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Shivangi Mishra
Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India

RS Verma
Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India

Vipnesh Singh
Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India

Dharmraj Meena
Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India

Corresponding Author:
RS Verma
Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India

Efficacy of various growing substrates on root development in cuttings of dragon fruit (*Hylocereus undatus* L.)

Shivangi Mishra, RS Verma, Vipnesh Singh and Dharmraj Meena

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Abstract
In this study conducted at Horticultural Research Farm No. 1, Babasaheb Bhimrao Ambedkar University, the impact of various growing media on the root and shoot growth of *Hylocereus undatus* L. (dragon fruit) cuttings was investigated. Different compositions, including pure and ratios of 1:1 and 2:1:1 (v/v), were employed in the media. The experiment encompassed nine treatments and followed a Randomised Block Design replicated three times. The most favorable root parameters such as the average number of roots (10.20), root thickness (0.32 mm), root volume (2.98 cc), and root fresh and dry weight (3.21 and 0.98 g, respectively)—were observed when utilizing a mixture of Soil + Sand + Vermicompost (in a 2:1:1 ratio). Notably, the initiation of roots occurred in the shortest duration (25 days) within the soil + sand + vermicompost (2:1:1) group. Additionally, this particular media combination demonstrated the longest average root length, measuring 25.05 cm.

Keywords: Dragon fruit, media, vermicompost, FYM, Sand

Introduction
The dragon fruit, scientifically known as [*Hylocereus undatus* (Webber) Britton and Rose], belongs to the Cactaceae family and is a tropical climbing vine fruit crop. It has garnered global attention due to its striking appearance as a plant and its significance in fruit production. Pitaya, pitahaya, strawberry pear, and night blooming cereus are some of its other names. The skins of dragon fruit are thorn less and red or pink, with a luscious flesh that ranges from white to magenta.

The skin of Hylocereus spp. is typically covered by bracts or scales. Originating from the tropical and subtropical forest regions of Mexico, Central, and South America, these species of dragon fruit show promise as a potential crop suitable for commercial production in dry areas. (Vaillant *et al*. 2005) [13]. Dragon fruit cultivation commonly involves both sexual propagation through seeds and asexual methods like grafting and stem cuttings. While seed propagation is straightforward, cross-pollination often leads to seeds that do not exhibit the exact characteristics of the parent plant, which can affect the consistency of the resulting fruit. (Andrade *et al*. 2005) [1]. The choice of growing media is crucial for the successful propagation and cultivation of dragon fruit. A well-balanced media composition, such as a mixture of sand and organic matter, plays a significant role in obtaining high-quality cuttings. Various readily available materials like soil, sand, Farm Yard Manure (FYM), Vermicompost, and other similar media can be used in different combinations to create an effective growing medium for dragon fruit propagation.

Materials and Methods
The current study, named "Impact of Varied Growing Substrates on Root Development in Dragon Fruit (*Hylocereus undatus* L.) Cuttings," was conducted at Horticultural Research Farm No. 1 BBAU Lucknow in the years 2021-2022. The investigation was conducted to three times using Randomly Block Design. To acquire the planting material, fresh dragon fruit cuttings were obtained from a one-year-old stem section of the Red to White genotype, sourced from Horticultural Research Farm no. 1 at BBAU Lucknow. Each treatment involved two cuttings. These cuttings were subjected to various media compositions, including soil, sand, FYM, Vermicompost, and their combinations, at different volume

ratios. The treatments were as follows: T_0-Soil (Control) T_1-Sand T_2-Vermicompost T_3-FYM T_4-Soil + Sand (1:1) T_5-Soil + Vermicompost (1:1) T_6-Soil + FYM (1:1) T_7-Soil + S and + Vermicompost (2:1:1) T_8-Soil + Sand + FYM (2:1:1) These cuttings were then planted in grow bags filled with the respective media combinations and positioned in areas receiving partial shade. It was then moved to an open field and arranged suitably once all of the cuttings had been planted. In the first week of December, the planting was completed. Throughout the inquiry, all of the experiment cuttings were kept in the same condition and subjected to the same cultural procedures, such as fertilisation, irrigation, and plant protection. Root growth characteristics were measured during the final harvest (120 DAP).

Results and Discussion

The following is a summary of the results of the experiment on several elements of root growth parameters:

Days taken to root initiation

Differences in the days to first root initiation among the various growing media and their combined effects were found to be statistically significant (as shown in Table-1). Analysis of the dragon fruit stem cuttings treated with different growing media indicated that T_7-Soil + Sand + Vermicompost (2:1:1) exhibited the shortest duration for root initiation, taking 25 days. This duration was comparable and not significantly different from T_2-Vermicompost, which had a mean value of 26.33 days in this particular study. Similarly, at the 5% level of significance, treatments T_8&T_6 and T_4&T_5 and T_3&T_1 with respective days taken to root initiation of 27.83 & 26.8 and 26.8 & 27.83 and 26.50 &27.66 days were statistically equivalent. In comparison to the other treatments, T_0-Soil (control) took the longest (28.90 days) to initiate root growth. The application of vermicompost to stem cuttings has been noted to enhance root initiation, elongation, and overall biomas (Tomati & Galli 1995) [12]. Additionally, research on rooting performance in sheanut trees by Yeboah *et al*. in 2009 [14] suggests that media providing better aeration play a significant role in facilitating metabolic processes, consequently promoting root initiation. Similarly, Knight (1926) [4] found that sand was the most preferred medium for roots in many fruit crops.

Average number of root per cutting

Table-1 indicates that the combination of T_7-Soil + Sand + Vermicompost (2:1:1) yielded the highest average number of roots (10.20). This average number of roots corresponded closely to the cuttings treated with T_8-Soil + Sand + FYM (2:1:1) in this study, which showed an average number of roots of 9.66.At a 5 percent LOS, the treatments T_6, T_5, T_4, T_2, T_3 & T_1 with average number of roots of 9.63, 9.43, 7.30, 7.64, 8.07 & 5.77 per cutting were statistically equivalent. However, in T_0-Soil, the minimum average number of roots was 5.44. (Control). According to Norman *et al*. in 2005, vermicompost has been shown to enhance the physical, chemical, and biological properties of soil. In the context of dragon fruit, the current study's observations regarding the average number of roots per cutting align with findings by Sudarjat, suggesting consistency between the current research and Sudarjat's work.

Average length of root (cm)

The statistical analysis, as depicted in Table-1, indicates a significant impact of the various media combinations on the average length of roots. The media combination of T_7-Soil + S and + Vermicompost (2:1:1) demonstrated the longest average root length, measuring at 25.05 cm. This length was statistically comparable to the mean lengths observed in T_4 (24 cm) and T_5 (24.26 cm) media combinations. Meanwhile, cuttings planted in T_1-Sand (20.33 cm) had shorter root lengths, which were not significantly different from those planted in T_2-Vermicompost (21 cm). T_0-Soil produced the shortest average length of root (11.33 cm) (control). The superior performance observed in the T_7 combination (Soil + Sand + Vermicompost) could be due to its ability to enhance soil porosity and reduce cutting desiccation. The addition of an aerating agent likely facilitated improved air circulation within the medium, contributing to longer root development. This finding is similar to that of Sudarjat *et al*. (2018) [11], The discovery that the combination of soil + sand resulted in the greatest average root length in dragon fruit cuttings was not attributed to a specific individual. However, similar findings regarding the effectiveness of this combination in promoting root growth were previously noted in pomegranate by Bagel and Saraswati in 1989 [2].

Root thickness (mm)

Table-1 shows how root thickness varied dramatically across different media and their combined effect. The thickness of the roots ranged from 0.13 to 0.32 mm. At 120 days after planting, the treatment T_7-Soil+ Sand+ Vermicompost (2:1:1) had the highest root mean thickness (0.32 mm), followed by T_6 and T_8, which had mean root thicknesses of 0.27 and 0.24 mm, respectively. The treatments T_1, T_2, T_3 & T_4, T_5 with mean root thicknesses of 0.14, 0.16, 0.12 & 0.17, 0.15 mm, respectively, were proven to be non-significant. At 120 DAP, however, T_0-Soil (control) had the smallest mean root thickness per cutting (0.13 mm). This could be due to the friable nature of rooting media, resulting in good penetration enriched with available nutrients, and the ability of plants to respond appropriately to nutrient availability in the medium, speeding up root growth and resulting in the development of root vascular cambium, which is responsible for increasing root length, diameter, and thickness. Kumar *et al*. (2015) [6] on rooting of lemon stem cuttings and Rathwa *et al*. (2017) [10] on pomegranate rooting found similar results.

Root Volume (cc)

At 120 DAP, significant differences in root volume were identified among growing media in the dragon fruit cuttings, as shown in table-1.T_7-Soil +Sand +Vermicompost (2:1:1) had the highest root volume (2.98 cc), which was statistically comparable to T_5 and T_8, which had respective root volumes of 1.98 and 1.96 cc during the trial. In T_0-Soil, the smallest mean root volume (1.38cc) was discovered (control). The media that generates more roots in cuttings compared to a controlled group often signifies improved nutrient uptake, leading to a substantial increase in root volume (O'Brien, E.E. & Brown, J.S., 2008) [8]. The present study's observations regarding root volume, in conjunction with the maximum average number of roots per cutting, align with Sudarjat *et al*. (2018) [11] concerning dragon fruit cuttings. This similarity indicates a correlation between root quantity and subsequent root volume, emphasizing the

significance of nutrient availability and root development in the selected media.

Fresh weight of root (g)

In the current study, T_7-Soil + Sand + Vermicompost (2:1:1) exhibited the highest root fresh weight at 3.64 g, followed by T_8-Soil + Sand + FYM (2:1:1) with a mean of 2.51 g. These two treatments were not significantly different from each other but showed significant variation from the other treatments (as shown in Table-1). T_4-Soil + Sand (1:1) had a slightly lower mean fresh weight of 1.43 g, while the control, T_0-Soil, showed the lowest fresh weight (1.25 g) among all treatments. Similar findings were reported by Yadav *et al*. in 2012, where media containing Soil + Sand + Vermicompost + Vermiculite + Coco peat in equal proportions (1:1:1:1:1) resulted in the maximum fresh weight of roots. These observations align with the current study's outcomes, showcasing the significance of specific media compositions in influencing root fresh weight in plants.

Dry weight of root (g)

The different growth conditions significantly influenced the dry weight of roots, as indicated in Table-1, showing variation between 0.25 and 0.98 grams. T_7-Soil + Sand + Vermicompost (2:1:1) demonstrated a significantly greater dry weight of roots per cutting at 0.98 grams, which was statistically similar to T_8-Soil + Sand + FYM (0.75 grams) in this study. Conversely, T_0-Soil (Control) showed the lowest dry weight of roots per cutting at 0.25 grams, a value that did not significantly differ from T_1-Sand (0.27 grams). In Bullock's heart, Khol *et al*. (2017) [3] found that media Soil + Vermicompost (1:1) produced the maximum root dry weight (*Annona reticulate* L.)

Table 1: Effect of Various Growing Media on Root Initiation Duration, Root Quantity, Root Length, Thickness, Volume, Fresh Weight, and Dry Weight of Dragon Fruit Cuttings.

Treatments	Days to Root Initiation	Average number of roots per cutting	Average length of roots per cutting (120 DAP)	Root thickness (mm) @ 120 DAP	Root volume (cc) @ 120 DAP	Root Fresh weight (g) @ 120 DAP	Root dry weight (g) @ 120 DAP
T_0-Soil	28.90	5.44	11.33	0.13	1.38	1.25	0.25
T_1-Sand	27.66	5.77	20.33	0.14	1.76	1.51	0.27
T_2-Vermicompost	26.33	7.64	21.00	0.16	1.83	1.53	0.31
T_3-FYM	26.50	8.07	23.60	0.12	1.71	1.54	0.34
T_4-Soil +Sand	26.33	7.30	24.00	0.17	1.91	1.43	0.36
T_5-Soil +Vermicompost	27.83	9.43	24.26	0.15	1.98	2.40	0.40
T_6-Soil+FYM	26.80	9.63	22.96	0.27	1.85	1.6	0.43
T_7-Soil +Sand + Vermicompost	25.00	10.20	25.05	0.32	2.98	3.21	0.98
T_8-Soil +Sand +FYM	27.83	9.66	22.08	0.24	1.96	2.51	0.75
SE(m)±	2.07	1.01	1.78	0.020	0.022	0.43	0.017
CD at 5%	0.68	0.33	0.59	0.006	0.007	0.14	0.005

Fig 1: Preparation of media

Fig 2: Tagging

Fig 3: After taggimg

Conclusions

The study highlights the significant impact of varied growing substrates on the success and growth of cuttings across various parameters. Specifically, the combination of vermicompost and soil emerged as the most successful among all treatments. The inclusion of vermicompost in the soil notably enhanced root growth in the cuttings, indicating its positive influence on the overall growth performance of the dragon fruit cuttings.

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