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Impact of Iba and Naa Concentrations on Growth Characteristics of MR2 Mulberry (*Morus sinensis*) Using Mini-Clonal Technology at Nursery Level

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Using mini-clonal technology, an experiment was carried out to examine the effects of rooting hormone on the growth and rooting characteristics of the mulberry (*Morus sinensis* L.) variety 'MR2'. Cuttings from the apical shoots of the mulberry variety MR2, which is the popular variety

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among farmers and have good resistance towards mildew attack was taken for the study. The experiment was conducted at the Department of Sericulture, Forest College and Research Institute, Mettupalayam. Four replications of the Completely Randomized Design (CRD) experiment were used to arrange the data. Two hormones, such as Indole-3-butyric acid (IBA) and Napthalene acetic acid (NAA), were used in the experiment. The hormones were replicated four times in each of the following concentration ranges: 1000, 2000, 3000, 4000, and 5000 ppm. Different hormone concentrations were applied to apical shoot cuttings before they were planted in the appropriate rooting medium in a greenhouse. At the 90th day, measurements were taken of the following parameters like shoot length (cm), number of roots per plant (no's), root length (cm) and number of leaves per plant (no's). IBA and NAA at 5000 ppm out performed all other treatments in terms of mulberry mini cutting growth and root characteristics.

Keywords: Auxins; apical cuttings; biochemical; mulberry; mini clonal technology; MR2 variety.

1. INTRODUCTION

The Mulberry (*Morus indica)* is a member of the family Moraceae. It is a woody, deciduous perennial tree with a deeper root system that grows quickly [1]. There are roughly 68 mulberry species in the world; in India, the most often utilized species are *M. indica*, also known as the Indian mulberry, followed by *M. alba*, also known as the White mulberry, *M. serrata, and M. laevigata* [2]. With 28 chromosomes, the majority of the species in the genus *Morus* are diploid [3]. Mulberry grows between 28°N and 55°N latitude and can withstand a variety of climates, from temperate to tropical [4]. The nominal temperature range is 24°C to 26°C, with 600–2500 mm of annual rainfall [5]. It has been grown all year round in the southern regions of India, specifically Tamil Nadu, Karnataka and Andra Pradesh [6].

Mulberry seeds have a 20–30% survival rate and low germination, making seed replication unfeasible [7]. Therefore, propagation techniques like as grafting and cutting are employed [8]. Mulberries are typically propagated in India using semi-hard wood cuttings, which are then either planted directly in the main field or grown in nurseries before being moved to the field [9]. Directly planting of cuttings in the main field frequently results in unfavourable development and a low survival rate [10]. Growing seasons and the cost of upkeep and care were the primary determinants of the rate of successful root growth of cuttings, even in nursery circumstances [11].

The auxin group of hormones is essential for the production of roots, and in nurseries, indole-3-butyric acid (IBA) is a routinely employed hormone that is used in a variety of concentrations in conjunction with NAA [12]. By accelerating the transition of rooting primordia and the transfer of sugars to the base of cuttings, they exhibit an indirect influence that resulted in the creation of active roots [13]. On the other hand, not much research has been done to assess how auxin affects the growth and development of mulberries. The goal of the current study was to clarify the impact of auxin on the rooting effectiveness of mulberry apical cuttings in this particular environment.

2. MATERIALS AND METHODS

Experiment conducted at 11°19'N, 76°56'E, 300 meters above sea level and 800 mm of rainfall, the experiment was conducted at the Department of Sericulture, Forest College and Research Institute, Mettupalayam. Cuttings from the apical shoots of the mulberry variety MR2, which is the popular variety among farmers and have good resistance towards mildew attack. Using sterile pruning secateurs, from the mother plants, these small cuttings were removed early in the morning to prevent excessive sun exposure [6]. Afterwards, they were cut with scissors to a length of 15 cm. Before being planted, a selection of cuttings were treated with a fungicidal solution (Carbendazim 50% WP) for 20 minutes, and then washed in distilled water to prevent desiccation [14]. IBA and NAA rooting hormones were made individually and at various concentrations in powder form *viz.,* 1000, 2000, 3000, 4000, and 5000 parts per million. Talc-based formulations were made by combining talc powder, boric acid crystal, systemic fungicide and the necessary amount of rooting hormone (100 mg, 200 mg, 300 mg, 400 mg, and 500 mg/100 g of talc, respectively) with the remainder of stock solutions [15]. The treated cuttings were placed in a suitable rooting medium (Soil + FYM + Coir pith) and maintained under shade net in

an inexpensive poly tunnel with a relative humidity of 75–80% and a temperature between 25 and 35°C [16]. They were also misted with water on occasion using rose cans and stored in a mist chamber. The shoot length, the number of roots per plant, the number of leaves per plant and the root length (cm) in each treatment were all observed after 90 days of planting in rooting mixture.

2.1 The Design of Statistics

Four replications of the Completely Randomized Design (CRD) experiment were used to arrange the data. According to the method developed by Panse and Sukhatme [17], data were subjected to Analysis of Variance (ANOVA) for significance and means were separated at the 95 per cent (P=0.05) significant level.

3. RESULTS AND DISCUSSION

3.1 Rooting Hormone's Impact on Mulberry Apical Cuttings Shoot Length

When comparing therapies with varying IBA and NAA concentrations, IBA at 5000 ppm showed the highest shoot length. At 5000 ppm, the shoot length was 22.20 cm in IBA, and 18.50 cm in NAA in MR2 variety. The administration of hormones stimulates and augments shoot development. According to Kalyoncu *et al.* [18], black mulberry cuttings with a IBA application had the maximum shoot length. Black mulberry cuttings treated with 5g l-1 IBA dose in bunch planting method suits for its superior shoot length, according to Koyuncu and Senel's [19].

According to Habibi [20], an increase in auxin concentrations caused the shoot length of oleander plants to grow up. A subsequent increase in IBA caused the shoot length to drop. In specific Triphlochiton scleroxylon clones, a larger dosage of auxin (200 µg per cutting) had been demonstrated to prevent roots and shoots growth in cuttings [21]. Likewise, in our investigation shoot length dropped below 3000 ppm of auxin concentration. Similar results have been reported by Husen *et al.* [22], Singh *et al.* [23], Singh *et al.* [24] in *Bougainvillea glabra,* Singh *et al.* [25] in Citrus lemon cv. Cuttings and Packialakshmi and Sudhagar [26] in teak mini cuttings, suggesting that the application of auxin could increase the shoot length in many species.

3.2 Rooting Hormone's Effect on Mulberry Apical Cutting's Root Number

The greatest number of roots was found in IBA compared to NAA when two hormones, such as IBA and NAA were used. At 90 DAP, IBA at 5000 ppm recorded the greatest number of roots (15.50 no's) followed by NAA at 5000 ppm (14.00 no's). In *Psidium guajava*, apical cuttings treated with IBA at 3000 ppm and high concentration developed more roots, which may have been caused by an optimal hormonal impact that accumulates necessary internal substances and promotes their downward movement [27] and Singh (2008). According to Ullah *et al.* [28], numerous species exhibit increased rooting in cuttings as a result of hormone treatment stimulating cambium activity. The fluctuation in dosage in relation to the quantity of roots might be led to the varietal and climatic variations in the location [29].

3.3 Effect of Rooting Hormone on Root Length of MR2 Apical Cuttings

The current study found that IBA recorded the highest root length across all treatments. The greatest root length measured at 90 DAP was 25.75 cm in IBA at 5000 ppm followed by 23.30 cm in IBA at 4000 ppm similarly 22.50 cm in NAA at 5000 ppm followed by 21.25 cm in NAA at 4000 ppm concentration. Similar hormonal effect was noted by Krishankumar [30] in mulberry leading to maximal root length. Maximum root length was observed by Ghatnatti in [31]. This was attributed to auxin activity, which may have been brought on by the hydrolysis and transport of carbohydrates towards the cuttings base, which resulted in cell division and elongation. According to Baroudi *et al.* [32], mulberry (*Morus alba*) softwood cuttings treated with 2000 ppm and high concentrations of IBA showed good root length, root number and rooting per cent. The results of Kumar [33] in *Melia dubia* and Galavi *et al.,* [34] in *Vitis vinifera* are comparable to the current findings.

Table 1. Effect of IBA on growth attributes of *Morus sinensis*

Treatments (IBA)	On 90DAP			
	Shoot length (cm) *	**No of roots/plant (no's) ***	**Root length (cm) ***	**No of leaves/plant (no's) ***
IBA@1000ppm	12.50^{e} (3.67)	9.10^{e} (3.17)	15.20^{e} (4.02)	5.75^{e} (2.59)
IBA@ 2000ppm	14.33^{d} (3.91)	10.75^{d} (3.42)	16.50^{d} (4.18)	6.70^{d} (2.77)
IBA@3000ppm	16.50^{c} (4.18)	12.00^{c} (3.60)	20.33^{c} (4.61)	7.50^{c} (2.91)
IBA@ 4000ppm	18.33^{b} (4.39)	13.33^{b} (3.78)	23.30^{b} (4.92)	9.25^{b} (3.20)
IBA@ 5000ppm	**22.20^{a} (4.81)**	**15.50^{a} (4.06)**	**25.75^{a} (5.17)**	**11.33^{a} (3.51)**
Control	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
SEd	**0.04**	**0.05**	**0.07**	**0.07**
CD (.05%)	**0.09***	**0.13***	**0.16***	**0.15***

Significant @ P=0.05 level, Each value is the mean of four replications; ( ) Values are square root transformed values

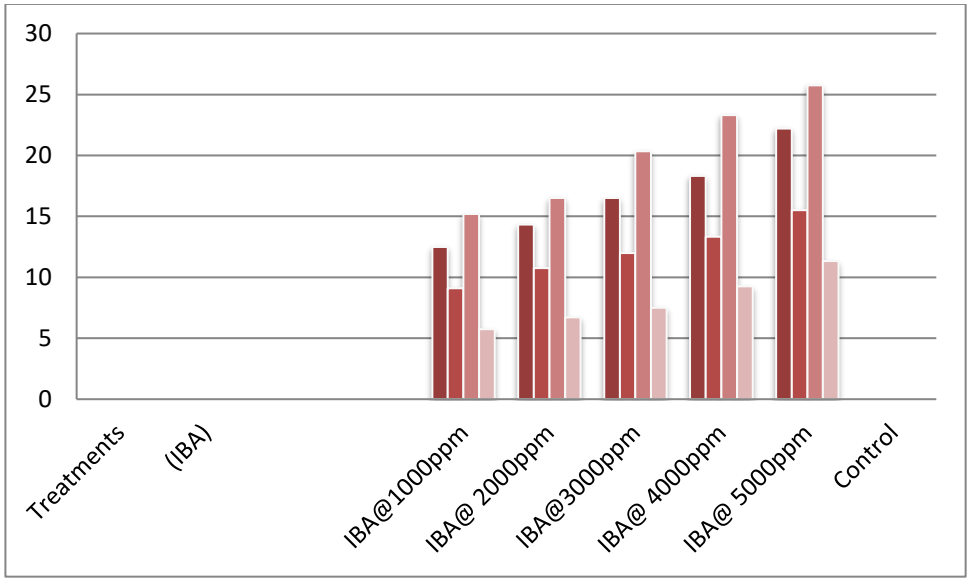

Fig. 1. Effect of IBA on growth attributes of Morus sinensis

Table 2. Effect of NAA on growth attributes of *Morus sinensis*

Treatments (NAA)	On 90DAP			
	Shoot length (cm)*	**No of roots/plant (no's) ***	**Root length (cm) ***	**No of leaves/plant (no's) ***
NAA@ 1000ppm	11.25^{e} (3.50)	8.33^{e} (3.05)	14.25^{e} (3.90)	5.33^{e} (2.51)
NAA@ 2000ppm	13.00^{d} (3.74)	10.25^{d} (3.35)	16.33^{d} (4.16)	6.00^{d} (2.64)
NAA@ 3000ppm	16.33^{c} (4.16)	11.00^{c} (3.46)	19.10^{c} (4.48)	7.22^{c} (2.86)
NAA@ 4000ppm	17.10^{b} (4.25)	12.33^{b} (3.65)	21.25^{b} (4.71)	8.22^{b} (3.03)
NAA@ 5000ppm	**18.50^{a} (4.41)**	**14.00^{a} (3.87)**	**22.50^{a} (4.84)**	**10.50^{a} (3.39)**
Control	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
SEd	**0.06**	**0.05**	**0.08**	**0.05**
CD (.05%)	**0.13***	**0.12***	**0.19***	**0.10***

Significant @ P=0.05 level, Each value is the mean of four replications; ( ) Values are square root transformed values

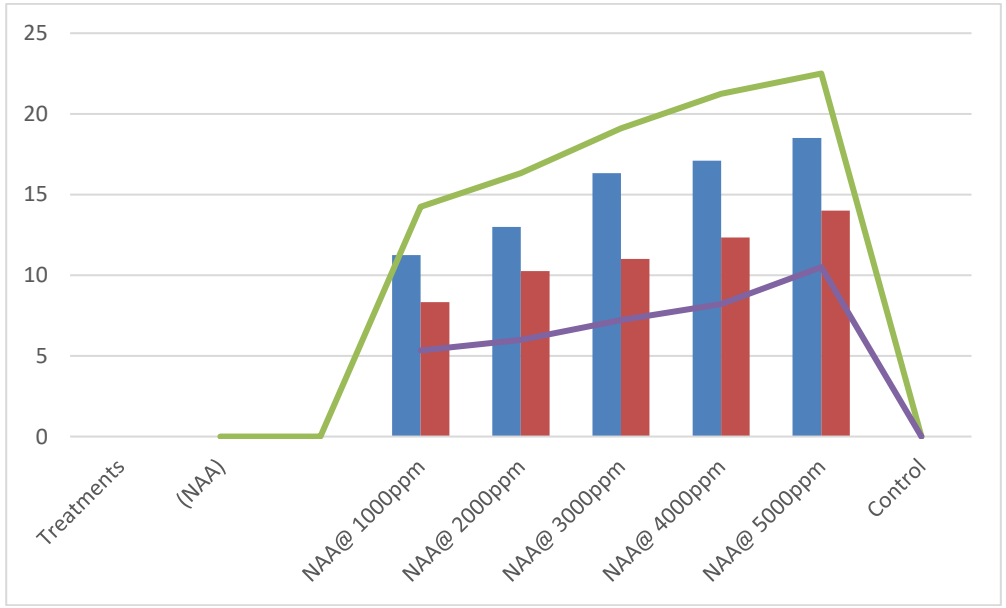

Fig. 2. Effect of NAA on growth attributes of Morus sinensis

3.4 Effect of Rooting Hormone on Number of Leaves of MR2 Apical Cuttings

In the current study, IBA at 5000 ppm recorded the most leaves of 11.33 no's at 90 DAP among the two treatments (IBA and NAA). IBA at 4000 ppm recorded the second-highest number of leaves of 9.25 no's. NAA at 5000 ppm registered the highest number of leaves of 10.50 no's. According to Pallavi *et al.* [29], there may be more roots, a higher plant, and more branches in mulberry cuttings at high ppm IBA concentration, which led to increase in leaves. According to Wahab *et al.* [35], there is a possibility that the influence of IBA on the number of leaves arises from the activation of shoot growth, which results in an increase in nodes and the subsequent formation of additional leaves in *Psidium guajava* L., Kiwi cuttings [36], Ficus, Hawaii [37] which supports the current study.

4. CONCLUSION

Using mini-clonal technology, the present investigation's findings indicate that IBA and NAA at 5000 ppm elicits the effective concentration for significant growth features in mulberry apical cuttings. Among all the treatment, IBA at 5000 ppm registered shoot length (22.20 cm), number of roots per plant (14.50 no's), root length (25.75 cm) and number of leaves per plant (11.33 cm). While NAA at 5000 ppm registered shoot length (18.50 cm), number of roots per plant (14.00 no's), root length (22.50 cm) and number of leaves per plant (10.50 cm). The main application of this mini-clonal technique is the multiplication of tree species. This is suggested due to its great rooting capability, ability to produce a larger number of plants annually, and affordable, high-quality root system. As a result, the rooting hormone and its effective concentration have been standardized in this work to enable mass mulberry proliferation in less time and space. Moreover, Mulberry is commonly propagated through cuttings but due to lack of 6 month old shoots for sapling production, mulberry sapling production becomes unstable but using mini clonal technique and standardization of rooting hormone, consistent mulberry sapling production is achievable and it is very helpful for the farmers.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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