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EVALUATION OF ROOTING RESPONSES IN *Lagerstroemia indica* L. CUTTINGS UNDER DIFFERENT GREENHOUSE SETTINGS, ROOTING MEDIA, AND PHYTOHORMONAL APPLICATIONS

PROCJENA UKORJENJIVANJA REZNICA *Lagerstroemia indica* L. U RAZLIČITIM UVJETIMA STAKLENIKA, MEDIJIMA ZA UKORJENJIVANJE I PRIMJENAMA FITOHORMONA

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SUMMARY

Lagerstroemia indica L. is a favored ornamental plant in landscaping projects and its various vegetative parts are widely used in medicine. This study aimed to propagate the species using hardwood cuttings due to its desired traits. For this purpose, three different greenhouse media were set up, each containing perlite and peat rooting media. In each medium, in addition to the control, cuttings treated with 1000 ppm and 5000 ppm doses of indole-3-butyric acid (IBA) and α-naphthaleneacetic acid (NAA), which are auxin group phytohormones, were used. The study's findings revealed that GM-2 (air temperature: 20±2°C; rooting table temperature: 25±2°C) and GM-3 (nylon tunnel greenhouse) had greater rooting percentages and root lengths than GM-1 (air and rooting table temperatures: 20±2°C), which had the highest number of roots. In all three greenhouse conditions, perlite rooting medium had a definite advantage in terms of rooting percentage; nevertheless, peat rooting medium mostly produced greater results with regard to both root length and the number of roots. As a result of the study, the highest rooting percentages were recorded in perlite rooting media, with 90.00% in the NAA 1000 ppm treatment in GM-2 and NAA 5000 ppm treatment in GM-3. Based on these findings, to achieve a high rooting success rate, it can be recommended to use cuttings treated with NAA 1000 ppm in perlite rooting medium in a greenhouse medium where the rooting table temperature is set 5°C higher than the air temperature.

KEY WORDS: Crape myrtle, landscape, vegetative propagation, auxin, rooting percentage

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INTRODUCTION
UVOD

Crape myrtle (*Lagerstroemia indica* L.), a member of the Lythraceae family native to Asia and widely cultivated in tropical regions, is a deciduous shrub or tree, and is highly valued for its ornamental qualities (Williams et al., 2000; Wei & Liu, 2022; Chang et al., 2023). The species is planted as a decorative plant in Türkiye, particularly along roadsides and in parks and gardens in temperate climates (Anşin & Terzioğlu, 1998; Mamıkoğlu, 2015; Koçan & Cengiz-Gökçe, 2021). In addition to being used as an ornamental plant, its roots, bark, leaves and flowers are also used in folkloric medicine, and it has anti-inflammatory, antioxidant, analgesic, anticancer, antimicrobial, antipyretic, anti-Alzheimer's, antidiabetic, hepatoprotective and antithrombin effects (Yang et al., 2011; Ajaib et al., 2016; Al-Snafi, 2019; Behera & Awasthi, 2021). Based on this, it is critical to examine the propagation techniques of crape myrtle since the species is used in landscaping and has potential health advantages.

Rapid production of plants and obtaining individuals with the same genetic structure as the stock plant is possible with the vegetative propagation method (Hartmann et al., 2002; Tchoundjeu et al., 2004), and this method is considered an indispensable tool for the mass propagation of superior trees (Leakey et al., 1994; Poupard et al., 1994; Swamy et al., 2000). Propagation with stem cuttings, as a vegetative propagation method, stands out as the most commonly used method in the production of herbaceous and woody plant species in many parts of the world (Platt & Opitz, 1973; Debnath et al., 1986; Singh et al., 2013). Some internal and external factors affect the rooting ability of ornamental plants when propagated by cuttings. While internal factors include nutrient content stored in the cutting, type of cutting, age of the stock plant, formation of callus and adventitious roots, presence of leaves or buds on the cuttings, etc., external factors include various factors such as phytohormone application, rooting medium, light, and bottom heat application (Hartmann et al., 2002; Sevik & Guney, 2013; Gehlot et al., 2014; Kaushik & Shukla, 2020; Yıldırım et al., 2020; Güney et al., 2021a; Bayraktar et al., 2022).

Plants can be propagated through stem cuttings taken at various seasons from spring to autumn, and even in winter (Pijut & Moore, 2002; Güney et al., 2023). Although it varies by species, one important factor affecting rooting success is the classification of stem cuttings into softwood, semi-hardwood, and hardwood types based on the time of collection and the degree of lignification (Hartmann et al., 2002; Yahyaoğlu & Güney, 2013; Turna, 2017).

Phytohormones, another important factor, synthesized in plant tissues to regulate and promote plant growth such as root formation and shoot development (Dunsin et al., 2016; Monteuuis, 2016), are classified primarily as auxins, gibberellins, cytokinins, abscisic acid, and ethylene (Iqbal et al., 2014). In the method of propagation by stem cuttings, the use of phytohormones is necessary to accelerate or enhance the rooting and growth of the cuttings (Arif et al., 2022). Auxins are phytohormones that have a positive effect on root formation and the quality of stem cuttings (Blythe et al., 2007). Phytohormones such as indole-3-acetic acid (IAA), indole-3-butyric acid (IBA), and α-naphthaleneacetic acid (NAA), which belong to auxins, are used to regulate the rooting ability of stem cuttings. This has been proven by various studies (Tchoundjeu et al., 2002; Gateablé & Pastor, 2006; Husen & Pal, 2007; Sudomo et al., 2013; Bayraktar et al., 2018a; Güney et al., 2023). The concentration of rooting hormone in stem cutting propagation varies according to species, cutting type, season, growth conditions, and cost-effectiveness of hormone components. Selecting the optimal concentration of the rooting hormone is crucial for successful plant production (Kaushik & Shukla, 2020).

The rooting medium, which plays a role in the rooting and vegetative growth of cuttings, directly influences the rooting percentage and root quality (Farooq et al., 2018). A good rooting medium retains water for the plant's use, provides space for aeration and gas exchange, and offers support to the plants (Kumar et al., 2019). Rooting media such as perlite and peat are widely used in plant propagation, and choosing the most suitable medium is important for successful plant production (Popescu & Popescu, 2015; Jaleta & Sulaiman, 2019). In addition, bottom heating application also positively affects rooting success (Grolli et al., 2005; Güney et al., 2021b).

Although some studies have investigated the effects of different factors on the rooting of crape myrtle cuttings (Bandana & Shamet, 2011; Yılmaz & Yıldız, 2020; Temim et al., 2021), a study that evaluates multiple variables together is needed to determine the most suitable propagation conditions. This study's goal was to discover the ideal rooting conditions by evaluating the influence of various greenhouse settings, rooting media, and phytohormones on rooting in crape myrtle propagation via hardwood cutting.

MATERIAL AND METHODS
MATERIJAL I METODE

The current study was conducted in the Research and Application Greenhouse of the Faculty of Forestry of Karadeniz Technical University (KTU) in Trabzon, Türkiye. Cutting materials were taken on March 15 from the last annual shoots of a 20-year-old stock plant of crape myrtle (*Lagerstroemia indica* L.) located in KTU Kanuni Campus. In addition, the materials were obtained from a single stock

Figure 1. General appearance of the stock plant within the growth period and the planted hardwood cuttings in perlite and peat rooting media (from left to right, respectively)

Slika 1. Opći izgled matične biljke tijekom razdoblja rasta i posađene drvenaste reznice u perlitnom i tresetnom supstratu za ukorjenjivanje (s lijeva na desno, redom)

plant in order to prevent genetic variation. The general view of the stock plant is given in Figure 1.

To avoid water loss, hardwood cuttings measuring 10-12 cm in length were planted in the rooting media (RM) on the same day. Plantings were made in perlite and peat rooting media in three different greenhouse media, including two sections of the Research and Application Greenhouse, where environmental conditions such as temperature and humidity can be adjusted by the automation system, and a nylon tunnel greenhouse. Based on this, the general features of the three different greenhouse media designed in the study are as follows.

(i) Greenhouse Medium-1 (GM-1): Temperatures of air and rooting table are 20±2°C.

(ii) Greenhouse Medium-2 (GM-2): Temperatures of air and rooting table are 20±2°C and 25±2°C, respectively.

(iii) Greenhouse Medium-3 (GM-3): Nylon tunnel greenhouse, where air and rooting table temperature regulation is not set and is affected by daily weather.

Temperatures in the GM-3 were obtained by measurements made three times a day throughout the study period. The monthly average temperatures from March to August, when the study was conducted, were determined as 18, 22, 29, 33, 35 and 37°C, respectively. While fogging and misting systems were used in GM-1 and GM-2, irrigation was carried out with the help of pitchers as a result of continuous controls in the GM-3.

For the study, 1000 ppm and 5000 ppm doses of indole-3-butyric acid (IBA) and α-naphthalene acetic acid (NAA), which are among the auxin group phytohormones (PH), were prepared in powder form in order to stimulate the rooting of the cuttings, and just before planting, the cuttings were dipped in these hormones. The study, which involved planting 900 cuttings, was set up in three repetitions using the randomised complete block design. In detail, a total of 720 cuttings including 1 species × 3 greenhouse media × 2 rooting media × 2 phytohormones × 2 doses × 10 cuttings × 3 repetitions and a total of 180 cuttings including 1 species × 3 greenhouse media × 2 rooting media × 10 cuttings × 3 repetitions were used in the study. In summary, cuttings treated with IBA 1000 ppm, IBA 5000 ppm, NAA 1000 ppm and NAA 5000 ppm in addition to the control cuttings and planted in perlite and peat rooting media in GM-1, GM-2 and GM-3 constituted the treatments of the study.

As a result of weekly checks within the scope of the study, the first root formation date was noted. The cuttings that completed the rooting process, identified by the transition of primary root color from white to brown, were removed from the rooting medium without damaging the roots. In addition, rooting percentage (RP), root length (RL) and root number (RN) were determined. The ratio of the number of rooted cuttings to the number of planted cuttings multiplied by one hundred expresses the rooting percentage. Meanwhile, the length of the longest main root represents the root length, and the total number of main roots represents the root number. The data obtained as a result of the study were subjected to univariate analysis of variance and Duncan's multiple range test using the IBM SPSS Statistics 27 program. Using analysis of variance, the statistical significance of greenhouse media, rooting media, phytohormones and the interactions of these factors in terms of rooting percentage, root length and root number parameters were tested. In cases where significant differences were detected, the groups occurring between greenhouse media or phytohormones were determined by Duncan's test. While conducting Duncan's test for greenhouse media, the results of all phytohormones in all rooting media in the relevant greenhouse medium were evaluated together. In contrast, when performing Duncan's test for phytohormones, the results of all rooting media in all greenhouse media for the relevant phytohormone were assessed collectively.

RESULTS
REZULTATI

The formation of callus, which is the proliferated mass of undifferentiated plant cells, did not occur in any treatment within the scope of this study on propagation by cuttings of crape myrtle. The first root formation was observed in the perlite rooting medium in GM-2 after 28 days in IBA 1000 ppm and IBA 5000 ppm treatments. In addition, the entire rooting process of the planted cuttings took approximately five months, and at the end of 149 days, the cuttings were removed from the rooting medium. Table 1 presents the findings of the variance analysis for greenhouse media, rooting media, phytohormones, and the interactions between greenhouse media, rooting media and phytohormones with respect to RP, RL, and RN.

The analysis of variance results revealed statistically significant differences at the 99% confidence level in the rooting percentage among greenhouse media, rooting media, and phytohormones, along with their interactions. Specifically, there were significant differences among greenhouse media and rooting media regarding root length at the 99% confidence level, but no difference was found among phytohormones. Additionally, significant differences were observed only in the interaction between greenhouse media and rooting media at the 95% confidence level. Regarding the number of roots, statistically significant differences were identified at the 95% confidence level among greenhouse media and phytohormones, while significant differences were found at the 99% confidence level among rooting media and the interaction between greenhouse media and rooting media. The average rooting percentages obtained in crape myrtle hardwood cuttings are given in the graph in Figure 2.

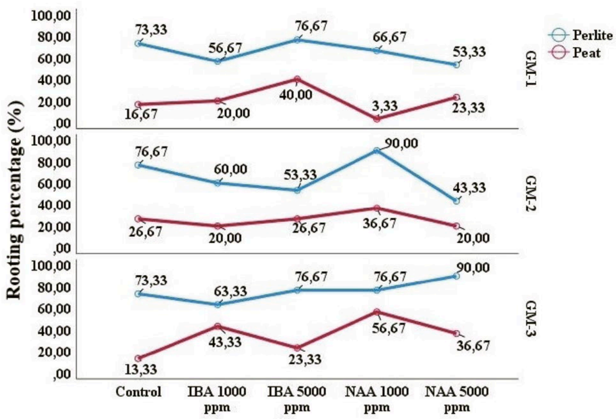
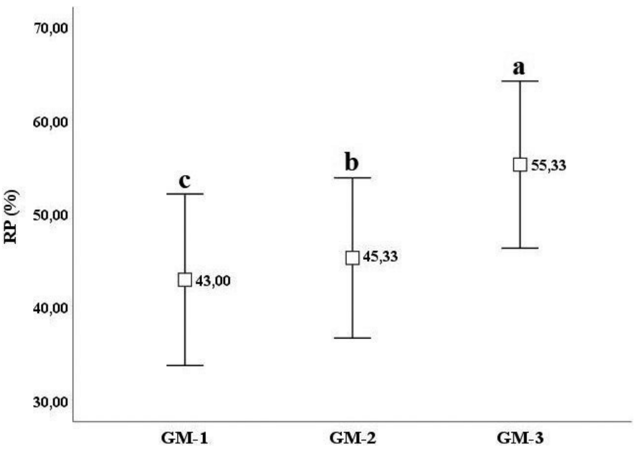


Figure 2. The average rooting percentages depending on the treatments
Slika 2. Prosječni postotci ukorjenjivanja ovisno o tretmanima

The graph revealed that the perlite rooting media resulted with greater rooting success in all greenhouse settings. The perlite rooting medium of GM-2 and GM-3 yielded the greatest rooting percentage of 90.00%. This value was observed in GM-2 with the NAA 1000 ppm treatment, while

Table 1. The findings of variance analysis for RP, RL and RN
Tablica 1. Rezultati analize varijance za PU, DK i BK

	RP (PU)		RL (DK)		RN (BK)	
	F	p	F	p	F	p
GM (SM)	321.913	<0.001**	20.954	<0.001**	3.644	0.027*
RM (UM)	9713.507	<0.001**	16.023	<0.001**	12.629	<0.001**
PH (FH)	92.681	<0.001**	0.329	0.858	2.849	0.024*
GM × RM	16.966	<0.001**	3.727	0.025*	10.348	<0.001**
GM × PH	201.861	<0.001**	1.651	0.109	1.901	0.059
RM × PH	96.235	<0.001**	0.651	0.626	0.806	0.522
GM × RM × PH	97.518	<0.001**	0.617	0.763	1.669	0.105



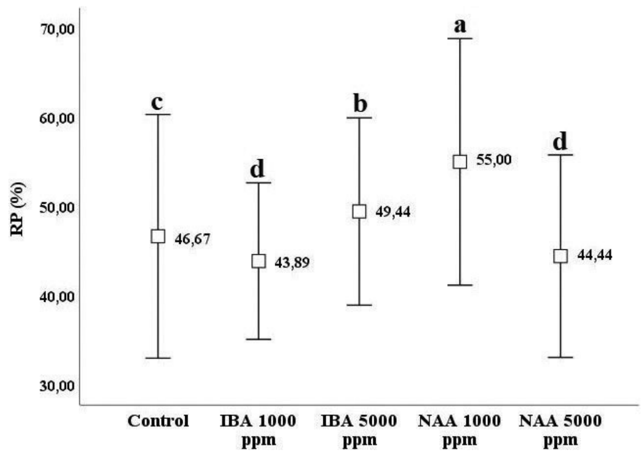


Figure 3. Duncan's test results on rooting percentage in terms of greenhouse media and phytohormones
Slika 3. Rezultati Duncanovog testa za postotak ukorjenjivanja u odnosu na stakleničke medije i fitohormone

in GM-3 it was noted with the NAA 5000 ppm treatment. Conversely, the study's lowest rooting percentage was found as 3.33% in the NAA 1000 ppm treatment within the peat rooting medium in GM-1. The graph below displays the findings of Duncan's test, which was carried out as a result of the differences in the variance analysis of rooting percentages in respect to greenhouse media and phytohormones (Figure 3).

Considering the results of Duncan's test, three distinct groups emerged among greenhouse media in terms of rooting percentage, with each greenhouse medium placed in a separate group. Accordingly, GM-3 formed the first group, while GM-1 constituted the last group. On the other hand, four different groups were established among phytohormone applications regarding rooting percentage. The NAA 1000 ppm treatment, which yielded the highest value, formed the first group; the IBA 5000 ppm treatment formed the second group; the control cuttings formed the third group; and the IBA 1000 ppm and NAA 5000 ppm treatments together formed the fourth group. The average root length values obtained from cuttings are visualized in Figure 4 below.

In terms of root lengths obtained from the hardwood cuttings, longer root lengths were observed in peat rooting medium in all treatments except for IBA 1000 ppm in GM-1, in all treatments in GM-2, and in NAA 1000 ppm and NAA 5000 ppm treatments in GM-3. The longest root length of 26.58 cm was found in the IBA 1000 ppm treatment in GM-2, while the shortest root length of 9.01 cm was recorded in the NAA 1000 ppm treatment in GM-1. Furthermore, it was determined that GM-2 had the highest values in both perlite (except for the control in GM-1) and peat rooting media compared to the results from the other two greenhouse media. This situation was also reflected in the results of Duncan's test regarding root length (Figure 5).

Two different groups were found among the greenhouse media in terms of root length. As a result, GM-2 alone comprised the first group, and GM-1 and GM-3 together made up the second group. The average root number values obtained for all treatments are presented graphically in Figure 6.

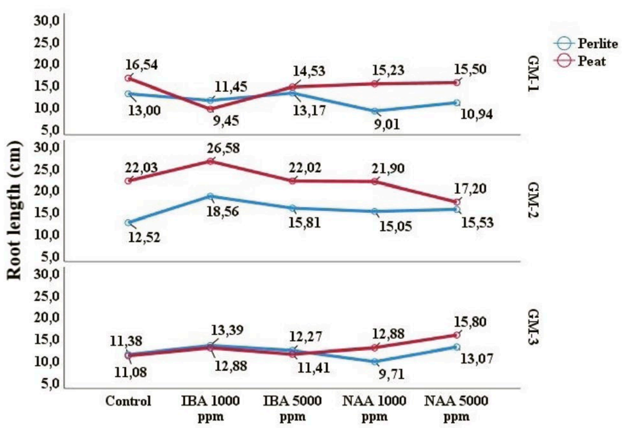


Figure 4. The average root lengths depending on the treatments
Slika 4. Prosječne duljine korijena ovisno o tretmanima

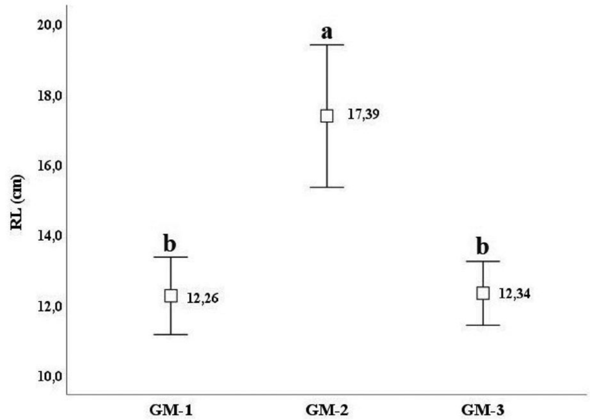


Figure 5. Duncan's test results for root length in greenhouse media
Slika 5. Rezultati Duncanovog testa za duljinu korijena u stakleničkim medijima

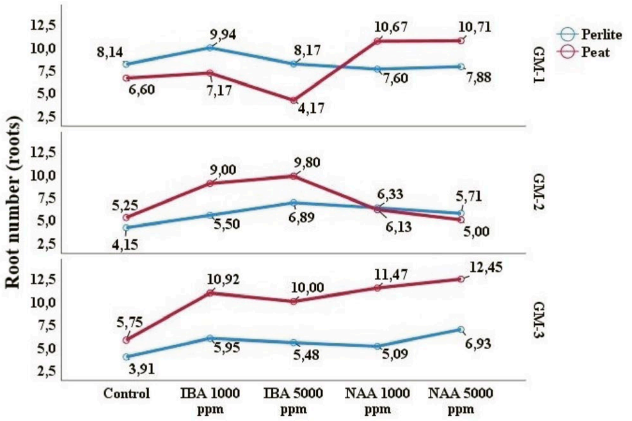


Figure 6. The average root numbers depending on the treatments
Slika 6. Prosječni broj korijena ovisno o tretmanima

In contrast to the situation observed for root lengths among the greenhouse media, GM-2 had the lowest average root number value. The highest root number was determined to be 12.45 roots in the NAA 5000 ppm treatment in the peat rooting medium of GM-3. However, despite GM-2 having the weakest average among the greenhouse media, the lowest root number was found to be 3.91 roots in the control cuttings in the perlite rooting medium of GM-3. The results of Duncan's test regarding the number of roots for the greenhouse media and phytohormones are presented in Figure 7.

Upon examining Figure 7, two distinct groups emerged among the greenhouse media in terms of the number of roots, while three different groups were formed among the phytohormones. GM-1 and GM-3 together constituted the first group, while GM-2 formed the second group on its own. The first group consisted of the IBA 1000 ppm, NAA 1000 ppm, and NAA 5000 ppm treatments; the second group was made up of the IBA 5000 ppm treatment; and the third group had the control cuttings. The images related to the sample rooting status of the hardwood cuttings are presented in Figure 8.

Figure 8. Rooting status of crape myrtle cuttings (Left: IBA 1000 ppm in GM-2; Right: NAA 5000 ppm in GM-3)
Slika 8. Status ukorjenjivanja reznica krep mirte (Lijevo: IMK 1000 ppm u SM-2; Desno: NAK 5000 ppm u SM-3)

DISCUSSION
RASPRAVA

In the present study aimed at rooting the crape myrtle (Lagerstroemia indica L.) using cutting propagation as one of the vegetative methods, high success rates were achieved with the hardwood cuttings planted after applying specific treatments.

According to the study results, it was determined that GM-2 (air temperature: 20±2°C; rooting table temperature: 25±2°C) and GM-3 (nylon tunnel greenhouse) provided more favorable conditions for higher rooting percentage

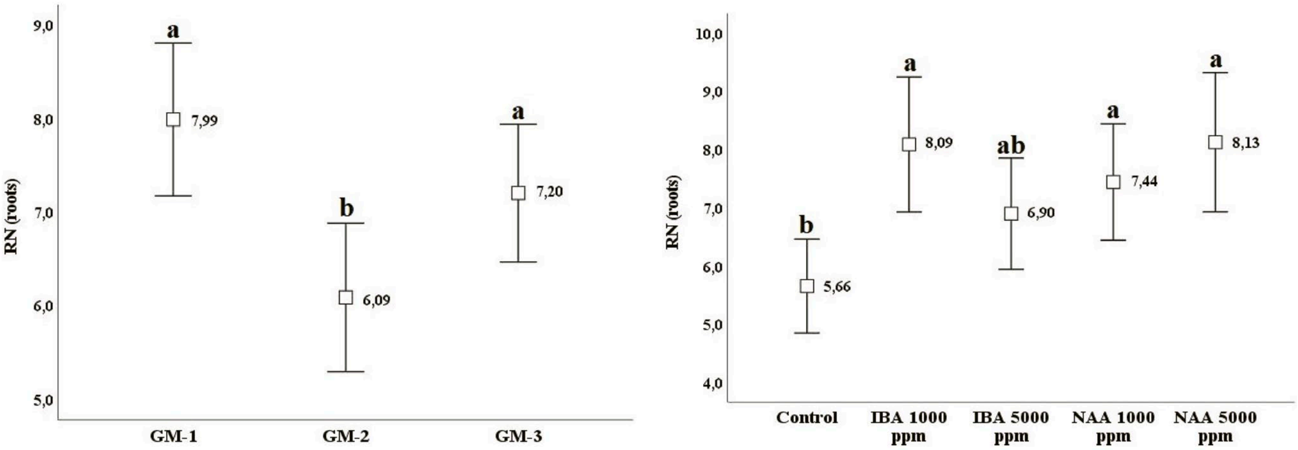


Figure 7. Duncan's test results for the number of roots in greenhouse media and phytohormones
Slika 7. Rezultati Duncanovog testa za broj korijena u stakleničkim medijima i fitohormonima

and root length among the three different greenhouse media evaluated. However, GM-1 (air and rooting table temperatures: 20±2°C) was the medium in which the highest average number of roots was obtained among the greenhouse environments. Furthermore, it is clear from the combined findings of the three greenhouse conditions that perlite rooting medium, which has a higher aeration capacity, is unquestionably more advantageous in terms of rooting percentage when comparing the two rooting media used. However, in terms of root length and the number of roots, peat rooting medium has demonstrated higher or competitive results compared to perlite rooting medium. The reason for this may be that the high aeration and water retention capacity of the perlite rooting medium may have provided a suitable environment for the rooting of cuttings. In a study conducted by Kreen et al. (2002), while stem cuttings had a higher rooting percentage in perlite rooting medium, it was much lower in peat-perlite mixed medium. Various studies have found that raising the temperature of the rooting media by around 5°C above the air temperature improves rooting success (Bayraktar et al., 2018b; Kaya-Şahin et al., 2019; Güney et al., 2021a). The phytohormone α-naphthalene acetic acid (NAA) produced the highest or comparable results in rooting percentage, root length, and the number of roots across various greenhouse and rooting media settings. There are numerous studies stating that exogenous auxin applications positively affect rooting and root morphology in cutting propagation (Copes & Mandel, 2000; Blythe et al., 2007; Pulatkan et al., 2018; Güney et al., 2023; Porras-García et al., 2023).

At the end of the study, approximately five months of rooting processes were completed and the highest rooting percentage values were obtained in perlite rooting media as 90.00% in the NAA 1000 ppm treatment in GM-2 and the NAA 5000 ppm treatment in GM-3. While the greatest root length of 26.58 cm was found in the IBA 1000 ppm treatment in the peat rooting medium in GM-2, the highest values were found in the NAA 5000 ppm treatments in the peat rooting media in GM-1 and GM-3, at 15.50 cm and 15.80 cm, respectively. The maximum average root number was 12.45 roots in the NAA 5000 ppm treatment in the peat rooting medium of GM-3. Again, peat rooting media in GM-1 and GM-2 yielded the highest results in their respective greenhouse environments. Specifically, in GM-1, the highest value of 10.71 roots was obtained with the NAA 5000 ppm treatment, while in GM-2, 9.80 roots were obtained with the IBA 5000 ppm treatment. As a result of literature reviews, it was found that diversified research on the propagation of crape myrtle through cuttings is necessary. However, there are still some previously conducted studies available. In a study conducted by Yılmaz and Yıldız (2020), the highest rooting percentage in softwood cuttings of L. indica was found to be 61.00%, the longest root length was 6.65 cm and the highest number of roots was 13.70 roots in the IBA 2000 ppm treatment. Bandana and Shamet (2011) stated that lateral cuttings of L. indica treated with a formulation of 0.4% IBA + 1% captan + 2% sucrose-talc and planted during the monsoon season (August) achieved a maximum rooting percentage of 86.67%. Again, in another study where softwood and hardwood cuttings of this species were tried to be rooted using 1000, 3000 and 6000 ppm IBA, the best rooting for hardwood cuttings was achieved as 24.07% with IBA 6000 ppm in peat rooting medium, while the best rooting for softwood cuttings was achieved as 42.14% with IBA 3000 ppm in peat rooting medium (Mengüç & Zencirkıran, 1994). Although different on a species basis, Mohamed and Bashir (2023) achieved the highest rooting percentage of 90.00% using hardwood cuttings of L. flos-reginae Retz., with treatments of IBA at 2000 ppm and 3000 ppm. They also obtained the longest root length of 3.90 cm with the IBA 2000 ppm treatment and the highest number of roots, 3.6 roots per cutting, with the IBA 3000 ppm treatment. Razvi et al. (2018) conducted a study on softwood cuttings of L. speciosa (L.) Pers. in June, achieving a rooting percentage of 80.70% with the IBA 2000 ppm treatment, compared to 93.33% in control cuttings. In contrast, Abdul-Matin and Harun-ur-Rashid (1999) achieved the highest rooting percentage of 67.00% with the IBA 8000 ppm treatment in their study conducted on the same species in April. Additionally, in the study by Razvi et al. (2018), the finest values of root length and the number of roots were achieved with the IBA 4000 ppm treatment, measuring 16.60 cm and 4.87 roots, respectively. On the other hand, in the study by Abdul-Matin and Harun-ur-Rashid (1999), these values were 5.50 cm and 3.70 roots, respectively, with the IBA 8000 ppm treatment. Compared to previous studies, higher rooting success was achieved in this study using hard cuttings. In addition, very high values were revealed for root length and the number of roots, which are among the most important morphological root characters.

CONCLUSION
ZAKLJUČAK

As a result of the high rooting success achieved by rooting crape myrtle with hardwood cuttings taken in March, it can be concluded that there is a long collection time of cutting materials for this species outside the growth period. On the other hand, raising the rooting table temperature by 5°C above the air temperature can result in higher rooting percentage and root length values. Although choosing a perlite rooting medium increases the likelihood of success in terms of rooting percentage, peat rooting medium may be preferred to obtain quality saplings with regard to root morphology. Moreover, auxin group phytohormones also had a positive effect on rooting. However, considering that the primary goal in cutting propagation studies is to achieve rooting in cuttings, and taking into account the cost-effectiveness of using the lowest hormone dose, it is reasonable to suggest that using 1000 ppm of NAA hormone is practical for crape myrtle. It is thought that this study, which attempts to reveal the most suitable conditions for the production of this species which has a wide range of uses due to its important effects on landscape and health, will be both a basis for subsequent scientific studies and a guide for sapling producers.

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SAŽETAK

Lagerstroemia indica L. omiljena je ukrasna biljka u projektima uređenja krajobraza, a njezini različiti vegetativni dijelovi uvelike se koriste u medicini. Ova studija imala je za cilj razmnožiti tu vrstu korištenjem drvenastih reznica zbog njezinih poželjnih značajki. U tu svrhu postavljena su tri različita staklenička medija (SM), svaki sa supstratima perlita i treseta za ukorjenjivanje (UM). U svakom mediju, uz kontrolu, korištene su reznice tretirane s dozama od 1000 ppm i 5000 ppm indol-3-maslačne kiseline (IMK) i α-naftalenoctene kiseline (NAK), koje pripadaju skupini fitohormona (FH) auksina. Rezultati istraživanja pokazali su da su SM-2 (temperatura zraka: 20±2 °C; temperatura stola za ukorjenjivanje: 25±2 °C) i SM-3 (staklenik s najlonskim tunelom) imale veće postotke ukorjenjivanja (PU) i duljine korijena (DK) u usporedbi s SM-1 (temperatura zraka i stola za ukorjenjivanje: 20±2 °C), koji je imao najveći broj korijena (BK). U svim trima uvjetima staklenika, perlitni supstrat pokazao je jasnu prednost u pogledu postotka ukorjenjivanja; ipak, tresetni supstrat uglavnom je dao bolje rezultate u pogledu duljine i broja korijena. Kao rezultat istraživanja, najviši postotci ukorjenjivanja zabilježeni su u perlitnom mediju za ukorjenjivanje, s 90.00 % u tretmanu NAK 1000 ppm u SM-2 i tretmanu NAK 5000 ppm u SM-3. Na temelju rezultata studije, za postizanje visokog uspjeha ukorjenjivanja preporučuje se koristiti reznice tretirane s NAK 1000 ppm u perlitnom supstratu za ukorjenjivanje u stakleničkom mediju gdje je temperatura stola za ukorjenjivanje postavljena 5 °C više od temperature zraka.

KLJUČNE RIJEČI: lagerstremija, krajobraz, vegetativno razmnožavanje, auksin, postotak ukorjenjivanja