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RESEARCH PAPER

Rooting and shooting behaviour of red and white pulped varieties of dragon fruit (*Hylocereus undatus*) in relation to indole butyric acid concentrations

Lalit Dhruve, V. Suchitra*, V. Sudha Vani, P. Subbaramamma **and** L. Saravanan
College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, WEST GODAVARI (A.P.) INDIA (Email : varakalasuchi3@gmail.com)

Abstract : The investigation was carried out to study the effect of IBA at different concentrations (2000ppm, 4000ppm, 6000ppm) on cuttings of dragon fruit cultivars *viz.*, red pulped variety and white pulped variety to elicit their rooting and shooting parameters. The cuttings of the red pulped variety performed better than the white pulped variety. Indole butyric acid (IBA) had significant effect on rooting and shooting performance of both the varieties over control. IBA @ 6000 ppm recorded minimum number of days for sprouting (43days), maximum rooting and shooting parameters like percentage of rooted cuttings (86.77%), number of roots (9.87), length of longest root (22.93cm), root fresh weight (1.83 g) and dry weight (0.58 g), length of the longest shoot (23.93cm), number of new shoots per cutting (4.00), shoot fresh weight (112.09 g), shoot dry weight (9.47 g) and survival percentage (90.26 %). The least performance was observed in the cuttings of white pulped variety for almost all parameters tested except for length of shoot.

Key Words : Dragon fruit, *Hylocereus undatus*, Indole butryric acid, Rooting, Shooting, Cuttings

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INTRODUCTION

Dragon fruit (*Hylocereus undatus*) is a perennial, climbing cactus, belonging to the family Cactaceae. It is native to tropical areas of North, Central and South America (Morton, 1987 and Mirzahi and Nerd, 1996).The stem is succulent vine, having many branched segments. Different types of dragon fruit of *Hylocereus* species have red to purple pigmented skin, while the pulp colour ranges from white in *H.undatus* to red and purple in *H. polyrhizus* and *H.costaricensis* (Esquivel *et al*., 2007). Flesh (pulp) and seeds are edible parts and they are eaten altogether. Dragon fruits are an excellent source of vitamin C and are abundant with minerals, particularly calcium and phosphorus. Fruits can be processed into products such as juice, sherbets, jams, jellies, ice cream, candies and pastries (Morton, 1987). They also possess

*** Author for correspondence:**

some medicinal properties, especially the red fleshed varieties are rich in anti oxidants. Regular consumption of fresh dragon fruit greatly controls asthma, cough, cholesterol and high blood pressure (Suryono, 2006). It has received worldwide recognition as an ornamental as well as fruit crop. Major dragon fruit growing countries are Vietnam, Columbia, Mexico, Costa Rica and Nicaragua and to a lesser degree, cultivation occurs in Australia and Israel. The European Union and Asia especially China are the largest import markets (Le Bellec *et al*., 2006). It is one of the newly introduced exotic fruit crop in India and is being cultivated in an area of less than 100 acres mainly in Maharashtra, Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu.

Dragon fruit is considered a promising crop to be grown commercially in dry regions (Vaillant *et al*., 2005). This species is found to have high water use efficiency (Nobel and De La Barrera, 2004). It is usually propagated by seeds or cuttings. Though seed propagation method is very simple but seeds are not true to type due to cross pollination (Andrade *et al*., 2005). Therefore, large number of plantlets with healthy shoot and root system can be produced to meet the demand of increasing commercial cultivation through vegetative propagation methods like cuttings in India. Dragon fruit which are propagated by stem cuttings may be directly planted in the field or in pots (Zee *et al*., 2005). Cuttings of many plants are normally dipped in rooting hormone before planting to boost root formation. Therefore, the present investigation was carried out to study the effect of indole butryic acid (IBA) on establishment of stem cuttings of two dragon fruit varieties and to standardize the optimum concentration of IBA for better growth of stem cuttings of dragon fruit.

MATERIAL AND METHODS

The present investigation was carried out at College of Horticulture, Dr.Y.S.R. Horticultural University, Venkataramannagudem, West Godavari District of Andhra Pradesh. The experimental site was located at an altitude of 34 m (112 feet) above mean sea level and geographically situated at 16.8°N latitude and 81.5°E longitude.

Preparation of stem cuttings:

The study was conducted on two varieties of dragon fruit *i.e.* red pulped and white pulped variety. The cuttings were procured from Sandal wood Farms, Guntur, Andhra Pradesh. Cuttings were collected from one year old shoots. The length of the cuttings used for planting was ranging from 7-12 cm having 4-5 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.

Rooting media:

The rooting media was homogenized by hand, mixed with top soil, sand, coco peat and farm yard manure in the ratio of 2:1:1:1. Polyethylene bags of 11.5 × 26 cm size with 235 gauges were used for filling rooting media. Single super phosphate at the rate of 2 g / bag was added. Furadon 3G granules were also added for the control the pest infestation.

Treatment of cuttings:

Before plantings, the cuttings of two varieties were treated with three concentrations of indole butryic acid (IBA) *i.e*. 2000, 4000 and 6000 ppm. They were prepared by dissolving 2000 mg, 4000 mg and 6000 mg IBA, respectively in a small quantity of 0.1 N NaOH and the volume was made upto 1 litre by adding distilled water. The cuttings were treated by quick dipping for 5 seconds, later they were allowed to dry for 15 minutes under shade and planted in poly bags containing the rooting media.

Data collection on root characters :

Five sprouted cuttings were randomly selected for recording the observations from each replication of every treatment throughout the study on destructive basis. The observations included were, days to first sprouting, average number of roots formed, percentage of rooted cuttings (calculated using the formula, number of cuttings rooted/total number of cuttings planted x 100), length of roots (measured with the help of measuring scale from the base to the tip of root and the mean length was calculated and expressed in centimeters), root fresh weight (measured with the help of an electronic balance and the mean values were calculated and expressed in grams), root dry weight (After recording the fresh weight, the roots were kept in brown covers oven dried at 80 ^{o}C temperature until it attained a constant weight and root dry weights were recorded with the help of electronic balance. The mean root dry weight was calculated and expressed in grams).

Data collection on shoot characters:

Five sprouted cuttings were randomly selected for recording shoot related observations from each replication of every treatment throughout the study. The observations included were, number of new shoots per cutting (the observations were recorded starting from 30 days after planting to 120th day after planting at 15 days interval *i.e.* 30, 45, 60, 75, 90, 105 and 120th days, respectively), length of shoot (it was measured at 120th day), fresh weight of shoot, dry weight of shoot (sprouted cuttings were collected and kept in brown covers). The shoots in brown covers were first sun dried, later oven dried at 80 ^{o}C until it attained constant weight and dry weights were recorded with the help of electronic balance and it was expressed in grams), survival per centage of rooted cuttings (it was calculated by using the formula, number of rooted cuttings survived/ total number of rooted cuttings x 100).

Data analysis:

The data recorded on various growth parameters of stem cutting of two varieties were statistically analyzed by adopting the Factorial Completely Randomized Design as suggested by Panse and Sukhatme (1967). Critical difference values were calculated where ever F-test was found to be significant at 5 per cent level of probability.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect of IBA on rooting behaviour of dragon fruit :

The result on effect of IBA on rooting behaviour of cuttings of both dragon fruit varieties are presented in Table 1. The statistical analysis indicated that there were significant differences between the two varieties for all the root parameters.

It was found that cuttings of red pulped variety produced significantly more number of roots (8.62), maximum percentage of rooted cuttings (78.77%), maximum root length (21.61 cm), maximum root fresh weight (1.30 g) and root dry weight (0.46 g) than white pulped variety. The variation in root parameters among the varieties could be attributed to genotypic character.

Irrespective of the variety tested, IBA at 6000 ppm initiated significantly more number of roots per cutting (9.87) and gave maximum results for percentage of rooted cuttings (86.77), length of longest root (22.93cm), root fresh weight (1.83 g) and root dry weight (0.58 g). Like many other species, rooting ability of dragon fruit was also sensitive to the IBA application. IBA at higher concentrations induces re-differentiation of mature parenchyma cells into cambial tissue and supply of food material to cambial tissue by rapid hydrolysis of reserve

Table 1: Effect of different concentrations of IBA on root parameters of dragon fruit varieties

	Days to first sprouting (d)			Average no. of roots			Percentage of rooted cuttings			Length of longest root (cm)			Root fresh weight (g)			Root dry weight (g)		
IBA Conc.	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
0 (Control)	47.43	65.67	56.55	6.40	5.40	5.90	71.40 (57.65)	70.32 (56.96)	70.86 (57.31)	18.57	15.90	17.24	0.51	0.39	0.45	0.15	0.13	0.14
2000 ppm	44.80	54.57	49.68	8.33	7.47	7.90	75.37 (60.22)	76.69 (61.11)	76.03 (60.66)	20.56	17.94	19.25	0.86	0.59	0.73	0.33	0.19	0.26
4000 ppm	40.97	52.33	46.65	9.47	8.53	9.00	80.19 (63.55)	78.69 (62.48)	79.44 (63.02)	22.70	19.75	21.23	1.53	0.87	1.20	0.57	0.29	0.43
6000 ppm	37.67	48.33	43.00	10.27	9.47	9.87	88.10 (69.80)	85.44 (67.54)	86.77 (68.67)	24.61	21.25	22.93	2.30	1.36	1.83	0.78	0.38	0.58
Mean	42.72	55.23		8.62	7.72		78.77 (62.80)	77.79 (62.02)		21.61	18.71		1.30	0.80		0.46	0.25	
C.D. (P=0.05) for varieties		1.044			0.330			0.602			0.162			0.170			0.016	
C.D. (P=0.05) For IBA concentrations		1.477			0.466			0.851			0.229			0.240			0.023	
C.D. (P=0.05) For interactions		2.088			NS			1.698			0.325			0.340			0.032	

Note : V1= Red pulped variety; V2 = White pulped variety; Figures in parenthesis indicate angular values

carbohydrates stored in the stem cuttings. It helps in rapid cell division and cell elongation in cambial tissue which might have resulted in earlier rooting, more number of adventitious roots per cutting, longest roots per cutting and root fresh weight per cutting which lead to an improvement in root dry weight per cutting. Similar opinions were also reported by Deb *et al*. (2009) and Singh *et al.* (2013) in lemon, Porghorban *et al*. (2014) in olive, Seran and Thiresh (2015) and Rahad *et al*. (2016) in dragon fruit.

Effect of IBA on shooting behaviour of dragon fruit:

The results on effect of IBA on shooting behaviour of both dragon fruit varieties are presented in Table 2. Significant differences were noticed between varieties for all shoot parameters on all the days of observations. The red pulped variety recorded earlier days for sprouting (42.72 days) and showed maximum number of new shoots per cutting (3.70), shoot fresh weight (103.05 g) and shoot dry weight (7.58g) than white pulped variety but for the length of longest shoot, maximum values (21.74 cm) was observed in white pulped variety.

Number of new shoots per cutting in red pulped dragon fruit were 1.16, 1.65, 2.20, 2.70, 3.00, 3.30 and 3.70 shoots at 30, 45, 60, 75, 90, 105 and 120 DAP respectively. Regardless of varieties, IBA @ 6000 ppm (1.47, 1.95, 2.50, 3.00, 3.30, 3.60 and 4.00 at 30, 45, 60, 75, 90, 105 and 120 DAP, respectively) exhibited superior performance in relation to number of new shoots per cutting followed by IBA @ 4000 ppm while the minimum response was observed in control (0.65, 1.10, 1.50, 2.00, 2.30, 2.60 and 3.00 at 30, 45, 60, 75, 90, 105 and 120 DAP, respectively). The interaction between varieties and IBA concentrations on number of new shoots per cutting was found to be non-significant.

Irrespective of the variety, IBA at 6000 ppm recorded significantly superior values for all the shoot parameters like number of new shoots, shoot length, shoot fresh weight, shoot dry weight) over control. It is followed by IBA 4000ppm and IBA 2000ppm. The longest shoot length was observed when dragon fruit cuttings are treated with IBA 6000ppm at 120 DAP (23.93 cm) and the same treatment recorded maximum values for shoot fresh weight (112.09 g) and shoot dry weight (9.47g) at 120 DAP.

The increased shoot performance at higher concentration of IBA might be attributed to activation of dormant buds by the activation of hydrolytic enzymes, which acted upon reserve food materials stored in the cuttings. The supply of respiratory substrates to glycolytic enzymes leads to release of energy and helps in early sprouting of dormant buds. It was also observed that the same treatment recorded the more number of roots in cutting which could help more in absorption of water and nutrients from the soil which in turn enhanced the formation of more number of new shoots per cutting

Table 2 : Effect of different concentrations of IBA on shoot parameters of dragon fruit varieties

	Days to first sprouting (d)			Length of longest shoot (cm)			Shoot fresh weight (g)			Shoot dry weight (g)			Survival percentage of cuttings		
IBA Conc.	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
0 (Control)	47.43	65.67	56.55	10.24	16.71	13.47	77.65	70.25	73.95	3.46	2.79	3.13	73.36 (58.90)	73.25 (58.83)	73.31 (58.86)
2000 ppm	44.80	54.57	49.68	15.53	20.18	17.86	100.47	86.54	93.51	5.45	4.60	5.03	83.58 (66.07)	77.78 (61.85)	80.68 (63.96)
4000 ppm	40.97	52.33	46.65	18.72	23.47	21.10	111.33	91.28	101.31	9.92	6.37	8.14	86.55 (68.45)	85.40 (67.51)	85.98 (67.51)
6000 ppm	37.67	48.33	43.00	21.25	26.61	23.93	122.76	101.42	112.09	11.50	7.45	9.47	90.41 (71.93)	90.10 (71.63)	90.26 (71.78)
Mean	42.72	55.23		16.44	21.74		103.05	87.37	73.95	7.58	5.30		83.48 (66.34)	81.63 (64.95)	
C.D. (P=0.05) for varieties		1.044			0.246			0.253			0.250			0.205	
C.D. (P=0.05) For IBA concentrations		1.477			0.347			0.357			0.353			0.290	
C.D. (P=0.05) for interactions		2.088			0.491			0.506			0.501			0.410	

Note : V1= Red pulped variety; V2 = White pulped variety; Figures in parenthesis indicate angular values

compared to control. The present findings are in conformity with Rohit *et al*. (2004); Ram *et al*. (2005); Upadhyay and Badyal (2007) in pomegranate, Singh *et al*. (2013) in lemon and Rahad *et al*. (2016) in dragon fruit and Stancato *et al*. (2003) in cactus.

The interaction between varieties and concentrations of IBA was also found to be significant for most of the rooting and shooting parameters. The survival percentage of rooted cuttings differed significantly between the varieties. It was more in red pulped variety (83.48 %) than in white pulped variety (81.63 %). It might be due to the presence of differential levels of endogenous rooting cofactors and carbohydrates (Hartmann and Kester, 1989) and their differential behavior in different growth parameters.

Survival percentage of rooted cuttings was significantly influenced by the IBA concentrations. IBA at 6000 ppm recorded significantly the maximum survival percentage (90.41%) while the lowest was noticed in control (73.36%) treatment. IBA was found to be best auxin for general use because it was nontoxic to plants over a wide range of concentrations than NAA or IAA (Hartmann *et al.*, 2002) and also found to be effective in promotion of rooting and survival of a large number of plant species (Henrique *et al*., 2006). The results are in agreement with the findings of Shukla and Bist (1994) in pear, Lakhani and Gajapara (1998); Srivastava *et al*. (2005) in kiwifruit, Saed (2010) in pomegranate and Rahad *et al*. (2016) in dragon fruit.

From this investigation, it could be concluded that the IBA @ 6000 ppm was found to be best irrespective of the variety in increasing the number of new shoots, fresh and dry weight of shoot, length of longest root, number of roots, percentage of rooted cuttings and survival percentage of cutting and reducing the days to first sprouting.

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