^{ab}
NAA 3000	16.86 ± 2.19 ^{ab}	20.09 ± 9.18 ^{a}	16.30 ± 9.18 ^{a}	22.82 ± 5.33 ^{a}	11.18 ± 3.49 ^{abc}	1.15 ± 0.29 ^{c}
NAA 4000	15.50 ± 2.78 ^{b}	11.75 ± 4.89 ^{abc}	13.28 ± 4.89 ^{abc}	11.69 ± 4.66 ^{b}	8.50 ± 2.62 ^{bc}	1.51 ± 0.32 ^{abc}

HC= hormone concentrations, SL= seedling length, RN= root number, RL= root length, LRL=longest root length, NL= number of laterals, LL= lateral length (cm), ^{a,b,c}The difference between averages without common letters in the same column is statistically significant (P<0.01).

This outcome was in line with the research's findings that hormone administration promoted rooting (Atıcı, 1999; Şekeroğlu et al., 2001; Ilgın and Bulat, 2001; Uysal et al., 2010; Pulatkan et al., 2018; Sarı and Kaçar, 2019). Additionally, Pulatkan et al. (2018) observed that when IBA, IAA, and NAA hormones were provided at dosages of 0, 1000, 3000, 5000, and 8000 ppm upon rooting of *Berberis thunbergii*, the largest number of roots occurred at the dose of 3000 ppm of each hormone.

3.3. Root Length (cm)

The longest root length was determined at 16.30 cm at an NAA concentration of 3000 ppm, and the root length change was between 7.77 cm and 16.30 cm. When the impact of different hormone types and concentrations on root lengths was studied, root lengths ranged from 10.05 cm (control) to 13.83 cm (1000 ppm) in IAA, 7.7 cm (1000 ppm) to 12.94 cm (2000 ppm) in IBA, and 8.97 cm (1000 ppm) to 16.30 cm (3000 ppm) in NAA. It was discovered during the study that applying 3000 ppm of NAA considerably enhanced the quantity of roots compared to the control plants. This result was consistent with 6000 mg/L NAA application in *Bougainvillea* by Memon et al. (2013), 500 mg/L NAA administration in Oleander (*Nerium oleander*) by Akat et al. (2017), Pulatkan et al. (2018) study in where they reported that 3000 ppm NAA concentration increased root length in *Berberis thunbergii* compared to control plants.

3.4. Maximum Root Length (cm)

The maximum root length was calculated to be 22.82 cm at a 3000-ppm concentration of the NAA hormone. The maximum root lengths were then statistically measured at 1000 ppm (17.95 cm), 2000 ppm (15.76 cm) of IAA, 2000 ppm (17.53 cm), 3000 ppm (15.87 cm), 4000 ppm (15.34 cm) of IBA, and 2000 ppm (17.03 cm) of NAA in the same group. According to the root length data, the maximum root length was observed at an NAA hormone concentration of 3000 ppm. Only 3000 ppm of NAA concentration revealed the highest statistical root length. Other applications did not produce a statistically significant difference ($P>0.01$) from the control group when compared to the other hormones, IAA, IBA, and NAA, which are also widely used commercially to promote root formation in plants (Table 1).

3.5. Number of Laterals (pcs)

The maximum number of laterals was 12.60 of 3000 ppm IAA concentration, and the lowest number of laterals was 8.28 found in control plants. Regarding the number of laterals, there was no statistically significant difference ($P>0.01$) between the other hormone concentrations. It is believed that these seedlings do not have a high branching level, and that branching at a concentration of 3000 ppm IAA has increased the number of laterals (12.60 pcs) (Altun et al., 2021).

3.6. Lateral Length (cm)

The highest lateral length was found in the control group (1.99 cm), which received no treatment, in this study, where it was determined that the lateral length was changed by the administered hormone and hormone concentrations at the 0.01 significant level. The lowest lateral length was 1.28 cm at 2000 ppm IBA hormone concentration and 1.15 cm at 3000 ppm NAA concentration.

4. Conclusion

The seedling height and several laterals at 3000 ppm concentration of IAA hormone have come to the fore in this study studying the effect of IAA, IBA, and NAA hormones on steel production in Rosmarinus *officinalis* L. species. The maximum root length was found at a concentration of NAA hormone of 3000 ppm. The control plants that received no treatment had the highest value regarding lateral length. The IAA and NAA roots determined at 3000 ppm concentrations formed the highest number of roots and were included in the same statistical group. According to the research's findings, a quality seedling of the *Rosmarinus officinalis* L. plant should be produced at hormone and concentration concentrations of 3000 ppm for both IAA and NAA.

Author Contributions

The percentage of the author(s) contributions is present below. All authors reviewed and approved final version of the manuscript.

	M.Y.	E.K.Ö.
C	50	50
D	50	50
S	50	50
DCP	50	50
DAI	50	50
L	50	50
W	50	50
CR	50	50
SR	50	50
PM	50	50
FA	50	50

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

References

Akat H, Demirkan GC, Tuna AL. 2017. The effect of naphthalene acetic acid and some rooting media on rooting abilities and shoot growth of Dwarf Nerium cuttings. J Environ Biol, 38: 903-909.

Algül BE, Tekintaş FE, Günver Dalkılıç G. 2016. The usage of

plant growth regulators and hormone biosynthesis booster applications. J Adnan Menderes Univ Agri Fac, 13(2): 87-95.

Altun B, Güngör R, Çetin AN, Başpınar A, Özkan Z. 2021. Effects of holding time and different IBA doses on rooting of Lavandula angustifolia "Sevtopolis" cuttings. In: Proceedings of the Ahi Evran International Conference on Scientific Research, 30 November - 2 December, Kırşehir, Türkiye, pp: 44-53.

Andrade JM, Faustino C, Garcia C, Ladeiras D, Reis CP, Rijo P. 2018. *Rosmarinus officinalis* L.: An update review of its phytochemistry and biological activity. Future Sci OA, 4(4): 1-18.

Atıcı A. 1999. The effect of naftalen acedic acid on rooting of stem cuttings of of rosemary (*Rosmarinus officinalis* L.). MSch thesis, Ankara University, Gradute School of Natural and Applied Sciences, Department of Agronomy, Ankara, Türkiye, pp: 36.

Baydar H. 2019. Tıbbi ve Aromatik Bitkiler Bilimi ve Teknolojisi. Nobel Yayınevi, Ankara, Türkiye, pp: 2328.

Begum A, Sandhya S, Syed Shaff Ath A, Vinod KR, Swapna R, Banji D. 2013. An in-depth review on the medicinal flora *Rosmarinus officinalis* L. (Lamiaceae). Acta Sci Pol Tech Aliment, 12(1): 61-74.

Boyer NZ, Graves WR. 2009. NAA is more effective than IBA for rooting stem cuttings of two Nyssa spp. J Environ Horticult, 27(3): 183-187.

Calvo MI, Akerreta S, Cavero RY. 2011. Pharmaceutical ethnobotany in the Riverside of Navarra (Iberian Peninsula). J Ethnopharmacol, 135: 22-33.

Deytieux-Belleau C, Gagne S, L'hyvernay A, Donèche B, Geny L. 2007. Possible roles of both Abscisic Acid and Indol-Acetic Acid in controlling Grape Berry ripenıng process. J Int Sci Vigne Vin, 41(3): 141-148.

Grunewald W, Noorden GV, Isterdael GV, Beeckman T, Gheysen G, Mathesius U. 2009. Manipulation of auxin transport in plant roots during Rhizobium symbiosis and nematode parasitism. Plant Cell, 21: 2553-2562.

Habtemariam S. 2016. The therapeutic potential of rosemary (Rosmarinus officinalis) diterpenes for Alzheimer's disease. Hindawi Publishing Corporation Evidence-Based Complementary and Alternative Medicine, London, UK, pp: 14.

Ilgın M, Bulat L. 2001. The Effects of cutting season and different IBA (Indol-3 butyric acide) concentrations on the rooting success of GF-677 cuttings. Alatarım, 13(2):15-22.

Kara N, Baydar H, Erbaş S. 2011. Effects of different cuttings periods and IBA concentrations on rooting ability of some medicinal plant. Horticult Stud, 28(2): 71-81.

Memon N, Ali N, Baloch MA, Chachar Q. 2013. Influence of Naphthalene Acetic Acid (NAA) on sprouting and rooting potential of stem cuttings of Bougaınvillea. Sci Int (Lahore), 25(2): 299-304.

Nieto G, Ros, G, Castillo J. 2018. Antioxidant and antimicrobial properties of Rosemary (*Rosmarinus officinalis*, L.): A Review. Medicines, 5(98): 1-13.

Parađiković N, Zeljković S, Tkalec M, Vinković T, Dervić I, Milica M. 2013. Influence of rooting powder on propagation of Sage (*Salvia officinalis* L.) and Rosemary (*Rosmarinus officinalis* L.) with green cuttings. Poljoprivreda, 19(2): 10-15.

Parlak S. 2008. Defne (*Laurus nobilis* L.)'nin çelikle üretilmesi. T.C Çevre ve Orman Bakanlığı Ege Ormancılık Araştırma Müdürlüğü, Ankara, Türkiye, pp: 71.

Pulatkan M, Yıldırım N, Kaya Şahin E. 2018. Effect of different hormone doses on rooting of Berberis thunbergii "Atropurpurea Nana" cuttings. Turkish J Forestry, 19(4): 386-390.

Sarı Y, Kaçar O. 2019. The effects of different rooting media and IBA doses on rooting of Rosemary (*Rosmarinus officinalis* L.) stem cuttings. Bahçe, 48(1): 27-37.

Satya P, Jones TH, Lopez EM, McFeeters RL, Awadh Ali NA, Mansi I, Al-kaf AG, Setzer WN. 2017. Chemotypic characterization and biological activity of Rosmarinus officinalis. Foods, 6(20): 1-15.

Şekeroğlu N, Kırpık M, Özgüven M. 2001. Effects of different rooting media and IBA concentrations on rooting of Thymbra spicata L. In: Proceedings of the Workshop on Agricultural and Quality Aspects of Medicinal and Aromatic Plants. May 29-June 1, Adana, Türkiye, pp: 211-216.

Uysal F, Atmaca S, Kolak B. 2010. Effects of different NAA concentrations and rooting media on the rooting quality of the Rosemary (*Rosmarinus officinalis* L.). In: Proceedings of the 4th Ornamental Plant Congress, October 14-16, Mersin, Türkiye, pp: 393-397.