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Effect of Cutting Type and IBA Concentrations on Rooting of Crape Myrtle Plant (Lagerstroemia Indica L).

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ABSTRACT
The investigation was conducted at the Bakrajo Technical Institute, Sulaimani Politechnic University located in the Kurdistan Region of Iraq, from 1th December to 1th April to examine the implication of various concentrations of IBA (0, 3000, 4000, and 5000 mg. L-) and types of cutting (semi-hardwood and hardwood) on the rooting process in the propagation of Myrtle cuttings. In the experimental investigation, treatments were organized, according to a completely randomized block design, encompassing three replications. The means were differentiated utilizing Duncan's multiple range tests at a significance level of 5%. The cuttings for this research were120 cuttings were collected from the garden of the Bakrajo Technical Institute. In this study, the parameters evaluated included rooting percentage, root length, number of roots per cutting, shoot length, number of leaves per cutting, and shoot diameter.The findings revealed that the two different categories of cuttings exhibit in rooting efficacy across all parameters. Furthermore, elevated concentrations of IBA significantly cause a significant augmentation in the rooting percentage, shoot diameter, leaf number, and root length compared to the control treatment at significance. regarding the interactive effect of the two variables it was determined that cuttings subject to 5000 mg. L-1 IBA with semi-hardwood cutting exhibited the highest (55%) rooting, and the most favorable root and shoot characteristics were attained in the identical interaction as well, shoot length (23.23 cm), shoot diameter (3.05 mm), leaf number (12.00), and root length (33.30 cm). In light of these results, we inferred that the type of cutting and the varying concentrations of IBA, had exerted differential effects on the rooting success of cuttings myrtle). Consequently, this study recommends the propagation of Myrtus indica through semi- hardwood cuttings treated with a 5000 mg-L-1 IBA solution.

***Keywords*:** IBA concentrations, myrtle cuttings, cutting types, vegetative propagation, rooting percentage of cuttings.

Introduction

Myrtle is classified within the Myrtaceae family scientifically designated as Lagerstroemia, and is widely regarded as a fundamental component within numerous horticultural landscapes [1]. Several cultivars of crape myrtle exhibit flowering duration exceeding 100 days, thereby offering a visually attractive landscape feature characterized by a continuously diversifying color spectrum [2]. The myrtle plant is characterized as a perennial shrub or diminutive tree and the occurring myrtle plant exhibits resistance to various diseases and pests, in addition to being resilient against drought and soil stressors. This inherent attribute facilitates the cultivation of myrtle [3]. This species of myrtle is recognized as an ornamental shrub in the context of landscaping, [4]. Lagerstroemia indica L. is primarily spread through woody stem cuttings or seeds also propagated by tissue culture. The method of propagation via cuttings is predominantly favored [5] owing to its advantages, which include simplicity and ease of implementation. Variations in the rooting capabilities of cuttings can be attributed to anatomical, physiological, biochemical, and environmental parameters [6,7]. The propagation of crape myrtle through the utilization of either softwood or hardwood cuttings is extensively acknowledged as a straightforward process [8]. Also [9] indicated that the spread of crape myrtle is most effectively achieved when employing cuttings of semi-hardwood derived from fresh developmentStem cutting enables the production of a substantial number of individuals within a condensed time. Among the numerous forms of asexual propagation, this method is distinguished by its greater prevalence due to its technical simplicity and economic viability in comparison to all alternative methodologies [10]. Also, the type of cutting extraction is pivotal for rooting efficacy in woody plants [11].In addition, the rooting competence of cuttings is determined not by a singular factor, but rather by a specific interplay among them. Several factors recognized to influence rooting in woody species include the kind of cutting (softwood, semi-hardwood, or hardwood cuttings), as well as the rate of food storage in cuttings [12,13], environmental conditions [14], genotype, seasonal variations and application of plant growth regulators [15], wounding [16]. For the general propagation of a majority of plant species via cuttings, the application of Auxin is typically advocated [17]. Auxin treatments are frequently employed in the commercial propagation of plants to enhance overall rooting percentages, expedite the initiation of roots, augment both the quantity and quality of roots, and promote uniformity in rooting processes [10]. Also, the utilization of synthetic auxin is essential for achieving successful rooting in cuttings [18]. The synthetic auxin IBA (indole-3-butyric acid) effectively stimulates root formation by promoting cell division and elongation at the cutting base. This hormone significantly improves rooting efficiency and root system quality, proving especially valuable for difficult-to-root species [5]. In the case of most ornamental shrubs and trees propagated through woody cuttings, the physiological condition of the mother plant, alongside the type of growth regulators employed, constitutes critical factors influencing the success of rooting cuttings.This study aimed to investigate the effects of different IBA concentrations (0, 3000, 4000, and 5000 mg·L⁻ ¹) and cutting types (semi-hardwood and hardwood) on the rooting performance of Lagerstroemia indica cuttings.

Materials and methods

This study was conducted at Bakrajo Technical Institute, Sulaimany Polytechnic University, Bakrajo, Sulaimany city, Kurdistan Region-Iraq, with(350 32, N, 450 21, E) and 743 meters above sea level. Conducted this study spanned four months from 1th December 2024 to 1th April 2025. A low tunnel plastic measuring 2 by 4 by 2 meters in width, length, and height was constructed utilizing a bent metal frame that was coated in clear polyethylene.

Semi-hardwood and hardwood cuttings of crape myrtle (Lagerstroemia indica L.) were collected from mature shrubs (10) years old within the garden of the institute. All cuttings were uniform to a length of (15 cm). The average diameter was approximately (7 mm) for semi-hardwood and (10 mm) for hardwood cuttings. After preparation, the cuttings were immediately transferred to the plastic house for hormone treatment, and the total of cuttings was 120 cuttings, ware 60 cuttings from the category of semi-hardwood, and 60 cuttings from hardwood cuttings.The basal ends (1–2 cm) of the cuttings were dipped for 10 seconds in (IBA) or indole-3-butyric acid solutions from different concentrations:(0,3000,4000, and 5000mg·L⁻ ¹). A 50% ethanol solution was used to dissolve IBA. Treated cuttings were then immediately transplanted into polyethylene bags with size (15 × 30 cm) filled with builder's sand as the rooting medium. Each bag contained five cuttings with three replications used for each treatment, and for each replicate four levels of IBA treatments.

In the test was Completely Randomized Block Design (RCBD) used. The plastic house conditions were unregulated, with no environmental controls applied during the study period. Cuttings were maintained under a low tunnel plastic structure to provide moderate protection and humidity.The experiment concluded on April 1st, 2025. At this point the following factor data were recorded: percentage of rooting, the primary number of roots, primary length of roots, leaves number, length of shoot, and diameter of shoot. Collected data were statistically analysed using XLSTAT software. Mean comparisons among treatments were performed using Duncan's Multiple Range Test (DMRT) at a 5% level of significance.

Results and dissociation

As shown in (Table 1) the classification of cutting exhibited a substantial impact on the percentage of rooting. Semi-hardwood cuttings resulted in the highest rooting percentage, achieving (15%), while hardwood cuttings demonstrated a diminished percentage of rooting (10%). A comparison of semi-hardwood and hardwood cuttings in terms of the number of roots and length of roots revealed notable differences. Semi-hardwood cuttings were responsible for producing greater roots of number (4.83) and a length of root (4 cm), whereas hardwood cuttings yielded fewer roots (3.02) and shorter roots (2 cm). Furthermore, Table 1 highlights the significant effect of cutting type on shoot growth parameters, including shoot height, number of leaves, and shoot diameter. Semi-hardwood cuttings outperformed hardwood cuttings in all these parameters. The average shoot height, number of leaves, and shoot diameter for semi-hardwood cuttings were (3.89 cm), (5 leaves), and (1.45 mm), respectively. In comparison, hardwood cuttings had a shoot height of (2.01 cm), (3.53 leaves), and a shoot diameter of (1.22 mm). These results disagree with the findings of [19], who observed that hardwood cuttings are more effective for propagating of bougainvillea buttiana.

Table 1: impact of cutting type on roots and shoots traits of myrtle cuttings.

Cutting Type	Rooting (%)	Root Length (cm)	Number of Roots	Number of Leaves	Shoot Length (cm)	Shoot Diameter (mm)
Semi-hardwood cuttings	15.00 a	4.00 a	4.83 a	5.00 a	3.89 a	1.45 a
Hardwood cuttings	10.00 b	2.00 b	3.02 b	3.53 b	2.01 b	1.22 a

Duncan's Multiple Range Test ($P \leq 0.05$) shows that values in the same column with identical letters do not differ significantly
The results presented in (Table 2) indicate that significant differences in growth parameters between semi-hardwood and hardwood cuttings, the importance of varying concentrations of Indole-3-butyric acid (IBA) affect root length, quantity of roots, leaf count, shoot length, and shoot diameter. These results emphasize the critical role of enhancing IBA concentrations to improve rooting success and overall plant development. Enhanced propagation outcomes can lead to higher survival rates and more vigorous growth in propagated plants, which ultimately supports more efficient and sustainable horticultural practices. Results showed that applying IBA significantly improved the ability for rooting of semi-hardwood cuttings compared to the control group. Cuttings treated with 5000 mg. L^{-1} IBA recorded a great percentage of rooting at (47%),while the minimum result was observed in the control treatment for each IBA concentrations. As IBA concentration decreased to 4000 and 3000 mg. L^{-1}, the rooting percentages declined to (35% and 29%), respectively. These results indicate a favorable association between increased IBA density and improved rooting. Auxin like IBA serve a crucial function in the induction of primary roots through various physiological mechanisms. Histological studies have demonstrated that IBA application enhances cell division in the cambial zone, where root primordia initiates. Furthermore, exogenous applied IBA may be transformed into Indole-3-acetic acid (IAA), thereby increasing endogenous auxin levels or enhancing tissue sensitivity to IAA, which further promotes rooting. The improved root formation and a greater number of roots observed at higher IBA concentrations could be attributed to the earlier initiation of rooting and better mobilization of nutrient reserves, allowing for stronger root establishment [20, 21]. Similar results have been reported by [16], where higher IBA concentrations led to increased rooting percentages and root numbers per cutting. In addition to rooting percentage, IBA treatment at 5000 mg. L^{-1} also exhibited a substantial impact on root length and shoot diameter, with the longest roots measuring (3.90 cm) and the thickest shoots reaching (3.01 mm). In contrast, no measurable root or shoot growth was recorded in the control group. Also, the best result was recorded from 5000 mg. L^{-1} IBA for each parameter (number of roots, number of leaves, and length of shoot) were (3.34, 9.00, and 15.22cm) respectively. In contrast, the minimum results for rooting (%), root Length (cm), number of Roots, number of Leaves shoot length (cm), and shoot diameter (mm) was recorded in the control group. Which were 15.00% , 2.20 cm, 1.72 , 3.00 ,4.21cm, 1.00 mm)respectively. these finding agree with [22] who had reported there are lowest results from control group for Rose. These improvements are likely due to earlier root formation, which enhances nutrient uptake and supports subsequent shoot development. Moreover, all three densities of IBA markedly influenced the quantity of roots, leaf count, and shoot length, while the control treatment showed no significant differences across any parameter. This confirms the necessity of auxin application for successful myrtle propagation via cuttings. These findings align with previous research by [23, 24], which found that immersing basal myrtle cuttings in 4000 mg. L^{-1} IBA significantly improved rooting rates. Conversely, [11] reported that 1000 mg. L^{-1} IBA was optimal, while [16] observed the best rooting outcomes at 3000 mg. L^{-1} IBA in hardwood myrtle cuttings .
Duncan's Multiple Range Test ($P \leq 0.05$) shows that values in the same column with identical letters do not differ significantly.

Table 2: Impact of IBA density on root and shoot traits of myrtle cuttings

IBA Concentration ($mg \cdot L^{-1}$)	Rooting (%)	Root Length (cm)	Number of Roots	Number of Leaves	Shoot Length (cm)	Shoot Diameter(mm)
5000	47.00 a	3.90 a	3.34 a	9.00 a	15.22 a	3.01 a
4000	35.00 ab	3.00 ab	2.39 a	7.00 a	11.03 a	2.03 a
3000	29.00 ab	2.70 ab	1.40 ab	6.00 a	10.00 ab	2.00 a
control	15.00 b	2.20 b	1.72 b	3.00 b	4.21 b	1.00 b

The combination of cutting category and IBA density showed significant differences across all evaluated parameters, as presented in (Table 3), The immersion of cuttings in a 5000 mg. L^{-1} IBA solution recorded the best rooting percentages (55%) for semi-hardwood cuttings and (40%) for hardwood cuttings. In contrast, the minimum percentages of rooting were recorded in the control treatment, with (30%) and (15%) for semi-hardwood and hardwood cuttings, respectively. These findings indicate that IBA is instrumental in accelerating root initiation, enhancing both the quantity and quality of roots, and improving rooting uniformity, which in turn facilitates more efficient uptake of nutrients and water [25]. The overall increase across all parameters may also indicate a highly significant positive correlation among them. The number of roots per cutting varied significantly across the different IBA treatments, with the highest quantity of roots (11.31) documented in semi-hardwood cuttings subjected to 5000 mg. L^{-1} IBA. This aligns with the findings of [23], who identified 4000 mg. L^{-1} IBA is the ideal density for promoting rooting semi-hardwood cuttings of Myrtus communis. Root length was also significantly affected by IBA concentration, as all IBA treatments outperformed the control group. The maximum root length (33.30 cm) was identified in semi-hardwood cuttings administered with 5000 mg. L^{-1} IBA, while hardwood cuttings recorded root lengths of (31.41 cm), (28.09 cm), and (13.41 cm) at 5000, 4000, and 3000 mg. L^{-1} IBA, respectively. These findings demonstrate that root length increased with higher IBA concentrations, reaching its maximum at 5000 mg. L^{-1} for both cutting types. Similarly, [26] reported that IBA markedly enhanced the rooting percentage and average root length in Pinus ocarpa, along with the number of roots per cutting. The observed root elongation may be attributed to the accelerated onset of root development at higher IBA concentrations, coupled with improved assimilation of nutritional reserves due to early root establishment [27]. In terms of leaf development, all IBA concentrations resulted in a considerable increase in the number of leaves compared to the control. For semi-hardwood cuttings, the number of leaves reached (12.00, 9.31, and 7.01) at IBA concentrations of 5000, 4000, and 3000 mg. L^{-1}, respectively, while hardwood cuttings recorded (10.50, 8.44, and 5.00) leaves for the same concentrations. Shoot diameter also responded positively to IBA application, with the highest mean values recorded at 5000 mg. L^{-1} (3.05 mm) for semi-hardwood and (2.91 mm) for hardwood cuttings. Increasing IBA concentration led to improved shoot growth, leaf production, and shoot diameter in both cutting types when compared to the control. Comparative analysis further revealed that semi-hardwood cuttings were subjected to 5000 mg. L^{-1} IBA attained the greatest shoot height (23.23 cm), whereas the minimal shoot lengths were recorded in the control group, with (9.03cm) and (6.33 cm) for semi-hardwood and hardwood cuttings, respectively. These findings agree with [28] had report that the higher density of IBA caused of best shoot length for hardwood of photinia fraseri.

Table 3. Combination impact of cutting type and IBA concentration on root and shoot traits of myrtle cuttings.

Cutting Type	IBA Concentration (mg·L^{-1})	Rooting (%)	Root Length (cm)	Number of Roots	Number of Leaves	Shoot Length (cm)	Shoot Diameter (mm)
Semi-hardwood cuttings	5000	55.00 a	33.30 a	11.31 a	12.00 a	23.23 a	3.05 a
	4000	43.00 a	31.04 a	9.41 ab	9.31 ab	17.51 ab	2.55 a
	3000	41.00 a	15.00 ab	8.31 ab	7.01 ab	13.41 ab	1.06 b
	control	30.00 ab	8.10 b	6.66 b	6.03 b	9.03 b	1.00 b
Hardwood cuttings	5000	40.00 a	31.41 a	10.07 a	10.50 ab	21.04 a	2.91 a
	4000	37.00 ab	28.09 ab	7.93 ab	8.44 ab	15.02 ab	1.40 b
	3000	29.00 ab	13.41 ab	6.81 b	5.00 b	8.60 b	1.03 b
	control	15.00 b	8.31 b	4.02 b	3.01 b	6.33 b	1.00 b

Duncan's Multiple Range Test ($P \leq 0.05$) shows that values in the same column with identical letters do not differ significantly.

It was concluded that both cutting category and IBA density significantly influence the shoot development and rooting of *Lagerstroemia indica*. Semi-hardwood cuttings outperformed hardwood cuttings in all measured traits. The highest rooting success and growth parameters were achieved with 5000 mg. L^{-1} IBA, while no rooting occurred in the control. This highlights-the essential role of auxins like IBA in promoting adventitious root formation. A positive correlation was observed between increasing IBA concentration and improved root and shoot traits. Overall, the study suggests that semi-hardwood cuttings dipped with 5000 mg. L^{-1} IBA provides the most effective method for propagating *Lagerstroemia indica*.

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تأثير انوع العقل و التراكيز فى IBA تجذير نبات ورد القهوة (Lagerstroemia Indica L) .

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الخلاصة

أُجريت هذه الدراسة في المعهد بكرجوالتقني التابع لجامعة السليمانية التقنية في إقليم كردستان العراق، خلال الفترة من 1 كانون الأول إلى 1 نيسان، بهدف دراسة تأثير نوعين من الأقلام (الخشبية وشبه الخشبية) وتراكيز مختلفة من حامض الإندول بيوتريك اسيد (٠ ، ٣٠٠٠، ٤٠٠٠ و ٥٠٠٠ ملغم/لتر) على تجذير عقل اللاجستروميا. نُفذت المعاملات وفقًا لتصميم القطاعات العشوائية الكاملة *(RCBD)* بثلاث مكررات، وتمت مقارنة المتوسطات باستخدام اختبار دنكن متعدد الحدود عن مستوى احتمالية 5. %

جُمعت 120 عقلة من حديقة معهد بكرجو التقني لغرض إجراء التجربة. شملت الصفات المدروسة: نسبة التجذير، وطول الجذر، وعدد الجذور في العقلة، وطول الجزء الخضري، وعدد الأوراق، وقطر الجزء الخضري. أظهرت النتائج أن نوعي الأقلام أظهرا تفوقًا في نسبة التجذير وبقية الصفات المدروسة. علاوة على ذلك، أدت التراكيز المرتفعة من *IBA* إلى زيادات واضحة في نسبة التجذير، وقطر البراعم، وعدد الأوراق، وطول الجذور مقارنةً بمعاملة المقارنة. وفيما يتعلق بالنسبة تأثير التداخل ، فقد حُدد أن العقل التي نقعت لتركيز 5000 ملغم لتر-1 من اندول البيوتريك اسيد مع اقلام شبه الخشبة أظهرت أعلى نسبة تجذير (55%)، كما تم تحقيق أفضل خصائص للجذور والبراعم في التفاعل المتطابق أيضًا، طول البراعم (23.23 سم)، قطر البراعم (3.05 ملم)، عدد الأوراق (12.00)، وطول الجذر (33.30 سم). في ضوء هذه النتائج، استنتجنا أن نوع اقلام والتراكيز المختلفة من اندول البيوتريك اسيد، كان لها تأثيرات مفيدة على نجاح تجذير نبات ورد القهوة. وعليه توصي هذه الدراسة بإكثار نبات ورد القهوة زينة عن طريق استخدام العقل شبه الخشبة و بتركيز 5000 ملغم/لترمن اندول البيوتريك اسيد.

الكلمات المفتاحية: تركيزات *IBA* ، العقل لاجستروميا ، أنواع القطع ، التكاثر الخضري. نسبة تجذير العقل.