

Effect of Synthetic and Natural Growth Hormones on Morphology of Rooting in Grape (*Vitis vinifera* L.) Cuttings Cultivar Punjab Macs Purple

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Abstract

In this research, effect of the different natural (*Cinnamon powder*, apple cider, honey, *Aloe vera*) and synthetic hormones like growth regulators (IAA, IBA, GA₃) were tested along with control treatment on the rooting in hardwood cuttings of grape (*Vitis vinifera* L.), cultivar Punjab Macs Purple. The hardwood cuttings were dipped in solution of IBA 2000ppm for 2 minutes and then planted in the main field. The observations were recorded at an interval of thirty, sixty and ninety days after planting. The treatment T₉, applied with IBA 2000 ppm was found with highest number of roots (52.66), number of shoots (52.66) root girth (7.83mm), shoot length (30.73cm), chlorophyll content (30.60nm) and survival percentage (73.33%) after 90 days. Treatment of IBA 2000 ppm was found more effective in rooting and shoot growth of hardwood grapes cutting. Natural hormones like *Aloe vera* was found as promising alternative rooting hormone for the propagation of grape cuttings.

Keywords: Hardwood cutting, Hormones, Grapes rooting, Iba, Natural rooting substances cines

1. Introduction

The grape (*Vitis vinifera* L.) is an important fruit crop and the most economically significant fruit crop in the world is a member of the Vitaceae family and native to the Black Caspian Sea. It is a woody vine crop that can reach a height of 17 metres or higher (Kaur, 2017). According to the Food and Agriculture Organisation (FAO), 2022, temperate regions, principally China, France, and Italy produce the majority of grapes, with a total expected production of 78,034,332 metric tonnes (FAO, 2020). The most efficient and affordable method to propagate and enhance the rooting ability while bringing sustainability is by using different hormones and other natural treatments, such as aloe vera, apple cider vinegar, cinnamon powder, and honey (Rajan *et al.*, 2023). These treatments can be used to obtain root initiation and root formation in grape cutting.

Nowadays, many farmers are using aloe vera as an inducing agent for rooting as there are antibacterial properties in it along with some root-inducing agents (Kaur, 2017). Dipping or incorporating the root stimulation agents into the tip of the cutting can help to promote the root as well as plant growth and also kill the weeds (Rajan *et al.*, 2021). Plants majorly produce natural and synthetic hormones in very low concentration that help in plant growth regulation. Plant hormones like auxin, gibberellin, and cytokinin are available in two forms, i.e., natural and synthetic forms.

Aloe vera, honey, cinnamon powder, coconut water, vermiwash, and apple cider vinegar are some examples of natural compounds that affect the growth and rooting of grape cuttings and can be used in place of synthetic hormones (Sokhuma *et al.*, 2018; Abebe, 2017). Plant hormones include synthetic or natural substances that, when treated at extremely low concentrations, affect the physiological reactions of plants.

An auxin found in plants called indole-3-acetic acid aids in improved plant growth and has an impact on developmental processes like elongation of the cell, division of cell, cell differentiation, apical dominance, etc. IAA is also required for root initiation, i.e., both primary and lateral roots. It helps to increase the root hair development so that root length can also increase. The roots of the plant produce many organic compounds such as vitamins, sugars, acids, etc. All of these are used by the fungal populations as nutrients for growth and development (Muttulani, 2022). Indole-

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3-butyric acid (IBA) is mainly a synthetic hormone that has some similar effects to auxin, like the initiation of roots, etc. It is also used as a medium for plant propagation in roots and stem cuttings that help in root development, particularly root hair development (Rajan, *et al.*, 2021). Gibberellic acid (GA₃) is a plant hormone that occurs naturally and helps in the regulation of plant growth, mainly in the cell division and cell elongation processes used for the elongation of plant leaves and stems (Muttulani, 2022) in the present research paper.

2. Materials and methods

The goal of the current study was to compare the effects of natural and synthetic hormones on the rooting of grape cuttings of the variety Punjab Macs Purple (*Vitis vinifera* L) in the agricultural research farm of Lovely Professional University in Punjab during the rabi season of 2021–2022. Different kinds of synthetic and natural hormones were used in this investigation. Cuttings of the disease-free and healthy Punjab Mac Purple grape variety were acquired from the Regional Research Station in Bathinda, Punjab. Local growers frequently utilize and plant this grape variety. Cuttings were collected from one year old plant, having 15-20 cm length and pencil thickness with 3-4 nodes and a node in the basal region. For rooting medium, farm yard manure (FYM) and fine sand at a ratio of 1:2 was prepared well, cleaned of weeds or stones, and thereafter placed in rooting media. Before transplanting the cuttings they were treated with the aloe vera 100% (12 hours), cinnamon powder 100% (12 hours), apple cider 100% (12 hours), honey 100% (12 hours), IAA (100 ppm, 300 ppm and 500 ppm for 12 hours) IBA (1000 ppm, 2000 ppm and 3000 ppm for 2 minutes) and GA₃ (50 ppm, 100 ppm and 150 ppm for 12 hours) and Control (Dipping in water for 12 hours) were taken from the horticultural farm, School of Agriculture, Lovely Professional University, Jalandhar. The observations were noted at three different time such as 30, 60 and 90 days after planting.

After treatment, cuttings were quickly planted in rooting media at a depth of 7.5 cm to the surface in plant trainers and planted in field. The effects of both natural and synthetic growth hormones on rooting of Punjab Macs Purple grape cuttings, such as number of roots in cuttings, no. of shoots, root girth (mm), shoot length (cm), no. of leaves, survival percentage of cuttings were observed and recorded. The concentration at which plant growth regulator or natural rooting substances responsible for better rooting and shooting were found after the analysis of data.

3. Results and Discussion

3.1 Number of roots and number of shoots

Table 1 provided information on how natural and synthetic growth hormones affected the number of roots and shoots. The recorded data on the number of roots revealed that the treatment T₉, in which 2000 ppm IBA applied on cuttings produced the most roots (20.33, 44.00, and 52.66), followed by treatment T₁, in which 100% aloe vera is treated was found with the highest number of roots 15.66, 28.66, 47.00 respectively at 30, 60 and 90DAP. The least number of roots was found in the treatment T₁₄ control (6.00) at 30DAP and T₁₁ with the application of 50 ppm GA₃ with (9, 12) at 60 and 90DAP. This effect of better root induction might be due to the involvement of increased cambial activities within which are stimulated by IBA thus, lead to a maximum number of roots. Similar results also found by Daoud *et al.* (1989) and this result also justified by Ahmad *et al.* (2016) in the rooting of dragon fruit (*Hylocereus undatus*). They reported that the impact of IBA increases plasticity of cell wall and increased division of cell in turn stimulates callus development and root growth. The data on no. of shoots gives an insight regarding shooting in grapes cutting. Collected data showed that the treatment T₉ with the application of 2000 ppm IBA had a maximum number of shoots (6.67) followed by the treatment T₁₀ which is the application of 3000 ppm IBA with (6.00). The least number of shoots was found in the treatment T₁₄ which is control with (3) at 30DAP. At 60DAP, the maximum no. of shoots (7.33) was found in the treatment T₉ with the application of 2000 ppm IBA followed by the treatment T₁ (5.67) with the application of 100% aloe vera as compared to control (3). At 90DAP, the maximum no. of shoots was found in the treatment T₉ (7.33) with the application of 2000 ppm IBA followed by the treatment T₁ (5.67) with the application of 100% aloe vera as compared to control. These results are related in pomegranate (*Punica granatum*) by (Mehta *et al.*, 2018). Similarly, with the use of 2000ppm IBA, the highest success percentages, number of sprouts, total number of leaves, leaf area index, number of roots per cutting, and root length were noticed by (Singh *et al.*, 2015) in an evaluation of IBA and NAA which managed to boost the number of leaf /cutting in phalsa (*Grewia subinaequalis* L.). IBA affected the cell growth, cell division in the vascular cambium, and control of differentiation into different types of cambial resulting in growth in the number of shoots (Devi *et al.*, 2016) in phalsa (*Grewia asiatica* L).

3.2 Root girth (mm) and shoot length (cm)

Data regarding the impact of natural and synthetic growth hormones on root girth (mm) and shoot length (cm), is displayed in table 2. The data on root girth was recorded and it showed that the treatment T₉ with the application of 2000 ppm IBA had more root girth (1.76mm) followed by the treatment T₁ which is the application of 100% aloe vera with (1.56mm). The least root girth was observed in the treatment T₁₄-control with (0.56mm) at 30DAP. After 60 days of planting, the maximum root girth (4.26mm) was noticed in the T₉ treatment in which the IBA is applied at the rate of

2000 ppm followed by the treatment T₁ (3.26mm) with 100% aloe vera application in comparison to the least root girth of control (1.43mm). At 90DAP, the maximum root girth was present in T₉ (7.83mm) treatment of 2000 ppm IBA followed by 6.83mm in the treatment T₁ applied with 100% aloe vera and the least was in T₁₄-control (4.83mm). This might be due to the effect of IBA in enhancing the root girth by the promotion of cell elongation in plants which in turn increases the length of the root and the root girth due to improved vegetative growth and better carbohydrate accumulation as justified by different studies of Polat and Caliskan, 2006; Saroj *et al.*, 2008; Melgarejo *et al.*, 2008. They reported that in the cuttings there is already a certain level of auxin present as further application of IBA optimizes the auxin level and indirectly improves the cuttings that rooted. Similar results are also found by (Nanda, 1975) it could be due to accumulation of carbohydrate and more vegetative growth. The data on shoot length depicts the best treatment was T₉ in which the application of Indole Butyric Acid 2000 ppm showed highest shoot length (4.90cm), followed by the treatment T₁ (4.53cm) in which the cuttings base was applied with aloe vera (100%). The minimum shoot length (2.33cm) was observed after 30DAP in the treatment T₁₃ applied with 150 ppm GA₃. After 60 days of planting, the maximum shoot length (10.33cm) was shown by T₉ treatment of 2000 ppm IBA followed by the treatment T₁ (26.66cm) in which the natural hormone of aloe vera (100%) is applied. The least shoot length was noticed in the T₁₃ treatment (3.33cm) in which synthetic hormone of 150 ppm GA₃ is applied at 60DAP. At ninety days after planting, the maximum shoot length was observed in the T₉ treatment (30.37cm) of 2000 ppm IBA application, subsequently the treatment T₇ (28.83cm) with the application of the 500 ppm IAA. The least shoot length was found in the treatment T₄ which is the application of 100% honey (5.86cm). IBA promotes the cell division leading to early rooting and as a result the efficiency of mineral absorption is enhanced and thus shoot length is increased. Similar result is reported by Patil *et al.*, 2000 in which the IBA application lead to the increased cell division. This resulted on quick callus formation in the cuttings.

3.3 Chlorophyll content and survival percentage

According to the results of chlorophyll content shown in Table 3, the treatments considerably increased the chlorophyll content compared to the control. The data on chlorophyll content revealed that the treatment T₉ with application of 2000 ppm IBA was successful by showing maximum chlorophyll content (29.36 nm) which is followed by the T₁ (28.83 nm) with the treatment of 100% aloe vera applied on cuttings. The treatment T₁₄, the control, had the least chlorophyll content, measuring at 17.76 nm at 30DAP. At 60DAP, the treatment T₉ with the application of 2000 ppm IBA, had the highest chlorophyll concentration (29.36 nm) after that the treatment T₁, which involves applying 100% aloe vera, is shown to have the highest chlorophyll content (28.63 nm). The lowest level of chlorophyll was shown by the control treatment T₁₄ with 22.16 nm. At 90DAS, the maximum chlorophyll content was recorded in the treatment T₉ applied with IBA 2000 ppm (30.60 nm) followed by T₁ (30.06 nm) which is the treatment of aloe vera 100%. The lowest chlorophyll content was noticed in T₁₂, which is the treatment of 100 ppm GA₃ with (22.80 nm). As plants need light energy from the sun to store it as chemical energy, analysing the characteristics of a specific plant leaf is the main way to assess the health of a plant. The above finding was corroborated by Rao *et al.* (2020), who found that the application of 3000 ppm of IBA increased the chlorophyll content. They mentioned that this was because longer leaves may activate more photosynthates, which would increase the chlorophyll content of leaves per cutting. Growth hormones have been shown to have a major impact on how assimilates are distributed throughout plants (Galston and Davies, 1969). They found that cuttings with more leaves increased nutrient uptake, which increased the production of photosynthates and provided enough food for the plants' metabolic activities.

The data on survival percentage of cuttings was compiled and it revealed that the treatment T₉ in which 2000 ppm IBA applied has the highest survival percentage of grape cuttings (93.33%) followed by the treatment T₁ (90.00%) which used 100% aloe vera. With 76.66% of cuttings still alive at 30DAP, treatment T₁₄, the control, had the lowest cutting survival rate. The treatment T₉, which applies 2000 ppm IBA to the cuttings, displays the highest percentage survival of cuttings at 60DAP (83.33%), followed by the treatment T₁₂, which applies 100 ppm GA₃ to the cuttings (80.00%). The treatment T₂, which involves applying 100% cinnamon powder, had the lowest cutting survival rate (70.00%). At 90DAS, the treatment T₉, which involves applying 2000 ppm IBA, had the highest cutting survival rate (73.33%), followed by the treatment T₁, which involves applying 100% aloe vera (73.33%). The treatment T₁₄, which is the control, had the lowest cutting survival rate (46.66%). The ability of the growth regulator to encourage the production of adventitious roots may be directly related to the survival of cuttings treated with high doses of IBA. Cuttings' ability to survive is aided by the adventitious roots' ability to absorb mineral nutrients from the soil. This result was reported by Wang *et al.* (2003). Similar results also found by Kaur (2017) in flordagaurd peach (*Prunus persica* L.). IBA produces the best results, which are crucial for vegetative development and survival rates of cuttings. According to Rakibuzzaman *et al.*, (2018), IBA produced a higher survival percentage for stevia cuttings.

Table 1 Effect of natural and synthetic hormones on no. of roots and no. of shoots of grape

Treatments	No. of roots			No. of shoots		
	30DAP	60DAP	90DAP	30DAP	60DAP	90DAP
T ₁ - (Aloe Vera 100% -12 hours)	15.66	28.66	47.00	5.33	5.67	5.67
T ₂ -(Cinamon Powder 100% -12 hours)	10.33	21.00	38.00	3.33	4.33	4.33
T ₃ - (Apple Cider 100% -12 hours)	8.00	12.66	16.66	3.00	3.33	3.33
T ₄ - (Honey 100% -12 hours)	7.00	10.33	17.33	3.33	3.33	3.33
T ₅ - (IAA 100 ppm -12 hours)	13.66	27.00	16.66	6.00	5.33	5.33
T ₆ - (IAA 300 ppm -12 hours)	12.66	24.33	19.66	4.33	4.33	4.33
T ₇ - (IAA 500 ppm -12 hours)	11.33	19.66	32.33	3.33	5.33	5.33
T ₈ - (IBA 1000 ppm -2 minutes)	8.00	12.66	16.00	3.67	4.00	3.67
T ₉ - (IBA 2000 ppm -2 minutes)	20.33	44.00	52.66	6.67	7.33	7.33
T ₁₀ - (IBA 3000 ppm -2 minutes)	13.33	24.33	16.66	6.00	5.33	5.33
T ₁₁ - (GA ₃ 50 ppm -12 hours)	6.66	9.00	12.00	4.67	4.33	4.33
T ₁₂ - (GA ₃ 100 ppm -12hours)	9.33	19.00	31.00	4.33	3.67	3.66
T ₁₃ - (GA ₃ 150 ppm -12hours)	6.66	10.00	15.33	4.00	3.67	3.67
T ₁₄ - (Control Dipping in water - 12 hours)	6.00	12.00	18.00	3.00	3.00	3.00
CD	1.53	2.61	3.01	0.87	0.98	0.99
SE(m)	0.52	0.89	1.03	0.30	0.33	0.34
SE(d)	0.74	1.26	1.45	0.42	0.47	0.48
C.V	8.52	7.89	7.14	11.91	12.86	13.07

Table 2 Effect of natural and synthetic hormones on root girth (mm) and shoot length (cm) of grape

Treatments	Root girth (mm)			Shoot length (cm)		
	30DAP	60DAP	90DAP	30DAP	60DAP	90DAP
T ₁ - (Aloe Vera 100% -12 hours)	1.56	3.26	6.83	4.53	8.00	28.63
T ₂ - (Cinamon Powder 100% -12 hours)	1.23	2.53	5.83	3.03	7.57	24.90
T ₃ - (Apple Cider 100% -12 hours)	0.53	1.46	4.26	3.10	3.63	7.00
T ₄ - (Honey 100% -12 hours)	0.60	1.63	4.96	3.27	4.13	5.86
T ₅ - (IAA 100 ppm -12 hours)	1.20	3.03	5.73	4.47	6.50	27.00
T ₆ - (IAA 300 ppm -12 hours)	1.23	2.83	6.16	3.97	7.63	25.10
T ₇ - (IAA 500 ppm -12 hours)	1.36	3.16	5.53	3.70	6.97	28.83
T ₈ - (IBA 1000 ppm -2 minutes)	0.56	3.06	6.03	4.03	5.93	24.83
T ₉ - (IBA 2000 ppm -2 minutes)	1.76	4.26	7.83	4.90	10.33	30.73
T ₁₀ - (IBA 3000 ppm -2 minutes)	1.43	2.46	6.63	3.87	7.27	15.00
T ₁₁ - (GA ₃ 50 ppm -12 hours)	1.16	2.73	5.16	3.53	8.03	17.86
T ₁₂ - (GA ₃ 100 ppm -12hours)	1.13	2.33	5.13	4.10	7.37	20.33
T ₁₃ - (GA ₃ 150 ppm -12hours)	0.63	1.73	5.23	2.33	3.33	9.53
T ₁₄ - (Control Dipping in water - 12 hours)	0.56	1.43	4.83	3.67	4.67	7.67
CD	0.20	0.31	0.75	0.57	0.77	2.01
SE(m)	0.07	0.10	0.25	0.19	0.26	0.69
SE(d)	0.10	0.15	0.36	0.28	0.37	0.97
C.V	11.43	7.18	7.80	9.03	7.00	6.09

Table 3 Effect of natural and synthetic hormones on chlorophyll content (nm), and survival percentage of grape cuttings

Treatments	Chlorophyll content(nm)			Survival percentage (%)		
	30DAP	60DAP	90DAP	30DAP	60DAP	90DAP
T ₁ - (Aloe Vera 100% -12 hours)	28.83	28.63	30.06	90.00	76.66	73.33
T ₂ - (Cinamon Powder 100% -12 hours)	27.93	26.80	28.20	83.33	70.00	66.66
T ₃ - (Apple Cider 100% -12 hours)	21.83	23.60	23.63	80.00	63.33	53.33
T ₄ - (Honey 100% -12 hours)	20.03	23.20	23.33	80.00	73.33	53.33
T ₅ - (IAA 100 ppm -12 hours)	25.50	23.16	24.73	86.66	73.33	66.66
T ₆ - (IAA 300 ppm -12 hours)	28.03	24.33	27.90	83.33	66.66	60.00
T ₇ - (IAA 500 ppm -12 hours)	25.93	26.03	26.83	83.33	80.00	60.00
T ₈ - (IBA 1000 ppm -2 minutes)	25.23	23.86	26.73	90.00	73.33	60.00
T ₉ - (IBA 2000 ppm -2 minutes)	29.36	29.86	30.60	93.33	83.33	73.33
T ₁₀ - (IBA 3000 ppm -2 minutes)	23.46	24.56	25.10	86.66	73.33	60.00
T ₁₁ - (GA ₃ 50 ppm -12 hours)	26.16	26.86	28.80	76.66	63.33	53.33
T ₁₂ - (GA ₃ 100 ppm -12hours)	24.96	24.40	22.80	86.66	80.00	60.00
T ₁₃ - (GA ₃ 150 ppm -12hours)	22.16	25.10	26.80	80.00	66.66	53.33
T ₁₄ - (Control Dipping in water - 12 hours)	17.76	22.96	23.10	76.66	63.33	46.66
CD	2.76	2.68	2.70	10.13	N/A	14.37
SE(m)	0.94	0.92	0.92	3.46	4.76	4.91
SE(d)	1.33	1.30	1.30	4.90	6.74	6.95
C.V	6.59	6.30	6.09	7.14	11.47	14.19

4. Conclusion

The findings of the study demonstrated that the artificial rooting hormone Indole-3-Butyric acid significantly affected on number shoots, shoot length, number of roots, root girth, chlorophyll content and survival percentage in cuttings. In natural hormone *Aloe vera* gel treatment gives best result. So, it can be said that synthetic hormone IBA could be the potential root hormone for grapevine cutting.

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