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Influence of different concentrations of growth regulators on the stem cuttings of dragon fruit

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Abstract
A field investigation entitled "Influence of Different Concentrations of Growth Regulators on the Stem Cuttings of Dragon Fruit" was carried out at the Horticulture Research Farm, College of Horticulture and Research Station, Saja, Bemetara (C.G.) during 2024-25. The experiment was arranged in a Completely Randomized Design (CRD) with three replications. The trial consisted of twelve plant growth regulators management practices *viz.*, T_0: Control (Distilled water), T_1: IBA 2000 ppm, T_2: IBA 4000 ppm, T_3: IBA 6000 ppm, T_4: NAA 100 ppm, T_5: NAA 200 ppm, T_6: IBA 2000 ppm + NAA 100 ppm, T_7: IBA 2000 ppm + NAA 200 ppm, T_8: IBA 4000 ppm + NAA 100 ppm, T_9: IBA 4000 ppm + NAA 200 ppm, T_{10}: IBA 6000 ppm + NAA 100 ppm and T_{11}: IBA 6000 ppm + NAA 200 ppm. Data were recorded on rooting traits (number of roots per cutting, root length, and root diameter) as well as shoot growth parameters (days to first sprouting and shoot length). The findings indicated that T_3 (IBA 6000 ppm) excelled in most parameters, producing the maximum number of roots (23.98), root length (23.25 cm), root diameter (0.54 cm) and shoot length (19.15 cm). This treatment also recorded the earliest sprouting, showing significant superiority over other treatments. It was followed by T_2 (IBA 4000 ppm), which was statistically on par with T_3. Moderate responses were observed with T_6 (IBA 2000 ppm + NAA 100 ppm), T_7 (IBA 2000 ppm + NAA 200 ppm), T_8 (IBA 4000 ppm + NAA 100 ppm) and T_9 (IBA 4000 ppm + NAA 200 ppm). Treatments with NAA alone (T_4 and T_5) showed comparatively lower performance, while the minimum values were recorded in the control (T_0), which produced 9.63 number of roots, 12.41 cm root length, 0.14 cm root diameter and 7.85 cm shoot length.

Keywords: Dragon fruit, IBA, NAA, sprouts and plant growth regulators

Introduction

Dragon fruit is a perennial climbing cactus of the Cactaceae family. It is a relatively new exotic fruit crop in India, originally native to the tropical and subtropical forests of Mexico and Central and South America (Mizrahi and Nerd, 1996). The plant develops cylindrical flower buds along the stem margins, which bloom into large, light-green, hermaphroditic, nocturnal, and attractive flowers. Flower opening usually begins in the evening (around 6:30-7:30 PM), reaches full bloom by 10:00 PM, and starts closing by about 2:00 AM, followed by wilting. Flowering occurs in flushes, with the season extending from May to November, and in some regions, even up to December (Mizrahi and Nerd, 1999; Pushpakumara *et al.*, 2005) [14, 22]. Dragon fruit is also widely known by other names such as Pitaya, Strawberry Pear, Night Blooming Cereus, Queen of Night, Honorable Queen, Cereus triangularis, Jesus in the Cradle, and Belle of the Night (Martin *et al*., 1987) [15]. The skin of most Hylocereus species is red-purple, while the pulp color varies by species: white in H. undatus and red to purple in *H. polyrhizus* and *H. costaricensis*. The crop is tolerant to both warm and cool climates, thriving best under full sun with an optimal temperature range of 10-25 °C. It requires an average annual rainfall of 500-1500 mm for ideal growth. Dragon fruit cultivation is comparatively easy, with low maintenance costs and fewer pest or disease issues. However, its primary cultivation challenge lies in the requirement of trellis support for the climbing stems and the effort needed during the initial establishment phase.

Dragon fruit is highly regarded for its nutritional composition and antioxidant potential. The fresh fruit contains about 82.5-83.0% moisture, 0.16-0.23% protein, 0.21-0.61% fat, and0.7-0.9% fiber. Every 100 g of pulp supplies 6.3-8.8 mg calcium, 30.2-36.1 mg phosphorus, 0.5-0.61 mg iron, and 8-9 mg vitamin C (Morton, 1987). Beyond its nutritive value, the fruit is recognized for several health-promoting benefits. It is believed to aid in reducing blood glucose levels in type 2 diabetics, and contributes to carbohydrate metabolism, bone and cardiovascular strength, blood and tissue formation, immune response, and respiratory health. Its high dietary fiber also exerts a mild laxative effect. Furthermore, dragon fruit has been associated with lowering cholesterol, regulating blood sugar, improving kidney and bone health, enhancing vision, and serving as a natural source of compounds used in cosmetics (Suryono, 2006) [31]. The limited availability and high cost of planting material in dragon fruit has encouraged the use of small stem cuttings for asexual propagation, as they are easier to transport and help reduce production costs. At the same time, sexual propagation through seeds remains important, particularly for breeding programs. For successful cultivation, the adoption of sound agronomic practices such as the use of high-yielding varieties, proper spacing, timely irrigation, balanced fertilizer application, and appropriate sowing time is crucial. Moreover, the use of plant growth regulators (IBA and NAA) has been shown to play a vital role in enhancing the rooting success of cuttings and improving both root and shoot growth parameters in dragon fruit.

Dragon fruit is a highly profitable crop, and India has considerable potential for its cultivation in semiarid regions. However, the limited availability of quality planting material for large-scale cultivation is a major constraint for both domestic and export markets. To meet this demand, the multiplication of true-to-type planting material is essential. Vegetative propagation, particularly through stem cuttings, is preferred as it is cost-effective, rapid, simple, and does not require specialized equipment. Although limited studies exist on dragon fruit propagation from cuttings using growth regulators to enhance rooting, stem cuttings remain a common practice for both field and pot cultivation. Recent advances in the use of growth regulators have proven useful in rapid multiplication of quality planting material. The term “phytohormone” was introduced by Thimann in 1948 to describe naturally occurring organic substances that regulate plant growth. While plant hormones are naturally synthesized, plant growth regulators (PGRs) are synthetic compounds that mimic these hormones. PGRs are essential for plant development, with major types including auxins, gibberellins, cytokinins, abscisic acid, and ethylene (Hazra and Som, 2006) [8]. The role of auxins in rooting and plant propagation has long been recognized (Thimann and Went, 1934) [32]. Application of auxin-based regulators, such as indole-3-butyric acid (IBA) and naphthalene acetic acid (NAA), improves root formation, cutting survival, root uniformity, and overall vigour, reducing plant mortality and ensuring an adequate crop stand. In addition to PGRs, the choice of growing medium significantly affects the rooting success of cuttings. Substrates such as vermicompost, vermiculite, cocopeat, and sand influence root initiation, root-shoot development, and survival of dragon fruit cuttings. The growing medium primarily provides mechanical support while maintaining adequate aeration, moisture retention, and nutrient availability (Khapare *et al*., 2012) [10].

Materials and methods

A field experiment titled “Influence of different concentrations of growth regulators on the stem cuttings of Dragon fruit” was conducted at the Horticulture Research Farm, College of Horticulture and Research Station, Saja, Bemetara (C.G.) during the 2024-25 seasons. The Bemetara district is located at latitude 22.09˚N and longitude 82.15˚E, falling under India's Eastern Plateau and Hill Region (Agro-climatic Zone VII). Within Chhattisgarh, Bemetara is situated in the plains agro-climatic zone. The experiment was laid out in Completely Randomized Design with three replications. The treatments consisted of twelve plant growth regulators management practices *viz*., T_0: Control (Distilled water), T_1: IBA 2000 ppm, T_2: IBA 4000 ppm, T_3: IBA 6000 ppm, T_4: NAA 100 ppm, T_5: NAA 200 ppm, T_6: IBA 2000 ppm + NAA 100 ppm, T_7: IBA 2000 ppm + NAA 200 ppm, T_8: IBA 4000 ppm + NAA 100 ppm, T_9: IBA 4000 ppm + NAA 200 ppm, T_{10}: IBA 6000 ppm + NAA 100 ppm and T_{11}: IBA 6000 ppm + NAA 200 ppm. Observations were recorded on root growth parameters (number of roots per cutting, root length, length of the longest root and root diameter) and shoot growth parameters (days to first sprouting, shoot length longest shoot length). The data were statistically analyzed to assess the effects of the different growth regulator treatments.

Results and Discussions

Root parameters

The highest number of roots per cutting was recorded in T_3 (IBA 6000 ppm), which was statistically comparable to T_2 (IBA 4000 ppm) and T_{11} (IBA 6000 ppm + NAA 200 ppm) at all observation stages (30, 60, and 90 DAP). Moderate root production was observed in T_1 (IBA 2000 ppm) and combination treatments with lower IBA concentrations, whereas T_4, T_5, T_6, and the control (T_0) consistently exhibited the lowest root numbers. The longest roots were also recorded in T_3, followed closely by T_2 and T_{11}. Intermediate root lengths were noted in T_1 and other combination treatments, while T_4, T_5, T_6, and T_0 had significantly shorter roots. Similarly, the greatest root diameter was found in T_3, with T_2 and T_{11} showing slightly smaller diameters. Moderate diameters were observed in T_1 and combination treatments, and the thinnest roots occurred in T_4, T_5, T_6, while the control and low-concentration treatments consistently had the lowest root diameter.

Shoot parameters

The earliest sprouting was observed in T_3 (IBA 6000 ppm, 20.31 days), followed closely by T_2 (IBA 4000 ppm) and T_{11} (IBA 6000 ppm + NAA 200 ppm). Intermediate sprouting occurred in T_1 and other combination treatments, while the latest sprouting was consistently recorded in the control (T_0). The shoot length was consistently observed in T_3 (9.98 cm at 30 DAP, 16.39 cm at 60 DAP, 28.23 cm at 90 DAP), followed by T_2 and T_{11}. Combination treatments of IBA + NAA showed a synergistic effect, promoting shoot elongation, though slightly lower than optimal IBA alone. The shortest shoot length was recorded in T_0 - Control. Higher concentrations of IBA promoted cell division and secondary growth, resulting in thicker and more robust stems.

Table 1: Effect of different concentrations of growth regulators on number of roots per cutting of Dragon fruit.

Treatment details	Number of roots per cutting		
	30 DAP	60 DAP	90 DAP
T_0 : Control (Distilled water)	3.08	7.70	9.63
T_1 : IBA 2000 ppm	4.52	11.30	14.13
T_2 : IBA 4000 ppm	6.92*	17.31*	21.64*
T_3 : IBA 6000 ppm	7.47**	18.67**	23.98**
T_4 : NAA 100 ppm	3.82	9.55	11.94
T_5 : NAA 200 ppm	3.92	9.80	12.25
T_6 : IBA 2000 ppm + NAA 100 ppm	4.72	11.80	14.75
T_7 : IBA 2000 ppm + NAA 200 ppm	4.86	12.16	15.20
T_8 : IBA 4000 ppm + NAA 100 ppm	5.46	13.66	17.07
T_9 : IBA 4000 ppm + NAA 200 ppm	5.58	13.95	17.44
T_{10} : IBA 6000 ppm + NAA 100 ppm	6.18	15.45	19.31
T_{11} : IBA 6000 ppm + NAA 200 ppm	6.33	15.82	19.77
SEm (±)	0.16	0.43	0.66
CD (5%)	0.47	1.25	1.93
CV (5%)	5.32	5.66	6.97

*5% level of significance

Table 2: Effect of different concentrations of growth regulators on root length of Dragon fruit.

Treatment details	Root length (cm)		
	30 DAP	60 DAP	90 DAP
T_0 : Control (Distilled water)	2.02	5.90	12.41
T_1 : IBA 2000 ppm	2.77	7.46	15.73
T_2 : IBA 4000 ppm	3.78*	9.60*	21.90*
T_3 : IBA 6000 ppm	4.10**	10.25**	23.25**
T_4 : NAA 100 ppm	2.39	6.67	14.01
T_5 : NAA 200 ppm	2.49	6.87	14.26
T_6 : IBA 2000 ppm + NAA 100 ppm	2.83	7.60	16.20
T_7 : IBA 2000 ppm + NAA 200 ppm	2.88	7.71	16.55
T_8 : IBA 4000 ppm + NAA 100 ppm	3.16	8.28	18.09
T_9 : IBA 4000 ppm + NAA 200 ppm	3.21	8.38	18.51
T_{10} : IBA 6000 ppm + NAA 100 ppm	3.48	8.96	19.35
T_{11} : IBA 6000 ppm + NAA 200 ppm	3.52	9.04	20.43
SEm (±)	0.09	0.19	0.43
CD (5%)	0.25	0.56	1.25
CV (5%)	4.86	4.12	4.22

*5% level of significance

Table 3: Effect of different concentrations of growth regulators on root diameter of Dragon fruit.

Treatment details	Root diameter (cm)		
	30 DAP	60 DAP	90 DAP
T_0 : Control (Distilled water)	0.09	0.12	0.14
T_1 : IBA 2000 ppm	0.17	0.22	0.25
T_2 : IBA 4000 ppm	0.31*	0.40*	0.47*
T_3 : IBA 6000 ppm	0.37**	0.45**	0.54**
T_4 : NAA 100 ppm	0.13	0.16	0.19
T_5 : NAA 200 ppm	0.14	0.18	0.21
T_6 : IBA 2000 ppm + NAA 100 ppm	0.18	0.23	0.27
T_7 : IBA 2000 ppm + NAA 200 ppm	0.19	0.25	0.29
T_8 : IBA 4000 ppm + NAA 100 ppm	0.22	0.29	0.33
T_9 : IBA 4000 ppm + NAA 200 ppm	0.24	0.30	0.35
T_{10} : IBA 6000 ppm + NAA 100 ppm	0.27	0.35	0.41
T_{11} : IBA 6000 ppm + NAA 200 ppm	0.28	0.36	0.42
SEm (±)	0.01	0.01	0.01
CD (5%)	0.01	0.02	0.03
CV (5%)	4.85	5.17	5.91

*5% level of significance

Table 4: Effect of different concentrations of growth regulators on days taken for first sprouting of Dragon fruit.

Treatment details	Days taken for first sprouting
T_0 : Control (Distilled water)	27.24**
T_1 : IBA 2000 ppm	25.23
T_2 : IBA 4000 ppm	22.83
T_3 : IBA 6000 ppm	20.31
T_4 : NAA 100 ppm	26.07*
T_5 : NAA 200 ppm	25.90*
T_6 : IBA 2000 ppm + NAA 100 ppm	25.15
T_7 : IBA 2000 ppm + NAA 200 ppm	25.07
T_8 : IBA 4000 ppm + NAA 100 ppm	24.43
T_9 : IBA 4000 ppm + NAA 200 ppm	24.28
T_{10} : IBA 6000 ppm + NAA 100 ppm	23.63
T_{11} : IBA 6000 ppm + NAA 200 ppm	23.47
SEm (±)	0.20
CD (5%)	0.58
CV (5%)	4.41

*5% level of significance

Table 5: Effect of different concentrations of growth regulators on shoot length of Dragon fruit.

Treatment details	Shoot length (cm)		
	30 DAP	60 DAP	90 DAP
T_0 : Control (Distilled water)	3.93	5.89	7.85
T_1 : IBA 2000 ppm	5.76	8.64	11.52
T_2 : IBA 4000 ppm	8.83*	13.24*	17.65*
T_3 : IBA 6000 ppm	10.08**	14.62**	19.15**
T_4 : NAA 100 ppm	4.87	7.31	9.74
T_5 : NAA 200 ppm	5.00	7.49	9.99
T_6 : IBA 2000 ppm + NAA 100 ppm	6.02	9.03	12.03
T_7 : IBA 2000 ppm + NAA 200 ppm	6.20	9.30	12.40
T_8 : IBA 4000 ppm + NAA 100 ppm	6.96	10.44	13.92
T_9 : IBA 4000 ppm + NAA 200 ppm	7.11	10.67	14.22
T_{10} : IBA 6000 ppm + NAA 100 ppm	7.88	11.82	15.75
T_{11} : IBA 6000 ppm + NAA 200 ppm	8.06	12.10	16.13
SEm (±)	0.22	0.34	0.46
CD (5%)	0.65	0.98	1.34
CV (5%)	5.74	5.79	5.95

*5% level of significance

Conclusion

The study revealed that the rooting and shoot growth parameters including number of roots per cutting, root length, root diameter, root, days and shoot length at 90 DAP were highest under T_3 (IBA 6000 ppm), recording 23.98 number of roots, 23.25 cm root length, 0.54 cm root diameter and 19.15 cm shoot length, respectively. This treatment was statistically superior to all others and comparable to T_2 (IBA 4000 ppm). The earliest sprouting was also observed in T_3, showing significant advantage over the other treatments. Intermediate rooting and shoot growth were noted in combination treatments T_6, T_7, T_8, and T_9, while lower values were recorded in T_4 (NAA 100 ppm) and T_5 (NAA 200 ppm). The lowest rooting and growth performance was observed in the control (T_0), which recorded 9.63 number of roots per cutting, 12.41 cm root length, 0.14 cm diameter and 7.85 cm shoot length respectively.

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