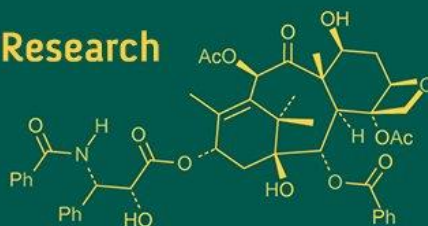


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Studies on effect of auxin on rooting of stem cuttings of crape jasmine (*Tabernaemontana coronaria*)

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Abstract

Crape jasmine (*Tabernaemontana coronaria*) is a valued ornamental shrub, but its commercial propagation is hindered by poor and slow rooting of stem cuttings. This study investigated the effects of auxin types, concentrations, and cutting types on the rooting and subsequent survival of stem cuttings. An experiment was conducted using semi-hardwood and hardwood cuttings treated with various concentrations of Indole-3-butyric acid (IBA), α -Naphthalene acetic acid (NAA), and their combinations (1000, 2000, 3000 ppm), including a control. The treatments were arranged in a Factorial Completely Randomized Design. Results indicated that while the type of cutting (semi-hardwood vs. hardwood) alone did not show significant differences for most parameters, semi-hardwood cuttings generally performed better. The application of auxins significantly enhanced all measured growth parameters compared to the control. The combination of IBA + NAA at 2000 ppm (T₉) proved most effective, resulting in the earliest shoot initiation (8.07 days) and root initiation (12.60 days), the longest root (9.34 cm), highest root fresh weight (3.82 g) and dry weight (1.09 g), maximum rooting percentage (96.33%), and ultimate survival rate (99.87%) in semi-hardwood cuttings.

Keywords: *Tabernaemontana coronaria*, Semi-hardwood cuttings, hardwood cuttings, auxins, rooting percentage and survival percentage

Introduction

Crape jasmine (*Tabernaemontana coronaria* (L.) Willd. ex Roxb.), an evergreen shrub of the Apocynaceae family, is esteemed in tropical and subtropical horticulture for its exquisite ornamental appeal (Kumar *et al.*, 2018) [8]. The plant is characterized by its glossy, dark green foliage and, most notably, its prolific production of pinwheel-shaped, fragrant white flowers that often display a captivating double corolla, reminiscent of a miniature rose. This aesthetic versatility makes it an invaluable resource for floriculture and landscaping, serving as an elegant standalone specimen, a densely flowering hedge, or a potted ornamental plant for terraces and patios. Its extended blooming period and ability to thrive in partial shade further enhance its commercial and utilitarian value. Nowadays, *Tabernaemontana* varieties with longer flower stalks are becoming popular and used for making garlands, venis etc. Commercial cultivation of *Tabernaemontana coronaria* is started in parts of Tamil Nadu and Karnataka in smaller area. Despite its significant ornamental potential, the mass propagation of superior *T. coronaria* genotypes to meet market demand faces a considerable constraint: its relatively challenging and slow rooting ability from stem cuttings (Hartmann *et al.*, 2011) [7]. Conventional propagation methods often result in inconsistent and low rooting percentages, extended nursery periods, and high mortality rates, creating a bottleneck for commercial growers and nurseries seeking rapid and uniform production. Overcoming this propagation barrier is therefore crucial for the sustainable commercial exploitation of this species. The application of synthetic auxins, such as Indole-3-butyric acid (IBA) and α -Naphthalene acetic acid (NAA), has been a cornerstone of horticultural science for decades, proven to significantly enhance adventitious root initiation and development in a wide range of difficult-to-root species (Davies *et al.*, 2018) [5, 6]. This research is strategically designed to investigate the efficacy of various auxin types, concentrations, and treatment methods on the rooting performance of *T. coronaria* stem cuttings. The findings of this study hold the potential to establish a standardized, efficient, and economically viable propagation protocol,

thereby ensuring the reliable production of high-quality planting material, boosting the commercial supply, and ultimately supporting the broader ornamental horticulture industry.

Materials and Methods

The experiment was carried out in the mist house of Department of Floriculture and Landscape Architecture, Kittur Rani Channamma College of Horticulture, Arabhavi during December 2020 to June 2021. The maximum temperature during the experiment was 32.55 °C and relative humidity of 88.59 percent. The planting material was obtained from uniformly grown plants of crape jasmine planted at the Department of Floriculture and Landscape Architecture nursery of KRCCH, Arabhavi. The cuttings of *Tabernaemontana coronaria* of length 12-15cm with one or two trimmed leaves were left on semi-hardwood cuttings and no leaves were left on hardwood cuttings. A slant cut was given at the base of each cutting near to the node and three to four buds were retained. cocopeat was used as the rooting media and it was filled in to the root trainers. There were ten treatments of auxins formulations used at different concentrations (Control, IBA at 1000ppm, 2000 ppm, 3000 ppm, NAA at 1000ppm, 2000 ppm, 3000 ppm and IBA + NAA at 1000ppm, 2000 ppm, 3000 ppm); twenty cuttings were used for each treatment which was replicated thrice.

The prepared cuttings were dipped in different concentrations of auxins and their combinations. The basal 1.0-2.0 cm portion of the cuttings was dipped in auxins formulation for 10 minutes and immediately planted in medium to a depth of 2 cm. Later the planted cuttings were placed in mist house. The planted cuttings were allowed to root for 120 days. The cuttings were carefully removed from the trainers and washed in water to remove the soil particles adhering to roots to record the observations pertaining to roots viz., days taken for root initiation, rooting percentage, length of longest root, fresh and dry weight and percent success after 120 days of planting. Various shoot characters observations were also recorded after planting. The data pertaining to root and shoot character were tabulated. The experiment was laid Factorial Completely Randomized Design (FCRD) with 10 treatments replicated thrice and statistically analysed as per the methods outlined by Panse and Sukhatme (1967). The appropriate standard error of mean (S.Em.±) and the critical difference (C.D) was calculated at five percent level of probability. Data has been depicted by suitable figures with the appropriate tables.

Results and Discussion

Days taken for shooting

The data on minimum days taken for shoot initiation showed no significant difference between two cuttings (Table 1). However, early shoot initiation was observed in semi hard wood cuttings (9.68 days) in comparison to hard

wood cuttings (9.85 days). This is due to the presence of more stored carbohydrates in semi-hard wood (Aishwarya, 2019). The data pertaining to days taken for shooting indicated that there was significant effect due to application of various concentrations of IBA, NAA and their combination on cuttings. Among the different concentrations of auxins, cuttings treated with the T₉ (IBA + NAA at 2000 ppm) took minimum days for shooting (8.17 days), followed by T₇ (NAA at 3000 ppm) at 8.53 days and T₄ (IBA at 3000 ppm) at 8.73 days. This is due to better utilization of stored carbohydrates, nitrogen and other factors with the help of growth regulators (Abebe, 2017) ^[1]. The interaction effect found significant between types of cuttings and auxins with respect to days taken for shoot initiation. Minimum days taken for shoot initiation were found in semi-hard wood cuttings treated with IBA + NAA (C₁T₉) at 2000 ppm (8.07 days), which was on par with the hardwood cuttings treated with IBA + NAA (C₂T₉) at 2000 ppm (8.27 days) and semi-hard wood cuttings treated with NAA (C₁T₇) at 3000 ppm (8.47 days) whereas, maximum days was taken by hardwood cuttings treated without auxins (12.13 days) (C₂T₁). This result is due to juvenility of cuttings and synergetic effect of the growth hormones and apical dominance is suppressed which encourages the shoots (Yusnita *et al.*, 2017) ^[12].

Length of longest shoot (cm)

The data on length of longest shoot showed no significant difference between the two types of cuttings (Table 1). The more length of shoot was observed in semi-hard wood cuttings (12.84 cm), as compared to hard wood cuttings (12.58 cm). The data pertaining to length of longest shoot indicated that there was significant effect due to application of various concentrations of IBA, NAA and their combination on cuttings. Among the different concentrations of auxins, cuttings treated with the T₉ (IBA + NAA at 2000 ppm) recorded maximum length of shoot (14.04 cm) which was on par with T₇ (NAA at 3000 ppm) 13.85 cm and T₄ (IBA at 3000 ppm) 13.64 cm. This might be due to better utilization of stored carbohydrates, nitrogen and other factors with the help of growth regulators (Abebe, 2017) ^[1]. The interaction effect was found significant between types of cuttings and auxins with respect to length of longest shoot per cutting. Maximum length of shoots was obtained in the semi-hardwood cuttings treated with (C₁T₉) IBA + NAA at 2000 ppm (14.11 cm) which was on par with semi-hard wood cuttings treated with (C₁T₇) NAA at 3000 ppm (13.96 cm) and hard wood cuttings treated with (C₂T₉) IBA + NAA at 2000 ppm (13.98 cm), whereas, minimum length of shoot was recorded in hard wood cuttings treated without auxins (C₂T₁) was 9.88 cm. This result may be due to juvenility of cuttings and synergetic effect of the growth hormones and apical dominance is suppressed which encourages the shoots (Yusnita *et al.*, 2017) ^[12].

Table 1: Days taken for shoot initiation, number of shoots per cutting, days for rooting and length of longest root as influenced by types of cuttings and auxins and their interaction effect in *Tabernaemontana coronaria*

Treatments	Days taken for shoot initiation	Length of longest shoot (cm)	Days taken for root initiation	Length of longest root (cm)
Factor A (C-Types of cuttings)				
C ₁ : Semi-hard wood cuttings	9.68	12.84	19.76	5.49
C ₂ : Hard wood cuttings	9.85	12.58	20.56	4.51
S.Em±	0.04	0.10	0.06	0.03
C.D @ 5%	NS	NS	NS	NS
Factor B (T-Auxins)				
T ₁ : Control	12.00	10.31	27.00	3.81
T ₂ : IBA @ 1000 ppm	11.23	10.36	25.10	4.01
T ₃ : IBA @ 2000 ppm	10.30	13.28	22.75	4.52
T ₄ : IBA @ 3000 ppm	8.73	13.64	18.28	5.03
T ₅ : NAA @ 1000 ppm	10.50	11.05	23.65	4.14
T ₆ : NAA @ 2000 ppm	9.90	13.44	19.75	4.31
T ₇ : NAA @ 3000 ppm	8.53	13.85	13.73	5.89
T ₈ : IBA + NAA @ 1000 ppm	8.90	13.58	18.62	4.88
T ₉ : IBA + NAA @ 2000 ppm	8.17	14.04	13.17	8.82
T ₁₀ : IBA + NAA @ 3000 ppm	9.40	13.54	19.53	4.63
S.Em±	0.09	0.24	0.13	0.08
C.D @ 5%	0.27	0.69	0.38	0.23
Factor A x B (C X T)				
C ₁ T ₁	11.87	10.75	26.00	4.38
C ₁ T ₂	11.13	10.25	24.87	4.54
C ₁ T ₃	10.13	13.44	22.33	4.85
C ₁ T ₄	8.60	13.76	18.20	5.39
C ₁ T ₅	10.47	11.17	23.27	4.69
C ₁ T ₆	9.87	13.56	19.27	4.95
C ₁ T ₇	8.47	13.96	13.53	6.39
C ₁ T ₈	8.87	13.72	18.47	5.26
C ₁ T ₉	8.07	14.11	12.60	9.34
C ₁ T ₁₀	9.33	13.71	19.07	5.17
C ₂ T ₁	12.13	9.88	28.00	3.25
C ₂ T ₂	11.33	10.47	25.33	3.49
C ₂ T ₃	10.47	13.11	23.17	4.18
C ₂ T ₄	8.87	13.52	18.37	4.67
C ₂ T ₅	10.53	10.94	24.03	3.59
C ₂ T ₆	9.93	13.32	20.23	3.66
C ₂ T ₇	8.60	13.74	13.93	5.40
C ₂ T ₈	8.93	13.45	18.77	4.51
C ₂ T ₉	8.27	13.98	13.73	8.29
C ₂ T ₁₀	9.47	13.39	20.00	4.11
S.Em±	0.13	0.34	0.19	0.11
C.D @ 5%	0.39	0.99	0.55	0.34

NS: Non Significant

DAP: Days After Planting

Days taken for root initiation

The data on days taken for root initiation was found non-significant for two types of cuttings (Table 1). However, the earlier root initiation was observed in semi hard wood cuttings (19.76 days), followed by hard wood cuttings (20.56 days). This may be due to early initiation of shoot providing carbohydrates for rooting along with endogenous auxin and also due to juvenility of plant material (Yusnita *et al.*, 2017) [12]. The data pertaining to days taken for rooting indicated that there was significant effect due to application of various concentrations of IBA, NAA and their combination on cuttings. Among the different concentrations of auxins, cuttings treated with the T₉ (IBA + NAA at 2000 ppm) took minimum days for rooting (13.17 days), followed by T₇ (NAA at 3000 ppm) and T₄ (IBA at 3000 ppm) at 13.73 days and 18.28 days, respectively. The higher rooting was due to its effect on increasing the cell wall plasticity and cell division, stimulation of callus development and root growth (Weaver, 1972). The

interaction effect found significant between types of cuttings and auxins with respect to days taken for root initiation. Minimum days taken for root initiation were recorded in semi-hardwood cuttings treated with (C₁T₉) IBA + NAA at 2000 ppm (12.6 days), followed by semi-hardwood cuttings treated with (C₂T₉) NAA at 3000 ppm (13.53 days) and (C₁T₇) IBA at 3000 ppm (18.2 days) whereas, as maximum days (28 days) were taken by hardwood cuttings treated without auxins (C₂T₁). Initiation and development of roots on stem cuttings is controlled by complex eco-physiological and biochemical processes as well as anatomical factors and exogenous application of rooting hormones help in enhancing these factors as well mobilizing sucrose or its derivative to the site of root formation (Yusnita *et al.*, 2017) [12].

Length of longest root

The data noted on length of longest root was found no significant difference between types of cuttings (Table 1).

However, the more length of root was observed in semi hard wood cuttings (5.49 cm) followed by hard wood cuttings (4.51 cm). The data pertaining to length of longest root indicated that there was significant effect due to application of various concentrations of IBA, NAA and their combination on cuttings. Among the different concentrations of auxins, cuttings treated with the T₉ (IBA + NAA at 2000 ppm) recorded maximum length of root (8.82 cm), followed by T₇ (NAA at 3000 ppm) and T₄ (IBA at 3000 ppm) i.e., 5.89 cm and 5.03 cm, respectively. The interaction effect found significant between types of cuttings and auxins with respect to maximum length of root. Maximum length of root was found in semi-hard wood cuttings treated with (C₁T₉) IBA + NAA at 2000 ppm (9.34 cm), followed by semi-hard wood cuttings treated (C₁T₇) NAA at 3000 ppm (6.39 cm) and (C₁T₄) IBA at 3000 ppm (5.39 cm) whereas, minimum length (3.25 cm) of root was observed in hard wood cuttings treated without auxins (C₂T₁).

Root fresh weight

The data on root fresh weight showed no significant difference between two types of cuttings (Table 2). However, the highest root fresh weight was observed in semi hard wood cuttings (3.47 g), followed by hard wood cuttings (3.08 g). The data pertaining to root fresh weight indicated that there was significant effect due to application of various concentrations of IBA, NAA and their combination on cuttings. Among the different concentrations of auxins, cuttings treated with the T₉ (IBA + NAA at 2000 ppm) recorded maximum root fresh weight (3.71 g), which was on par with T₇ (NAA at 3000 ppm) and T₄ (IBA at 3000 ppm) at 3.64 g and 3.58 g respectively. Whereas cuttings without rooting hormone treatment recorded minimum fresh weight (2.66 g). The interaction effect found significant between types of cuttings and auxins with respect to root fresh weight. Maximum root fresh weight was found in semi-hard wood cuttings treated with (C₁T₉) IBA + NAA at 2000 ppm (3.82 g), which was on par with semi-hard wood cuttings treated with (C₁T₇) NAA at 3000 ppm (3.74 g) and (C₁T₄) IBA at 3000 ppm (3.69 g). Minimum root fresh weight was observed in hard wood cuttings treated without auxins (2.51 g).

Root dry weight

The data on root dry weight showed no significant difference between two types of cuttings (Table 3). However, the highest root dry weight was observed in semi hard wood cuttings (0.84 g), followed by hard wood cuttings (0.62 g). The data pertaining to root dry weight indicated that there was significant effect due to application of various concentrations of IBA, NAA and their combination on cuttings. Among the different concentrations of auxins, cuttings treated with the IBA + NAA at 2000 ppm recorded

maximum root dry weight (0.99 g), which was on par with NAA at 3000 ppm and IBA at 3000 ppm (0.92 g and 0.87 g, respectively). Whereas cuttings without rooting hormone treatment recorded minimum dry weight (0.3 g). The interaction effect found significant between types of cuttings and auxins with respect to root dry weight. Maximum root dry weight was found in semi-hard wood cuttings treated with (C₁T₉) IBA + NAA at 2000 ppm (1.09 g) which was on par with semi-hard wood cuttings treated with (C₁T₇) NAA at 3000 ppm (1.03 g) and (C₁T₄) IBA at 3000 ppm (1.00 g). Minimum root dry weight was observed in hard wood cuttings treated without auxin (0.19 g).

Percentage of rooting

The data on percentage of rooting showed no significant difference between two types of cuttings (Fig 1a). The highest percentage of rooting was observed in semi-hard wood cuttings (79.39%), followed by hard wood cuttings (73.93%). Both semi-hardwood and hardwood cuttings of crape jasmine have sufficient carbohydrate reserves and endogenous auxins to initiate root primordia effectively (Hartmann *et al.*, 2018) [6]. The data pertaining to percentage of rooting indicated that there was significant effect due to application of various concentrations of IBA, NAA and their combination on cuttings.

Among the different concentrations of auxins, cuttings treated with the T₉ (IBA + NAA at 2000 ppm) resulted in maximum percentage of rooting (93.83%), followed by T₇ (NAA at 3000 ppm) and T₄ (IBA at 3000 ppm) at 90.77% and 78.77%, respectively. Whereas cuttings without rooting hormone treatment recorded minimum percentage of rooting was found in (52.55%). The synergistic effect of IBA and NAA provides a broader spectrum of auxin activity, enhancing cell division and differentiation at the optimal concentration for root initiation (Davies *et al.*, 2016). The interaction effect found significant between types of cuttings and auxins with respect to percentage of rooting. Maximum percentage of rooting was found in semi-hard wood cuttings treated with (C₁T₉) IBA + NAA at 2000 ppm (96.33%), followed by semi-hard wood cuttings treated with (C₁T₇) NAA at 3000 ppm (92.22%) and (C₁T₄) IBA at 3000 ppm (86.55%). Minimum percentage of rooting was obtained in hard wood cuttings treated without auxins (48.66%). The physiological state of semi-hardwood cuttings (active cambium, optimal nutrient status) interacts synergistically with the specific combination and concentration of applied auxins to maximize root initiation (Blythe *et al.*, 2007) [3].

Survival percentage

The data on survival percentage showed no significant difference between two types of cuttings (Fig. 1b). The highest survival percentage was observed in semi-hard wood cuttings (91.07%), followed by hard wood cuttings (86.17%).

Table 2: Fresh weight of roots as influenced by types of cuttings, auxins and their interaction effect in *Tabernaemontana coronaria*

Type of Cuttings	Rooting hormones										Mean
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀	
Semi-hard wood cuttings	2.80	2.97	3.48	3.69	3.11	3.67	3.74	3.72	3.82	3.68	3.47
Hard-woodcuttings	2.51	2.66	2.95	3.47	2.73	3.02	3.54	3.20	3.62	3.08	3.08
Mean	2.66	2.82	3.21	3.58	2.92	3.34	3.64	3.46	3.72	3.38	
Sources	S.E m±					CD (5%)					
C	0.02					0.07					
T	0.05					0.15					
C×T	0.07					0.22					

Table 3: Dry weight of roots as influenced by types of cuttings, auxins and their interaction effect in *Tabernaemontana coronaria*

Type of Cuttings	Rooting hormones										Mean
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀	
Semi-hard wood cuttings	0.41	0.52	0.84	1.00	0.58	0.96	1.03	1.00	1.09	0.96	0.84
Hard wood cuttings	0.19	0.33	0.62	0.75	0.39	0.69	0.81	0.80	0.9	0.74	0.62
Mean	0.30	0.43	0.73	0.87	0.49	0.82	0.92	0.91	0.99	0.85	
Sources	S.E m±					CD (5%)					
C	0.04					0.06					
T	0.02					0.02					
C×T	0.06					0.04					

Note: T₁ to T₁₀ different concentrations of auxin (T₁: Control, T₂: IBA @ 1000 ppm, T₃: IBA @ 2000 ppm, T₄: IBA @ 3000 ppm, T₅: NAA @ 1000 ppm, T₆: NAA @ 2000 ppm, T₇: NAA @ 3000 ppm, T₈: IBA + NAA @ 1000 ppm, T₉: IBA + NAA @ 2000 ppm, T₁₀: IBA + NAA @ 3000 ppm)

This is because of having a greater number of shoots, primary and secondary roots which help in easy establishment after transplantation. The data pertaining to survival percentage indicated that there was a significant effect due to application of various concentrations of IBA, NAA and their combination on cuttings. Among the different concentrations of auxins, cuttings treated with the T₉ (IBA + NAA at 2000 ppm) recorded the maximum survival percentage (96.10%), followed by T₇ (NAA at 3000 ppm) and T₄ (IBA at 3000 ppm) at 95.33% and 94.33%, respectively. The plant growth regulators treated cuttings tended to give better survival might be due to a greater

number of roots which some role in establishment of plants (Singh and Singh, 2018) [10]. The interaction effect found significant between types of cuttings and auxins with respect to survival percentage. Maximum survival percentage was found in semi-hard wood cuttings treated with (C₁T₉) IBA + NAA at 2000 ppm (99.87%), which was on par with semi-hard wood cuttings treated with (C₁T₇) NAA at 3000 ppm (99.33%) whereas, minimum survival percentage was hard wood cuttings treated without auxins (69.33%). It is due to the synergic effect of rooting hormones which influences more roots by influencing early shooting.

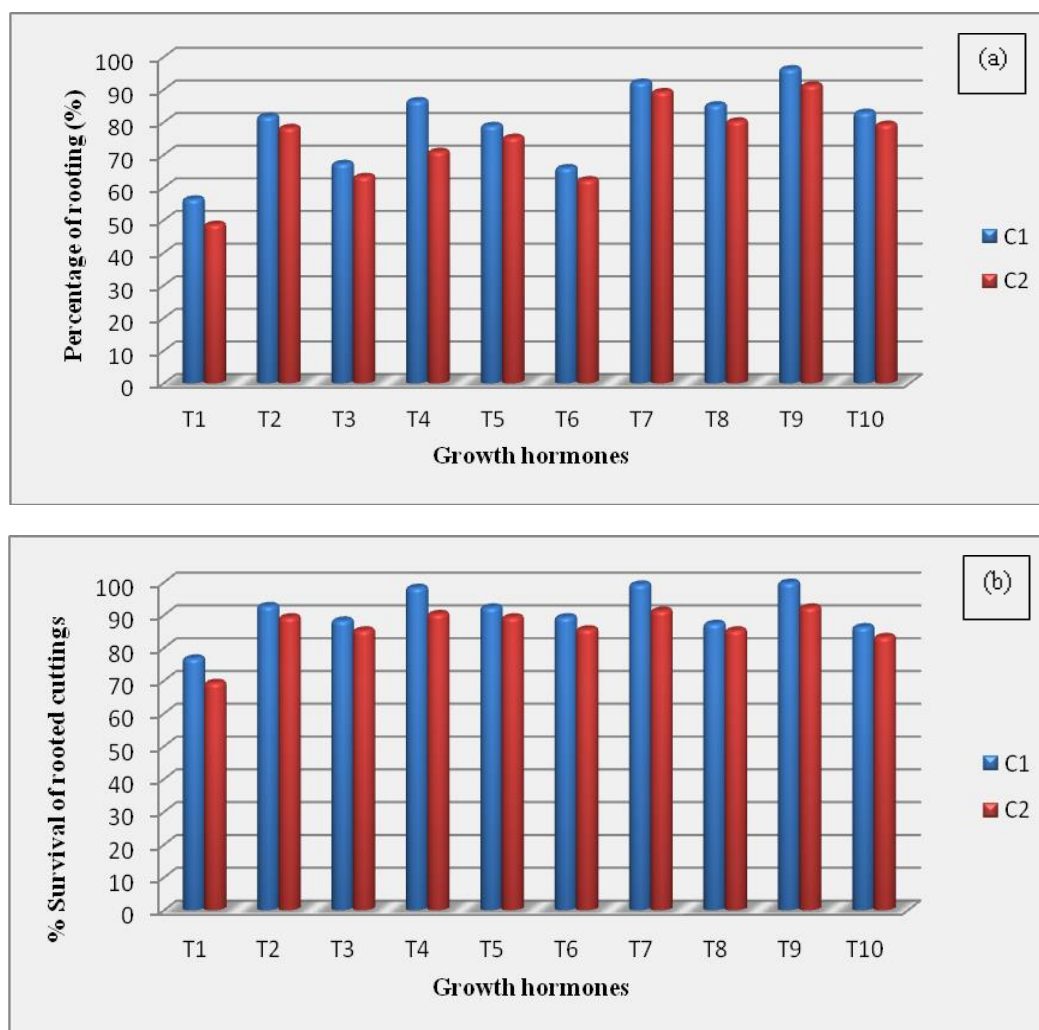


Fig 1: Percentage of rooting of cuttings (a) and survival percentage of rooted cuttings (b) as influenced by auxins in *Tabernaemontana coronaria*. Where, C₁: Semi-hard wood cuttings, C₂: Hard wood cuttings. T₁ to T₁₀ different concentrations of auxin (T₁: Control, T₂: IBA @ 1000 ppm, T₃: IBA @ 2000 ppm, T₄: IBA @ 3000 ppm, T₅: NAA @ 1000 ppm, T₆: NAA @ 2000 ppm, T₇: NAA @ 3000 ppm, T₈: IBA + NAA @ 1000 ppm, T₉: IBA + NAA @ 2000 ppm, T₁₀: IBA + NAA @ 3000 ppm)

Conclusion

The study demonstrated that semi-hardwood cuttings of crape jasmine, when treated with a combination of IBA and NAA at 2000 ppm, produced the most favorable outcomes for vegetative propagation. This treatment resulted in the earliest shoot and root initiation, longest shoot and root development, highest fresh and dry biomass, maximum rooting percentage (96.33%), and the highest survival rate (99.87%) of rooted cuttings. These findings suggest that this specific hormone combination is highly effective for improving the efficiency and success of crape jasmine propagation. The superiority of semi-hardwood cuttings was also attributed to better physiological status, likely due to higher endogenous carbohydrate and hormone levels.

Future scope

- Further studies can explore intermediate concentrations of IBA and NAA (e.g., between 2000 ppm and 3000 ppm) to identify the most cost-effective and efficient dosage for commercial propagation.
- Research could assess the impact of environmental variables (e.g., temperature, humidity, light intensity) on the efficacy of auxin treatments to refine propagation protocols for different climatic zones.
- Studies on physiological mechanisms (e.g., hormone transport, gene expression) underlying the observed synergistic effects of IBA and NAA could deepen understanding of rooting processes.

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