Original Research Article

Standardization of Length of cuttings and auxin levels on root and shoot growth of Dragon fruit (*Hylocereusundatus*L.)

ABSTRACT

Dragon fruit as the "Wondrous Fruit" of the twenty-first century is a cactus-like vine with great economic and nutritional potential as exotic fruit crops in domestic and foreign markets. One of the biggest issues with commercial fruit production is the development of high-quality planting materials. Considering that it is a cross-pollinated crop, true-to-type plants could not be obtained through seed propagation. Hence, standardization of vegetative propagation protocol is necessary for commercial production. Therefore the experiment was conducted at Department of Fruit Science, Horticultural College and Research Institute, Periyakulam, to assessdifferent length of stem cuttings (*viz.,* C_1 -10cm, C_2 – 15cm, C_3 – 20cm and C_4 - 25 cm) with various concentration of auxin level (*viz.,* G_1 – IBA 2000 ppm, G_2 – IBA 4000 ppm, G_3 - IBA 6000 ppm, G_4 – NAA 50 ppm, G_5 - NAA 100 ppm, G_6 – NAA 150 ppm) for achieving growth and rooting of dragon fruit. According to the experimental findings, among the different treatments 25cm cuttings treated with IBA 6000ppm showed noticeably superior results in early root initiation (12.11 DAP) and sprout initiation (8.26 DAP), highest shoot length (75.52cm) and root length (17.64cm), Average number of roots per cutting (20.17), Average number of shoots per cutting (3.7), maximum survival percentage (93.42%) than other treatments.

Keywords : *Auxin, Dragon fruit, Growth parameters, Length of the cuttings, Survival percentage*

INTRODUCTION

Pitaya, also known as the Dragon fruit (*Hylocereusundatus*L.)are perennial epiphytic cactus being grown as an economical fruit crop throughout Southeast Asia, particularly in China, Vietnam, and Thailand. It has medium-sized scaly fruit and a photosynthetic stem without leaves (Nerd and Neumann, 2004) i.e., triangular green stem with a tendency to produce aerial roots, which spread out from the stems bases and act as anchors for the plants (Zee *et al.,* 2004). The majority of species are considered for their ornamental attributes however 250 species are recognised as fruits (Hunt, 2006; Anderson, 2001; Barcenas *et al.,* 2011). Due to their capacity to withstand abiotic stress such as drought and harsh temperatures, dragon fruit is extremely adaptable to new environments. Being a CAM plant, it has the ability to open its closed stomata at night so that it can absorb CO_2 and fix it during the day (Ben-Asher *et al.,* 2006; Weiss *et al.,* 2010).

It has gained more attention due to its high nutritional value, particularly its vitamin C, phosphorus, and calcium content as well as its fibre content, antioxidative effects, and therapeutic benefits. Regular intake of fresh dragon fruit significantly lowers the risk of developing asthma, cholesterol, high blood pressure, cancer, congenital glaucoma, lessens the pain associated with arthritis, is safe for pregnant women, prevents renal bone disease, improves eye and brain health, and flowers are used in aromatherapy (Ayesha Siddiqua *et al.,* 2018). Additionally, it has betacyanins, which are water-soluble pigments that gives red colour to its pulp and their peel (Wybraniec*et al.,* 2007).

In India, dragon fruit is mostly grown in the states of Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu, and some regions of West Bengal on an area of less than 100 acres (Dhruve*et al.,* 2018). A shortage of quality planting supplies is one of the main obstacles to extending the area of dragon fruit production. There are two ways to multiply dragon fruit: (i) seeds, (ii) through stem cuttings. Lots of variability is observed among the plants developed from seeds, that were not true to type. Vegetative propagation methods like stem cutting and grafting can be used to overcome the constraints of seed propagation (Winson *et.al.,* 2016). For easy multiplication and early fruiting, majority of dragon fruit propagation efforts are concentrated on stem cuttings (Tripathi *et.al.,* 2014). However, rooting problems with stem cuttings can also lead to lower output. Cuttings from some cultivars of dragon fruit, like *H. undatus*, require auxin treatment in order to root development, and treated cuttings have a faster root initiation time, and longer roots than untreated cuttings. According to earlier research, IBA treatment was effective at concentrations between 6000 and 7000 ppm. The auxins may function even at extremely low concentrations and that using them excessively can be detrimental to the plants (Dhruve*et al.,* 2018). The focus of the present study is to investigate the effects of cuttings length with auxin treatments on the stem cuttings of dragon fruit.

MATERIALS AND METHODS

A study was conducted on Dragon Fruit (*Hylocereusundatus*L.) in the field trial of Fruit Science Department, Horticultural College and Research Institute, Periyakulam of Tamilnadu, India. A Factorial completely randomised design was used for the experiment, with twenty eight treatments distributed among two replications to assess the interaction effect of four different length cuttings *viz.,* C_1 -10cm, C_2 -15cm, C_3 -20cm and C_4 -25 cm at various auxin concentrations like G_1 – IBA 2000 ppm, G_2 – IBA 4000 ppm, G_3 – IBA 6000 ppm, and G_4 –NAA 50 ppm, G_5 – NAA 100 ppm, G_6 – NAA 150 ppm and G_7 – Control on the growth of root and shoot in dragon fruit.

The stem cuttings are chosen from one year old shoots by direct observation from the healthy plants that were the same size and age. These were divided into the necessary sizes and it was allowed to cure for two days in a cool, dry environment for removing the gummy exudation from the cuttings. Then the basal cut ends were soaked in a 0.5% Bavistin (Carbendazim) solution for ten seconds to avoid the fungal disease. The cuttings were positioned at least 1.5 to 2 inches deep, with the spine facing up to retain polarity in polybags with a thickness of 250 gauge and a 15 cm diameter (15 x 20 cm) were filled with a 1:2:1 potting combination of soil, sand, and FYM.

After planting of cuttings, data on shoot emergence was recorded as soon as new growth of buds occurred. Shoot growth like number of days taken for sprouting, number of shoots per cutting, shoot length, dry weight and fresh weight of the shoot was measured in cm using a measuring scale from the base to the tip of the shoot beginning at 30 to 90 days of shoot emergence at every 30 days interval. The efficacy of the treatments were evaluated based on root parameters like number of days taken for root initiation, root length, average number of roots per cutting at 30 days, 60 days, 90 days after planting.

RESULTS AND DISCUSSION:

Effect of Growth regulators on the Growth character of Dragon fruit:

1. Number of days taken for sprout initiation: Significant difference was noted between the various cuttings length, growth regulator treatments and their interaction for the shoot characteristics of Dragon fruit stem cuttings. Analysis of the data in Table 1 revealed that, among the various cuttings length, 25 cm (C_4) - longest cuttings established early sprout initiation (12.99 DAP) and delayed sprouting was observed in 10 cm (C_1) cuttings (16.70 DAP). Among the different IBA concentrations, cuttings treated with IBA at 6000 ppm (G_3) significantly produced new sprouts at the earliest possible time (10.45 DAP) and maximum number of time taken for new sprout initiation (16.87 DAP) in Control (G_7). Among the different treatment combinations, 25 cm cuttings with IBA – 6000ppm shows shorter duration (8.26 DAP) for sprout initiation and 10cm with control taken longer duration (16.70 DAP). Because, the presence of more endogenous auxins in longer cuttings caused early rupture of bud dormancy, which led to early shoot emergence (Iqbal *et al*., 1999). Dhruve*et al.*, (2018) and Balaguera - Lopez *et al.*, (2010) both found similar results in dragon fruit. Earlier sprout initiation occurs due to the availability of respiratory substrates to glycolytic enzymes, which results in the release of energy and aids in the early sprouting of dormant buds. In plum, IBA treatment improved the utilisation of nitrogen and stored carbohydrates in the nodal region and increases cell division, which accelerates the production of calluses in the cutting (Chauhan and Reddy (1974).

2. Number of days taken for root initiation: Significant differences between the various cutting length, growth regulators, and their interactions on root characteristics were noted in Table 1. Among the various length of cuttings 25 cm cuttings taken minimum duration (14.65 days) to initiate the roots and 10cm cuttings taken maximum duration (17.17 days). The cuttings treated with IBA 6000ppm will showed earliest root initiation (12.32 days) and more number of days taken to initiate the roots in untreated cuttings (20.40 days). Also proven to significant variation among the treatment combinations. 25cm cuttings with IBA 6000ppm produce the roots earlier (11.63 days) than 10cm cuttings with control (21.59 days). Ullah *et al.* (2005) stated that growth regulators are involved in root initiation by stimulating cambial activity, it is possible that IBA treated cuttings induced the greatestnumber of roots. Nanda (1975), who suggested that, external application of auxin which hydrolyzes starch into simple sugars. It leads to the development of new root primordia because it triggers the synthesis of new cells and improve the respiratory activity in regeneration tissue.

3. Survival percentage: Data present in the Table 1 indicated highest value of survival percentage (85.39%) was found in 25cm long cuttings and lowest survival percentage (57.97%) was found in 10cm long cuttings. In the application growth regulators, IBA 6000ppm treated cuttings showed superior result (79.22%) than the rest of the other treatments. But there is no substantial interaction noted in between the cuttings length and IBA treatment combination. The same results discussed in stevia cutting by Rakibuzzaman*et al.* (2018).

The fact that of higher amount of food reserves and sugars may be the reason of the highest reserves and sugars may be the reason of the highest survival percentage of rooted cuttings. It leads to increased the number of shoots and roots per cutting and the length of the roots, which in turn increased the survival rate. Reddy *et al.* (2008) suggested that the survival rate, which is correlated with the effective root system *i.e.*, emergence of adventitious roots.

4. Average shoot growth: According to Table 2, the 25 cm cuttings provided the highest average shoot growth per plant (10.16cm, 30.35cm & 60.77 cm) at 30, 60 and 90 DAP which was far superior than 10 cm cuttings (2.33cm, 13.03cm & 38.86cm respectively). Among all auxin concentrations at 30, 60 and 90 DAP, the cuttings treated with IBA at 6000ppm proved considerably greater shoot growth (12.98cm, 33.09cm and 59.72cm). While the lowest shoot growth was found in untreated cuttings (2.80cm, 18.61cm & 37.75cm at 30, 60 and 90 DAP respectively. Significant distinctions also existed between different treatment combinations. The 25cm cuttings treated with IBA 6000ppm showed maximum shoot growth at 30, 60 and 90 DAP were 20.96cm, 42.19cm and 75.52cm than 10cm cuttings with control at 30, 60 and 90 DAP were 1.23cm, 10.51cm, 23.49cm respectively. The same results were also found in *Ficus hawaii*(Siddiqui and Hussain 2007). They emphasised the link between longer shoots and improved rooting performance. Cuttings treated with rooting hormone produced more roots, which aided in improved nutrient absorption and ultimately lengthened the shoots.

5. Average root growth: The Table 3, indicated that there were significant variation among the cuttings length, growth regulators and their combinations.. At 30, 60 and 90 DAPthe length of 25cm cuttings showed longest root length *viz.,* 7.96cm, 8.57cm, 9.39cm respectively and smallest root length was observed in 10cm cuttings. The length of the cuttings recorded were3.96cm, 6.49cm and 6.64cm. While considering the auxin level the cuttings treated with IBA 6000 ppm showed maximum root length per cutting *i.e.,* 9.81, 12.43, 13.83cm and minimum length was observed in untreated cuttings *i.e.,* 3.71, 4.73, 5.23cm with the time interval of 30, 60 and 90 DAP.In the study, there was a substantial interaction between IBA concentrations and cuttings length. Thecombination of IBA 6000 ppm with 25 cm cutting at 90 DAP results in highest individual length of root (17.64cm) and minimum length (4.57cm) in 10cm cuttings with control. Ayesha *et al.,* 2018 also found similar results in Dragon fruit stem cuttings. Maji *et al.,* 2021 indicates, rooting was fastened by a high C/N ratio and the presence of greater amounts of starch, sucrose, and reducing sugars due to the result of auxins effect on the cuttings. Higher accumulation of food reserves at longer cuttings may have accelerated carbohydrate depletion, which in turn initiate the longest roots by hastening the elongation of meristematic tissues.

6. Average number of shoots: The data provided in Table 4, describes the number of shoots per cutting as impacted by cuttings length, growth regulators in various combination. The average number of shoots per individual at 30, 60 and 90 DAP was highest in 25cm length cuttings (2.30, 2.54 and 2.85) whereas lowest shoot number (1.31, 1.43 and 1.77 respectively), in 10cm length cuttings. When compared to the other treatments, the IBA 6000 ppm-treated cuttings produced more shoots per cutting (2.60, 2.78 and 3.11 at 30, 60 and 90 days after planting) than untreated cuttings (1.19, 1.29 and 1.56 respectively). This study revealed significant interaction between IBA concentrations and cuttings length. IBA 6000 ppm with 25 cm cutting at 30, 60 and 90 DAP provide the greatest number of shoots per individual (*viz.,* 3.20, 3.58, 3.70) and lowest number of shoots (*viz.,* 0.83, 0.90, 1.15 respectively), was observed in 10cm cuttings with control. The rate of increase in number of shoots may be the impact of increased nutrient uptake by a stronger root system which in turn affected the vascular cambium's cell division, cell expansion, and control of differentiation into different types of cambial, leading to an increase in the number of shoots (Devi *et al.,* 2016).

7. Average number of roots : As per the Table 5, maximum number of roots at 30, 60, and 90 DAP was recorded in 25cm cuttings (9.77, 11.73 and 12.51 respectively) and minimum number of roots was recorded in 10cm cuttings (8.32, 8.78 and 9.40 respectively). Among the various concentration IBA 6000ppm produce more number of roots at 30, 60, and 90 DAP (13.42, 15.76 and 16.28 respectively) than controlled treatments (6.36, 7.11 and 7.64 respectively). There were notable differences between various treatment combinations as well 25cm cuttings treated with IBA 6000ppm produce higher number of roots (14.00, 19.25 and 20.17) and 10cm cuttings with control produce lesser number of roots (5.52, 5.99 and 6.67) at 30, 60, and 90 DAP respectively. Similar results also found in pomegranate Bhosale *et al.* (2010). They concluded that, a certain amount of root growth may have been hastened by the higher auxin content, which also causes rapid water uptake and improved cell wall flexibility. The highest number of roots were found in longest cuttings. This may be because longer cuttings have more reserved material, which is essential for the growth and development of roots, compared to shorter cuttings (Sangeet *et al.,* 2021).

Table 1: Effect of cuttings length and different auxin concentration on the growth parameters in Dragon fruit

G	Number of days taken for sprout initiation (days)	Mean	Number of days taken for root initiation (days)	Mean	Survival percentage (%)	Mean

	C_1	C_2	C_3	C_4		C_1	C_2	C_3	C_4		C_1	C_2	C_3	C_4	
G_1	16.75	14.75	16.15	12.20	14.96	17.10	15.49	14.76	13.70	15.26	61.50	70.65	77.36	85.83	73.83
G_2	15.55	13.00	13.61	12.40	13.64	16.30	14.61	13.77	12.62	14.32	62.85	75.97	79.13	86.70	76.16
G_3	14.27	9.67	9.60	8.26	10.45	13.26	12.76	11.66	11.63	12.32	63.57	77.57	82.35	93.42	79.22
G_4	17.88	15.65	15.65	14.96	16.03	20.65	19.15	17.75	16.50	18.51	56.53	67.74	74.75	83.82	70.71
G_5	16.82	15.15	15.65	13.90	15.38	19.56	18.43	16.52	15.60	17.53	57.21	68.67	75.31	84.68	71.47
G_6	16.71	15.04	15.00	14.35	15.27	18.60	18.16	15.87	14.37	16.75	60.71	69.85	78.52	85.47	73.63
G_7	18.95	16.95	16.71	14.89	16.87	22.15	21.59	19.74	18.14	20.40	43.45	56.67	67.35	77.83	61.32
Mean	16.70	14.31	14.62	12.99		18.23	17.17	15.72	14.65	16.44	57.97	69.59	76.39	85.39	72.33
Factor	**C**	**G**	**C X G**			**C**	**G**	**C X G**			**C**	**G**	**C X G**		
SE.d	0.32	0.43	0.87			0.17	0.35	0.46			1.10	1.46	2.93		
CD at 5%	0.67**	0.89**	1.78**			0.35**	0.47**	0.95**			2.27**	3.00*	6.01**		

*Significant at 5% level, G- Growth regulators, G_1 – IBA 2000ppm, G_2 – IBA 4000ppm, G_3 – IBA 6000ppm, G_4 – NAA 50ppm, G_5 – NAA 100ppm, G_6 – NAA 200ppm, G_7– Control, C_1 –10cm length, C_2 – 15cm length, C_3 – 20cm length, C_4 – 25cm length.

Table 2: Effect of cuttings length and different auxin concentration on the shoot growth in Dragon fruit

G	**Shoot growth (cm)**														
	30 days after planting				**Mean**	**60 days after planting**				**Mean**	**90 days after planting**				**Mean**
	C_1	**C_2**	**C_3**	**C_4**		**C_1**	**C_2**	**C_3**	**C_4**		**C_1**	**C_2**	**C_3**	**C_4**	
G_1	2.34	3.76	4.85	9.56	5.12	15.61	27.84	32.35	36.00	27.95	27.69	41.92	48.59	66.86	46.26
G_2	2.66	4.57	5.18	12.33	6.18	16.29	31.21	36.21	37.82	30.38	40.47	42.53	52.55	68.43	50.99
G_3	4.61	12.48	13.87	20.96	12.98	16.57	36.42	37.18	42.19	33.09	47.71	53.84	61.83	75.52	59.72
G_4	1.32	2.18	3.00	6.80	3.32	9.57	19.41	22.72	25.36	19.26	49.18	44.65	38.13	48.08	45.01
G_5	1.98	2.80	3.86	7.73	4.09	10.43	23.33	29.65	27.76	22.79	39.51	35.96	49.70	52.82	44.50
G_6	2.22	3.68	4.53	9.09	4.88	15.26	26.43	31.82	30.17	25.92	43.97	29.69	53.00	61.53	47.05
G_7	1.23	1.66	3.68	4.67	2.80	10.51	15.86	22.52	25.57	18.61	23.49	28.26	47.11	52.13	37.75
Mean	2.33	4.44	5.56	10.16		13.03	13.46	25.78	30.35	32.12	38.86	39.55	50.13	60.77	47.33
Factor	**C**	**G**	**C X G**			**C**	**G**	**C X G**			**C**	**G**	**C X G**		
SE.d	0.13	0.18	0.36			1.79	2.37	4.74			1.24	1.64	3.29		
CD at 5%	0.28**	0.37**	0.75**			3.67**	4.85**	9.71**			2.55**	3.37**	6.75**		

*Significant at 5% level, G- Growth regulators, G_1 – IBA 2000ppm, G_2 – IBA 4000ppm, G_3 – IBA 6000ppm, G_4 – NAA 50ppm, G_5 – NAA 100ppm, G_6 – NAA 200ppm, G_7– Control, C_1 –10cm length, C_2 – 15cm length, C_3 – 20cm length, C_4 – 25cm length.

Table 3: Effect of cuttings length and different auxin concentration on the average number of shoots in Dragon fruit

G	**Average number of shoots per cutting**

	30 days after planting				Mean	60 days after planting				Mean	90 days after planting				Mean
	C_1	C_2	C_3	C_4		C_1	C_2	C_3	C_4		C_1	C_2	C_3	C_4	
G_1	1.38	1.85	2.31	2.39	1.98	1.46	1.87	2.33	2.71	2.09	1.81	2.5	3.2	3.28	2.69
G_2	1.70	2.20	2.75	3.00	2.41	1.74	2.26	2.81	3.15	2.48	2.22	2.28	3.26	3.32	2.80
G_3	2.00	2.30	2.90	3.20	2.60	2.08	2.34	3.14	3.58	2.78	2.55	2.7	3.5	3.7	3.11
G_4	0.70	1.30	1.50	1.60	1.27	1.08	1.41	1.63	1.75	1.47	1.35	1.5	1.7	2.05	1.65
G_5	1.30	1.40	1.90	2.05	1.66	1.37	1.48	2.03	2.37	1.80	1.58	2.1	2.35	2.7	2.18
G_6	1.32	1.80	2.28	2.32	1.93	1.40	1.85	2.29	2.61	2.03	1.75	2.37	2.7	2.85	2.41
G_7	0.83	0.90	1.50	1.56	1.19	0.90	1.01	1.61	1.64	1.29	1.15	1.3	1.7	2.1	1.56
Mean	1.31	1.67	2.16	2.30		1.43	1.74	2.26	2.54	1.99	38.86	39.55	50.13	60.77	2.34
Factor	C	G	C X G			C	G	C X G			C	G	C X G		
SE.d	0.14	0.19	0.38			0.05	0.07	0.14			0.08	0.11	0.23		
CD at 5%	0.30**	0.39**	0.79**			0.10**	0.14**	0.28**			1.77**	2.10**	0.47**		

*Significant at 5% level, G- Growth regulators, G_1 – IBA 2000ppm, G_2 – IBA 4000ppm, G_3 – IBA 6000ppm, G_4 – NAA 50ppm, G_5 – NAA 100ppm, G_6 – NAA 200ppm, G_7– Control, C_1 –10cm length, C_2 – 15cm length, C_3 – 20cm length, C_4 – 25cm length.

Table 4 : Effect of cuttings length and different auxin concentration on the root growth in Dragon fruit

G	Root growth (cm)														
	30 days after planting				Mean	60 days after planting				Mean	90 days after planting				Mean
	C_1	C_2	C_3	C_4		C_1	C_2	C_3	C_4		C_1	C_2	C_3	C_4	
G_1	3.91	4.09	5.44	7.37	5.20	5.63	5.93	6.50	7.30	6.34	5.75	6.29	8.17	8.35	7.13
G_2	4.14	4.80	6.34	7.67	5.73	7.71	7.98	8.08	8.14	7.98	8.02	8.19	8.76	9.18	8.53
G_3	6.58	8.61	7.57	16.48	9.81	10.79	10.90	11.42	16.63	12.43	11.66	12.51	13.54	17.64	13.83
G_4	3.06	3.86	4.30	5.53	4.18	6.58	7.02	7.21	7.71	7.13	5.37	5.87	6.29	7.72	6.31
G_5	3.67	3.99	4.77	6.34	4.69	5.36	5.40	5.46	6.99	5.80	5.48	6.11	7.82	8.15	6.88
G_6	4.00	4.27	5.20	7.00	5.11	5.46	5.82	6.29	7.27	6.21	5.66	6.15	7.93	8.26	6.99
G_7	2.37	3.13	3.97	5.38	3.71	3.93	4.23	4.78	6.00	4.73	4.57	4.70	5.21	6.47	5.23
Mean	3.96	4.67	5.37	7.96		6.49	6.75	7.10	8.57		6.64	7.11	8.24	9.39	7.84
Factor	**C**	**G**	**C X G**			**C**	**G**	**C X G**			**C**	G	**C X G**		
SE.d	**0.10**	**0.13**	**0.26**			**0.30**	0.41	0.82			0.12	0.16	0.32		
CD at 5%	**0.21****	**0.27****	**0.55****			0.63**	0.83**	1.67**			0.24**	0.32**	0.65**		

*Significant at 5% level, G- Growth regulators, G_1 – IBA 2000ppm, G_2 – IBA 4000ppm, G_3 – IBA 6000ppm, G_4 – NAA 50ppm, G_5 – NAA 100ppm, G_6 – NAA 200ppm, G_7– Control, C_1 –10cm length, C_2 – 15cm length, C_3 – 20cm length, C_4 – 25cm length.

Table 5 : Effect of cuttings length and different auxin concentration on the average number of roots in Dragon fruit

G	Average number of shoots per cutting														
	30 days after planting				Mean	60 days after planting				Mean	90 days after planting				Mean
	C_1	C_2	C_3	C_4		C_1	C_2	C_3	C_4		C_1	C_2	C_3	C_4	
G_1	8.43	8.72	8.94	9.60	8.92	8.73	9.18	10.27	10.66	9.70	9.33	9.69	10.74	11.14	10.22
G_2	9.62	9.95	10.51	11.99	10.51	9.80	10.19	11.37	13.06	11.10	10.46	10.65	11.80	13.89	11.69
G_3	12.56	13.25	13.90	14.00	13.42	13.16	13.77	16.87	19.25	15.76	13.90	14.56	16.50	20.17	16.28
G_4	6.71	6.98	7.38	7.79	7.21	7.32	7.91	8.94	9.51	8.41	7.94	8.11	9.40	10.49	8.98
G_5	7.48	7.91	8.03	8.36	7.94	7.88	8.46	9.39	10.46	9.04	8.46	8.81	9.71	11.33	9.57
G_6	8.00	8.59	8.70	9.28	8.64	8.60	9.26	9.96	11.09	9.72	9.10	9.65	10.47	11.86	10.26
G_7	5.52	6.03	6.51	7.42	6.36	5.99	6.49	7.85	8.14	7.11	6.67	7.08	8.12	8.70	7.64
Mean	8.32	8.77	9.13	9.77	9.00	8.78	9.32	10.66	11.73	10.12	9.40	9.79	10.96	12.51	10.66
Factor	C	G	C X G			C	G	C X G			C	G	C X G		
SE.d	0.07	0.10	0.20			0.16	0.21	0.42			0.10	0.14	0.29		
CD at 5%	0.15**	0.21**	0.42**			0.32**	0.43**	0.87**			0.22**	0.29**	0.59**		

*Significant at 5% level, G- Growth regulators, G_1 – IBA 2000ppm, G_2 – IBA 4000ppm, G_3 – IBA 6000ppm, G_4 – NAA 50ppm, G_5 – NAA 100ppm, G_6 – NAA 200ppm, G_7– Control, C_1 –10cm length, C_2 – 15cm length, C_3 – 20cm length, C_4 – 25cm length.

Conclusion:

The results of the study showed that plant growth regulators, Cuttings length and their interaction significantly impacted the growth parameters of dragon fruit cutting.Based on the overall performance of varied length of shoot cuttings with different growth regulators resulted in 25cm length cuttings treated with IBA 6000ppm as economical. In comparison to smaller cuttings, the larger ones produced earlier sprout initiation and root initiation, higher shoot and root growth, maximum survival percentage. Therefore, the 25cm cuttings length might be suggested for better multiplication because it has proven to promote better growth and development of shoots and roots.

Reference :

Anderson, E. F. (2001). Selenicereus.

Ayesha, S., &Thippesha, D. (2018). Influence of plant growth regulators on rooting of stem cuttings in dragon fruit (Hylocereusundatus). International Journal of Chemical Studies, 6, 1834–1839.

Balaguera-Lopez, H. E., Morales, E. I., Almanza-Merchán, P. J., &Balaguera L, W. A. (2010). Effect of different cladode size and auxin levels in asexual propagation of pitaya (Selenicereusmegalanthus Haw.). Revista Colombiana de CienciasHorticolas, 4(1), 33-42.

Barcenas, R.T., Yesson, C., & Hawkins, J.A. (2011). Molecular systematics of the Cactaceae. Cladistics, 27, 470–489.

Bhosale, V. P., Jadav, R. G., & Masu, M. M. (2010). Response of different media and PGR's on rooting and survival of air layers in pomegranate (*Punica granatum* L.)Cv. Sindhuri. Asian Journal of Horticulture. 4(2), 194-197.

Chauhan, K. S., & Reddy, T. S. (1974). Effect of growth regulators and mist on rooting in stem cuttings of plum (Prunus domestica L.). Indian Journal of Horticulture, 31(3), 229-231.

Hunt, D.R., 2006. The New Cactus Lexicon. Milborne Port.

Iqbal, M., Subhan, F., Ghafoor, A., & Jilani, M.S. (1999). Effect of different concentrations of IBA on root initiation and plant survival of apple cuttings. Pak Journal of Biological Science, 2(4), 1314-1316.

Lalit, D., Suchitra, V., Vani, V. S., Subbaramamma, P., & Saravanan, L. (2018). Rooting and shooting behaviour of red and white pulped varieties of dragon fruit (Hylocereusundatus) in relation to indole butyric acid concentrations. International Journal of Agricultural Sciences, 14(1), 229-234.

Loach, K. (1987). Hormone applications and adventitious root formation in cuttings - a critical review. Acta Horticulturae, 126–133. doi: 10.17660/actahortic.1988.227.19.

Maji, S. (2019). Dragon fruit: The super fruit. BP International Pub., 1-40.

Nanda, K. K. (1975). Physiology of adventitious root formation. Indian Journal of Plant Physiology, 18, 80-89.

Nerd, A., & Neumann, P. M. (2004). Phloem water transport maintains stem growth in a drought-stressed crop cactus (*Hylocereusundatus*). Journal of the American Society for Horticultural Science, 129(4), 486-490.

Rakibuzzaman, M., Shimasaki, K., & Uddin, A. J. (2018). Influence of Cutting Position and Rooting Hormones on Rooting of Stevia (*Stevia rebaudiana*) Stem Cutting. International Journal of Business, Social and Scientific Research, 6(4), 122-121.

Reddy, K., Reddy, C.P., & Goud, P. (2008). Effect of Auxins on the rooting of Fig (*Ficus carica*L.) hardwood and semi hardwood cuttings. Indian Journal of Agricultural Research, 42(1), 75-78.

Sangeet, C., Hasan, M. A., & Tamang, A. (2021). Influence of Varying Length of Stem Cutting and IBA Concentrations on Root and Shoot Growth in Dragon Fruit cv. Giant White (*Hylocereusundatus*). Environment and Ecology, 39 (4A), 1114-1118,

Siddiqui, M. I., & Hussain, S. A. (2007). Effect of indole butyric acid and types of cuttings on root initiation of Ficus hawaii. Sarhad Journal of Agriculture, 23(4), 919.

Seran, T. M., &Thiresh, A. (2015). Root and shoot growth of dragon fruit (Hylocereusundatus) stem cutting as influenced by indole butyric acid. Agricultural and Biological Sciences Journal, 1, 27-30.

Tripathi, P. C., Karunakaran, G., Sankar, V., & Kumar, R. S. (2014). Dragon Fruit: Nutritive and ruminative fruit. Technical Bulletin, 11(2014), 10.

Ullah, T., Wazir, F. U., Ahmad, M., Analoui, F., & Khan, M. U. (2005). A break through in guava (Psidium guajava L.) propagation from cutting. Asian Journal of Plant Sciences.

Wybraniec, S., Nowak-Wydra, B., Mitka, K., Kowalski, P., & Mizrahi, Y. (2007). Minor betalains in fruits of Hylocereus species. Phytochemistry, 68(2), 251-259.

Zee, F., Yen, C. R., & Nishina, M. (2004). Pitaya (dragon fruit, strawberry pear).