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Influence of plant growth regulators on rooting of stem cuttings in dragon fruit [*Hylocereus undatus* (Haworth) Britton & Rose]

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Abstract
An experiment was conducted at College of Agriculture, UAHS, Shivamogga, from 2017 to 2018 to know the influence of growth regulators on rooting of stem cuttings in Dragon Fruit. Number of days taken for root initiation was found early in IBA 7000 ppm (14.54), Percentage of cuttings rooted at 30 and 60 DAP (33.66 and 57.75 %), Length of the longest root at 30, 60 and 90 DAP (4.57, 10.65 and 23.07 cm), Average number of roots per cutting (12.70, 21.74 and 46.68), Average length of the roots per cutting (3.95, 6.32 and 12.41 cm), Root volume (0.31, 1.81 and 1.97 cc), Root diameter (0.56, 0.76 and 1.47), Fresh weight of the root (0.46, 1.87 and 2.28) and Dry weight of the root (0.25, 0.46 and 0.67) respectively at 30, 60 and 90 DAP. The results revealed that cuttings treated with IBA 7000 ppm gave the best root growth.

Keywords: dragon fruit, rooting, stem cutting, IBA (Indole-3-butyric acid), NAA (Naphthalene acetic acid), DAP (days after planting)

Introduction
Dragon fruit (*Hylocereus undatus*) commonly known as Pitahaya belongs to family Cactaceae are perennial climbing cactus native to Central and South America. Pitahaya is considered as a promising crop to be commercially grown in dry regions. The species have high water use efficiency as they have the mechanism to secure water requirement from the developing aerial roots from the sides of the stem to collect water from surroundings. Dragon fruit is an excellent source of Vitamin-C, minerals particularly calcium, phosphorous and is a good source of natural pigments known as Bitalins. It is valuable for treating different types of diseases and also has significant economic value. It is usually propagated by seeds and stem cuttings. Seed propagated plants are not true to type and fruit bearing occurs in three and half to four years but the stem propagated plants bears fruit in one and half to two years. Therefore, large number of plantlets with healthy root and shoot system can be produced to meet the demand of increasing commercial cultivation through stem cuttings.
The use of plant growth regulators in dragon fruit propagation through stem cuttings is very scanty. In India, it is newly extending in all the dry areas. Therefore, it is important to select the appropriate concentration of growth regulators for rapid and commercially production of plantlets. Hence, the experiment was conducted to know the influence of Indole -3- byturic acid (IAA) and Naphthalene acetic acid (NAA) as single and in combination on stem cuttings in Dragon fruit.

Materials and Methods
The present investigation was conducted in the Department of Horticulture, College of Agriculture, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka state during 2017 to 2018. The experiment was laid out in a Complete Randomized Design (CRD) with 12 treatments replicated thrice consisting of growth regulators IBA, NAA and their different combinations (T_1- IBA 5000 ppm, T_2- IBA 6000 ppm, T_3-IBA 7000 ppm, T_4- NAA 100 ppm, T_5- NAA 200 ppm, T_6- IBA 5000 ppm+NAA 100 ppm, T_7- IBA 5000 ppm+NAA 200 ppm, T_8- IBA 6000 ppm+NAA 100 ppm, T_9- IBA 6000 ppm+NAA 200 ppm, T_{10}- IBA 7000 ppm + NAA 100 ppm, T_{11}- IBA 7000 ppm + NAA 200 ppm and T_{12}- control (dipped in distilled water). 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 cuttings was

treated with growth regulators by quick dip method and for this a required amount of growth regulator was weighed and dissolved in 0.2 N NaOH and then the volume was made up to 1 litre using distilled water and the cutting was dipped in solution for 2 minutes and planted in poly bags. The observations were taken at 30, 60 and 90 Days after planting on days taken for root initiation, per cent of cuttings rooted, length of longest root per cutting, average number of roots per cutting, average length of root, root volume, root diameter, fresh and dry weight of root.

Results and Discussion

Number of days taken for root initiation

The number of days taken for root initiation in dragon fruit stem cuttings as influenced by growth regulators at different concentrations with different combinations are presented in (Figure. 1).

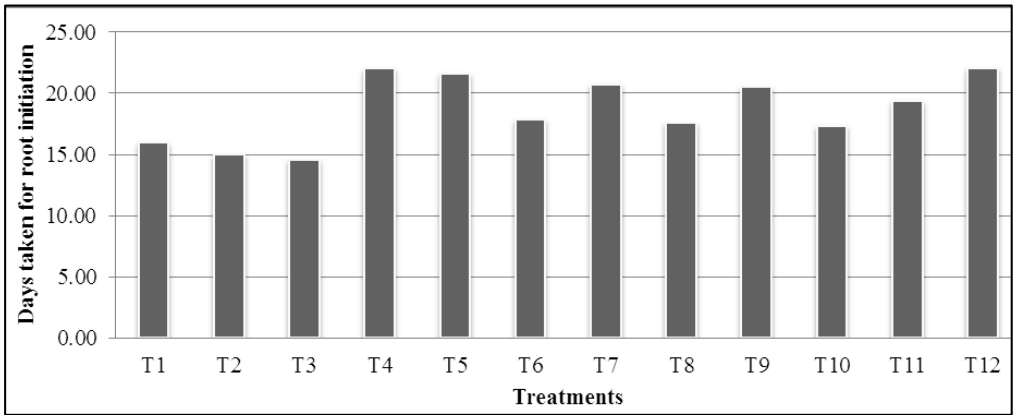

Fig 1: Number of days taken for root initiation of stem cuttings

The dragon fruit cuttings treated with different growth regulators reveals that, the less number of days taken for root initiation (14.54) in cuttings treated with T_3- IBA 7000 ppm, which was on par with T_2- IBA 6000 ppm (15.04), T_1- IBA 5000 ppm (15.95). The more number of days taken for root initiation was recorded in control T_{12}- Dipped in distilled water (22.08). This may be due to the exogenous application of auxin which hydrolysis starch into sugars. This is needed to a greater extent for the production of new cells and for increased respiratory activity in the regeneration tissue at the time of initiation of new root primordial. The results obtained in this study are in conformity with Bhattacharjee and Thimmappa (1993) [1] in Scented geranium.

Percentage of cuttings rooted (%)

The per cent of rooting in stem cuttings of dragon fruit at 30 days after planting was significantly higher in stem cuttings treated with T_3- IBA 7000 ppm (33.66 %) which was on par with T_2- IBA 6000 ppm and (33.22 %) and T_1- IBA 5000 ppm (31.02 %) respectively, whereas lowest rooting percentage (13.35 %) was recorded in control as presented in (Figure. 2)

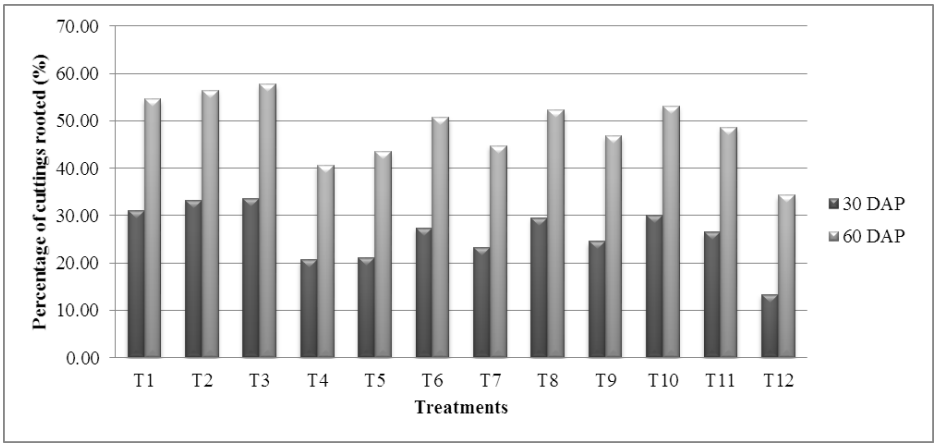

Fig 2: Percentage of cuttings rooted at 30 and 60 DAP

The per cent of rooting in stem cuttings of dragon fruit at 60 days after planting was significantly higher in stem cuttings treated with T_3- IBA 7000 ppm (57.75 %) which was on par with T_2- IBA 6000 ppm (56.48 %) and T_1- IBA 5000 ppm (54.58 %) respectively, whereas control T_{12} recorded the minimum percentage of rooting (34.36 %). It might be due to the rapid hydrolysis of polysaccharides stored in stem cuttings into physiologically active sugars which provide energy to meristematic tissues and activate the root primodia to initiate formation of more number of roots in stem cuttings as reported by Karimi *et al*., (2012) [5] in Pomegranate.

Length of the longest root (cm)

Significant difference between treatments with respect to length of longest root was observed. The maximum length of longest root (4.57 cm, 10.65 cm and 23.07 cm) was observed in IBA 7000 ppm and the minimum length of longest root was observed in control (2.77 cm, 6.10 cm and 12.06 cm respectively) at 30, 60 and 90 days after planting as presented in (Figure. 3). The cuttings treated with IBA at 7000 ppm initiate the formation of longest roots per cuttings could be

due to rapid hydrolysis of starch stored in the cuttings into physiologically active sugars, which provide energy through respiratory activity to the root primordia and helps in rapid elongation of the meristematic cells there by initiate the longest roots per cutting. Similar results were reported by Srivastava *et al.,* (2005) [10] in Kiwi fruit.

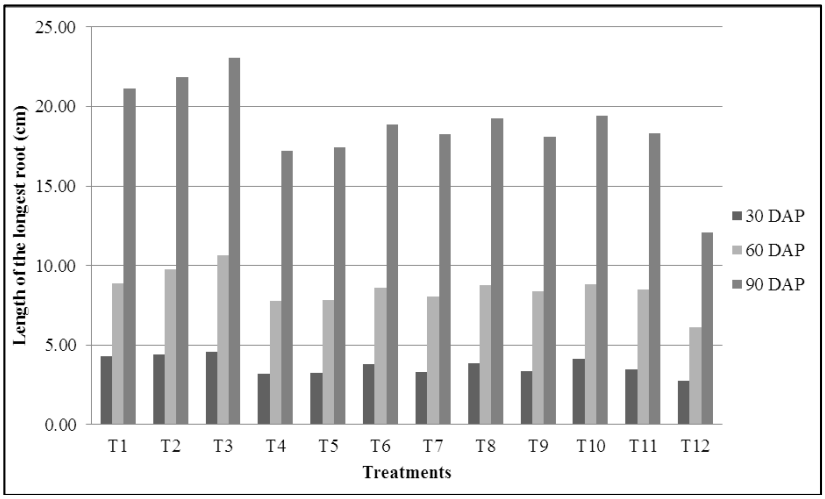

Fig 3: Length of the longest root per cutting at 30, 60 and 90 DAP

Average number of roots per rooted cutting (cm)

In the present study, application of different growth regulators significantly influenced the maximum number of roots per cutting at 30, 60 and 90 days after planting as presented in (Figure.4). Untreated cuttings showed minimum number of roots in all stages of growth. 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) [11]. It was observed that the cuttings treated with IBA 7000 ppm showed more number of roots per cutting (12.70, 21.74 and 46.88 respectively) at 30, 60 and 90 days after planting compared to control T_{12} (3.28, 6.12 and 17.87). 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) [3].

There was increase in the number of roots per cuttings as there was increase in concentration of IBA from 5000 to 7000 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) [2] in Pomegranate.

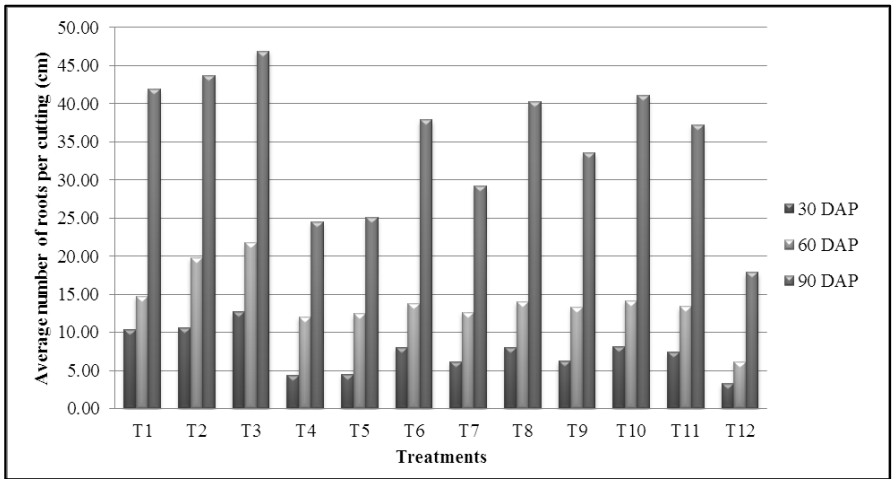

Fig 4: Average number of roots per cutting at 30, 60 and 90 DAP

Average length of roots per rooted cutting (cm)

In the present study growth regulators treatments exhibited a great effect on average length of roots per cutting. The maximum average length of root per cutting (3.95 cm, 6.32 cm and 12.41 cm) was recorded in IBA 7000 ppm as presented in (Figure.5). The minimum average length of root per cuttings (1.97 cm, 2.09 cm and 5.62 cm at 30, 60 and 90 days after planting, respectively) was observed in control. It might be due to an auxin application has been found to enhance the histological features like formation of callus, tissue and differentiation of vascular tissue. These findings are similar with the findings of Galavi *et al.,* (2013) [4] in Grape.

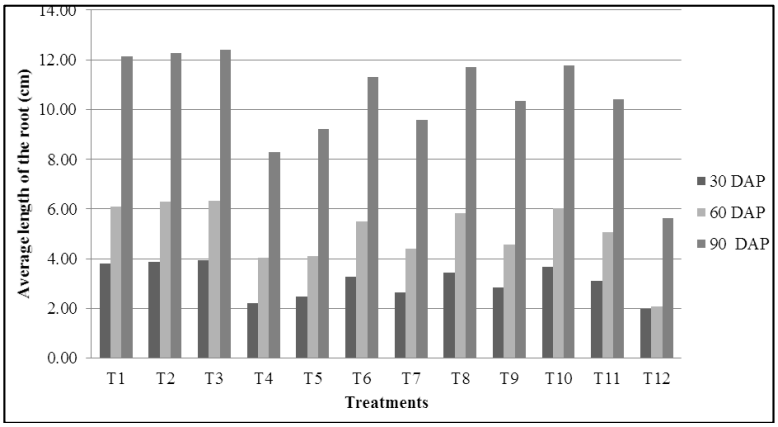

Fig 5: Average length of the root per cutting at 30, 60 and 90 DAP

Root volume (cc)

The data revealed that growth regulators promoted root volume of cuttings as compared to control. Highest root volume was seen in cuttings treated with T_3- IBA 7000 ppm (0.31, 1.81 and 1.97 cc) at 30, 60 and 90 days after planting respectively as presented in (Figure. 6). While, the least root volume was found in T_{12}- control (0.08, 1.19 and 1.34 cc) at 30, 60 and 90 days after planting respectively.

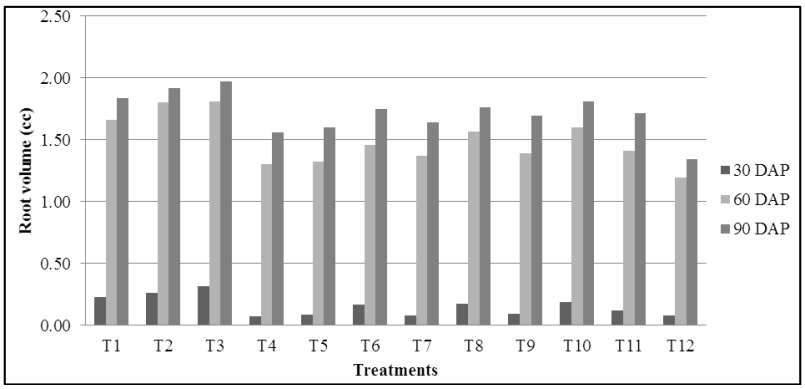

Fig 6: Root volume at 30, 60 and 90 DAP

It might be due to the greater portion of available photosynthates influenced by auxins, which helps in root growth resulting in higher root volume. Similar results are reported by Shashidhar (2014) [8] in litchi.

Root diameter (mm)

Diameter of the root varied significantly among different treatments with different IBA treatments.

The highest mean diameter (0.56, 0.76 and 1.47) was observed in the cuttings treated with IBA 7000 ppm and the lowest (0.11, 0.28 and 0.87 at 30, 60 and 90 days after planting)respectively was observed in control at 30,60 and 90 days after planting as presented in (Figure. 7).

The present findings can be confirmed by Singh and Singh (2005) [9] 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.

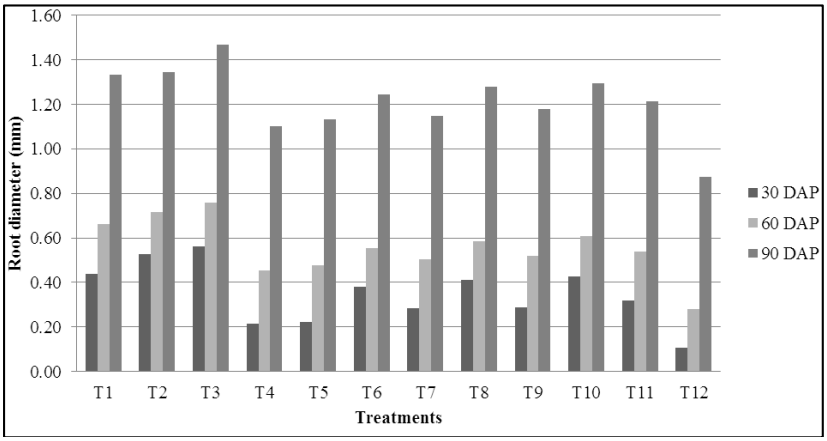

Fig 7: Root diameter at 30, 60 and 90 DAP

Fresh weight of the root (g)

The maximum fresh weight of the root was recorded in T_3- IBA 7000 ppm (0.46, 1.87 and 2.28g) at 30, 60 and 90 days after planting. While, minimum fresh weight was recorded in T_{12}- control (0.11, 0.98 and 1.45g) as presented in (Figure. 8).

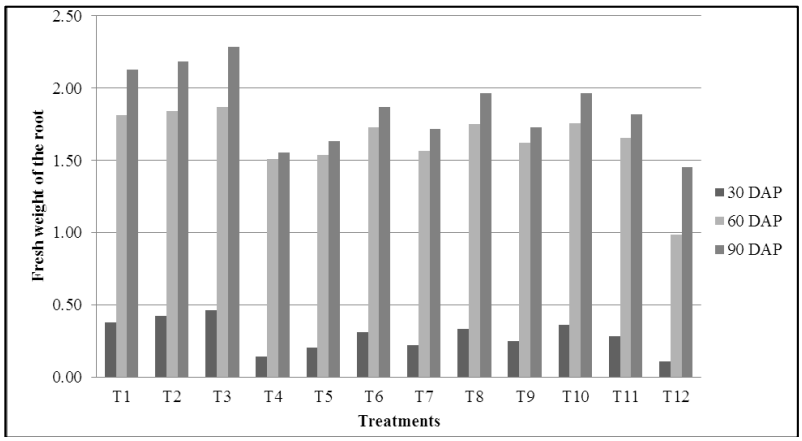

Fig 8: Fresh weight of the root at 30, 60 and 90 DAP

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 more 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 Rahad *et al.*, (2016) [6] in Dragon fruit.

Dry weight of the root (g)

The dry weight of the roots was recorded highest in T_3- IBA 7000 ppm (0.25, 0.46 and 0.67g) while the lowest dry weight was recorded in T_{12}- control (0.01, 0.19 and 0.23 g) at 30, 60 and 90 days after planting as presented in (Figure. 9). This might be due to the fact that, Auxin stimulates the initiation of lateral and adventitious roots because of their affect 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. Similar findings have been observed by Rymbai and Reddy (2010) [7] in Guava.

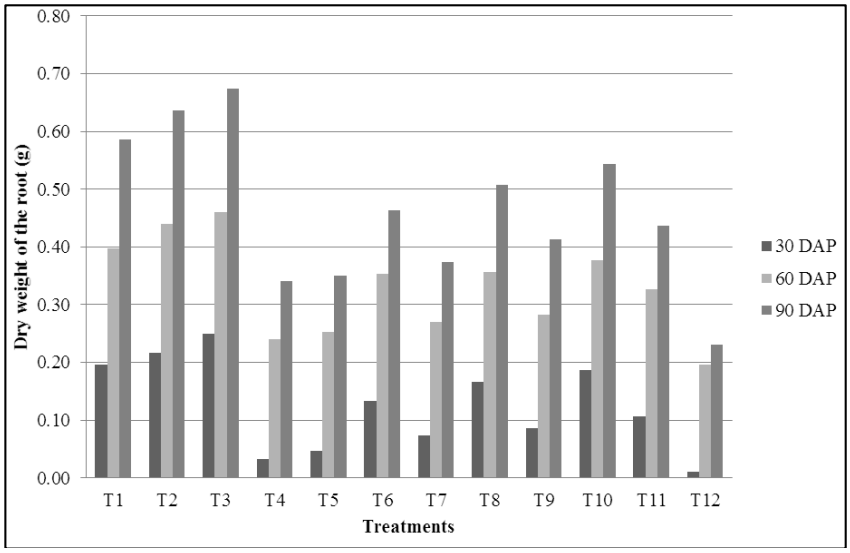

Fig 9: Dry weight of the root at 30, 60 and 90 DAP

Conclusion

From the present study, it can be concluded that vegetative propagation by stem cuttings in dragon fruit root formation was significantly influenced by the application of IBA at 7000 ppm compared to control. Higher the concentration of IBA used better is the rooting. Therefore, IBA 7000 ppm can be recommended for commercial rising of plantlets.

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