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Influence of auxins on callus induction in different cuttings of grapevine (*Vitis vinifera* L.) var. paneer

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Abstract

Grape is considered a novel fruit crop believed to have been cultivated since the Neolithic era, propagated mainly by hardwood cuttings. The rooting and callus induction of grapevine depend mainly on the type of cuttings and the growth regulators. To identify the best type of cuttings and growth regulator concentration, an experiment on the influence of auxins on callus induction in different cuttings of grapevine (*Vitis vinifera* L.) var. paneer was conducted at North Farm Shade net, Karunya Institute of Technology and Sciences during 2025-2026, using FRBD. The findings showed that hardwood cuttings treated with 3000 mg L⁻¹ of IBA (T₄C₂) showed significantly higher values for callus parameters, i.e., Maximum Callus diameter (15.88 mm), Maximum callus area (3.07 cm²), Maximum callus length (20.24 mm), Maximum callus breadth (18.70 mm), and Maximum callus induction rate (90.33%). From the investigation, it was concluded that IBA 3000 mg L⁻¹ and a hardwood cutting combination is best for the successful induction of callus in grapevine under Coimbatore conditions.

Keywords: Callus induction, auxins, grapes, stem cuttings, growth regulator, *Vitis vinifera*

1. Introduction

Grapes stand as the earliest domesticated, delicious, and refreshing fruit crops. It is a fruit crop that is widely grown globally, and it belongs to the family Vitaceae (2n = 2x = 38). The grapevine, *V. vinifera* subsp. *vinifera* (which originated from *V. vinifera* subsp. *Sylvestris*, its wild relative), and according to historical documents, it was first cultivated in the Near East 6,000–8,000 years ago (McGovern, 2003) [13]. It is considered that grape cultivation started in Armenia, close to the Russian Caspian Sea. From there, it appears to have migrated east to Iran, west to Europe, and possibly even to Afghanistan. Cultivated grapes were introduced to northern India by the Persian invaders in 1300 AD, in the event of the capital's relocation to Daulatabad (situated in Maharashtra's Aurangabad district) from Delhi by King Mohammed-bin-Tughlak. By this event, they were introduced into southern India (Sunitha, 2018) [20].

Grapes grow as a deciduous woody perennial climbing vine, and are non-climacteric. It is the crop from the temperate region that has adapted to the subtropical climate of peninsular India. Indian grapes exhibit a variety of traits, including large and small berries, white and coloured, seeded and unseeded (Angamuthu, 2021) [2]. Grapes are consumed fresh and used to make juice, jam, vinegar, jelly, grape seed extracts, grape seed oil, and wine. In the world, 71 per cent of grape production is used for winemaking, 27 per cent for fresh fruit, and 2 per cent for dried fruit. Despite advances in processing, 90 per cent of grapes in India are used for table purposes. The remaining grapes are used mostly for raisins (TNAU Agritech Portal) [21]. Grapes are a rich source of health-benefiting nutrients, including polyphenolic antioxidants, vitamins, and minerals. In the Indian subcontinent, 80 per cent of total grape production is accounted for by Maharashtra, with 3.4 million tonnes produced over 161,000 hectares of land, followed by Karnataka, Tamil Nadu, and Andhra Pradesh (National Horticulture Board, 2023) [14]. The overall grape production of Tamil Nadu in 2025 is 57.756 tonnes. In Tamil Nadu, Theni ranks first in grape cultivation area at 1685.00 Ha, and Dindigul ranks second with 199 Ha. Theni District was the top producer, with 50681.00 tons of grapes, followed by Dindigul District with 2675.00 tons, and Krishnagiri District with 443.00 tons. In terms of productivity, the districts of

Salem, Tiruppur, and Tiruchirappalli are ranked first, while Dharmapuri District is ranked second (Angamuthu, 2021) [2].

Grape is vegetatively propagated by cuttings, layering, budding, and grafting, but hardwood cuttings are the most popular and commercial methods because they allow for earlier fruit bearing, higher yields, and yearly production of high-quality, true-to-type fruit (Verdegaal, 2009) [24]; Shriram *et al.*, 2021) [17]. A callus is an undifferentiated aggregation of unorganized parenchymatous cells. Grape is one of the crops that has the ability to form callus in the basal end of the cuttings in in-vivo conditions. Farmers traditionally practice tying the grape cuttings in bundles with banana fibre and allowing them to float in water. After one day, the cuttings were removed from the water and planted for callus induction. But by using this method, callus induction in grapevine cuttings was found to be uneven and less successful due to several interacting restrictions, and it is also affected by genotype dependency, since various grape genotypes respond unevenly to identical callus induction techniques, resulting in extremely varied callus formation rates (Daskalakis *et al.*, 2018) [5]. Callus formation can be inhibited by unfavorable conditions (Uddin *et al.*, 2020) [22]. It is also accompanied by different concentrations of growth regulators, which are responsible for the production of toxic substances that hinder callus formation.

In order to avoid the non-uniformity in callus induction and rooting, which is a drawback in farmers' practice, the use of different growth regulators will be more efficient to improve the histological characteristics, including callus and tissue development. Considering the existing problems in grapevine callus induction, and by utilizing the advantage of callus formation in in-vivo conditions, an attempt was made to standardize the suitable growth regulator concentration and type of cutting in callus induction of grapevine.

2. Materials and Methods

2.1. Experimental Location

The research study was conducted on "Influence of Auxins on Callus Induction in Different Cuttings of Grapevine (*Vitis vinifera* L.) var. Paneer" during 2025-2026 at the North Farm Shade net, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India, from August to December.

2.2. Collection of cuttings

The three types of grape vine cuttings of the Paneer variety were sourced from grape-growing farmers in Odaipatti Village of Theni District. The cuttings used in this experiment were uniform in thickness, standardized to a length of 15–20 cm, and possessed at least three to four nodes. After detaching from the mother plant, the cuttings are tied as bundles and wrapped with wet cotton cloth, and they are brought to the research location in gunny bags. This was done in order to prevent drying of cuttings during transportation. The farmer's practice served as the control treatment in the experiment.

2.3. Application of Treatment and Planting of Cuttings

Before treatment, the basal ends were freshly trimmed by using secateurs. Within 24 hours of separation from the mother vine, the cuttings were treated with a growth regulator solution. Each cutting's basal end was soaked for five minutes in the relevant growth regulator. A growing medium comprising soil, cocopeat, and farmyard manure (FYM) in a 2:1:1 ratio was filled in the polybags measuring 4×6 inches. The cuttings were planted in the polybags at a slanting angle after the treatment. The cuttings were planted in a way that one or two nodes were buried in the media and two or three nodes above the surface. After planting,

the polybags were kept under shade-net conditions to provide a suitable condition for callus induction.

2.4. Callus Observations

Callus growth parameters were recorded at 30,45, and 60 days after planting (DAP).

2.4.1. Microscopic Examination of Callus Tissue

To verify whether the formed tissue at the basal end of the grapevine cuttings was callus, microscopic examination was performed. Callus tissue obtained from the cutting's basal region was carefully collected, and a thin section was made by hand sectioning. The section was placed on a clean microscopic slide and stained with two drops of 0.1% Toluidine Blue O (Kazmi *et al.*, 2015) [10]. After one minute, it was gently rinsed with distilled water and mounted with a coverslip for microscopic observation. The prolonged process of this also causes excess staining of the sample. This method allows the visualization of undifferentiated and unorganized cell masses characteristic of callus tissue.

2.4.2. Callus Induction Rate (%)

The callus induction was measured using the formula,

$$\text{Callus Induction Rate(\%)} = \frac{\text{Total number of cuttings produced callus}}{\text{Total number of cuttings}} \times 100$$

2.4.3. Callus Diameter (mm)

A digital vernier calliper is used to measure the maximum length (L) and maximum width (W) of the callus, and the diameter was calculated using the formula,

$$\text{Callus Diameter (mm)} = \sqrt{L \times W}$$

2.4.4. Callus Area (cm²)

The basal area of the cutting that produced callus is known as the callus area. The area of the callus was calculated using the elliptical area formula from basic mathematics because the obtained callus had an elliptical shape. To measure the callus's greatest length (L) and width (W), a digital vernier calliper was used, and the following formula was used to determine its area:

$$\text{Elliptical : } A = \pi \times \frac{L}{2} \times \frac{W}{2}$$

2.4.5. Callus Length (mm) & Callus Width (mm)

It was measured using a digital vernier calliper.

2.4.6. Callus Colour & Texture

This is a visual method of characterizing callus. This helped in assessing the callus quality and its ability to regenerate. The callus colour can be as creamy white or brown. The texture of the callus can be loose and compact.

2.5. Statistical Analysis

The experimental design followed was Factorial Randomized Block Design (FRBD) consisting of ten treatments with various auxins of different concentrations (0, IBA- 1000, 2000, 3000 mg L⁻¹, IAA- 50,100,150 mg L⁻¹, and NAA- 500, 1000, 1500 mg L⁻¹) that are treated with 3 different types of grapevine cuttings (Semi-Hard, Hardwood and Softwood) respectively. All obtained data were subjected to an ANOVA analysis using GRAPES software by KAU, and significant differences between

treatments were indicated by $P < 0.05$.

3. Results and Discussion

3.1. Microscopic Examination of Callus Tissue

Microscopic examination of the tissue formed at the basal region of the grapevine cuttings confirmed the presence of callus. Staining with 0.1% Toluidine Blue O revealed an unorganized mass of thin-walled, isodiametric to polygonal parenchymatous cells, loosely arranged with prominent intercellular spaces (Fig 1). Histological observation reveals that callus is derived from immature ray parenchyma cells that undergo rapid and irregular divisions to generate isodiametrically shaped cells characteristic of differentiated callus following perception of wound signals (Ikeuchi *et al.*, 2013) [8]. Differential staining across the callus mass, with certain cells exhibiting intense blue coloration and others remaining lightly stained, reflected variability in cell wall composition and cytoplasmic content among the proliferating cells. No vascular elements, root primordia, or shoot primordia were detected in any section, confirming the fully undifferentiated status of the tissue at the time of examination. Internal factors affecting rooting of cuttings include the formation of callus and adventitious roots, while rooting media is one of the most important external factors influencing rooting and growth of grapevine cuttings (Jaleta and Sulaiman, 2019) [9].

3.2. Effect of Different Auxin Concentration on Callus Parameters of Grape Vine Cuttings Var. Paneer

Table 1 depicted that IBA at 3000 mg L⁻¹ (T₄) consistently outperformed all other treatments in callus induction and grapevine cutting development. T₄ led with the highest callus induction rate (89.53%), callus diameter (16.75 mm), callus area (1.54 cm²), callus length (17.32 mm), and callus width (16.27 mm), while T₅ had the lowest with the callus induction rate (2.78%). T₅ and T₆ do not initially exhibit callus formation at 30 DAP, but callus formation is gradually observed at the subsequent observation stages of 45 and 60 DAP. IBA at 3000 mg L⁻¹ provided an optimal auxin concentration at the basal wound zone that sustained maximum cell dedifferentiation and proliferation. Sun *et al.* (2023) [19] observed that when Yueshenda 10 mulberry cuttings were treated with auxin, roots primarily developed from the callus tissue of the cuttings. They stated that the development of callus in the cuttings' basal part is often associated with adventitious root initiation. Cuttings that were treated in 800 mg/L NAA for 60 minutes and 500 mg/L NAA for 30 minutes developed adventitious roots and calluses. El-Banna *et al.* (2023) [6] reported that IBA increases soluble sugars and phenolic content, promoting intense cell divisions that encourage callus formation, with its chemical stability giving it a longer half-life than IAA, while NAA can cause phytotoxicity at higher doses (da Costa *et al.*, 2013 [4]; Ercan Oguzturk *et al.*, 2025 [7]). Studies of Sekhukhune and Maila (2025) [16] showed that the highest callus percentage (94%) was attained at IBA 100 ppm in *A. deliciosa*, and IAA 100 ppm resulted in the maximum callus diameter (32.99mm) in 1613 grape rootstock (Shriram *et al.*, 2021) [17].

3.3. Effect of Different Types of Cutting on Callus Parameters of Grape Vine Cuttings Var. Paneer

Data from Table 2 showed that the type of cutting had a significant effect on callus induction of the grapevine. Softwood cuttings that were planted on polybags dried fully after seven days. In all observation periods, hardwood cuttings (C₂) consistently performed higher than other cutting types. C₂ led with the highest callus induction rate (53.36%), callus diameter (11.65 mm), callus area (1.42 cm²), callus length (11.59 mm), and callus width (11.84 mm), while C₁ had the lowest callus induction rate (44.77%). Pirlak and Cinar (2020) [15] studied the impact of IBA on cuttings' ability to root. They observed that, compared to softwood and hardwood cuttings, semi-hardwood cuttings of Carrizo citrange and Troyer citrange had greater callus formation rates (88.21%, 81.03%). Hardwood cuttings are often better due to their higher physiological maturity, thicker tissues, and larger carbohydrate reserves, making them the simplest and most economical method of grapevine vegetative propagation (Waite *et al.*, 2015 [25]; Singh and Chauhan, 2020 [18]), with stronger callogenesis followed by root formation at the physiological base (Veloza *et al.*, 2014 [23]; Sekhukhune and Maila, 2025 [16]). However, higher callus percentages in softwood cuttings have also been reported in Cornelian cherry (73.3%) (Markovic *et al.*, 2014) [12] and miraculous fruit softwood cuttings before root emergence (Chen *et al.*, 2012) [3].

3.4. Interaction Effect of Different Auxins and Type of Cutting on callus parameters of grape vine cuttings

Table 3 showed that the combination of growth regulators and cutting type significantly affected grapevine callus induction and development. Hardwood cuttings treated with IBA 3000 mgL⁻¹ (T₄C₂) consistently performed better than all other treatment combinations at every point of observation, while IAA-treated combinations showed the lowest values. Callus diameter (15.88 mm), callus area (3.07 cm²), callus length (20.24 mm), callus breadth (18.70 mm), and callus induction rate (90.33%) were all highest in T₄C₂, while T₆C₁ had the lowest callus induction rate (4.14%). Until the final day of observation, T₅C₁ showed no signs of callus. The callus was compact in texture and had a creamy white colour, especially in cuttings treated with IBA and NAA. Based on the findings of Sekhukhune and Maila (2025) [16], semi-hardwood cuttings of *A. deliciosa* rootstock treated with different concentrations of IBA yielded better results. The cuttings showed a higher callus percentage (94%) in IBA 100 ppm, larger callus formation (2.8) in IBA 100,000 ppm, and also found that higher values were obtained when cuttings were treated with increasing IBA concentrations. According to Abhinav *et al.* (2016) [1], auxin treatments increase cell activity, photosynthates, and promote larger stems, callus, and root diameters in grapes, while greater glucose storage and auxin-mediated cell division at the cutting base result in increased callus proliferation in hardwood cuttings under high IBA concentrations. These findings are consistent with earlier studies reporting the highest callusing and rooting efficiency in IBA-treated hardwood cuttings (Kumar *et al.*, 2023; Veloza *et al.*, 2014) [11, 23].

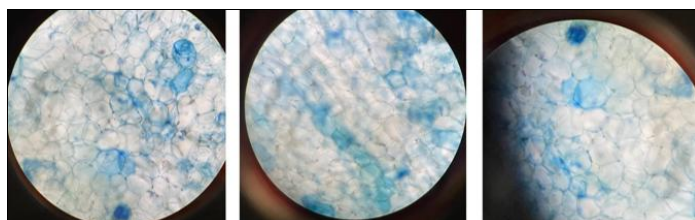


Fig 1: Callus formation at 30, 45, and 60 DAP under microscopic view

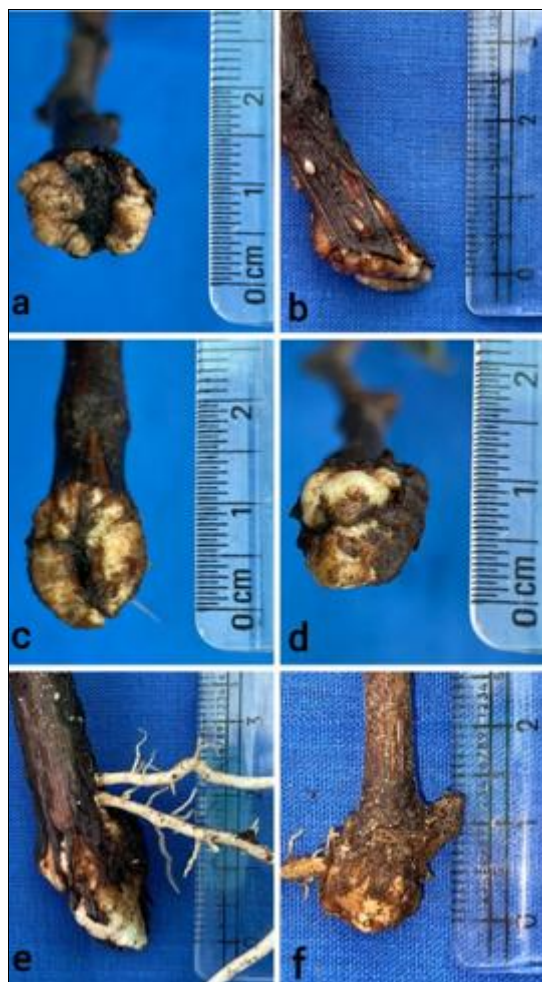


Fig 2: Callus formation at 30 (a&b), 45 (c&d), and 60 DAP (e&f) in semi-hardwood cuttings (a-T₄C₁, b-T₂C₁, c-T₄C₁, d-T₂C₁, e-T₄C₁, f-T₂C₁)

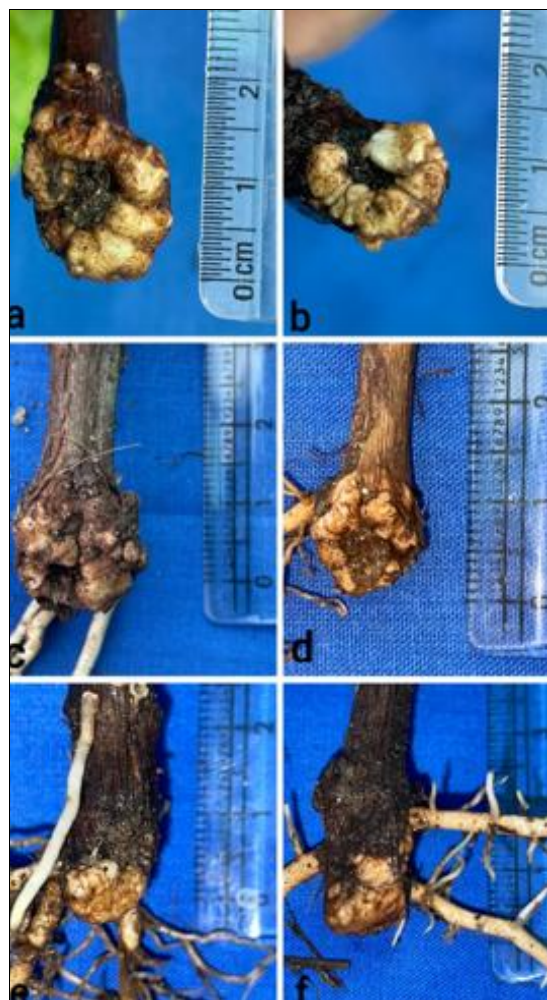


Fig 3: Callus formation at 30 (a&b), 45 (c&d), and 60 DAP (e&f) in hardwood cuttings (a-T₄C₂, b-T₁C₂, c-T₄C₂, d-T₂C₂, e-T₄C₂, f-T₂C₂)

Table 1: Influence of varying auxin concentrations on callus induction rate, callus diameter, and callus area of grape vine cuttings *var. Paneer*

Growth Regulators	Callus induction rate%				Callus diameter (mm)				Callus Area (cm ²)				Callus Length (mm)				Callus Width (mm)			
	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean
T ₁ : Control (Farmers' Practice)	82.84	83.33	63.88	76.68	13.22	17.09	9.48	13.26	1.44	2.47	0.73	1.55	13.27	17.21	9.94	13.47	13.29	16.97	9.09	13.11
T ₂ : IBA 2000 mg L ⁻¹ (Absolute control)	66.67	99.67	66.05	77.46	12.37	19.09	12.11	14.52	1.30	3.05	1.16	1.84	12.27	20.18	11.74	14.73	12.54	18.07	12.52	14.38
T ₃ : IBA 1000 mg L ⁻¹	46.38	59.30	39.01	48.23	10.02	14.32	8.76	11.03	0.86	1.79	0.65	1.10	10.13	14.57	8.40	11.03	9.97	14.09	9.19	11.08
T ₄ : IBA 3000 mg L ⁻¹	85.46	99.64	83.50	89.53	15.90	20.52	13.84	16.75	2.13	3.50	1.54	2.39	16.07	21.42	14.48	17.32	15.84	19.67	13.31	16.27
T ₅ : IAA 50 mg L ⁻¹	0.00	0.00	8.34	2.78	0.00	0.00	2.02	0.67	0.00	0.00	0.06	0.02	0.00	0.00	1.89	0.63	0.00	0.00	2.18	0.73
T ₆ : IAA 100 mg L ⁻¹	0.00	8.34	14.54	7.63	0.00	5.39	4.05	3.15	0.00	0.55	0.14	0.23	0.00	4.40	4.36	2.92	0.00	6.71	3.80	3.50
T ₇ : IAA 150 mg L ⁻¹	16.85	34.48	25.75	25.69	2.21	11.73	4.56	6.17	0.08	1.26	0.18	0.50	1.58	11.54	4.70	5.94	3.11	12.20	4.45	6.59
T ₈ : NAA 500 mg L ⁻¹	30.96	55.52	32.17	39.55	5.18	14.25	6.49	8.64	0.21	1.78	0.37	0.79	5.71	14.29	6.11	8.70	4.81	14.22	6.92	8.65
T ₉ : NAA 1000 mg L ⁻¹	66.82	83.33	57.01	69.05	12.01	17.83	9.34	13.06	1.22	2.71	0.73	1.55	11.42	18.01	9.04	12.82	12.75	17.67	9.90	13.44
T ₁₀ : NAA 1500 mg L ⁻¹	45.47	71.13	45.56	54.05	9.88	16.03	9.32	11.74	0.82	2.22	0.73	1.25	9.24	15.86	10.56	11.88	10.65	16.20	8.29	11.72
S.Em. ±	0.78	0.36	0.78		0.39	0.87	0.31		0.05	0.23	0.04		0.59	0.86	0.47		0.62	0.86	0.42	
C.D. at 5%	2.24	1.02	2.23		1.11	2.49	0.88		0.15	0.64	0.11		1.67	2.47	1.34		1.77	2.47	1.19	

Table 2: Influence of different types of Cuttings on callus induction rate, callus diameter, and callus area of grape vine cuttings *var.* Paneer

Type of Cutting	Callus induction rate%				Callus diameter (mm)				Callus Area (cm ²)				Callus Length (mm)				Callus Width (mm)			
	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean
C1: Semi-Hard Wood Cutting	41.00	55.67	37.63	44.77	6.02	12.11	6.32	8.15	0.44	1.62	0.41	0.82	6.07	12.50	6.33	8.30	6.03	11.76	6.38	8.06
C2: Hard Wood Cutting	47.29	63.27	49.53	53.36	10.14	15.13	9.68	11.65	1.18	2.25	0.84	1.42	9.87	14.99	9.91	11.59	10.56	15.40	9.55	11.84
S.Em. $\pm$	0.35	0.16	0.35		0.17	0.39	0.14		0.02	0.10	0.02		0.26	1.22	0.21		0.28	0.39	0.19	
C.D. at 5%	1.00	0.45	1.00		0.50	1.11	0.39		0.07	0.29	0.05		0.75	3.50	0.60		0.79	1.11	0.53	

Table 3: Interaction Effect of different auxin concentrations and different Types of cutting on callus induction rate, callus diameter, and callus area of grape vine cuttings *var.* Paneer

Growth Regulator + Type of Cutting	Callus induction rate%				Callus diameter (mm)				Callus Area (cm ²)				Callus Length (mm)				Callus Width (mm)				Callus colour & Texture
	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean	At 30 DAP	At 45 DAP	At 60 DAP	Mean	
T ₁ C ₁	81.09	83.33	61.09	75.17	10.22	16.56	7.70	11.49	0.82	2.33	0.47	1.21	10.29	16.52	8.07	11.63	10.24	16.61	7.38	11.41	Creamy White & Compact
T ₁ C ₂	84.59	83.33	66.67	78.20	16.22	17.62	11.26	15.03	2.07	2.61	1.00	1.89	16.25	17.91	11.81	15.32	16.33	17.33	10.79	14.82	Creamy White & Compact
T ₂ C ₁	66.67	99.67	65.43	77.26	9.09	17.76	11.38	12.74	0.68	2.65	1.02	1.45	9.27	19.28	11.35	13.30	8.91	16.37	11.42	12.23	Creamy White & Compact
T ₂ C ₂	66.67	99.67	66.67	77.67	15.65	20.41	12.85	16.30	1.92	3.44	1.30	2.22	15.26	21.08	12.13	16.16	16.17	19.77	13.62	16.52	Creamy White & Compact
T ₃ C ₁	42.76	51.93	29.05	41.25	7.20	13.62	6.56	9.12	0.43	1.63	0.36	0.81	7.39	13.65	6.41	9.15	7.02	13.59	6.71	9.11	Creamy White & Compact
T ₃ C ₂	50.00	66.67	48.96	55.21	12.84	15.03	10.97	12.94	1.29	1.95	0.95	1.40	12.86	15.49	10.38	12.91	12.93	14.59	11.66	13.06	Creamy White & Compact
T ₄ C ₁	83.33	99.55	83.33	88.74	11.61	18.89	11.80	14.10	1.06	2.98	1.09	1.71	11.81	19.59	11.82	14.41	11.44	18.22	11.89	13.85	Creamy White & Compact
T ₄ C ₂	87.58	99.73	83.67	90.33	20.19	22.15	15.88	19.41	3.20	4.03	1.98	3.07	20.33	23.25	17.14	20.24	20.23	21.12	14.74	18.70	Creamy White & Compact
T ₅ C ₁	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Nil
T ₅ C ₂	0.00	0.00	16.67	5.56	0.00	0.00	4.04	1.35	0.00	0.00	0.13	0.04	0.00	0.00	3.78	1.26	0.00	0.00	4.35	1.45	Creamy White & Loose
T ₆ C ₁	0.00	0.00	12.41	4.14	0.00	0.00	2.81	0.94	0.00	0.00	0.07	0.02	0.00	0.00	3.08	1.03	0.00	0.00	2.57	0.86	Creamy White & Loose
T ₆ C ₂	0.00	16.67	16.67	11.11	0.00	10.77	5.29	5.35	0.00	1.10	0.22	0.44	0.00	8.80	5.63	4.81	0.00	13.43	5.02	6.15	Creamy White & Loose
T ₇ C ₁	0.00	35.63	18.09	17.91	0.00	11.91	3.61	5.17	0.00	1.23	0.11	0.45	0.00	12.85	3.97	5.61	0.00	10.43	3.28	4.57	Creamy White & Loose
T ₇ C ₂	33.69	33.33	33.42	33.48	4.43	15.42	5.51	8.45	0.16	1.29	0.24	0.56	3.17	10.24	5.43	6.28	6.23	13.97	5.61	8.60	Creamy White & Loose
T ₈ C ₁	28.47	44.37	39.94	37.59	5.42	11.55	5.13	7.37	0.23	1.52	0.22	0.66	6.79	13.57	5.12	8.49	4.35	12.60	5.14	7.36	Creamy White & Loose
T ₈ C ₂	33.45	66.67	24.40	41.51	4.93	13.07	7.86	8.62	0.19	2.04	0.51	0.91	4.62	15.01	7.11	8.91	5.26	15.85	8.69	9.93	Creamy White & Compact
T ₉ C ₁	66.67	83.33	50.00	66.67	8.95	15.55	7.11	10.54	0.66	2.07	0.40	1.05	8.12	15.25	5.87	9.74	9.87	15.86	8.73	11.49	Creamy White & Compact
T ₉ C ₂	66.97	83.33	64.02	71.44	15.07	20.11	11.57	15.59	1.78	3.35	1.05	2.06	14.72	20.77	12.22	15.90	15.63	19.48	11.07	15.39	Creamy White & Compact

T ₁₀ C ₁	41.02	58.93	32.47	44.14	7.71	14.15	7.08	9.64	0.49	1.75	0.40	0.88	7.02	14.35	7.63	9.67	8.47	13.96	6.65	9.69	Creamy White & Compact
T ₁₀ C ₂	49.91	83.32	58.65	63.96	12.05	17.90	11.55	13.84	1.14	2.69	1.06	1.63	11.45	17.38	13.48	14.10	12.83	18.45	9.94	13.74	Creamy White & Compact
S.Em. ±	1.11	0.50	1.10		0.55	1.23	0.44		0.07	0.32	0.06		0.83	1.22	0.66		0.87	1.22	0.59		
C.D. at 5%	3.17	1.44	3.15		1.57	3.52	1.25		0.21	NS	0.16		2.37	3.50	1.90		2.50	3.50	NS		

4. Conclusion

The results of the study on the Influence of Auxins on Callus Induction in Different Cuttings of Grapevine (*Vitis vinifera* L.) var. Paneer revealed that, in terms of auxin concentration, grapevine cuttings treated with IBA 3000 mg L⁻¹ are the most effective auxin treatment for callus induction. In terms of cutting type, Hardwood cuttings performed better than the other types and resulted in the highest callus parameters. Overall, the interaction effect of IBA 3000 mg L⁻¹ treatment in hardwood cuttings gives higher results than the other combinations. This combination resulted in maximum terms of callus induction rate, callus diameter, callus area, callus length, and callus width over the observations at 30, 45, and 60 days after planting the cuttings. This research study also highlights the importance of callus induction in grapevine cuttings, demonstrating that callus induction plays a crucial role in the rooting of cuttings. Therefore, future research can focus on callus induction of various grapevine cuttings under different media and developing a commercial formulation by using auxins, especially IBA, to be used for effective callus induction. Such studies will help the farmers in the easy callus induction and rooting of grapevine cuttings. Ultimately, this will result in enhanced grape vineyard establishment and increased grape production.

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Conflict of Interest

The authors declare no conflict of interest regarding the publication of this research article.

Ethical approval

This doesn't apply to the study

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