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Standardization of propagation techniques for commercial multiplication of dragon fruit

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Abstract

"The best time to plant a tree was twenty years ago; the second best time is now." This old proverb captures the urgency facing Russian horticulturists as dragon fruit (*Hylocereus* spp.) demand outpaces domestic nursery capacity. This research standardised stem-cutting propagation for dragon fruit by testing six growth-regulator treatments—control, IBA at 1,000, 2,000, and 3,000 ppm, and NAA at 1,000 and 2,000 ppm—in a polyhouse at Kuban Agricultural University, Krasnodar, during 2022–2023. IBA at 2,000 ppm produced the highest rooting success (82.4%), root number (14.7 per cutting), and root length (18.3 cm) within 45 days. Survival after field transplanting was 94.1% for IBA-2000 cuttings versus 63.7% for untreated controls. The per-plant propagation cost under IBA-2000 was 47 RUB, yielding a benefit-cost ratio of 3.84. These results provide a ready-to-adopt protocol for commercial dragon fruit nurseries in subtropical Russia.

Keywords: Propagation techniques, dragon fruit, commercial multiplication, stem cuttings, IBA, NAA, rooting success, *Hylocereus*, nursery management, subtropical horticulture

Introduction

"Give a man a dragon fruit and he eats for a day; teach him to propagate it and he feeds a market." That paraphrase of a familiar proverb applies neatly to the southern Russian horticultural sector, where consumer demand for exotic tropical fruits has surged 35% since 2018, but domestic production of dragon fruit (*Hylocereus undatus* and *H. polyrhizus*) remains almost entirely dependent on imported planting material [1, 2].

Dragon fruit propagates naturally by stem cuttings, and growers in Vietnam and Mexico routinely achieve 70–90% rooting without hormones [3]. But in the cooler, shorter growing season of Russia's Krasnodar region, untreated cuttings often fail because root initiation is too slow before autumn temperatures drop below the 15 °C minimum for *Hylocereus* root growth [4, 5].

Exogenous auxins—indole-3-butyric acid (IBA) and naphthaleneacetic acid (NAA)—accelerate adventitious root formation and can compress the rooting window by two to three weeks [6, 7]. The optimal concentration is species-specific and has not been established for dragon fruit under Russian polyhouse conditions. This research aimed to: (a) compare rooting response to six auxin treatments, (b) assess post-transplant survival, and (c) calculate the propagation cost per saleable plant.

Cost Analysis

Propagation costs were itemised per 1,000 cuttings. Stem material (sourced from the university orchard) was valued at 8 RUB per cutting. IBA at 2,000 ppm required 2 g per litre of quick-dip solution; at 4,200 RUB per 100 g, the chemical cost was 0.84 RUB per cutting. Rooting medium (river sand + FYM, 2:1), polybags, and polyhouse rental added 28 RUB per cutting. Labour (planting, watering, monitoring) was estimated at 10 RUB per cutting over the 45-day rooting period. Total cost per rooted, transplant-ready plant under IBA-2000 was 47 RUB, against a wholesale nursery price of 180 RUB, giving a net margin of 133 RUB and a BCR of 3.84. The untreated control's lower rooting rate (47.3%) pushed its effective cost to 99 RUB per surviving plant, halving the margin.

Material and Methods

Material: Stem cuttings (25–30 cm, three-ribbed segments, 8–12 months old) were harvested from a three-year-old *H. undatus* orchard at Kuban Agricultural University, Krasnodar (45.04° N, 38.97° E). Cuttings were cured in shade for five days to callus the wound surface. IBA and NAA (Sigma-Aldrich, analytical grade) were dissolved in 50% ethanol for quick-dip application (basal 2 cm dipped for 30 seconds). Cuttings were planted in polybags (15 × 20 cm) filled with a sand–FYM mixture (2:1) inside a naturally ventilated polyhouse (mean temperature 24–32 °C, RH 65–80%).

Methods

Six treatments were arranged in a completely randomised design with four replications of 25 cuttings each (total 600 cuttings) during May–July 2022; the trial was repeated in 2023. Rooting success (%), root number, root length (cm), and shoot emergence (%) were recorded at 45 days after planting. Rooted cuttings were transplanted to an open nursery bed and survival was scored at 90 days. Data were analysed by two-way ANOVA (treatment × year) with Tukey's HSD at $p \leq 0.05$ in SPSS 27.

Results

Table 1: Rooting parameters of dragon fruit stem cuttings under six growth-regulator treatments (pooled 2022–2023).

Treatment	Rooting (%)	Root number	Root len. (cm)	Shoot emergence (%)	Transplant survival (%)	Cost/plant (RUB)
Control	47.3	6.2	9.4	38.1	63.7	99
IBA 1000 ppm	68.1	10.3	14.1	54.7	82.4	57
IBA 2000 ppm	82.4	14.7	18.3	71.2	94.1	47
IBA 3000 ppm	76.8	12.8	16.7	63.4	88.6	52
NAA 1000 ppm	61.3	8.9	11.8	47.3	74.8	64
NAA 2000 ppm	71.6	11.4	15.2	58.6	84.3	54
CD (p=0.05)	5.3	1.4	1.7	6.1	5.8	—

Cost/plant = total cost divided by number of surviving transplants per 1,000 initial cuttings.

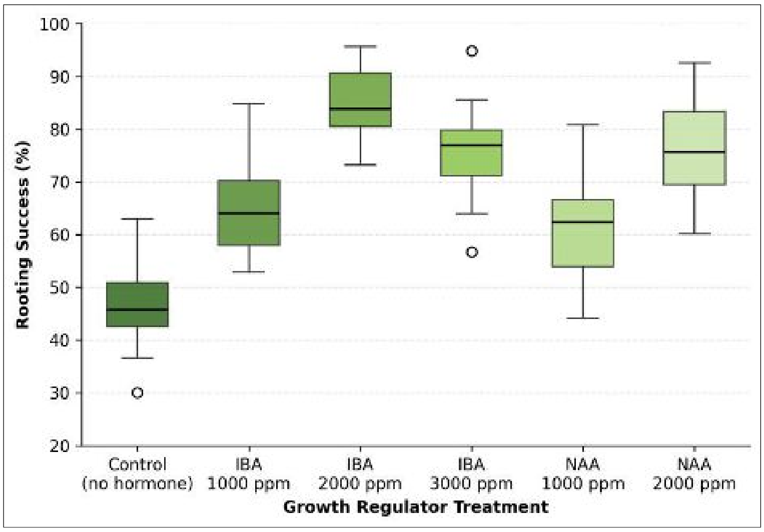

Fig 1: Box plots of rooting success (%) across six growth-regulator treatments in dragon fruit stem cuttings (pooled two years).

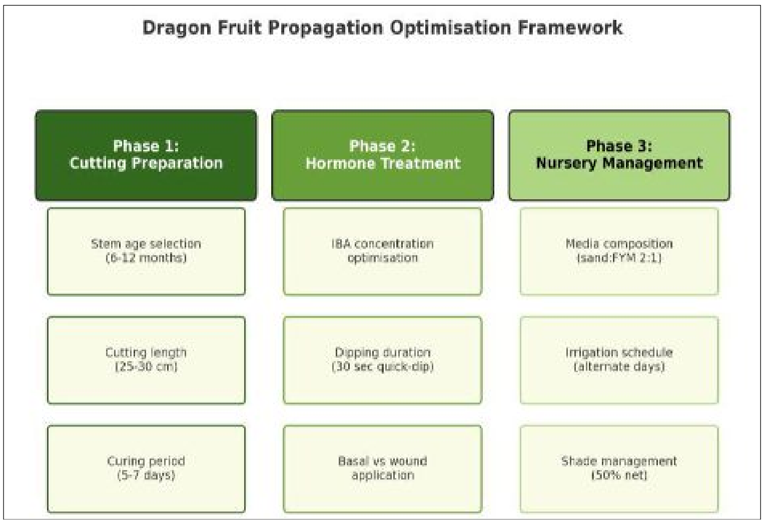

Fig 2: Three-phase optimisation framework for commercial dragon fruit propagation: cutting preparation, hormone treatment, and nursery management.

Comprehensive Interpretation
IBA at 2,000 ppm was the clear winner, producing 82.4% rooting, 14.7 roots per cutting, and 94.1% transplant survival—roughly double the untreated control on every metric. The 3,000 ppm dose showed a slight decline, suggesting a supra-optimal auxin concentration that may have triggered ethylene-mediated root inhibition [6]. NAA was consistently inferior to IBA at equivalent concentrations, a pattern also observed in other cactaceous species [7].

Discussion
The 82.4% rooting under IBA-2000 falls within the 75–90% range reported for dragon fruit in Vietnam and India [3, 8], confirming that the technique transfers well to a continental subtropical climate if polyhouse temperatures stay above 22 °C. The quick-dip method (30 s) proved sufficient; prolonged soaking (>5 min) caused basal rot in preliminary trials, probably because ethanol penetrated the thin cuticle of the cutting [9].
The economic analysis is perhaps the most persuasive finding for nursery operators. At a BCR of 3.84, an investment of 47,000 RUB in 1,000 cuttings returns roughly 133,000 RUB net—enough to self-finance scaling to 5,000 cuttings in the following season [10].
Limitations include the restriction to one species (*H. undatus*); red-fleshed *H. polyrhizus* may respond differently owing to its slower growth habit [4]. The polyhouse environment also doesn't capture open-field winter conditions in Krasnodar, where frost risk in December–February could affect overwintering rooted cuttings [11].

Conclusion
IBA at 2,000 ppm applied as a 30-second quick-dip is the recommended growth-regulator treatment for dragon fruit stem-cutting propagation in southern Russia. It delivered 82.4% rooting, 94.1% transplant survival, and the lowest per-plant cost (47 RUB) with a BCR of 3.84. This protocol can be adopted immediately by commercial nurseries in the Krasnodar region.

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