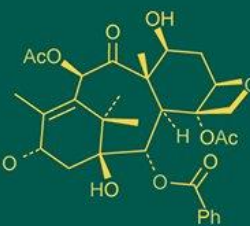
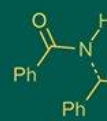
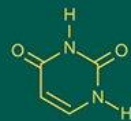
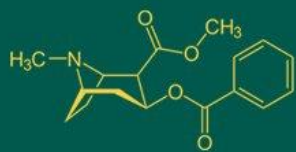


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Effect of different auxin concentrations and media combinations on vegetative parameters of grape rootstock dogridge using thin semi-hardwood cuttings

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Abstract

The present investigation was undertaken to evaluate the effect of different auxin concentrations and rooting media on the vegetative growth and rooting performance of grape rootstock Dogridge (*Vitis champinii* Planch.) propagated through thin semi-hardwood cuttings. The experiment was conducted at the Division of Fruit Crops, ICAR-Indian Institute of Horticultural Research (IIHR), Bengaluru, India, during 2022-2025 using a Factorial Randomized Block Design (FRBD) with seven auxin treatments and three rooting media. The auxin treatments included control, IBA at 2000, 2500 and 3000 ppm (quick dip), IBA + IAA (2000 ppm), and two talc formulations of IBA, while the rooting media comprised cocopeat, cocopeat (1:1), and soil. Observations were recorded on days to first bud sprouting, days to first leaf opening, number of shoots per cutting, root length, number of roots per cutting, and survival percentage. Significant differences were observed among the treatments for all the vegetative and rooting parameters. Cuttings treated with 3000 ppm IBA (quick dip) exhibited the earliest bud sprouting (8.74 days) and leaf emergence (15.88 days), the highest number of shoots (6.23 per cutting), maximum root length (9.57 cm), greatest number of roots (12.92 per cutting), and the highest survival percentage (89.45%). Among the rooting media, the cocopeat: sand (1:1:1) mixture proved superior by promoting earlier bud sprouting and leaf emergence, greater shoot proliferation, enhanced root development, and maximum survival (85.13%). The interaction between auxin treatments and rooting media was non-significant for most parameters, indicating that both factors independently influenced the vegetative performance of the cuttings.

Keywords: Grape rootstock, auxin, media, semi-hard wood cutting

Introduction

Grapevine (*Vitis vinifera* L.) is one of the most extensively cultivated fruit crops in the world and plays a crucial role in the global horticultural economy because of its diverse uses as fresh fruit, raisins, juice, and wine. The crop is grown across a wide range of agro-climatic conditions owing to its remarkable adaptability and the availability of suitable rootstocks for different environments. In recent decades, the expansion of commercial viticulture has increased the demand for high-quality planting material that is genetically uniform, healthy, and capable of establishing rapidly in the field. Consequently, the development of efficient propagation techniques has become an important area of research in grape production systems (Keller, 2020; Mullins *et al.*, 1992)^[13].

Grape rootstocks are indispensable components of modern viticulture because they improve vine performance under adverse soil and environmental conditions. Besides providing resistance to phylloxera and several soil-borne pests, rootstocks impart tolerance to salinity, drought, excess soil moisture, and lime-induced chlorosis while enhancing nutrient uptake and vine vigour. Among the available rootstocks, Dogridge (*Vitis champinii* Planch.) is one of the most widely adopted in tropical and subtropical grape-growing regions, particularly in India. It is preferred because of its vigorous growth, extensive root system, excellent compatibility with commercial scion cultivars, and tolerance to drought, salinity, and root-knot nematodes, making it an ideal rootstock for sustainable vineyard establishment (Walker and Clingeffer, 2009)^[18].

Vegetative propagation through stem cuttings remains the most economical and reliable method for multiplying grape rootstocks while maintaining genetic fidelity. However, the

success of rooting and subsequent vegetative growth depends on several interacting factors, including the physiological age of the cutting, seasonal conditions, rooting substrate, environmental factors, and the application of plant growth regulators. Semi-hardwood cuttings, particularly thin semi-hardwood cuttings, have attracted considerable attention because they require less mother plant material, allow rapid multiplication, and can produce vigorous rooted plants when appropriate rooting conditions are provided. Nevertheless, rooting efficiency of thin cuttings is often inconsistent, necessitating the optimization of propagation protocols (Hartmann *et al.*, 2018)^[10].

Among plant growth regulators, auxins are considered the most effective substances for promoting adventitious root formation in stem cuttings. Auxins stimulate cell division, cell differentiation, and the initiation of root primordia, thereby increasing rooting percentage, root number, root length, and overall plant establishment. Indole-3-butyric acid (IBA) is the most widely used auxin in grape propagation because of its greater stability, lower susceptibility to degradation, and consistent rooting response compared with other auxins. However, the effectiveness of auxin treatment varies with concentration, genotype, and type of cutting. Excessively low concentrations may fail to induce sufficient rooting, whereas very high concentrations may inhibit root development or produce phytotoxic effects. Therefore, identifying the optimum auxin concentration for Dogridge thin semi-hardwood cuttings is essential for improving propagation efficiency (De Klerk *et al.*, 1999; Hartmann *et al.*, 2018)^[6, 10].

The rooting medium is another critical factor influencing successful propagation because it determines the availability of moisture, aeration, nutrient supply, and physical support for developing roots. An ideal rooting medium should possess high water-holding capacity while maintaining adequate porosity and drainage. Various substrates such as cocopeat, perlite, vermiculite, sand, soil, farmyard manure, and their combinations have been evaluated for grape propagation with varying degrees of success. Cocopeat-based media are increasingly preferred due to their favourable physical properties, whereas combinations of cocopeat, perlite, vermiculite, and sand often provide an optimal balance between aeration and moisture retention, leading to improved rooting and vegetative growth (Abad *et al.*, 2005; Gruda, 2012)^[1, 9].

Several studies have independently demonstrated the beneficial effects of auxin application and suitable rooting substrates on grape cutting propagation. Nevertheless, relatively limited information is available regarding the combined influence of different auxin concentrations and media combinations on the vegetative performance of Dogridge propagated through thin semi-hardwood cuttings under Indian conditions. Since the interaction between auxin treatment and rooting medium can substantially influence shoot emergence, leaf production, plant height, stem girth, and root development, systematic evaluation of these factors is necessary for developing standardized nursery protocols (Blythe *et al.*, 2007)^[3].

The present investigation, entitled "Effect of Different Auxin Concentrations and Media Combinations on Vegetative Parameters of Grape Rootstock Dogridge Using Thin Semi-hardwood Cuttings," was undertaken to evaluate the

influence of varying auxin concentrations and different rooting media on the vegetative growth of Dogridge cuttings. The findings of this study are expected to contribute towards the development of an efficient, economical, and reproducible propagation protocol for large-scale production of healthy grape rootstock planting material suitable for commercial vineyard establishment.

Materials and Methods

The present investigation, entitled "Effect of Different Auxin Concentrations and Media Combinations on Vegetative Parameters of Grape Rootstock Dogridge Using Thin Semi-hardwood Cuttings," was conducted at the Division of Fruit Crops, ICAR-Indian Institute of Horticultural Research (IIHR), Bengaluru, India, during the period from January 2022 to October 2025. Biochemical analyses were performed in the Physiology and Tissue Nutrient Analysis Laboratories of the Division of Fruit Crops and Horticultural Technology, ICAR-IIHR, Bengaluru. Bengaluru experiences a tropical savanna climate with moderate temperature and humidity, providing favourable conditions for grape propagation. During the experimental period, the average minimum and maximum temperatures ranged from 12.5 to 21.7°C and 27.9 to 35.6°C, respectively. The region receives an average annual rainfall of approximately 400 mm, with the majority of precipitation occurring between July and September.

The experiment was laid out in a Factorial Randomized Block Design (FRBD) comprising two factors with three replications. Each replication consisted of 25 cuttings, and four pots were maintained per replication.

Table 1: Plant Growth Regulator (Auxin) Treatments

Treatment	Description
T ₀	Control (without auxin)
T ₁	IBA 2000 ppm (Quick dip)
T ₂	IBA 2500 ppm (Quick dip)
T ₃	IBA 3000 ppm (Quick dip)
T ₄	IBA + IAA 2000 ppm (Quick dip)
T ₅	IBA 0.4 g per 100 g talc powder
T ₆	IBA 2.0 g per 100 g talc powder

Table 2: Rooting Media

Medium	Composition
M ₁	Cocopeat
M ₂	Cocopeat: Sand (1:1, v/v)
M ₃	Soil

Preparation of Stem Cuttings

Healthy, disease-free thin semi-hardwood cuttings of grape rootstock Dogridge possessing 3-4 nodes were collected from established mother vines. The cuttings were soaked in water overnight to facilitate the removal of endogenous rooting inhibitors. Before planting, the basal end of each cutting was recut obliquely and treated with the respective auxin treatments using either the quick-dip or talc formulation method according to the treatment schedule.

Raising of Planting Material

The treated cuttings were planted in the respective rooting media filled in plastic nursery polybag. Proper cultural practices, including regular irrigation, hand weeding, nutrient application, and plant protection measures, were followed

throughout the propagation period to ensure uniform growth. The cuttings were maintained under nursery conditions until sufficient rooting and shoot development were achieved.

Transplanting

After successful root establishment, the rooted cuttings were transplanted into 14-inch earthen pots containing a standard potting mixture of red soil, sand, and farmyard manure (2:1:1). Routine management practices, including irrigation, fertilization, weed control, and plant protection measures, were carried out uniformly throughout the experimental period.

Observations Recorded

Vegetative growth, rooting performance, and survival of the cuttings were evaluated using standard procedures. The following observations were recorded:

- **Days to first bud sprouting:** Number of days from planting until the appearance of the first sprouted bud.
- **Days to first leaf opening:** Number of days from bud emergence to the opening of the first leaf.
- **Number of shoots per cutting:** Total number of shoots produced per cutting at 30 days after planting (DAP).
- **Root length (cm):** Length of the longest root measured from the base of the cutting to the root tip at 30 DAP, expressed in centimeters.
- **Number of roots per cutting:** Total number of roots developed per cutting at 30 DAP.
- **Cutting survival (%):** Survival percentage of rooted cuttings recorded at 60 days after planting, calculated using the following formula:

Survival (%) = Number of surviving cuttings / Total number of cuttings planted X 100

The experimental data were subjected to analysis of variance (ANOVA) appropriate for a Factorial Randomized Block Design (FRBD). Treatment means were compared using the least significant difference (LSD)/critical difference (CD) test at the 5% level of significance, and statistical analyses were performed following standard experimental procedures.

Results

Thin semi-hardwood cuttings of grape rootstock Dogridge were evaluated under nursery conditions to standardize rapid multiplication techniques through the application of different auxin concentrations in combination with varied growing media. The experiment was designed to assess the influence of these treatments on the vegetative performance.

The performance of the cuttings was assessed based on key vegetative and rooting parameters, including the number of days taken for first bud sprouting, number of days to first leaf emergence, number of shoots per cutting, root length at 30 days (cm), number of roots per cutting at 30 days, and survival percentage recorded at 60 days after planting (DAP). All observations were systematically recorded and subjected to statistical analysis to determine the effect of treatments. The results obtained from these evaluations are presented in the following sections.

Days to first bud sprout

A total of 25 cuttings per treatment were evaluated for days

to bud sprouting, and the results revealed significant differences among the treatments (Table 4.1). Among the auxin treatments, the earliest bud sprouting was recorded in T₃ (3000 ppm IBA, quick dip) with 8.74 days, followed by T₄ (2000 ppm IBA + IAA, quick dip) with 9.58 days. In contrast, the maximum number of days for bud sprouting (11.54 days) was observed in the untreated control (T₀), indicating that exogenous auxin application markedly accelerated bud break compared to untreated cuttings. Similarly, the effect of growing media was found to be significant on bud sprouting. The minimum number of days to bud sprouting (8.41 days) was recorded in M₂ (cocopeat: sand: soil, 1:1:1), which may be attributed to improved moisture retention, aeration, and favourable physical conditions of the medium. Conversely, the maximum delay in bud sprouting (10.92 days) was observed in M₃ (sand alone), which exhibited comparatively poorer performance, likely due to limited water-holding capacity and suboptimal conditions for early bud activation.

Days to first leaf sprout

A total of 25 cuttings per treatment were evaluated for days to first leaf opening, and the results revealed significant differences among treatments (Table 4.1). Among the auxin treatments, the earliest leaf opening was recorded in T₃ (3000 ppm IBA, quick dip) with 15.88 days, followed by T₄ (2000 ppm IBA + IAA, quick dip) with 16.68 days. In contrast, the maximum delay in leaf opening (22.45 days) was observed in the untreated control (T₀), indicating that exogenous auxin application significantly enhanced and accelerated early vegetative development. Treatments with lower or no auxin concentration showed comparatively delayed physiological responses. With respect to growing media, significant variation was also observed in days to first leaf opening. The minimum duration (16.82 days) was recorded in M₂ (cocopeat: sand: soil, 1:1:1), which may be attributed to improved physical conditions such as enhanced moisture retention, aeration, and better nutrient availability. In contrast, the maximum delay (20.28 days) was observed in M₃ (sand alone), which exhibited comparatively poor performance due to its limited water-holding capacity and suboptimal conditions for early growth initiation.

Number of shoots per cutting

The significant variation was observed among the treatments with respect to the number of shoots per cutting. The highest number of shoots per cutting (6.23) was recorded in T₃ (3000 ppm IBA), followed by T₄ (2000 ppm IBA & IAA (Quick dip), which recorded 5.208 shoots per cutting. In contrast, the minimum number of shoots (3.28) was observed in the control treatment, indicating that exogenous application of auxin markedly enhanced shoot initiation and overall vegetative vigour in grape rootstock cuttings. Similarly, the effect of growing media was found to be statistically significant on shoot production. The maximum number of shoots per cutting (5.461) was recorded in M₂ (cocopeat: sand: soil, 1:1:1), whereas the minimum (4.34) was observed in M₃ (sand alone). The superior performance of the mixed medium may be attributed to its improved physicochemical properties, particularly enhanced moisture retention, aeration, and nutrient availability, which collectively create a more conducive environment for shoot development compared to the relatively poor performance of sand alone.

Root length

Root length at 30 days after planting was significantly influenced by the application of different auxin treatments. The maximum root length (9.57 cm) was recorded in T₃ (3000 ppm IBA), followed by T₅ (0.4 g IBA talc formulation) with 8.89 cm. In contrast, the minimum root length (6.95 cm) was observed in the control treatment, indicating that exogenous application of auxins had a pronounced positive effect on root initiation and elongation in grape rootstock cuttings. Similarly, the effect of growing media on root development was found to be statistically significant. The highest root length (8.77 cm) was recorded in M₂ (cocopeat: sand: soil, 1:1:1), whereas the lowest root length (7.00 cm) was observed in M₃ (sand alone). The superior performance of the mixed medium may be attributed to its improved physical and chemical properties, particularly better moisture retention, aeration, and nutrient availability, which collectively created a more favourable environment for root growth compared to sand alone.

Number of roots per cutting

The number of roots per cutting was significantly influenced by different auxin treatments. The highest number of roots (12.92) was recorded in T₃ (3000 ppm IBA), which was markedly superior to all other treatments. T₅ and T₆ also exhibited comparatively higher root numbers; however, the lowest number of roots per cutting (5.475) was observed in the control treatment, indicating the strong promotive effect of auxin application on root initiation and proliferation in grape dogridge rootstock cuttings. Similarly, growing media combinations exerted a significant influence on root production. The maximum number of roots per cutting (10.03) was recorded in M₂ (cocopeat: sand: soil, 1:1:1), whereas the minimum (8.03) was observed in M₃ (sand alone). The inferior performance of sand alone as a rooting medium may be attributed to its limited moisture retention

and suboptimal physical conditions, whereas the superior performance of M₂ (cocopeat: sand: soil, 1:1:1), suggests that a more balanced medium enhances root initiation and overall root development.

Survival Percentage

The final survival percentage of different treatments was recorded at 60 days after planting (DAP), and significant variation was observed among the treatments. The maximum survival percentage (89.45%) was recorded in T₃ (3000 ppm IBA, quick dip), followed by T₄ (86.948%), whereas the minimum survival (45.514%) was observed in the control treatment. These findings clearly indicate that exogenous auxin application substantially enhances establishment success and improves the survival of grape rootstock cuttings under nursery conditions. With respect to growing media, significant differences were also observed in survival percentage. The highest survival (85.133%) was recorded in M₂ (cocopeat: sand: soil, 1:1:1), while the lowest (70.725%) was observed in M₃ (sand alone). The superior performance of the mixed medium may be attributed to its improved physicochemical properties, particularly enhanced moisture retention, aeration, and nutrient availability, which collectively promote better establishment and survival of cuttings. The interaction effect between auxin levels and growing media was found to be non-significant for most of the studied parameters, except for survival percentage and number of roots, indicating that both factors largely acted independently in influencing the vegetative performance of cuttings. Among all treatments, T₃ (3000 ppm IBA, quick dip) consistently exhibited superior performance in terms of early bud sprouting, leaf emergence, shoot proliferation, rooting characteristics, and survival. Similarly, the growing medium comprising cocopeat: sand: soil (1:1:1) proved to be most effective in enhancing overall vegetative growth and establishment of grape rootstock Dogridge cuttings.

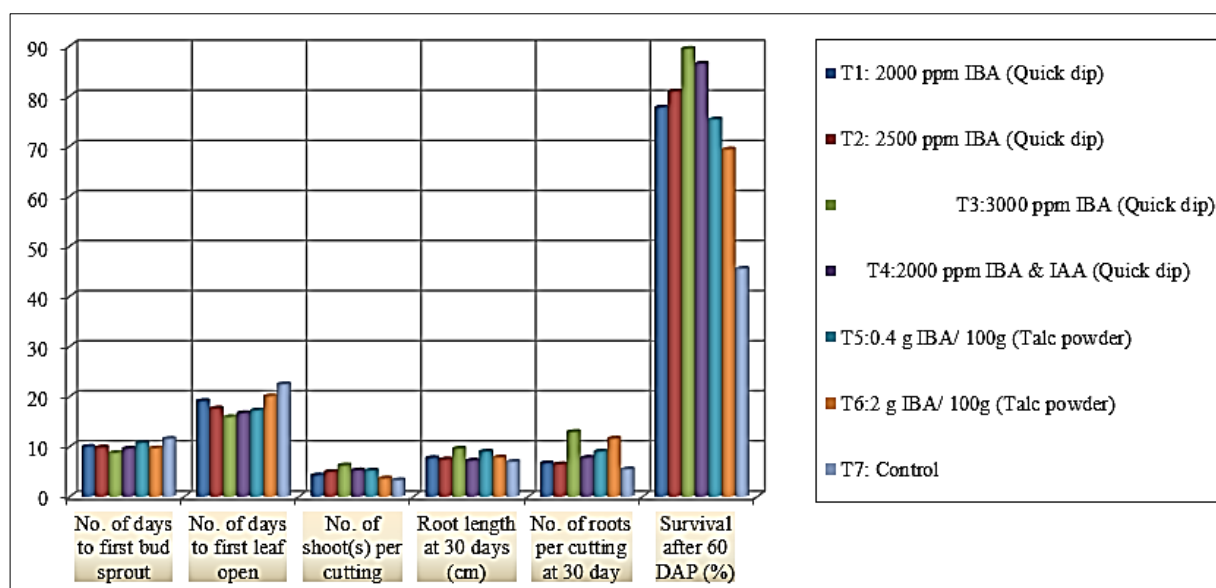


Fig 1: Effect of IBA treatments on rooting

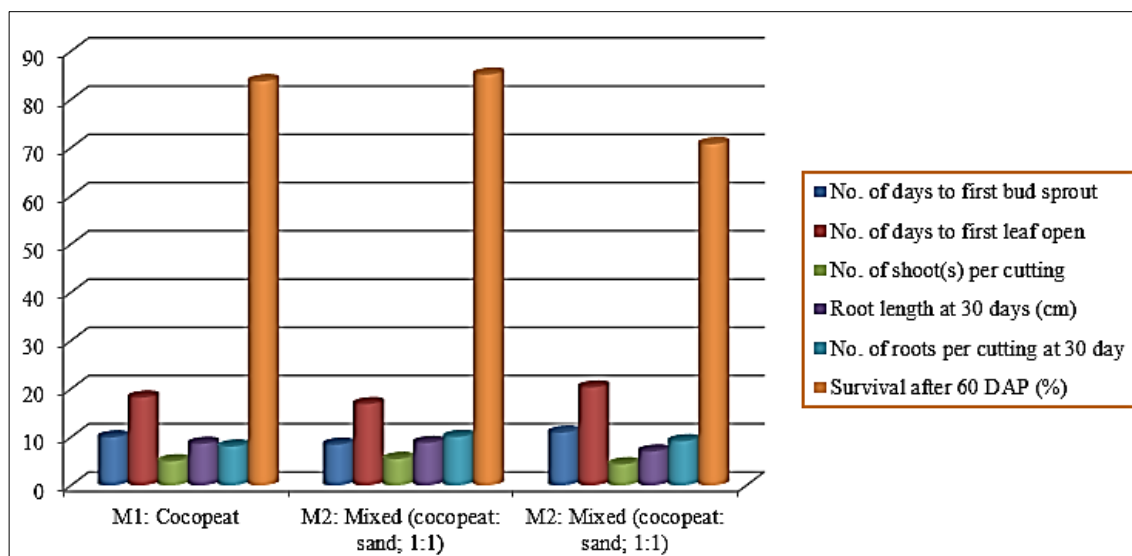


Fig 2: Effect of rooting media on propagation



Fig 3: Vegetative growth and rooting performance of grape rootstock dogridge



Fig 4: Transplanting of rooted grape rootstock dogridge

Discussion

The vegetative performance and rooting behaviour of thin semi-hardwood cuttings of grape rootstock Dogridge are significantly influenced by auxin concentrations and rooting media combinations. The observed improvement in sprouting, shoot growth, and rooting parameters under auxin treatments is in agreement with the well-established role of auxins in promoting cell division, callus formation, and adventitious root initiation in woody cuttings. Similar enhancements in rooting response due to IBA application have been reported in grapevine and other perennial fruit crops, where exogenous auxin was found to stimulate endogenous hormonal balance and accelerate root primordia development (Hartmann *et al.*, 2011; Davies, 2010)^[5,10]. The superiority of specific auxin-media combinations observed in the present study may be attributed to improved physiological conditions such as enhanced aeration, moisture retention, and nutrient availability in the rooting substrate, which collectively facilitate better expression of auxin-induced rooting responses. These findings are in conformity with earlier reports indicating that propagation media significantly influence rooting success by modifying the rhizosphere environment and supporting better carbohydrate utilization and hormonal activity (Leakey *et al.*, 1990; Husen & Pal, 2007)^[12,14]. The combined influence of growth regulators and rooting media plays a crucial role in determining propagation success, as rooting response depends on the interaction between hormonal stimulation and the physical properties of the growing substrate (Blythe *et al.*, 2007)^[3].

The earliest bud sprouting and leaf emergence observed in cuttings treated with 3000 ppm IBA may be attributed to the promotive effect of auxins on cell division, cell elongation, and mobilization of stored carbohydrates towards actively growing meristematic tissues. Although bud break is primarily regulated by endogenous cytokinins and environmental conditions, exogenously applied IBA enhances the physiological status of cuttings by promoting rapid root initiation, thereby improving water uptake and nutrient translocation necessary for bud development. Enhanced rooting also reduces transplant shock and facilitates early establishment, resulting in faster sprouting and leaf emergence. Similar observations have been reported by Hartmann *et al.* (2018)^[10], who stated that auxins indirectly accelerate bud growth by promoting adventitious root formation and improving the physiological balance within propagules. Comparable findings in grape have also been reported by Galavi *et al.* (2013)^[9], who observed earlier bud break and improved vegetative growth in IBA-treated hardwood cuttings.

The significantly higher number of shoots per cutting recorded under 3000 ppm IBA suggests that optimum auxin concentration promotes vigorous vegetative growth following successful root establishment. The formation of a healthy root system enhances the uptake of water and mineral nutrients, thereby increasing photosynthetic activity and supporting the development of new shoots. Moreover, auxin-mediated activation of cambial tissues promotes vascular differentiation, ensuring efficient translocation of nutrients from the rooting zone to developing shoots. Similar findings have been reported by Purohit and Shekharappa (1985)^[15], who observed enhanced shoot proliferation in pomegranate cuttings treated with IBA. Likewise, Daskalakis *et al.* (2018)^[4] reported that appropriate IBA concentrations significantly enhanced rooting efficiency and improved the establishment

of grapevine cuttings by promoting adventitious root formation.

The remarkable improvement in root length and number of roots under 3000 ppm IBA confirms the well-established role of indole-3-butyric acid in adventitious root formation. IBA is considered one of the most effective synthetic auxins because of its greater chemical stability, lower susceptibility to enzymatic degradation, and prolonged physiological activity compared with naturally occurring auxins such as IAA. Exogenous application of IBA promotes dedifferentiation of parenchymatous cells, stimulates cambial activity, and induces the formation of root primordia. It also enhances the accumulation of rooting cofactors, soluble sugars, proteins, and hydrolytic enzymes at the basal end of cuttings, thereby accelerating root initiation and elongation. These findings are consistent with the classical observations of Hess (1961)^[11], who demonstrated that auxins stimulate the formation of adventitious roots by activating meristematic tissues. Similar conclusions were drawn by Hartmann *et al.* (2018)^[10], who identified IBA as the most effective rooting hormone for propagation of woody perennial species. In grapevine, several researchers including Bose *et al.* (1982), Biasi *et al.* (1997), and Singh *et al.* (2017)^[2] have reported significant improvements in rooting characteristics following IBA application.

The higher survival percentage observed in IBA-treated cuttings is a direct consequence of improved rooting and enhanced vegetative growth. Successful root establishment enables greater absorption of water and nutrients, reducing moisture stress immediately after planting and improving the physiological balance between the root and shoot systems. The increased survival may also be associated with enhanced synthesis of endogenous growth regulators, greater carbohydrate accumulation, and improved metabolic activity in rooted cuttings. Similar results have been reported by Hartmann *et al.* (2018)^[10], who emphasized that rapid and extensive root development is the primary determinant of survival during vegetative propagation. Comparable findings in grape rootstocks have also been documented Somkuwar *et al.* (2015)^[17], who observed significantly higher survival in IBA-treated cuttings.

Among the rooting media, the cocopeat: sand: soil (1:1:1) mixture consistently recorded superior performance for all vegetative and rooting parameters. This medium likely provided an optimum balance of moisture retention, aeration, drainage, and nutrient availability, thereby creating favourable conditions for root initiation and subsequent shoot growth. Cocopeat possesses high water-holding capacity and excellent porosity, while sand improves drainage and aeration, and soil contributes mineral nutrients and buffering capacity. The synergistic effect of these components creates an ideal rooting environment by maintaining adequate moisture without causing water logging. Similar observations have been reported by Evans *et al.* (1996)^[7], who demonstrated that physical characteristics of rooting substrates greatly influence adventitious root formation. Likewise, Abad *et al.* (2002)^[1] reported that cocopeat improves water retention, air-filled porosity, and root proliferation in nursery crops. Comparable results in grapevine propagation have also been reported by Satisha *et al.* (2007)^[16], who found that media containing cocopeat significantly enhanced rooting success and survival of grape cuttings.

The interaction between auxin treatments and rooting media was non-significant for most vegetative parameters, suggesting that both factors contributed independently towards improved propagation. Nevertheless, the combination of 3000 ppm IBA and cocopeat: sand: soil (1:1:1) produced the highest overall performance, indicating that optimum hormonal stimulation together with a

favourable rooting environment is essential for successful rapid multiplication of grape rootstock Dogridge. The results of the present study corroborate the findings of Hartmann *et al.* (2018) ^[10], who emphasized that successful vegetative propagation depends on the interaction between endogenous physiological factors and external environmental conditions, particularly rooting substrates and auxin treatments.

Table 3: Effect of different auxin concentration and media combination on vegetative parameters on grape rootstock Dogridge using thin semi-hardwood cuttings

Treatments	No. of days to first bud sprout	No. of days to first leaf open	No. of shoot(s) per cutting	Root length at 30 days (cm)	No. of roots per cutting at 30 day	Survival after 60 DAP (%)
Factor A: Plant Growth Regulator						
T ₁ : 2000 ppm IBA (Quick dip)	9.989	19.104	4.244	7.711	6.662	77.689
T ₂ : 2500 ppm IBA (Quick dip)	9.829	17.627	4.97	7.438	6.474	80.919
T ₃ : 3000 ppm IBA (Quick dip)	8.744	15.888	6.237	9.577	12.924	89.45
T ₄ : 2000 ppm IBA & IAA (Quick dip)	9.586	16.689	5.263	7.203	7.763	86.481
T ₅ : 0.4 g IBA/ 100g (Talc powder)	10.721	17.222	5.208	8.994	8.996	75.328
T ₆ : 2 g IBA/ 100g (Talc powder)	9.664	20.05	3.65	7.824	11.587	69.347
T ₇ : Control	11.547	22.457	3.287	6.954	5.475	45.514
SE(m)	0.305	0.414	0.397	0.397	2.102	1.084
CD@1%	0.882	1.195	1.146	1.146	N/A	3.13
Factor B: Growth medium						
M ₁ : Cocopeat	9.93	18.179	4.976	8.594	8.031	83.748
z M ₂ : Mixed (cocopeat: sand; 1:1)	8.416	16.828	5.461	8.773	10.036	85.133
M ₂ : Mixed (cocopeat: sand; 1:1)	10.921	20.283	4.349	7.007	9.136	70.725
SE(m) ±	0.216	0.293	0.281	0.281	1.487	0.767
CD@1%	0.623	0.845	0.811	0.811	N/A	2.213
Interaction (TXM)						
CD@5%	1.527	N/A	N/A	N/A	N/A	5.421
SE(m)±	0.529	0.717	0.688	0.688	3.642	1.878

Conclusion

The study demonstrated that treatment of thin semi-hardwood Dogridge cuttings with 3000 ppm IBA through the quick-dip method, combined with a cocopeat:sand (1:1:1) rooting medium, provides an efficient propagation protocol for producing vigorous, well-rooted planting material suitable for large-scale commercial multiplication of grape rootstocks.

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