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Effect of Naphthalene Acetic Acid (NAA) for root induction of dragon fruit explants under laboratory conditions

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Abstract
The purpose of the experiment was to determine the role that naphthalene acetic acid (NAA) played in the effective root induction of dragon fruit explants. Six levels of naphthalene acetic acid (NAA) were applied for root multiplication of dragon fruit explants, which were 0, 0.1, 0.2, 0.3, 0.4, and 0.5 µM. The treatments were executed in the laboratory with four replications with ten samples each and laid out in completely randomized design (CRD). Results of the experiment showed that the earliest days to induce the first root (11.25 days) were observed in 0.3 µM NAA-containing medium. 100% root formation was recorded from 0.3 µM NAA containing medium from explants. The maximum root number per plantlet (4) was produced in the medium supplemented with 0.3 µM NAA. The explants grown in the medium containing 0.3 and 0.4 µM NAA produced the longest shoots at 9.35 cm and 8.25 cm, respectively. In 0.3 µM NAA-containing media, the maximum fresh weight of plantlets (0.60 g) was obtained.

Keywords: NAA, root induction, dragon fruit, tissue culture

Introduction
Dragon fruit, pitaya, or strawberry pear (*Hylocereus* spp. and *Selenicereus* spp.) is becoming a super crop, even on marginal terrain, due to its numerous health and therapeutic benefits. It is a climbing xerophyte vine that is indigenous to Central and South America. The flower is referred to as "Noble Woman" or "Queen of the Night" because of its beauty. Fruits have a pleasant taste and are nutrient-dense, containing vitamins C, B2, B3, protein, dietary fibres, and minerals (Fe, P, and Ca). Due to its crassulacean acid metabolism (CAM) plant status and xerophyte traits, it can grow in a variety of agro-climates, including hot and dry regions.
Dragon fruit can be grown commercially up to 1700 metres in altitude with 500 to 1500 mm of rainfall annually. Its shallow roots (40 cm) make it less particular about the types of soil it may grow in, and it can be cultivated in a variety of soils without becoming overly wet. However, for the commercial development of dragon fruit orchards, slightly acidic (pH 5.5-6.0) loamy soil rich in organic matter and air temperatures ranging from 20 to 30 °C are preferred. Due to this, dragon fruit has gained appeal in tropical Asian nations during the past two decades, and commercial production has started all over the world (Sanoamuang, 2019) [7].
The use of tissue culture in-vitro propagation technologies can help in the production of high-quality and large-scale plantlets. According to Castillo *et al.* (2003) [2] and Le Bellec (2004) [4], there aren't many recent studies on tissue culture in dragon fruit. Dahanayake *et al.* (2010) [3] investigated the ability of direct regeneration of dragon fruit explants utilising leaf and stem cuttings in varied concentrations of indole 3-butyric acid (IBA) or naphthaleneacetic acid (NAA) in MS basal regeneration media. Abdul Razak (2017) [1] created an in vitro regeneration and mass propagation methodology. A variety of aspects that could aid in the growth of dragon fruit micropropagation were discussed by Trivellini *et al.* (2020) [9]. Although stem cutting is still the most common practice but, the micropropagation technique may be an excellent alternative for high-quality planting materials and large multiplication.

Materials and Methods
The experiment was conducted between 2021 and 2022 at Babasaheb Bhimrao Ambedkar University's Laboratory of the Department of Horticulture in Lucknow (Uttar Pradesh). The region has a humid subtropical agroclimate. The experiment was laid out in a completely randomized design (CRD) with four replications.

Six concentrations of NAA were used as treatments, which were 0, 0.1, 0.2, 0.3, 0.4, and 0.5 µM. The total number of explants was 10 in each treatment per replication. Murashige and Skoog media was used as a basal medium, and the stem portion of dragon fruit was used as a source of explants (Murashige and Skoog, 1962) [5]. Within four weeks of culture, observations were recorded for days to induce the first root and root development percentage. At thirteen weeks, observations were measured for the quantity of roots per plantlet, root length (cm), and fresh weight of the plantlet (g). Based on the following fixed effect statistical model as proposed by Panse and Sukhatme (1985) [6], the analysis of variance was conducted to examine the significance of differences among treatments for all observations.

Results and Discussion

The effects of different levels of naphthalene acetic acid (NAA) on all the observations of dragon fruit explants are presented in Table 1. It shows that the earliest days to induce the first root (11.25 days) were observed in 0.3 µM NAA-containing medium. It was in line with the finding of Seyyedyousefi *et al.* (2013) [8], who stated that apical and lateral bud explants cultured in MS media with 5 µM NAA gave the highest root proliferation on *Alstroemeria* cv. "Fuego". 100% root formation was recorded from 0.3 µM NAA-containing medium from explants, which was followed by 98.76% at 0.4 µM NAA. In addition, the minimum root formation percent was recorded in controlled medium from explants. Dahanayake and Ranawake (2011) [3] observed root induction of proliferated shoots on MS medium supplemented with 0.05 µM NAA regardless of the shoot induction medium in the dragon fruit crop. NAA levels had a highly significant effect on the number of roots per plantlet. The maximum root number per plantlet was produced in the medium supplemented with 0.3 µM NAA, which was followed by a 0.4 µM NAA-containing medium. The minimum number of roots (2.5) was observed in the controlled medium. The explants grown in the medium containing 0.3 and 0.4 µM NAA produced the longest root at 9.35 cm and 8.25 cm, respectively, while those grown in the medium without hormone gave the shortest root (6.58 cm). In 0.3 µM NAA-containing media, the largest fresh weight of plantlets (0.60 g) was obtained, followed by 0.53 g in MS medium with 0.4 µM NAA. Plantlets with the lowest fresh weight (0.46 g) were grown in controlled media.

Table 1: Effect of naphthalene acetic acid (NAA) levels on all the observations of dragon fruit explants for root induction

Treatment	NAA (µM)	Days to induce first root	Root formation percent	Number of roots per plantlet	Root length (cm)	Fresh weight of plantlet (g)
T_1	0	13.5	96.17	2.5	6.58	0.46
T_2	0.1	12.75	97.65	2.75	7.73	0.50
T_3	0.2	12.25	98.61	2.75	8.21	0.52
T_4	0.3	11.25	100.00	4	9.35	0.60
T_5	0.4	13.25	98.76	3	8.25	0.53
T_6	0.5	15	98.35	2.5	8.02	0.48
Mean		13	98.32	2.916	8.02	0.52
LSD (0.05)		0.864	0.467	0.660	0.112	0.017
SE(m)		0.289	0.156	0.220	0.037	0.006
SE(d)		0.408	0.221	0.312	0.053	0.008
CV%		4.441	0.317	15.119	0.930	2.265

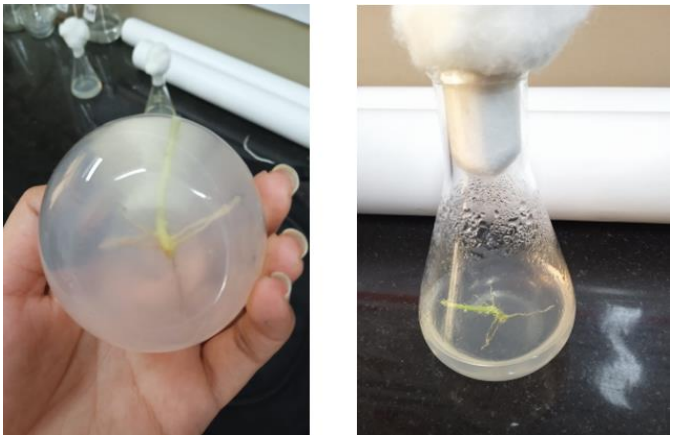

Fig 1: Effect of naphthalene acetic acid (NAA) levels on root formation of shoot developed from shoot culture of dragon fruit crop at 13 weeks after culture

Conclusion

Days to induce the first root are significantly influenced by different levels of NAA. The earliest days to induce the first root (11.25 days) were observed in 0.3 µM NAA-containing medium. Different NAA levels influence the root formation percent. It was found that 100% root formation was recorded from 0.3 µM NAA-containing medium from explants. NAA levels had a highly significant effect on the number of roots per plantlet. The maximum root number per plantlet was produced in the medium supplemented with 0.3 µM NAA. Root length is significantly influenced by different levels of NAA. The explants grown in the medium containing 0.3 and 0.4 µM NAA produced the longest roots at 9.35 cm and 8.25 cm, respectively. Different NAA levels influence the fresh weight of plantlets. In 0.3 µM NAA-containing media, the largest fresh weight of plantlets (0.60 g) was obtained**.**

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