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EFFECT OF AUXINS AND ROOTING MEDIA ON ROOT INITIATION AND ROOT DEVELOPMENT OF DRAGON FRUIT (HYLOCEREUS UNDATUS) STEM CUTTINGS UNDER SUB-MOUNTAINOUS CONDITIONS OF PUNJAB

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ABSTRACT
Shortage of uniform, well-rooted planting material is one of the main bottlenecks in the expansion of dragon fruit (Hylocereus undatus) cultivation in India. This study examined how two auxins, alone and in combination, interact with three rooting media to influence root initiation and root development in dragon fruit stem cuttings under the sub-mountainous conditions of Punjab. Ten treatments were tested in a completely randomized design with three replications: IBA (5000 ppm), IAA (200 ppm) and IBA + IAA, each in soil, cocopeat or soil + cocopeat (1:1, v/v), and an untreated control in soil. Root traits were recorded at 30 and 60 days after planting (DAP). Treatments differed significantly for all traits except rooting percentage. The earliest root initiation (14.53 days) occurred in IBA + cocopeat (T4), compared with 23.57 days in the control, and T4 also gave the most roots per cutting (12.90 and 18.27 at 30 and 60 DAP). IBA in soil + cocopeat (T7) produced the longest root (6.57 and 12.24 cm), the greatest average root length (5.77 and 11.90 cm), the largest root diameter (0.91 and 1.62 mm) and the highest root dry weight (0.59 and 0.93 g) at 30 and 60 DAP, respectively. Rooting percentage was statistically similar across treatments (73.33–96.67% at 60 DAP), indicating that dragon fruit cuttings root readily even without auxin. Under the tested nursery conditions, IBA 5000 ppm with soil + cocopeat gave the best-developed root system, whereas IBA with cocopeat alone favoured early and numerous roots. Field establishment of the rooted cuttings was not evaluated and needs confirmation.

KEYWORDS: Adventitious rooting, Cocopeat, Hylocereus undatus, IAA, IBA, Propagation, Stem cuttings

1. INTRODUCTION
Dragon fruit or pitaya [Hylocereus undatus (Haw.) Britton & Rose; syn. Selenicereus undatus (Haw.) D.R. Hunt] is a climbing, perennial member of the Cactaceae that is now grown commercially across many tropical and subtropical countries. The fruit is attractive in appearance and contributes dietary fibre, minerals, vitamins, betalain pigments and phenolic compounds with antioxidant properties (Martin et al., 1987; Vaillant et al., 2005). Because the crop needs comparatively little water, bears within a short period after planting and fetches a good market price, its area in India has grown quickly during the last decade. This growth has, in turn, created a heavy demand for healthy and uniform planting material that nurseries are not always able to meet (Pandey et al., 2022; Pradhan et al., 2024; Singh & Kaur, 2024).
Stem (cladode) cuttings are the usual means of multiplying dragon fruit on a commercial scale. Plants raised from cuttings remain true to the mother plant and start fruiting earlier than seedlings. How fast and how well a cutting roots, however, is not fixed; it is shaped by the physiological state and size of the cutting, the season, the propagation environment, the rooting substrate and any growth regulator applied (Hartmann et al., 2002; Singh et al., 2025b). Cutting length alone, for instance, has been shown to alter root and shoot growth of dragon fruit cuttings, with longer cuttings generally performing better (Kakade et al., 2019). For this reason, propagation recommendations developed in one region cannot be transferred automatically to another.
Auxins remain the most widely used group of regulators for promoting adventitious roots. They encourage cell division and the formation of root primordia at the base of the cutting (Thimann & Went, 1934; Krishnamurthy, 1981). Indole-3-butyric acid (IBA), although synthetic in commercial preparations, tends to outperform indole-3-acetic acid (IAA), the principal natural auxin. IAA is quickly broken down in tissues by light and oxidative enzymes, while IBA is more stable and can be converted gradually to IAA inside the plant (Hartmann et al., 2002). In dragon fruit, IBA application has repeatedly increased root number, root length, root biomass and the survival of cuttings in comparison with untreated cuttings (Pandey et al., 2022; Kakade et al., 2024; Singh et al., 2025a; Shrikrushna et al., 2026).
The concentration reported as most effective, however, varies widely between studies. In a shade-house trial in semi-arid Rajasthan, the best sprouting was recorded at 250 ppm IBA and the best rooting at 750 ppm (Keerthika et al., 2026). Singh and Kaur (2024) proposed 4000 ppm IBA for dragon fruit propagation, whereas a two-season study in Maharashtra that tested 5000–7000 ppm found 6000 ppm IBA with 30 cm cuttings to be the most effective combination (Shrikrushna et al.,

2026). Such differences suggest that the optimum auxin dose depends on local conditions, cutting type and the medium in which the cuttings are rooted.

The rooting medium has an equally important role. It holds the cutting in place and controls the supply of water and air to the developing roots. Rahad et al. (2016) found that rooting performance of dragon fruit cuttings changed considerably with the medium used, and Elobeidy (2006) likewise reported differences among substrates in addition to the benefit of IBA. Cocopeat is light, porous and retains a large amount of water, and it is therefore used increasingly in nurseries, either alone or blended with soil. Several recent reports indicate that dragon fruit cuttings root better when an auxin treatment is paired with a suitable medium (Amrutha, 2025; Anagha et al., 2025; Gupta & Lata, 2025). Comparable benefits of combining IBA with appropriate media have been recorded in other fruit crops, including fig (Aghera & Makwana, 2018). Despite this body of work, three gaps remain. First, most dragon fruit studies have tested IBA alone or compared IBA with NAA (Pandey et al., 2022; Pradhan et al., 2024), and few have compared IBA, IAA and their combination within the same experiment. Second, auxins and media have usually been studied separately, so it is not clear whether the best auxin treatment remains the best across different media. Third, nearly all of this information comes from semi-arid, coastal or eastern regions of India; we are not aware of any published study from the sub-mountainous (Kandi) zone of Punjab, where dragon fruit is a new crop and nursery protocols have not been standardized. Information of this kind would help local nurseries produce vigorous rooted cuttings in less time.

The present study was therefore undertaken with the following objectives: (i) to compare the effect of IBA, IAA and their combination on root initiation and root development of dragon fruit stem cuttings; (ii) to determine how these auxin treatments perform in soil, cocopeat and a soil + cocopeat mixture; and (iii) to identify a suitable auxin–medium combination for nursery propagation of dragon fruit under the sub-mountainous conditions of Punjab.

2. MATERIALS AND METHODS

2.1 Experimental site

The study was carried out from February to April 2025 in a protected nursery of the Department of Agriculture, GKSM Government College, Tanda Urmar, Hoshiarpur, Punjab, India. Cuttings were planted in February 2025, and the final observations were taken at 60 DAP. The site falls in the sub-mountainous zone of Punjab, which has a subtropical climate with hot summers and cool winters. The cuttings were kept under a 50% green shade net throughout the experiment.

2.2 Plant material

Cuttings were taken from two-year-old, healthy and disease-free mother plants of dragon fruit (H. undatus) growing under field conditions. Mature, one-year-old cladodes were selected, and cuttings 25 cm long and of nearly uniform thickness were prepared so that variation among cuttings was kept to a minimum. A straight cut was given at the base of each cutting. Before treatment, the cuttings were kept in shade for five days so that the cut surfaces could dry and heal, which lowers the chance of basal rot.

2.3 Treatments and rooting media

Ten treatments were tested (Table 1). Three auxin treatments, namely IBA 5000 ppm, IAA 200 ppm and IBA 5000 ppm + IAA 200 ppm, were each combined with three rooting media: soil (M1), cocopeat (M2) and soil + cocopeat (1:1, v/v; M3). Cuttings dipped in distilled water and planted in soil formed the control (T10). The soil used was collected from the college farm, and commercially available cocopeat was used.

Table 1. Details of treatments used in the experiment

Treatment	Auxin treatment	Rooting medium	Code
T1	IBA 5000 ppm	Soil	IBA + M1
T2	IAA 200 ppm	Soil	IAA + M1
T3	IBA 5000 ppm + IAA 200 ppm	Soil	IBA+IAA + M1
T4	IBA 5000 ppm	Cocopeat	IBA + M2
T5	IAA 200 ppm	Cocopeat	IAA + M2
T6	IBA 5000 ppm + IAA 200 ppm	Cocopeat	IBA+IAA + M2
T7	IBA 5000 ppm	Soil + Cocopeat (1:1)	IBA + M3
T8	IAA 200 ppm	Soil + Cocopeat (1:1)	IAA + M3
T9	IBA 5000 ppm + IAA 200 ppm	Soil + Cocopeat (1:1)	IBA+IAA + M3
T10	None (distilled water)	Soil	Control

M1 = soil; M2 = cocopeat; M3 = soil + cocopeat (1:1, v/v).

2.4 Preparation and application of auxins
Analytical grade IBA and IAA were used. For each solution, the required quantity of auxin was first dissolved in a small volume of ethanol and then made up to volume with distilled water to obtain 5000 ppm IBA and 200 ppm IAA. For the combined treatment, both auxins were included in the same solution at these concentrations. Solutions were prepared fresh on the day of use. The lower 2–3 cm of each cutting was dipped in the relevant solution for 10 seconds (quick-dip method), and the cuttings were planted straight away. Control cuttings were dipped in distilled water for the same duration.

2.5 Planting and nursery management
Treated cuttings were planted in black polythene bags (15 × 20 cm) filled with the respective medium, to a depth of 5–7 cm. Each replication of a treatment consisted of ten cuttings, giving 30 cuttings per treatment and 300 cuttings in total. All cuttings received the same cultural care during the experiment. Irrigation was applied every 2–3 days with a rose can to keep the media moist but not waterlogged, and weeds were removed by hand whenever they appeared.

2.6 Experimental design
The experiment followed a completely randomized design (CRD) with ten treatments and three replications. Although the nine auxin × medium treatments form a 3 × 3 factorial set, the control was included only in soil; therefore, all ten treatments were analysed together as a one-way CRD so that each could be compared with the control.

2.7 Observations recorded
Days to root initiation were counted from the date of planting until the first root became visible. Rooting percentage was worked out with the formula: Rooting (%) = (number of cuttings that formed roots ÷ total number of cuttings planted) × 100.
At 30 and 60 DAP, three cuttings per replication were carefully lifted, and their roots were washed free of the medium. Since this sampling was destructive, different cuttings were used at the two stages. On each sampled cutting, the number of roots was counted, the longest root was measured with a scale (cm), the average root length was computed from all roots of the sampled cutting, and the maximum root diameter was measured with a digital vernier caliper (mm). The roots were then excised, dried in a hot-air oven at 65 °C for 48–72 h until their weight became constant, and weighed to obtain root dry weight (g).

2.8 Statistical analysis
The data were analysed by one-way analysis of variance (ANOVA) for CRD using OPSTAT software. The standard error of mean was calculated as $SEm\pm = \sqrt{(EMS/r)}$, and the critical difference as $CD = t(0.05, \text{error df}) \times \sqrt{(2 \times EMS/r)}$, where EMS is the error mean square and r is the number of replications (r = 3; error df = 20). Treatment means were compared using CD at the 5% level of significance. Treatments whose means differed by less than the CD value were regarded as statistically at par.

3. RESULTS AND DISCUSSION
3.1 Days to root initiation
The time taken for roots to appear varied significantly with treatment (Table 2). Cuttings given IBA and planted in cocopeat (T4) were the quickest to root (14.53 days), statistically on a par with IBA in soil + cocopeat (T7; 15.07 days). The combined auxin treatment in cocopeat (T6; 15.59 days) was on a par with T7 but significantly slower than T4. Roots appeared last in the untreated control (T10; 23.57 days), followed by IAA in soil (T2; 22.53 days). Thus, the best treatment advanced root emergence by roughly nine days compared with the control.
A likely reason for the earlier rooting with IBA is the known role of auxin in stimulating cell division and the formation of root initials at the cut end, possibly assisted by greater movement of carbohydrates towards the base of the cutting (Krishnamurthy, 1981; Hartmann et al., 2002). Carbohydrate status was not measured in this study, so this explanation remains tentative. The advantage of cocopeat may relate to its porous structure and high water retention, which could keep the base of the cutting moist and aerated; medium moisture and aeration were not measured either, and these too should be regarded as possible rather than confirmed causes. Earlier root emergence in IBA-treated dragon fruit cuttings has also been reported by Pandey et al. (2022) and Kakade et al. (2024). The late rooting recorded with IAA alone (T2, T5 and T8) agrees with the lower stability of IAA in plant tissue. It should be noted, however, that IAA was applied at a much lower concentration (200 ppm) than IBA (5000 ppm); hence, the poorer performance of IAA cannot be attributed to the type of auxin alone.

3.2 Number of roots per cutting
Root number was significantly influenced by the treatments at both stages (Table 3). At 30 DAP, T4 (IBA + cocopeat) produced significantly more roots (12.90) than any other treatment. It was followed by T7 (10.73) and T6 (10.47), which did not differ from each other. The control had the fewest roots (4.66), on a par with T2 (5.47). The pattern was similar at 60 DAP: T4 again had the most roots (18.27), followed by T7 (16.20), and the control the fewest (7.00).
More roots on IBA-treated cuttings point to a greater number of root primordia being initiated under auxin influence (Thimann & Went, 1934; Hartmann et al., 2002). The fact that the highest count occurred in cocopeat (T4) suggests that the loose and moist character of this medium allowed more of the initiated primordia to emerge. Similar increases in root number after IBA treatment of dragon fruit cuttings have been recorded by Pandey et al. (2022) and Kakade et al. (2024). Shrikrushna et al. (2026) reported 19.53 primary roots per cutting with 6000 ppm IBA, but at 120 DAP and with 30 cm

cuttings; the values obtained here at 60 DAP are therefore of a comparable order, although direct comparison is limited by differences in cutting length and observation time.

3.3 Rooting percentage

Treatments did not significantly affect the proportion of cuttings that rooted at either 30 or 60 DAP (Table 4). In numerical terms, T4 had the highest rooting at 30 DAP (86.67%), followed by T6 and T7 (80.00% each), with the lowest values in T2 and the control (53.33% each). At 60 DAP, rooting ranged from 73.33% in the control to 96.67% in both T4 and T7.

Even without auxin, nearly three-quarters of the control cuttings had rooted by 60 DAP. This reflects the naturally high rooting ability of dragon fruit and probably explains why the treatment differences were not significant. The modest number of cuttings per replication (ten) and the resulting variation among replications may also have reduced the power to detect differences. With ten cuttings per replication, a single cutting represents 10% of a replication, so rooting percentage within a replication can change only in steps of 10 percentage points. Such coarse steps inflate the variation among replications and make it difficult for moderate treatment effects to reach significance. These results contrast partly with those of Rahad et al. (2016), who found that the rooting medium affected rooting of dragon fruit cuttings, and of Pandey et al. (2022), who reported higher rooting with IBA. In the present study, the influence of auxins and media appeared mainly in the speed of rooting and the quality of the root system rather than in the proportion of cuttings that rooted. The numerically large differences at 30 DAP (53–87%) suggest that a larger sample size may be needed to test this trait reliably.

3.4 Length of the longest root

The longest root differed significantly among treatments at both stages (Table 5). At 30 DAP, cuttings treated with IBA and grown in soil + cocopeat (T7) had the longest root (6.57 cm), significantly longer than in all other treatments. T9 (IBA + IAA in soil + cocopeat; 5.70 cm) and T1 (IBA in soil; 5.43 cm) came next. The shortest root was found in IAA + cocopeat (T5; 2.83 cm). At 60 DAP, T7 still ranked first (12.24 cm), followed by T9 (10.10 cm), and T5 again had the shortest root (4.10 cm).

Root elongation thus responded differently from root number. Cuttings in cocopeat alone formed many roots but these remained short, while those in the soil + cocopeat mixture formed fewer but longer roots. One possible explanation is that the mixture combined the aeration and moisture of cocopeat with the nutrients and firmer anchorage supplied by soil, whereas cocopeat alone is low in available nutrients. Nutrient content of the media was not analysed, so this interpretation needs to be tested. The very short roots in T5 suggest that 200 ppm IAA was not sufficient to support root growth in a nutrient-poor medium. Longer roots in IBA-treated dragon fruit cuttings have also been observed by Kakade et al. (2024) and Amrutha (2025).

3.5 Average root length

Average root length also differed significantly (Table 6). T7 recorded the greatest average length at 30 DAP (5.77 cm), significantly above T9 (4.97 cm), while T5 had the least (2.04 cm). At 60 DAP, T7 remained highest (11.90 cm), followed by T9 (10.64 cm) and T1 (9.77 cm), and T5 lowest (3.97 cm).

Because the ranking for average root length closely followed that for the longest root, the improvement in T7 appears to apply to the root system as a whole rather than to a few exceptionally long roots. Gupta and Lata (2025) and Singh et al. (2025a) likewise found that root length of dragon fruit cuttings increased when IBA was used together with a suitable medium.

3.6 Maximum root diameter

Root diameter was significantly affected by the treatments (Table 7). At 30 DAP, the thickest roots occurred in T7 (0.91 mm), statistically on a par with T9 (0.79 mm), and the thinnest in T5 (0.35 mm). The same order was seen at 60 DAP: T7 (1.62 mm) was on a par with T9 (1.50 mm), and T5 had the lowest value (0.62 mm).

Both treatments with the thickest roots combined IBA with the soil + cocopeat mixture. Auxin-promoted cell division and better nutrient supply in a soil-containing medium may together have supported greater radial growth of the roots, although neither process was measured directly. Cuttings in cocopeat alone (T4–T6) generally had thinner roots than those in media containing soil, which suggests that cocopeat favoured the formation of many fine roots rather than their thickening. Kakade et al. (2024) also observed better root growth in dragon fruit cuttings treated with IBA.

3.7 Root dry weight

Root dry weight varied significantly among treatments (Table 8). At 30 DAP, the heaviest roots were recorded in T7 (0.59 g), on a par with T9 (0.52 g), and the lightest in T5 (0.11 g), on a par with T6 (0.17 g). At 60 DAP, T7 gave significantly higher root dry weight (0.93 g) than all other treatments, followed by T9 (0.74 g) and T1 (0.70 g), with T5 again lowest (0.24 g).

Root dry weight integrates root number, length and thickness, so the high value in T7 is consistent with its longer and thicker roots. In contrast, T4 produced the most roots but only a moderate dry weight (0.27 and 0.44 g), confirming that the roots formed in cocopeat alone were numerous but fine. Increased root biomass after IBA application in dragon fruit has also been reported by Kakade et al. (2024), and Malik et al. (2023) noted better growth and survival of IBA-treated cuttings. Keerthika et al. (2026) found that root length and root number were strongly and linearly related to root dry weight, which agrees with the pattern observed here.

3.8 General discussion

Two distinct responses emerged from this study. IBA combined with cocopeat alone (T4) promoted rapid and abundant root initiation, while IBA combined with the soil + cocopeat mixture (T7) produced a longer, thicker and heavier root system. For a nursery, the second response is probably more useful, because a well-developed root system is generally expected to support better establishment after transplanting; this, however, was not tested here. In every medium, IBA alone performed better than IAA alone, and adding IAA to IBA brought no further benefit; in fact, the combination was consistently slightly inferior to IBA alone (T3 < T1, T6 < T4, T9 < T7).

When compared with earlier work, the effectiveness of 5000 ppm IBA in this study is in line with studies that used high IBA concentrations (Singh & Kaur, 2024; Shrikrushna et al., 2026), but differs from the much lower optimum (250–750 ppm) reported under semi-arid conditions by Keerthika et al. (2026). Such differences are likely related to variation in cutting length, cutting maturity, season and climate between locations, and they reinforce the need for region-specific recommendations. The finding that rooting percentage was not affected by auxin also differs from several earlier reports (Pandey et al., 2022; Pradhan et al., 2024) and suggests that, under the conditions of this study, auxins mainly improved the vigour of rooting rather than its success.

From a practical point of view, the results suggest that nurseries may be able to choose a treatment according to their aim. Where quick turnover is the priority, IBA with cocopeat gave the earliest and most numerous roots. Where sturdier rooted cuttings are wanted for sale or transplanting, IBA with a soil + cocopeat mixture produced a heavier and more extensive root system. Since the mixture uses only half the quantity of cocopeat, it may also lower the cost of the medium, although an economic analysis was not part of this study and would be a useful addition to future work.

3.9 Limitations of the study

Some limitations should be kept in mind when interpreting these results. First, IBA and IAA were applied at very different concentrations (5000 and 200 ppm); the comparison between the two auxins is therefore confounded with concentration, and a test at equal or multiple concentrations would be needed to compare them fairly. Second, the control was included only in soil, so the effect of the media in the absence of auxin could not be separated. Third, the physical and chemical properties of the media (moisture, aeration, nutrient content, pH and EC) and the carbohydrate status of the cuttings were not measured; the mechanisms discussed above are therefore suggested explanations. Fourth, the experiment was conducted for one season at one location with a limited number of cuttings, and observations ended at 60 DAP, so shoot growth, survival after transplanting and field establishment were not assessed.

4. CONCLUSION

Under the nursery conditions of this study, both the auxin treatment and the rooting medium significantly influenced root initiation and root growth of dragon fruit stem cuttings, whereas the proportion of cuttings that rooted was not significantly affected. IBA 5000 ppm with cocopeat (T4) resulted in the earliest root initiation and the highest number of roots, while IBA 5000 ppm with soil + cocopeat (1:1) (T7) produced the longest, thickest and heaviest root system at both 30 and 60 DAP. IBA alone was consistently more effective than IAA alone or the IBA + IAA combination at the concentrations tested. Within these limits, IBA 5000 ppm with soil + cocopeat (1:1) appears to be a suitable treatment for raising well-rooted dragon fruit cuttings in nurseries of the sub-mountainous region of Punjab. Because survival after transplanting, field establishment and large-scale nursery performance were not evaluated, and only one concentration of each auxin was tested, this recommendation should be confirmed through multi-season trials with additional auxin concentrations and field evaluation.

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CONFLICT OF INTEREST

The author has no conflict of interest to declare.

DATA AVAILABILITY

Data supporting the findings of this study can be obtained from the author on reasonable request.

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TABLES

Table 2. Effect of auxins and rooting media on days to root initiation in dragon fruit stem cuttings

Treatment	Treatment details	Days to root initiation
T1	IBA 5000 ppm + Soil	16.63
T2	IAA 200 ppm + Soil	22.53
T3	IBA 5000 ppm + IAA 200 ppm + Soil	19.27
T4	IBA 5000 ppm + Cocopeat	14.53
T5	IAA 200 ppm + Cocopeat	21.03
T6	IBA 5000 ppm + IAA 200 ppm + Cocopeat	15.59
T7	IBA 5000 ppm + Soil + Cocopeat (1:1)	15.07

Treatment	Treatment details	Days to root initiation
T8	IAA 200 ppm + Soil + Cocopeat (1:1)	21.53
T9	IBA 5000 ppm + IAA 200 ppm + Soil + Cocopeat (1:1)	17.37
T10	Control (distilled water) + Soil	23.57
	SEm±	0.32
	CD (p = 0.05)	0.93
	CV (%)	2.87

SEm± = standard error of mean; CD = critical difference at the 5% level of significance; CV = coefficient of variation; DAP = days after planting; NS = non-significant.

Table 3. Effect of auxins and rooting media on number of roots per cutting in dragon fruit stem cuttings at 30 and 60 DAP

Treatment	Treatment details	Number of roots per cutting	
		30 DAP	60 DAP
T1	IBA 5000 ppm + Soil	9.47	14.13
T2	IAA 200 ppm + Soil	5.47	8.13
T3	IBA 5000 ppm + IAA 200 ppm + Soil	7.41	11.53
T4	IBA 5000 ppm + Cocopeat	12.90	18.27
T5	IAA 200 ppm + Cocopeat	7.73	10.00
T6	IBA 5000 ppm + IAA 200 ppm + Cocopeat	10.47	15.00
T7	IBA 5000 ppm + Soil + Cocopeat (1:1)	10.73	16.20
T8	IAA 200 ppm + Soil + Cocopeat (1:1)	6.13	9.07
T9	IBA 5000 ppm + IAA 200 ppm + Soil + Cocopeat (1:1)	8.67	12.73
T10	Control (distilled water) + Soil	4.66	7.00
	SEm±	0.39	0.45
	CD (p = 0.05)	1.14	1.34
	CV (%)	7.89	6.34

Abbreviations as in Table 2.

Table 4. Effect of auxins and rooting media on rooting percentage of dragon fruit stem cuttings at 30 and 60 DAP

Treatment	Treatment details	Rooting (%)	
		30 DAP	60 DAP
T1	IBA 5000 ppm + Soil	73.33	93.33
T2	IAA 200 ppm + Soil	53.33	80.00
T3	IBA 5000 ppm + IAA 200 ppm + Soil	60.00	80.00
T4	IBA 5000 ppm + Cocopeat	86.67	96.67
T5	IAA 200 ppm + Cocopeat	73.33	93.33
T6	IBA 5000 ppm + IAA 200 ppm + Cocopeat	80.00	93.33
T7	IBA 5000 ppm + Soil + Cocopeat (1:1)	80.00	96.67
T8	IAA 200 ppm + Soil + Cocopeat (1:1)	60.00	86.67

Treatment	Treatment details	Rooting (%)	
		30 DAP	60 DAP
T9	IBA 5000 ppm + IAA 200 ppm + Soil + Cocopeat (1:1)	60.00	86.67
T10	Control (distilled water) + Soil	53.33	73.33
	F-test	NS	NS

Abbreviations as in Table 2.

Table 5. Effect of auxins and rooting media on length of the longest root in dragon fruit stem cuttings at 30 and 60 DAP

Treatment	Treatment details	Length of longest root (cm)	
		30 DAP	60 DAP
T1	IBA 5000 ppm + Soil	5.43	9.10
T2	IAA 200 ppm + Soil	4.44	6.17
T3	IBA 5000 ppm + IAA 200 ppm + Soil	4.96	7.90
T4	IBA 5000 ppm + Cocopeat	3.90	5.83
T5	IAA 200 ppm + Cocopeat	2.83	4.10
T6	IBA 5000 ppm + IAA 200 ppm + Cocopeat	3.57	5.30
T7	IBA 5000 ppm + Soil + Cocopeat (1:1)	6.57	12.24
T8	IAA 200 ppm + Soil + Cocopeat (1:1)	4.70	7.10
T9	IBA 5000 ppm + IAA 200 ppm + Soil + Cocopeat (1:1)	5.70	10.10
T10	Control (distilled water) + Soil	4.10	6.03
	SEm±	0.26	0.24
	CD (p = 0.05)	0.77	0.71
	CV (%)	9.75	5.59

Abbreviations as in Table 2.

Table 6. Effect of auxins and rooting media on average root length in dragon fruit stem cuttings at 30 and 60 DAP

Treatment	Treatment details	Average root length (cm)	
		30 DAP	60 DAP
T1	IBA 5000 ppm + Soil	3.97	9.77
T2	IAA 200 ppm + Soil	3.50	6.76
T3	IBA 5000 ppm + IAA 200 ppm + Soil	3.94	8.37
T4	IBA 5000 ppm + Cocopeat	3.03	5.70
T5	IAA 200 ppm + Cocopeat	2.04	3.97
T6	IBA 5000 ppm + IAA 200 ppm + Cocopeat	2.96	4.96
T7	IBA 5000 ppm + Soil + Cocopeat (1:1)	5.77	11.90
T8	IAA 200 ppm + Soil + Cocopeat (1:1)	3.76	6.96
T9	IBA 5000 ppm + IAA 200 ppm + Soil + Cocopeat (1:1)	4.97	10.64
T10	Control (distilled water) + Soil	3.50	6.10

Treatment	Treatment details	Average root length (cm)	
		30 DAP	60 DAP
	SEm±	0.15	0.27
	CD (p = 0.05)	0.45	0.80
	CV (%)	7.02	6.17

Abbreviations as in Table 2.

Table 7. Effect of auxins and rooting media on maximum root diameter in dragon fruit stem cuttings at 30 and 60 DAP

Treatment	Treatment details	Maximum root diameter (mm)	
		30 DAP	60 DAP
T1	IBA 5000 ppm + Soil	0.73	1.45
T2	IAA 200 ppm + Soil	0.71	1.25
T3	IBA 5000 ppm + IAA 200 ppm + Soil	0.71	1.37
T4	IBA 5000 ppm + Cocopeat	0.58	0.92
T5	IAA 200 ppm + Cocopeat	0.35	0.62
T6	IBA 5000 ppm + IAA 200 ppm + Cocopeat	0.52	0.78
T7	IBA 5000 ppm + Soil + Cocopeat (1:1)	0.91	1.62
T8	IAA 200 ppm + Soil + Cocopeat (1:1)	0.74	1.39
T9	IBA 5000 ppm + IAA 200 ppm + Soil + Cocopeat (1:1)	0.79	1.50
T10	Control (distilled water) + Soil	0.64	1.11
	SEm±	0.05	0.04
	CD (p = 0.05)	0.14	0.13
	CV (%)	12.00	6.42

Abbreviations as in Table 2.

Table 8. Effect of auxins and rooting media on root dry weight in dragon fruit stem cuttings at 30 and 60 DAP

Treatment	Treatment details	Root dry weight (g)	
		30 DAP	60 DAP
T1	IBA 5000 ppm + Soil	0.43	0.70
T2	IAA 200 ppm + Soil	0.34	0.56
T3	IBA 5000 ppm + IAA 200 ppm + Soil	0.40	0.65
T4	IBA 5000 ppm + Cocopeat	0.27	0.44
T5	IAA 200 ppm + Cocopeat	0.11	0.24
T6	IBA 5000 ppm + IAA 200 ppm + Cocopeat	0.17	0.40
T7	IBA 5000 ppm + Soil + Cocopeat (1:1)	0.59	0.93
T8	IAA 200 ppm + Soil + Cocopeat (1:1)	0.41	0.61
T9	IBA 5000 ppm + IAA 200 ppm + Soil + Cocopeat (1:1)	0.52	0.74
T10	Control (distilled water) + Soil	0.30	0.49

Treatment	Treatment details	Root dry weight (g)	
		30 DAP	60 DAP
	SEm±	0.04	0.04
	CD (p = 0.05)	0.11	0.11
	CV (%)	17.61	11.17

Abbreviations as in Table 2.