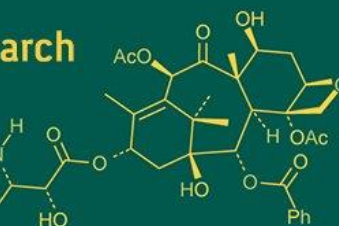
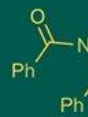


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Studies on the influence of IBA and different growing media on growth of root in dragon fruit [*Hylocereus undatus* L.]

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Abstract

A field experiment was conducted during the period of August, 2021 to November, 2021 at the Department of Horticulture, S.K.N. College of Agriculture (Sri Karan Narendara Agriculture University) Jobner, Rajasthan, India to explore how varying concentrations of IBA and different growing media influence the development of robust and high-quality planting materials. The design of experiment was Factorial CRD with three replications consisting of sixteen treatment combinations including IBA concentrations (control, 2000, 4000 and 6000 ppm) and various growing media compositions (1:1:1) by volume. The results demonstrated that dragon fruit cuttings treated with 6000 ppm of IBA displayed enhanced root characteristics, including early root initiation (15.06 days), maximum% of rooted cuttings (85.88), longest root length (20.60 cm), average root length (13.52 cm), root diameter (1.38 mm), average number of roots cutting⁻¹ (22.15), fresh (2.18 g) and dry (0.63 g) root weight. The application of sand : vermicompost: cocopeat (1:1:1) showed significantly higher results for root parameters viz., minimum days required for root initiation (15.04), maximum% of rooted cuttings (85.81), longest root length (20.05 cm), average root length (13.28 cm), root diameter (1.35 mm), average number of roots cutting⁻¹ (22.16), fresh (2.19 g) and dry (0.64 g) root weight at 75 days post-planting. The dragon fruit cuttings treated with 6000 ppm of IBA and grown in sand: vermicompost: cocopeat (1:1:1) media proved significantly superior combined treatment in maximum (17.14 cm) average root length. These findings highlight IBA and media's role in dragon fruit propagation.

Keywords: Dragon fruit propagation, IBA concentration, rooting response, growing media

1. Introduction

Dragon fruit (*Hylocereus undatus* L.) having diploid chromosome (2n = 22), which belongs to the Cactaceae family, is esteemed for its distinctive attributes. Originating from tropical forest region of Mexico and Central and South America (Mizrahi, 2014) [23], this graceful perennial thrives in countries like Vietnam, Nicaragua, Mexico and Colombia (Le Bellec *et al.*, 2006) [17]. Dragon fruit is grown in the Indian states of Maharashtra, Gujarat, Andhra Pradesh, Karnataka, and Tamil Nadu, although the total area under cultivation is less than 100 acres (Dhruve *et al.*, 2018) [7], affectionately known as "KAMALAM" due to its lotus-like appearance. Each 100 grams of fruit provides essential nutrients like calcium (8.5 mg), vitamin C (20.5 mg) and phosphorus (22.5 mg). Beyond nutrition, dragon fruit is prized for its medicinal properties, antioxidants (Vaillant *et al.*, 2005) [32] and significant economic impact in food processing. Dragon fruit is a promising crop for arid regions (Vaillant *et al.*, 2005) [32], characterized by a Crassulacean Acid Metabolism (CAM) pathway that enhances water-use efficiency (Cushman, 2005) [6]. It requires minimal input, low maintenance and is resistant to pests and diseases. In India, approximately 95% of dragon fruit demand is met through imports due to limited local cultivation, concentrated in a few regions (Maji, 2019) [18]. To increase domestic production, the development of new orchards and rapid propagation of quality planting material are crucial (Kumar *et al.*, 2022) [15]. While traditionally propagated by seeds and stem cuttings, seed propagation presents challenges such as variability from cross-pollination and extended juvenile stages. Current seed methods struggle to meet market demand (Gunaseena *et al.*, 2006) [11].

In contrast, vegetative propagation ensures uniformity and rapid production of true-to-type plants, making it ideal for commercial cultivation. Moreover, using cuttings for propagation leads to earlier fruit production (Merten, 2003) [22]. Rooting varies by dragon fruit species, some rooting naturally while others require auxin treatment (Blythe *et al.*, 2004; Rahad *et al.*, 2016; Chhetri *et al.*, 2021) [4, 27, 5]. Additionally, the choice of growing media significantly influences nutrient availability, crucial for healthy plant growth. IBA promotes root formation in dragon fruit cuttings by enhancing cell division and stimulating ethylene production, improving rooting success (Saini and Anmol, 2024) [30]. Studies have shown IBA concentrations from 100 ppm to 10,000 ppm enhance rooting in various crops (Seran and Thresh, 2015; Malik *et al.*, 2023; Meena *et al.*, 2023; Nale *et al.*, 2024) [31, 19, 21, 25]. This study was conducted in the subtropical climate of Jobner, Rajasthan, aims to assess its effect on root development. The selection of appropriate rooting media is essential for successful propagation (El Obeidy, 2006) [8]. Organic and synthetic media like compost, peat and coconut coir are preferred over soil due to better water retention and reduced loss (Gruda, 2019) [10]. Ideal media should contain 10-30 percent organic matter and be sterile (Yilmaz *et al.*, 2018; Romano *et al.*, 2020) [33, 29]. With limited topsoil availability, mixed organic media offer improved aeration, water retention, and nutrient availability, leading to higher success rates (Rashmita *et al.*, 2016; Mubarak *et al.*, 2017; Malik *et al.*, 2023; Ingole *et al.*, 2024) [28, 24, 19, 12]. Kumar *et al.*, 2015 [16] and Maurya *et al.*, 2022 [20] in lemon and Khandaker *et al.*, 2022 [13] reported in wax apple

In Rajasthan, as dragon fruit cultivation expands, there's limited data on ideal IBA concentrations and growing media. This study aims to clarify their impact on robust plant development, crucial for informed farming decisions and future cultivation expansion.

2. Materials and Methods

The experiment was conducted during August, 2021-November, 2021 at Department of Horticulture, S.K.N. College of Agriculture (Sri Karan Narendra Agriculture University) Jobner, Rajasthan, India. The experimental site was situated at 26° 5' N, 75° 28' E, 426 meters above sea level, in the Semi-Arid Eastern Plain Zone (agroclimatic zone III-A). The experiment employed a Factorial Complete Randomized Design (FCRD) with 16 treatments. These treatments combined different doses of Indole-3-butyric acid (IBA) (G₀-Control, G₁-IBA @ 2000 ppm, G₂-IBA @ 4000 ppm and G₃-IBA @ 6000 ppm) and varied compositions of growing media (M₀-Control, M₁-Sand: Cocopeat 1:1, M₂-Sand: Vermicompost 1:1, M₃-Sand: Vermicompost: Cocopeat 1:1:1). Each treatment used 30 stem cuttings from the Pink to White genotype, each with 4-5 nodes, sourced from the dragon fruit block at SKNCOA, Jobner. Cuttings were immersed in respective IBA solutions for 2 minutes and control in distilled water before planting in polyethylene bags of 20X8.5 cm filled with specific media compositions adjusted to three-quarters capacity.

The study recorded parameters such as days to root initiation, % of rooted cuttings at 75 days (calculated as rooted cuttings/total planted × 100), length of longest root (from initiation to tip, averaged in cm), root length (measured from base to tip, averaged in cm), average number of roots were observed at 25, 50 and 75 days, root

diameter, fresh and dry weight of root (g) at 75 days (after drying at 65 °C). The data under ANOVA for Factorial Complete Randomized Designs (Fisher and Yates, 1963) [9].

3. Results and Discussion

Dragon fruit rooting behaviour was investigated in relation to varying IBA concentrations (control, 2000, 4000 and 6000 ppm) and growing media (control, sand: cocopeat, sand: vermicompost and sand: vermicompost: cocopeat). Tables 1, 2 and graph display the acquired results.

3.1 Effect of IBA on root parameters

The data presented (Table 1 and 2) in the investigation indicated that application of IBA @ 6000 ppm was significantly favourable for root parameters i.e., initiated root formation 7.17 days earlier, % of rooted cutting (85.88), 42.86% increase in length of longest root (cm), average root length cutting⁻¹ (13.52 cm), average number of roots cuttings⁻¹ (22.15), 35.50% increase in the roots' diameter (mm) and root weight (fresh and dry) over the control. These positive effects on root development were likely attributable to IBA's influence on dragon fruit, which sensitively responded to its application. Higher concentrations of IBA stimulated mature parenchyma cells to re-differentiate into cambial tissue and facilitated rapid hydrolysis of stored carbohydrates in stem cuttings, providing necessary nutrients for cambial tissue. Optimal IBA concentrations also stimulated the mobilization and utilization of nitrogen and carbohydrates, supported by cofactors at the wounded site, thereby enhancing root initiation. This process accelerated cell division and elongation in cambial tissue, contributing to early root formation, longer roots cutting⁻¹, increased adventitious roots and higher root biomass. These outcomes confirmed with earlier studies on dragon fruit (Seran and Thresh, 2015; Rahad *et al.*, 2016 and Chhetri *et al.*, 2021) [31, 27, 5].

3.2 Effect of growing media on root parameters

Significant improvements in root parameters were observed when dragon fruit cuttings were propagated in a growing medium consisting of sand, vermicompost, and cocopeat in equal proportions (1:1:1). This medium outperformed both the control and a mixture of sand and vermicompost (1:1), yielding higher values for root initiation (7.26 days earlier), % of rooted cuttings (85.81%), 40.54% increase in longest root's length (cm), average root length cutting⁻¹ (13.28 cm), average number of roots cutting⁻¹ (22.16), root diameter (mm), fresh and dry root weight (g). Vermicompost, a nutrient-rich soil produced through earthworm activity, was integral to organic farming. It included 'teas' a wastewater enriched with essential plant nutrients and growth hormones (Arancon *et al.*, 2020) [2] that promoted rooting in cuttings. Vermicompost improved soil's physical, biological and chemical characteristics (Norman *et al.*, 2005) [26], boasting higher levels of nitrogen, potassium and phosphorus compared to other media, thereby facilitating microbial activity and nutrient absorption across the root surface. This resulted in enhanced root formation, increased accumulation of nutrients, longer roots and altered amino acid metabolism during root regeneration.

Cocopeat, renowned for its chemical properties including high phosphorus, potassium, moderate electrical conductivity and pH (Abad *et al.*, 2002) [1], was a favoured growth medium component. Its compatibility with other

substrates (Bhattacharjee, 2006) [3] made it versatile. Knight (1926) [14] identified sand as an optimal medium for rooting in certain fruit crops due to its cost-effectiveness stemming from excellent drainage and aeration properties. These findings aligned with studies of Malik *et al.*, 2023 [19] and Ingole *et al.*, 2024 [12] in dragon fruit plant.

3.3 Interactive effect IBA and growing media

The interactive effect was also found significant in terms of length of root cuttings⁻¹ at 25, 50 and 75 days after planting as shown in Table 3. The treatment combination G₃M₃ showed significantly higher length of root over other treatment combinations (Plate 1). Kumar *et al.* (2015) [16] reported that lemon cuttings treated with 800 ppm IBA and grown in a mix of garden soil, sand, and vermicompost (1:1:1) exhibited enhanced root length. This result aligned with the findings of Khandaker *et al.* (2022) [13] in wax apple and Kumar *et al.* (2015) [16] and Maurya *et al.* (2022) [20] in lemon.

G₃M₃

Control

Plate 1: Best treatment compared with control for root growth
[G₃M₃-Cutting treated in IBA 6000 + Sand: Vermicompost: Cocopeat (1:1:1)]

Table 1: Effect of different concentrations of IBA and growing media on days taken for root initiation, % of rooted cuttings, length of longest root (cm) and average length of roots cutting⁻¹ (cm) of dragon fruit

Treatments	Days taken for root initiation	% of rooted cuttings at 75 DAP (%)	Length of longest root (cm)			Average length of roots cutting ⁻¹ (cm)		
			25 DAP	50 DAP	75 DAP	25 DAP	50 DAP	75 DAP
IBA (ppm)								
G ₀ -Control	22.23	65.99	2.55	6.02	11.77	1.70	2.00	5.31
G ₁ -IBA 2000	16.56	75.66	3.45	6.66	14.89	2.75	4.52	10.11
G ₂ -IBA 4000	15.92	80.11	4.21	7.80	18.90	3.91	6.45	12.95
G ₃ -IBA 6000	15.06	85.88	4.29	10.12	20.60	4.05	6.71	13.52
SEm ±	0.38	1.71	0.09	0.21	0.39	0.07	0.11	0.24
CD (p = 0.05)	1.09	4.93	0.26	0.59	1.13	0.20	0.31	0.69
Growing media								
M ₀ -Control (Sand)	22.30	65.44	2.59	6.04	11.92	1.87	2.05	5.51
M ₁ -Sand: Cocopeat (1:1)	16.54	75.85	3.53	6.72	15.03	2.95	4.62	10.36
M ₂ -Sand: Vermicompost (1:1)	15.90	80.55	4.15	7.79	19.15	3.73	6.39	12.76
M ₃ -Sand: Vermicompost: Cocopeat (1:1:1)	15.04	85.81	4.24	10.04	20.05	3.87	6.62	13.28
SEm ±	0.38	1.71	0.09	0.21	0.39	0.07	0.11	0.24
CD (p = 0.05)	1.09	4.93	0.26	0.59	1.13	0.20	0.31	0.69

Significance at 5% level, DAP-Days after planting

Table 2: Effect of different concentrations of IBA and growing media on average number of roots cutting⁻¹, diameter of root (mm), fresh and dry weight of the root (g) of dragon fruit

Treatments	Average number of roots cutting ⁻¹			Diameter of root (mm)			Fresh weight of the root (g)	Dry weight of the root (g)
	25 DAP	50 DAP	75 DAP	25 DAP	50 DAP	75 DAP	75 DAP	75 DAP
IBA (ppm)								
G ₀ -Control	2.23	5.00	9.08	0.18	0.26	0.89	1.64	0.28
G ₁ -IBA 2000	3.87	9.55	17.42	0.29	0.50	1.19	1.54	0.45
G ₂ -IBA 4000	5.98	12.85	21.10	0.43	0.61	1.33	2.10	0.53
G ₃ -IBA 6000	6.00	13.45	22.15	0.54	0.75	1.38	2.18	0.63
SEm ±	0.12	0.21	0.37	0.01	0.01	0.03	0.04	0.01
CD (p = 0.05)	0.36	0.62	1.08	0.03	0.04	0.07	0.12	0.03
Growing media								
M ₀ -Control (Sand)	2.55	4.63	9.03	0.15	0.23	0.85	1.53	0.30
M ₁ -Sand: Cocopeat (1:1)	3.98	9.27	17.35	0.32	0.54	1.28	1.72	0.42
M ₂ -Sand: Vermicompost (1:1)	5.61	13.17	21.22	0.44	0.61	1.30	2.02	0.54
M ₃ -Sand: Vermicompost: Cocopeat (1:1:1)	5.95	13.79	22.16	0.53	0.74	1.35	2.19	0.64
SEm ±	0.12	0.21	0.37	0.01	0.01	0.03	0.04	0.01
CD (p = 0.05)	0.36	0.62	1.08	0.03	0.04	0.07	0.12	0.03

Significance at 5% level, DAP-Days after planting

Table 3: Interactive effect of plant growth regulator and growing media on average length of roots cutting⁻¹ in Dragon fruit stem cuttings at 25, 50 and 75 DAP (days after planting)

	Average length of root (cm)											
	25 DAP				50 DAP				75 DAP			
	G ₀	G ₁	G ₂	G ₃	G ₀	G ₁	G ₂	G ₃	G ₀	G ₁	G ₂	G ₃
M ₀	1.02	1.66	2.35	2.44	0.83	1.88	2.69	2.80	2.79	5.31	6.81	7.11
M ₁	1.62	2.61	3.71	3.85	1.88	4.24	6.06	6.30	5.25	10.00	12.80	13.37
M ₂	2.04	3.30	4.70	4.87	2.60	5.87	8.38	8.71	6.47	12.31	15.77	16.47
M ₃	2.12	3.43	4.87	5.05	2.69	6.08	8.68	9.03	6.73	12.82	16.42	17.14
SEm +				0.14				0.22				0.48
CD				0.39				0.62				1.37

Significance at 5% level, DAP-Days after planting

4. Conclusion

Based on the findings, cuttings treated with 6000 ppm of IBA and grown in sand, vermicompost and cocopeat (1:1:1 ratio) exhibited significantly superior root parameters compared to other treatment combinations, except for G₂M₂ (IBA @ 4000 ppm + sand: vermicompost), which showed comparable results. This combination was recommended for dragon fruit propagation.

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