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EFFECT OF PLANT GROWTH REGULATORS ON ROOT DEVELOPMENT OF DRAGON FRUIT CUTTINGS (*HYLOCEREUS COSTARICENSIS* BRITTON & ROSE)

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ABSTRACT

Dragon fruit (*Hylocereus costaricensis* L.) is an emerging commercial fruit crop propagated mainly through vegetative means to maintain varietal uniformity and early establishment. However, successful rooting of stem cuttings depends largely on the application of suitable plant growth regulators. The present experiment was conducted during 2022–23 under polyhouse conditions at the Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, to evaluate the effect of auxins on root development of dragon fruit cuttings. Uniform stem cuttings (10–15 cm length with 4–5 nodes) obtained from one-year-old mother plants were treated with different concentrations of Indole Butyric Acid (IBA), Naphthalene Acetic Acid (NAA) and their combinations. The experiment was laid out in a Completely Randomized Design with nine treatments including control, IBA (1500 and 3000 ppm), NAA (150 and 300 ppm) and their combinations. Observations were recorded at 30, 60 and 90 days after planting for rooting parameters such as longest root length, number of roots, root diameter, fresh weight and dry weight of roots. The results revealed significant improvement in rooting characteristics due to application of plant growth regulators. Among all treatments, IBA at 3000 ppm produced the best performance, followed closely by the combination of IBA 3000 ppm + NAA 300 ppm. Maximum root length (22.35 cm), number of roots (41.85), root diameter (1.497 mm), fresh root weight (2.10 g) and dry root weight (0.65 g) were recorded under IBA 3000 ppm treatment at 90 days after planting, whereas minimum values were observed in untreated control cuttings. The improved rooting response may be attributed to enhanced cell division, activation of meristematic tissues and efficient mobilization of stored carbohydrates into physiologically active sugars that promoted adventitious root formation. Higher auxin concentration also increased cambial activity, water uptake and elasticity of cell walls, leading to rapid root initiation and elongation.

***Key words*:** Dragon fruit, Stem cuttings, Auxins, Indole Butyric Acid, Rooting response, Vegetative propagation

Introduction

Kamlam, or dragon fruit, is a perennial fruit. Dragon fruit (*Hylocereus costaricensis* L.) is a Cactaceae plant with 22 chromosomes (2n=2x = 22). This plant grows as a perennial climbing cactus and produces fruit. This fruit is also known as Strawberry Night Blooming, Pear and Pitaya. Most cacti and succulents can be grown through seed and vegetative sources, including dragon fruit. Freshly removed seeds can yield seedlings, although they require longer maturing for planting. Plants grown from seeds may not be true to type and may have significant variation among the offspring. Thus, the vegetative method is best for dragons. Dragon fruit can be easily propagated by cutting the stem as soon as it touches the

ground (Fouque, 1969). Prolonged cutting leads to rapid regeneration of new shoots, perhaps due to food storage (Pushpakumara *et al*., 2006). Applying growth promoting hormone to cuttings before planting promotes rapid root development. Growth hormones help cacti and succulent plants, such as Pitaya, root cuttings by regulating cell growth and development. Root development speed in cuttings is influenced by cutting type, rooting medium and hormone type and concentration. Auxins are known to promote cutting roots (Hartman *et al*., 2002). Research confirms that auxin is necessary for adventitious root initiation on stems, with the first root cell division relying on either administered or endogenous auxins (Gaspar *et al*., 1988; Strom quits and Hansen, 1980). Auxins like Indole Butyric Acid (IBA) and Naphthalene Acetic Acid (NAA) are commonly used to root cacti and succulent plant cuttings. IBA, a naturally occurring auxin, is the most commonly utilised for commercial rooting (Nickel, 1990). IBA is the most commonly utilised auxin for rooting stem cuttings and tissue culture-produced micro cuttings (Zimmerman and Wilcoxon, 1935). IBA is naturally occurring. Auxins in the cutting and a synergistic substance like di phenol are necessary for the production of root primordium cells. According to Hartmann *et al*. (2002), these chemicals cause the creation of Ribose Nucleic Acid (RNA), which initiates root primordium. The indole molecule typically creates a more fibrous root structure.

Materials and Method

The present investigation was carried out on the "Effect of plant growth regulators on root and shoot development of dragon fruit cuttings [*Hylocereuscostaricensis* L. Britton & Rose]" during the year 2022-23 in poly-house at the Department of Horticulture, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae Bareli Road, Lucknow, (U.P.) India. The climatic situation of experimental region is subtropical with maximum temperature ranging from 22-450C in summer, minimum temperature ranging from 1.5-15^{0}C in winter and relative humidity ranging from 60-80% in different season of the year with annual rainfall of 110 cm. Dragon fruit cuttings of white fleshed variety were procured from old experiment field of Botanical Garden of BBAU. Uniform cuttings were collected from one-year old shoots with 4-5 nodes each. Length of the cuttings used for planting was ranging from 10-15 cm. The new shoots were removed from the cuttings and trimmed to a required length by removing the small portions from both the ends of cutting just above and below the nodes. A slant cut was given at basal end of the cuttings to expose maximum absorbing surface for effective rooting. Cuttings were shade dried for one day prior to planting to dry the ooze coming from the fresh cuttings. The experiment was conducted during October-November month of the light winter season. The basal portion of selected cuttings was treated with Indole butyric acid (IBA), Naphthalene acetic acid (NAA) and their combinations as per the treatments.

Design and layout of experiment

The experiment was laid out in a Completely Randomized Design. There were 9 treatments consisting of growth regulators singly or in combination. A total of 81 stem cuttings were taken in each treatment and replicated thrice.

Results and Discussion

Length of the longest root (cm)

Data on Dragon fruit cuttings' greatest root length at 30, 60 and 90 days post-planting (cm) differs according on growth regulator concentration and combination. Experiment reveals that plant growth regulators substantially affected the length of longest root at 30, 60 and 90 days after transplanting throughout the one-year study (2022-23). At 30 days, the largest root length reached 4.217 cm in 2022-23 under treatment T2 (IBA @3000 ppm). Next, T8 (IBA @3000 ppm+ NAA @300 ppm) was observed at 4.200 cm. In 2022-23, the minimum root length under treatment T0 (control) was 2.85 cm. At 60 DAT, the largest root length reached 8.990cm in 2022-23 under treatment T2 (IBA @3000 ppm). Next, T8 (IBA @3000 PPM+ NAA @300 PPM) was seen at 8.900 cm. In 2022-23, the minimum root length under treatment T0 (control) was 6.100 cm. At 90 DAT, the largest root length reached 22.350 cm in 2022-23 under treatment T2 (IBA @3000 PPM). Next, T8 (IBA @3000 ppm+ NAA @300 ppm) was observed (22.030 cm). In 2022-23, the minimum root length under treatment T0 (control) was 11.200 cm. This could be due to the rapid hydrolysis of starch stored in the cuttings into physiologically active sugars which provide energy to the root primordia via respiratory activity and aid in the rapid elongation of the meristematic cells, thereby initiating the longest roots per cutting. Similar results were reported by Srivastava *et al*., (2005) in Kiwifruit, Singh *et al*., (2013) in Lemon, Porghorban *et al*., (2014) in Olive, Seran and Thiresh (2015) and Rahad *et al*., (2016) in Dragon fruit.

Average number of roots per rooted cuttings (cm)

Experiment show substantial differences in average root count per Dragon fruit cutting based on growth regulator concentration and combination at 30, 60 and 90

Table 1: The details of treatments are depicted below.

S. No.	Symbol of Treatments	Treatment combinations
1	T_0	Control
2	T_1	IBA@1500ppm
3	T_2	IBA@3000ppm
4	T_3	NAA@150ppm
5	T_4	NAA@300ppm
6	T_5	IBA@1500+NAA@150ppm
7	T_6	IBA@1500+NAA@300ppm
8	T_7	IBA@3000+NAA@150ppm
9	T_8	IBA@3000+NAA@300ppm

Table 2: Details of experiment.

Age of mother plant for cutting	1 year
Number of treatments	9
Number of replications	3
Experimental Design	Completely Randomized Design
No. of cutting/replication/ treatment	03
Total number of cuttings	81
Composition of growing media	Sand: Soil: FYM (2:1:1)
Date of treatment	25 0ctober
Name of crop	Dragon fruit
Type	Pink fruit and flesh

days post-planting. Different plant growth regulators significantly influenced root count at 30, 60 and 90 days post-transplanting. The T_2 treatment (IBA @3000 PPM) resulted in the highest average number of roots per cutting (10.660) during 2022-2023. Next, T8 (IBA @3000 PPM+ NAA @300 PPM) revealed (9.940). In 2022-23, the minimum root length under treatment T0 (control) was 3.250. The T2 treatment (IBA @3000 PPM) resulted in the highest average number of roots per cuttings (13.380) during 2022-2023. Next, T8 (IBA @3000 PPM+ NAA @300 PPM) was observed (14.297). In 2022-23, the minimum root length under treatment T0 (control) was (6.097). The T2 treatment (IBA @300 0ppm) resulted in the highest average number of roots per cutting (41.850) during 2022-2023. Next, T8 (IBA @3000 PPM+ NAA @300 ppm) exhibited (40.957). In 2022-23, the minimum root length under treatment T0 (control) was 17.870. The induction of maximum number of roots in the treated cuttings may be due to cambial activity involved in root initiation was stimulated by growth regulators as seen in many species (Ullah *et al*., 2005). This might be due to the presence of the reserved food materials present in the cuttings. Initial internal sugar concentration and their metabolism are important during the early period of rooting process (Denaxa *et al*., 2001). There was increase in the number of roots per cuttings as there was increase in concentration of IBA from 1500 to 3000 ppm. Accelerated rooting in the cuttings with the increased IBA concentration might be due to increased water uptake and cell wall elasticity which further may have accelerated cell division and in turn increased number of roots to a certain level. These results are corroborated by the findings of Bhosale *et al*., (2010) in Pomegranate.

Fig. 1: Dragon fruits cuttings in various treatments.

Root diameter in stem cuttings (mm)

Results show significant differences in root diameter in dragon fruit stem cuttings from different concentrations and combinations of growth regulators at 30, 60 and 90 days after planting. The study (2022-23) revealed significant differences in longest root length at 30, 60 and 90 days post-transplantation based on plant growth regulators. Maximum root diameter (0.470 mm) in stem cuttings during 2022-23 with T2 treatment (IBA @3000 ppm) was observed. In 2022-23, the minimum root length under treatment T0 (control) was around 0.100 mm. A maximum root diameter of 0.880 mm was observed in

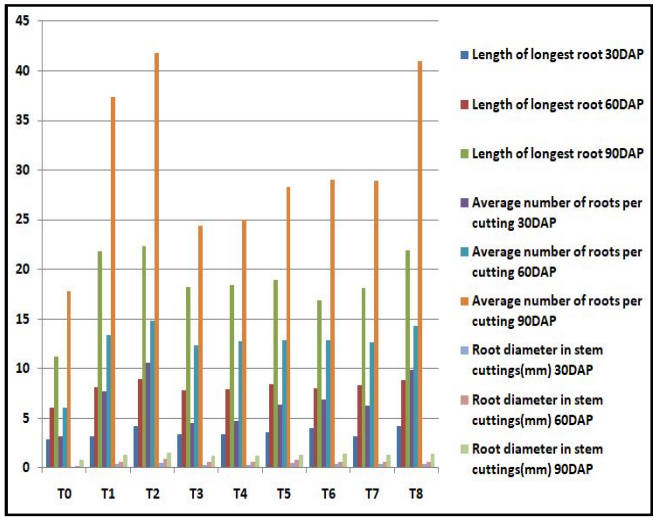

Fig. 2: Graphs representing longest root, average number of roots and diameter of stem in cuttings.

Table 3: Effect of plant growth regulators on root development of dragon fruit cuttings.

Treatment	Length of longest root			Average number of roots percutting			Root diameter in stem cuttings (mm)			Fresh weight of the root in stem cuttings(g)			Dry weight of the root in stemcuttings			NDTS
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	
T_0	2.850	6.100	11.200	3.250	6.097	17.870	0.100	0.210	0.823	0.100	0.880	1.250	0.030	0.200	0.360	17.333
T_1	3.190	8.190	21.920	7.747	13.380	37.500	0.440	0.607	1.383	0.300	1.747	2.100	0.150	0.390	0.590	9.880
T_2	4.217	8.990	22.350	10.660	14.870	41.850	0.470	0.880	1.497	0.410	1.860	2.230	0.190	0.450	0.650	8.103
T_3	3.400	7.860	18.297	4.500	12.400	24.450	0.250	0.590	1.220	0.170	1.550	1.560	0.080	0.290	0.400	12.550
T_4	3.457	7.987	18.497	4.750	12.800	25.100	0.293	0.610	1.240	0.200	1.760	1.947	0.070	0.310	0.423	13.740
T_5	3.657	8.450	18.990	6.450	12.900	28.410	0.450	0.790	1.350	0.180	1.550	1.850	0.090	0.333	0.430	12.310
T_6	3.990	8.050	16.960	6.903	12.890	29.080	0.353	0.627	1.450	0.210	1.587	1.873	0.060	0.230	0.380	12.630
T_7	3.230	8.403	18.137	6.250	12.683	29.010	0.380	0.603	1.350	0.280	1.790	1.950	0.110	0.350	0.410	10.450
T_8	4.200	8.900	22.030	9.940	14.297	40.957	0.360	0.657	1.480	0.347	1.810	2.180	0.170	0.410	0.630	8.900
S.Em. (±)	0.034	0.098	0.244	0.095	0.156	0.241	0.005	0.005	0.014	0.006	0.019	0.029	0.000	0.005	0.006	0.134
C.D @5%	0.102	0.298	0.739	0.287	0.471	0.729	0.016	0.016	0.041	0.017	0.057	0.087	0.000	0.015	0.017	0.404

NDTS: Number of days taken for sprouting

stem cuttings treated with T2 (IBA @3000 ppm) in 2022-23. Next, T5 (IBA @1500 ppm + NAA @150 PPM) shown in (0.790 mm). In the 2022-23 season, the minimum root length under treatment T0 (control) was 0.210 mm. The 2022-23 treatment T2 (IBA @3000 ppm) resulted in the largest root diameter (1.497 mm) in stem cuttings. Next was T8 (IBA @3000 ppm + NAA @300 ppm) at 1.480 mm. The minimal root length in the T0 treatment (control) was 0.823 mm in 2022-23. The present findings can be confirmed by Singh and Singh (2005) in Poinsettia, they also reported that IBA has significant effect on root diameter compared to all other growth regulators like Indole acetic acid and Naphthalene acetic acid.

Fresh weight of the root in stem cuttings (g)

Results show significant differences in fresh root weight (g) of Dragon fruit stem cuttings in response to different concentrations and combinations of growth regulators at 30, 60 and 90 days post-planting. Maximum fresh root weight in stem cuttings (0.410 g) in 2022-23 under treatment T2 (IBA @3000 PPM) was recorded. Next, T8 (IBA @3000 PPM+ NAA @300 PPM) was seen at 0.347g. In 2022-23, the minimal fresh root weight in stem cuttings was 0.900 g under treatment T0 (control). In 2022-23, the greatest fresh root weight in stem cuttings was 1.860 g under treatment T2 (IBA @3000 PPM). Next, T8 (IBA @3000 PPM+ NAA @300 PPM) was seen at 1.810 g. The root fresh weight in stem cuttings was 0.880 g under treatment T0 (control) in 2022-23. Maximum fresh root weight in stem cuttings (2.100 g) in 2022-23 under treatment T2 (IBA @3000 PPM) was reported. Next, T8 (IBA @3000 ppm+ NAA @300 ppm) was observed (2.180 g). In 2022-23, the minimal fresh root weight in stem cuttings was 1.250 g under treatment T0 (control). It could be attributed to the rapid hydrolysis of polysaccharides stored in the cuttings into physiologically active sugars by activation of hydrolytic enzymes. These sugars provide energy for the meristematic tissue through respiratory activity leads to initiate a greater number of adventitious roots as well as longest roots per cutting which helps in early establishment of cuttings and an increase in root fresh weight per cutting. The present findings are also in conformity with the results of Singh *et al.*, (2013) in Lemon, Porghorban *et al.*, (2014) in Olive, Seran and Thiresh (2015) and Rahad *et al.*, (2016) in Dragon fruit.

Dry weight of the root in stem cuttings

Result show significant differences in dry root weight in Dragon fruit stem cuttings depending on growth regulator concentration and combination at 30, 60 and 90 days post-planting. Maximum root dry weight (0.190) in stem cuttings during 2022-23 under treatment T2 (IBA @3000 ppm) was seen. Next, T8 (IBA @3000 ppm+ NAA @300 ppm) revealed (0.170). The root dry weight in stem cuttings under treatment T0 (control) was 0.030 in 2022-23. Maximum root dry weight (0.450) in stem cuttings during 2022-23 under treatment T2 (IBA @3000 ppm) was recorded. Next, T8 (IBA @3000 ppm+ NAA @300 ppm) was seen in (0.410). The root dry weight in stem cuttings under treatment T0 (control) was 0.200 in 2022-23. Maximum root dry weight (0.650) in stem cuttings during 2022-23 under treatment T2 (IBA @3000 ppm) was reported. Next, T8 (IBA @3000 ppm+ NAA @300 ppm) revealed (0.630). The root dry weight in stem cuttings under treatment T0 (control) was 0.360 in 2022-23. Significant differences were seen between the treated and untreated stem cuttings of Dragon fruit. The Auxins

increased root length and fresh weight of roots, resulting in increased dry weight of roots. This might be due to the fact that Auxin stimulates the initiation of lateral and adventitious roots because of their effect on cell division. Therefore, it is expected that the exogenous application of auxin like plant growth regulators such as IBA induce root formation in the cuttings (Ercisli *et al*., 2002). Similar findings have been observed by Rymbai and Reddy (2010) in Guava, Bhosale *et al*., (2010) in Pomegranate and Murthy *et al*., (2010) in Vanilla.

Conclusion

On the basis of present study, it is concluded that the applications of different plant growth regulators have great potential to induce rooting in stem cuttings of Dragon fruit. Among all the treatment, IBA@3000+NAA@300 ppm gave better results with respect to rooting parameters followed by the treatment IBA@3000+NAA@300 ppm. The longest length of roots per cutting was recorded significantly in cuttings treated with IBA 3000 ppm and (IBA @3000PPM+ NAA @300PPM), respectively. The maximum average number of roots per cutting was recorded significantly in cuttings treated with IBA 3000 ppm and (IBA @3000 PPM+ NAA @300 PPM) respectively. The maximum diameter of root per cutting was recorded significantly in cuttings treated with IBA 3000 ppm and (IBA @3000 PPM+ NAA @300 PPM) respectively. The maximum fresh weight of root per cutting was recorded significantly in cuttings treated with IBA 3000 ppm and (IBA @3000 PPM+ NAA @300 PPM), respectively. The maximum dry weight of root per cutting was recorded significantly in cuttings treated with IBA 3000 ppm and (IBA @3000 PPM+ NAA @300 PPM), respectively. Based on the findings of current investigation, it is recommended that vegetative method of propagation through stem cuttings in Dragon fruit is reliable for commercial production of planting materials, as it is quick and economical method of vegetative propagation.

References

Alexander, T.R. (1938). Carbohydrate of bean plant after treatment with indole acetic acid. *Plant Physiol*., **13**, 845-885.

Andrade, R.A., de, Oliveira I.V. de M. and Martins A.B.G. (2005). Influenceof Condition and storage period in germination of red pitaya seeds. *Revista- Brasileria-de Fruticuitura*, **27(3)**, 1130-1131.

Ayesha, D. and Thippesha D., (2018). Infiuence of plant growth regulators on rooting of stem cuttings in dragon fruit [*Hylocereus costaricensis* Britton & Rose]. *Int. J. Chem. Studies*. **6(5)**, 1834-1839.

Ahmad, H., Mirana A.S., Mahbuba S., Syed M. Tareq and Jamal Uddin A.F.M. (2016). Performance of IBA concentration for rooting of drgon fruit stem cutting. *Int. J. Bus. Soc. Sic. Res*. **4(4)**, 231-234.

Bausor, S.C. (1942). Effect of growth substances on reserve Starch. *Bot. Gaz.*, **102**, 366-372.

Britton, N.L. and Rose J.N. (1963). The cactaceae: *Description and Illustration of plants of the cactus Family, Dover, New York, USA*. **1(2)**, 183-195

Dahanayake, N. and Ranawake A.L. (2011). Regeneration of dragon fruit (*Hylocereus undatus*) plantlets from leaf and stem explants. *Trop. Agric. Res. Exl.*, **14**, 85 -89.

Dhurve, L., Suchitra V., Vani Sudha V., Subbaramamma P. and Saravanan (2014). Water and salt stress in germination seeds of Pitaya genotypes (*Hylocereus* spp.).

Fouque, A. Especesfruitieres d' (1969). Ameriquetropicale, famille des Cactaceae, IFAC, Paris, France. 25-34.

Fournet, J. (2002). Flore illustree des phanerogames de Guadeloupe et de Martinique, Tome I. Famille des Cactaceae, Inra- Cirad-Gondwana, Paris, France.

Gasper, T. and Hofinger M. (1988). Auxin metabolism during adventitious rooting. In: Davis, T.D.; Haissig, B.E. and Sankhla, N. (Eds.). Adventitious root formation in cuttings. Portland: Dioscoride Press. 61-69.

Grimaldo, J.O., Terrazas T., Garcia V.A. and Cruz M. (2007). Morhometric Analysis of 21 pitahayas (*Hylocereus undatus*) genotypes. *Journal. PACD*. **9**, 99-177.

Ha, D. and Tran Yen C.R. (2014). Morphological characteristics and pollination requirement in Red Pitaya (*Hylocereus* spp.). *Int. J. Agr. Biosyst. Engg*. **8(3)**.

Hartmam and Kester's Plant Propagation: Principles and Practices 7th Ed.

Hartmann, H.T. and Kester D.E., Davies F.T. and Geneve R.L. (2002).

Jafar, RA, Rahman, A.R.B.A, Mahmood, N.Z.C, and Vasudevan, R. (2009). Proximate analysis of dragon fruit (*Hylocereus polyrhizus*). *Amer. J App. Sci*. **6(7)**, 1341-1346.

Kraus, E.J. and Krybill H.R. (1918). Vegetation and reproduction with specialreference to tomato. *Oregon Sta. Bull*., **149**, 1-190.

L. (2018). Rooting and shooting behavior of red and white pulped varieties of dragon fruit (*Hylocereus undatus*) in relation to indole butyric acid concentrations. *Internal. J. agric. Sci*., **14(1)**, 229-234.

Le Bellec, F., Vaillant F. and Imbert E. (2006). Pitahaya (*Hylocereus* spp.): anew fruit crop, a market with a future. *Fruits*, **61**, 237-250.

Mejia, H.A., Ruiz S.B.M., Montaya C.A. and Saqueda C.R. (2013). "In situ Morphological characterization of *Hylocereus* spp. (Fam.: Cactaceae) Genotypesfrom Antioquia and Cordoda (Colombia). *Rev. Fac. Nal. Agr. Medellin*. **66(1)**, 6845-6854.

Merten, S. (2003) A review of *Hylocereus* production in the

United States. *J PACD* **5**, 98-105.

Mitchell, J.W., Kraus E.J. and Whitehead M.R. (1940). Starch hydrolysis inbean leaves following spraying with NAA emulsion. *Bot, Gat*., **102**, 97-104.

Moghadam, A.R.L., Ardebili Z.O. and Rezaei L. (2012). Effect of indole of butyric acid on micro grafting of cactos. *African J. of Biot*., **11(24)**, 6484-6493.

Morton, J. (1987). Cactaceae: strawberry pear and related species. In: Fruits of Warm Climates, ED., Miami, and FI, 347-348.

Nickel, L.G. (1990). Plant growth regulators. Agricultural uses. Springer, New York. 4-5.

Ortis, T.A., Gomes G.R., Takahashi L.S.A., Urbano M.R. and Strapasson, Parween T., Mandal K.K. and Hasan M.A. (2018). "Dragon fruit: An exotic super future fruit of India", *J. Pharm. Phytochem*. **7(2)**, 1022-1026.

Pushpakumara, D.K.N.G., Gunasena H.P.M. and Kariayawasam M. (2006). Flowering and fruiting phenology, pollination agents and Breeding system in *Hylocereus* spp. (*dragon fruit*). *Proc Peradeniya Univ. Res. Sess. Sri Lanka*. **11**, 15.

Rahad, M.K. and Das A.K. (2014). Agriculture and Applied Statistics - . 2nd Edition. Kalyani Publishers, New Delhi, India.

Seran, T.H. and Thiresh A. (2015). Root and shoot growth of dragon fruit (*Hylocereus undatus*) stem cutting as influenced by IBA. *Agric. Biological Sci. J*., **1(2)**, 27-30.

Stromquist, L.H. and Hansen J. (1980). Effects of auxin of irradiance on the rooting of cuttings of Pinus sylvestris. *Physion. Plant*. **49**, 346-350.

Suryono, J. (2006). Consuming dragon fruit to treat various diseases. Indonesia, 15-21.

Tripathi, P.C., Karumakaran G., Sankar V. and Senthilkumar R. (2014). Dragon Fruit: Nutritive and Ruminative Fruit. Central Horticultural Experiment Station, Indian institute of horticultural research, Chettali-571 248.

Zee, F., Yen C.R. and Nishina M. (2005). Pitaya (Dragon fruit, strawberry pear). Fruit and nuts 9. Co-operative extension service, College of tropical agriculture and human resources, University of Hawaii at Manoa, Honolulu, Hawaii. 1-3.

Zimmerman, P.W. and Wilcoxon F. (1935). Several chemical growth substances which cause initiation of roots and other responses in plants Contrib. Boyce. Thompson.