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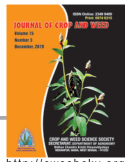

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# The efficacy of varying length of cladode cutting and IBA concentration on root and shoot growth in dragon fruit (*Hylocereus costaricensis* [F.A.C. Weber] Britton and Rose.) cv. Royal Moroccan Red

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## ABSTRACT

*An effective multiplication of dragon fruit by cladode cuttings is most preferred for large scale production of quality planting materials. Therefore, an experiment was carried out under poly house, Faculty of Horticulture, BCKV, Mohanpur, Nadia, West Bengal, India during the months of May-September., 2019 in Factorial Randomized Block Design with 5 replications considering two factors which included 4 levels of IBA concentrations (3000, 4000, 5000 and 6000 ppm) and 3 different lengths of cuttings (15, 20 and 30cm). An outcome clearly affirms a significant effect of IBA, length of cutting and their interaction on rooting and shooting parameters. The cuttings treated with IBA at 6000 ppm and the cutting length of 30cm showed significantly better results with respect to various rooting and shooting parameters followed by IBA at 5000ppm.*

***Keywords:*** Cladode cutting, cutting length, propagation of dragon fruit, IBA concentration, rooting and shooting

The dragon fruit (*Hylocereus costaricensis* [F.A.C. Weber] Britton and Rose.) is diploid (2n = 22) and belongs to Cactaceae family. It is a long-day plant with a stunning one-time night blooming flower and nicknamed as 'Wondrous Fruit' of the 21st century and "Queen of the Night" or "Noble Woman". It is also a plant of high economic potential as an exotic fruit crop and is being traded in national and international markets fetching higher prices. Fruit is the latest novice to the horticulture world of super fruits and are set to ring a revolution in the Indian horticulture scenario. In India, dragon fruit is grown in the states of Maharashtra, Gujarat, Andhra Pradesh, Karnataka, and Tamil Nadu over an area of less than 100 acres (Dhruve *et al.,* 2018) and some parts of West Bengal and North East states like Manipur, Nagaland and Assam.

The dragon fruit has been gaining popularity among the fruit's growers and consumers. The lack of planting materials is one of the major constraints in expanding the area of dragon fruit under cultivation. With increasing consumer demand, the question of availability of quality planting materials arises. Propagation by seed does not produce true-to-type plants due to cross pollination. The existing market demand could not meet by seed propagation. However, effective multiplication by cuttings is most preferred for large scale production of planting materials and early production of the variety. In addition, the fruiting stage is attained more rapidly with cuttings in almost 14 (fourteen) months after planting as opposed to 4-5 years for plants grown from seed. Therefore, it is possible to produce a large number of planting materials with healthy shoots and root systems to meet the increasing demand for commercial cultivation by vegetative propagation method. Besides, research on cladode cuttings of dragon fruit is very scanty regarding planting medium, cutting length, hormones and their specific doses, etc. which is needed standardization for commercial propagation.

## MATERIALS AND METHODS

An experiment was conducted during the month of May-September, 2019 in polyhouse adjacent to the Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India to know the effect of different length of cuttings, IBA concentrations and their interactions on rooting and shooting in dragon fruit in Factorial Randomized Block Design setup with 5 (five) replications comprising of 12 (twelve) treatment combinations with two factors which include 4 (four) levels of IBA concentrations (H) *viz*., 3000, 4000, 5000 and 6000 ppm and 3(three) different lengths of cuttings *viz*., 15, 20 and 30 cm. Data on shoot emergence was recorded as soon as new growth of buds appeared after planting of cuttings, shoot growth was measured in cm with measuring scale from the base

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to the tip of the shoot starting from 30 to 90 days of shoot emergence at every 30 days interval and the number of shoots per cuttings was counted at 90 days after planting (DAP). Number of roots per cuttings, root length, fresh weight of roots, dry weight of roots and dry matter content of roots were recorded after 90 DAP and was appropriately analyzed by applying Factorial Randomized Block Design (FRBD) setup. The level of significance was tested at 5 % of different variables.

## RESULTS AND DISCUSSION

### *Shoot parameters*

Perusal of the data in Table 1 showed that among the cuttings treated with IBA at 6000 ppm significantly emerged new shoots earliest at 26.63 DAP. The 30cm cutting length significantly reduced the days to shoot emergence (22.78 DAP). The interaction between concentrations of IBA and different lengths of cutting also varied significantly. The earliest shoot emergence (17.82 DAP) was noticed in the cutting treated with IBA at 3000 ppm with 30cm cutting length. The earliest shoot emergence with higher concentration of IBA, can be assigned to the presence of more endogenous auxins in longer cuttings which brought early breakage of bud dormancy and resulted in early shoot emergence (Iqbal *et al.*, 1999). The above results are in conformity with Chhetri *et al.* (2021) in dragon fruit.

Again, Table 1 revealed that the cuttings treated with IBA at 6000 ppm showed maximum shoot growth (5.99, 23.29 and 45.2cm) at 30, 60 and 90 DAP, respectively and were significantly superior among all the concentrations of IBA. Among the different lengths of cutting, cutting length 30cm produced the maximum shoot growth per plant (5.73cm, 26.5cm and 47.67cm) at 30, 60 and 90 DAP, respectively and was significantly superior to 20 and 15cm cutting. The interaction between several concentrations of IBA and different lengths of cutting also varied significantly. At 30 days after planting, cuttings treated with IBA at 6000 ppm showed maximum shoot growth (10.5cm) per plant and was significantly superior to all the treatment combinations. However, the minimum value was found in IBA at 5000 ppm with 15cm, whereas at 60 and 90 days after planting, the cuttings treated with IBA at 5000 ppm with 30cm cuttings (29.92 and 52.10cm, respectively). The maximum number of shoots per cutting (2.2) was found in the cuttings treated with IBA at 5000 ppm. Among the various lengths of cutting, 30cm cutting length gave significantly maximum number of shoots (2.25) per plant and it was significantly superior to 15 and 20cm cutting length and produced 1.85 and 1.8 numbers of shoots per plant, respectively. The interaction between various concentrations of IBA and different lengths of cutting also varied significantly. The maximum number of shoots per plant (2.80) was found in the cuttings treated with IBA at 5000 ppm with 30cm cutting length and was statistically at par with all the treatment combinations. The maximum number of shoots per plant at this concentration would be favorably assigned to the improvement of physiological functions of the cuttings (Iqbal *et al*., 1999). The above results are in accordance with Dhurve *et al*. (2018) and Enrique *et al*. (2010) in dragon fruit. However, the maximum number of shoots on 30cm cuttings is due to presence of a greater number of shooting zone as compared to 15 and 20cm cutting length. These results are in harmony with the outcome of Lima (2013), Marques *et al*. (2011), and Cavalcante and Martins (2008) in dragon fruit.

### *Root parameters*

It is evident from the Table 1, the cuttings treated with IBA at 6000 ppm gave maximum number of roots per cuttings (17.4, 23.6 and 26.66) at 90, 110 and 120 DAP, respectively, and were superior to all the concentrations of IBA. Among the various lengths of cutting, 30cm cutting length showed maximum number of roots per plant (20.6, 23.6 and 26.9) at 90, 110 and 120 DAP, respectively. The interaction between the various concentrations of IBA and different length of cuttings also varied significantly. At 90 days after planting, the maximum number of roots per plant (24.4) was observed in the cuttings treated with IBA at 4000 ppm with 30cm cutting length followed by IBA at 6000ppm with 30cm cutting length (21.8). At 100 and 110 DAP, cuttings treated with IBA at 5000 ppm with 30cm cutting length showed maximum number of roots (27.6 and 31.2, respectively). Induction of maximum root number in IBA treated cuttings could due to the fact that stimulation of cambium activity is implicated in root initiation by growth regulators in many species (Ullah *et al.*, 2005). Dhurvee *et al*. (2018) also reported that, like many other species, dragon fruit's rooting ability was also sensitive to the IBA application. The maximum number of roots with 30cm cutting length could due to the higher amount of reserved material stored which plays a vital role in growth and development of root while small length cuttings had a smaller number of reserved materials. This may lead to higher cutting length to develop maximum and better rooting. The rooting frequency was found to be significantly affected by size of the cutting (Browne *et. al*., 1997). The data presented in Table 1 indicate that there were significant differences among the various concentration of IBA on maximum root length per cutting. Cuttings treated with IBA at 4000 ppm showed maximum root length at 90 and 100 DAP (15.6 and 19.72cm respectively) and was at par with all the concentrations of IBA. The maximum root length (20cm) was observed in the cutting treated with IBA at 5000 ppm followed by IBA at 6000 ppm (18.7cm) at 110 DAP. Among the different lengths of cutting, at 90, 100 and 110 DAP, the cuttings of 30cm length showed maximum root length (17.8, 18.9 and 20. 8cm, respectively) followed by 20cm cutting length (12.9,

**Table 1: Effect of IBA, length of cuttings and their interaction on rooting and shooting in dragon fruit cv. Royal Moroccan Red (*Hylocereus costaricensis* [F.A.C. Weber] Britton and Rose.)**

| Treatments | Shoot initiation (DAP) | Number of shoots plant$^{-1}$ | Shoot growth (cm) at 90 DAP | Total number of roots | Root length (cm) at 90 DAP | Fresh weight of roots (g) at 90 DAP | Dry weight of root (g) at 90 DAP | Dry matter content of roots |
|---|---|---|---|---|---|---|---|---|
| $H_1$ | 28.41 | 1.73 | 36.2 | 20.66 | 12.78 | 1.68 | 0.36 | 18.53 |
| $H_2$ | 30.97 | 2.06 | 42.6 | 19.33 | 17.70 | 1.74 | 0.30 | 30.31 |
| $H_3$ | 29.27 | 2.2 | 43.5 | 18.33 | 20.0 | 1.15 | 0.39 | 39.28 |
| $H_4$ | 26.63 | 1.86 | 45.2 | 26.66 | 18.7 | 1.63 | 0.37 | 26.79 |
| L1 | 32.00 | 1.85 | 38.37 | 17.35 | 15.4 | 1.09 | 0.22 | 29.97 |
| L2 | 31.67 | 1.8 | 39.72 | 22.25 | 15.6 | 1.45 | 0.37 | 32.62 |
| L3 | 22.78 | 2.25 | 47.67 | 26.9 | 20.8 | 2.11 | 0.47 | 23.60 |
| $H_1 L_1$ | 36.90 | 1.40 | 29.16 | 16.20 | 12.34 | 1.78 | 0.15 | 8.45 |
| $H_1 L_2$ | 30.50 | 1.80 | 36.56 | 22.20 | 13.36 | 1.88 | 0.44 | 27.08 |
| $H_1 L_3$ | 17.82 | 2.00 | 42.34 | 23.0 | 12.64 | 1.40 | 0.28 | 20.06 |
| $H_2 L_1$ | 33.86 | 2.00 | 36.9 | 11.0 | 14.5 | 0.43 | 0.20 | 56.49 |
| $H_2 L_2$ | 30.16 | 2.00 | 41.44 | 18.20 | 17.82 | 2.10 | 0.22 | 10.43 |
| $H_2 L_3$ | 28.88 | 2.20 | 48.14 | 25.2 | 20.70 | 2.69 | 0.60 | 24.02 |
| $H_3L_1$ | 31.06 | 2.20 | 43.66 | 17.80 | 20.2 | 0.49 | 0.15 | 31.66 |
| $H_3 L_2$ | 34.70 | 1.60 | 34.96 | 23.40 | 14.6 | 0.57 | 0.29 | 53.81 |
| $H_3 L_3$ | 22.06 | 2.80 | 52.1 | 31.2 | 25.2 | 2.41 | 0.74 | 32.37 |
| $H_4 L_1$ | 26.20 | 1.80 | 43.78 | 24.40 | 14.5 | 1.68 | 0.39 | 23.30 |
| $H_4 L_2$ | 31.32 | 1.80 | 45.92 | 25.20 | 16.7 | 1.26 | 0.48 | 39.15 |
| $H_4L_3$ | 22.36 | 2.00 | 46.1 | 28.4 | 24.9 | 1.95 | 0.26 | 17.93 |

| | CD (5%) | SEm (±) | CD (5%) | SEm (±) | CD (5%) | SEm (±) | CD (5%) | SEm (±) | CD (5%) | SEm (±) | CD (5%) | S Em (±) | CD (5%) | SEm (±) | CD (5%) | S Em (±) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 6.74 | 3.05 | 0.51 | 0.25 | 0.36 | 0.18 | 0.36 | 0.18 | 0.91 | 0.31 | 0.54 | 0.19 | 0.05 | 0.01 | 9.94 | 3.47 |
| L | 5.22 | 2.60 | 0.39 | 0.19 | 0.32 | 0.15 | 0.32 | 0.15 | 0.78 | 0.27 | 0.47 | 0.16 | 0.04 | 0.01 | N/A | 3.01 |
| HxL | 20.68 | 4.12 | 1.57 | 0.31 | 2.82 | 1.34 | 2.82 | 1.34 | 1.57 | 0.55 | 0.54 | 0.19 | 0.09 | 0.03 | 17.21 | 6.02 |

**N.B.:** **$H_1L_1$**-IBA at 3000ppm + 15cm cutting; **$H_1L_2$**-IBA at 3000ppm + 20cm cutting; **$H_1L_3$**- IBA at 3000ppm + 30cm cutting; **$H_2L_1$** - IBA at 4000ppm + 15cm cutting; **$H_2L_2$** - IBA at 4000ppm +20cm cutting; **$H_2L_3$** - IBA at 4000ppm +30cm cutting; **$H_2L_1$**- IBA at 5000ppm + 15cm cutting; **$H_2L_2$** – IBA at 5000ppm + 20cm cutting; **$H_3L_3$** - IBA at 5000ppm +30cm cutting; **$H_3L_1$**- IBA at 6000ppm +15cm cutting; **$H_3L_2$** - IBA at 6000ppm + 20cm cutting; **$H_4L_3$** - IBA at 6000ppm + 30cm cutting.

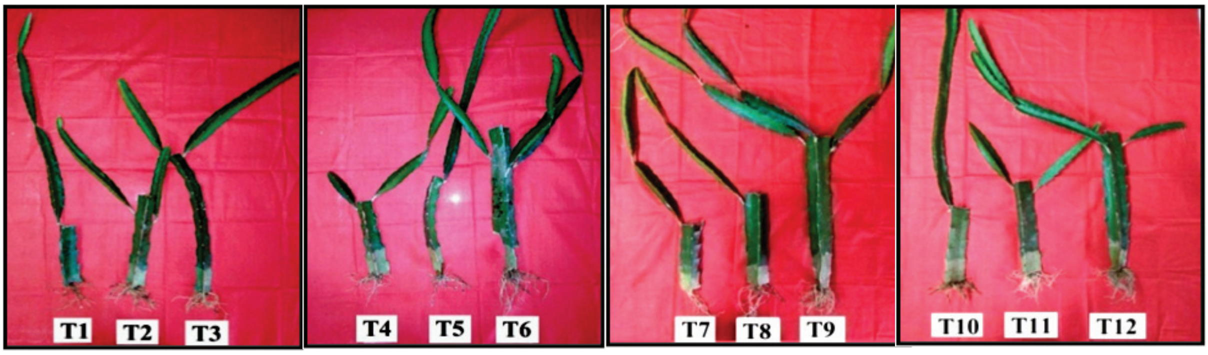


**Fig. 1: Effect of IBA, length of cuttings and their interaction on rooting and shooting in dragon fruit cv. Royal Moroccan Red (*Hylocereus costaricensis* [F.A.C. Weber] Britton and Rose.)**

*N.B.: $T_1$-IBA 3at 000ppm + 15cm cutting; $T_2$-IBA at 3000ppm + 20cm cutting; $T_3$- IBA at 3000ppm + 30cm cutting; $T_4$- IBA at 4000ppm + 15cm cutting; $T_5$- IBA at 4000ppm +20cm cutting; $T_6$- IBA at 4000ppm +30cm cutting; $T_7$- IBA at 5000ppm + 15cm cutting; $T_8$– IBA at 5000ppm + 20cm cutting; $T_9$- IBA at 5000ppm +30cm cutting; $T_{10}$- IBA at 6000ppm +15cm cutting; $T_{11}$ - IBA at 6000ppm + 20cm cutting; $T_{12}$- IBA at 6000ppm + 30cm cutting.*

15 and 15.4cm, respectively). There was a significant interaction between concentrations of IBA and length of cuttings in the study. At 90 DAP, cuttings treated with IBA at 4000 ppm with 30cm cutting length showed maximum root length (20.9cm) which was significantly superior to all the treatment combinations except IBA at 5000 ppm with 30cm cutting length (19.2cm). At 100 DAP, cuttings treated with IBA at 4000 ppm with 20cm cutting length produced root length of 23.3cm followed by IBA at 4000ppm with 30cm cutting length (21.3cm). IBA at 5000 ppm with 30cm cutting length produced root length of 25.2cm followed by IBA at 6000 ppm with 30cm cutting length (24.9cm) at 110 DAP and was found significantly superior to all the treatment combinations. The effect of IBA on rooting activity may be anticipated to its effect on turgidity of cell wall, which hasten cell division (Hartmann *et al*., 2002). This finding was similar to Salleh (2007) who concluded the increased dose of IBA at 300 to 1000 ppm gave significant difference for 30 cm cutting length in dragon fruit. The data pertaining the maximum fresh weight of roots (1.7g) per plant was recorded in cuttings treated with IBA at 4000 ppm followed by IBA at 3000 ppm (1.68g) at 90 DAP. The fresh weight of roots (1.77g) found maximum with IBA at 6000 ppm was not significant at 100 DAP. The maximum fresh weight (2.68g) was found in the cuttings treated with IBA at 6000ppm followed by IBA at 5000 ppm (3.54g) at 110 DAP. Among the different lengths of cutting, at 90, 100 and 110 DAP, the fresh weight of roots (2.11, 2.11 and 3.32g, respectively) was found maximum in 30cm cutting length. There was a significant interaction between the various concentrations of IBA and different lengths of cutting. The maximum fresh weight (2.67g) was observed in IBA at 4000 ppm with 30cm cutting length followed by IBA at 5000 ppm (2.42g) at 90 DAP. The cuttings treated with IBA at 6000 ppm with 15cm cutting length showed maximum fresh weight of roots (2.06g) per plant followed by IBA at 6000 ppm with 20 and 30cm cutting length (1.4g) at 100 DAP. The fresh weight of roots was found maximum (3.76g) in the cuttings treated with IBA at 4000 ppm with 30cm cutting length followed by IBA at 5000 ppm with 20cm cutting length (3.64g) at 110 DAP. It is evident from the Table 1 that dry weight of roots per plant was found maximum (0.39g) in the cuttings treated with IBA at 5000 ppm at 90 DAP which was significantly superior to other concentrations of IBA. At 100 and 110 DAP, the cuttings treated with 6000ppm showed maximum (0.50 and 0.67g) dry weight of roots followed by IBA at 5000 ppm (0.46 and 0.50g, respectively). Among the different length of cuttings, at 90, 100 and 110 DAP, the dry weight of roots per plant was maximum (0.47, 0.56 and 0.72g respectively) in 30cm cutting length followed by 20cm cutting length (0.37, 0.46 and 0.51g, respectively). The interaction between various concentrations of IBA and length of cuttings varied significantly. The dry weight of roots per cuttings was maximum (0.74g) in the cuttings treated with IBA at 5000ppm with 30cm cutting length at 90 and 100 DAP and was significantly superior to all other treatment combinations. the fresh weight of roots was recorded maximum (0.81g) at 110 DAP in the cuttings treated with IBA at 6000 ppm with 30cm cutting length and was statistically at par to IBA at 5000 ppm with 30cm cutting length and IBA at 3000 ppm with 30cm cutting length (0.74g and 0.72g, respectively). The dry matter accumulation on the roots was significantly influenced by various concentrations of IBA. The dry matter content of roots was found maximum (39.38%) in the cuttings treated with IBA at 5000ppm and was statistically at par with IBA at 4000ppm (30.31%) at 90 DAP. There was non-significant difference among various concentrations of IBA on dry matter content of roots per plant at 100 DAP.

The dry matters content was recorded maximum (25.23%) in the cuttings treated with IBA at 6000 ppm at 110 DAP. Among the various lengths of cutting, 30cm cutting length gave maximum dry weight of roots (0.30, 0.38 and 0.57g) at 90, 100 and 110 DAP, respectively. The interaction between concentrations of IBA and cutting length on dry weight of roots differed significantly at 90 days after planting. At 90 DAP the dry matter content of roots per plant was recorded maximum (56.49%) in the cuttings recorded with IBA at 4000 ppm with 15cm cutting length. The interaction between various concentration of IBA and different lengths of cutting was not significantly differed at 100 DAP. The cuttings treated with IBA at 6000 ppm with 30cm cutting length showed maximum dry matter content of roots (28.07%) per cutting followed by IBA at 3000 ppm with 15 cm cutting length (28.03%) at110 DAP. Higher concentrations of IBA may induce redifferentiation of mature parenchymal cells into cambium tissue and supply of food material to cambium tissue through rapid hydrolysis of reserve carbohydrates stored in the cuttings. It aids in rapid cell division and cell elongation in cambium tissue, which may have resulted in maximum fresh weight, dry weight and dry matter content of roots per cutting. These results are in harmony with the outcome of Chhetri *et al.* (2021); Dhurve *et al*.(2018); Rahad *et al*. (2016) and Seran and Thiresh (2015) in dragon fruit.

## CONCLUSION

The results of the investigation clearly revealed a significant effect of IBA, length of cuttings and their interaction on rooting potential and shoot growth in dragon fruit (*Hylocereus costaricensis* [F.A.C. Weber] Britton and Rose.) cv. 'Royal Moroccan Red'. The cuttings treated with IBA at 6000ppm showed significantly better results than other concentrations of IBA with respect to various rooting and shooting parameters followed by IBA at 5000ppm. The cutting length of 30cm showed significantly better results than other lengths of cutting with respect to various rooting and shooting parameters.

Further research can be taken up on the efficacy of cladode or stem of different maturity, multiplication in different seasons of the year, different rooting media and different concentration of IBA and other growth substances which can be tried for the multiplication of dragon fruit in the future.

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