DOI : 10.58993/ijh/2024.81.1.18

Indian J. Hortic. 81(1), March 2024: 110-114

Effect of microbial fertilizers and growth media on the rooting of passion fruit (cv. Possum Purple) cuttings

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ABSTRACT

Propagation by cuttings is widely used in the commercial propagation of passion fruits. In propagation with cuttings, hormones are generally applied to promote rooting. However, there is limited research on the use of microbial fertilizer for the rooting purpose of passion fruit cuttings. In the present study, perlite and vermiculite were used as rooting media, along with different doses of indole-3-butyric acid (IBA) (750 and 1500 ppm) and microbial fertilizer (Best-doll), which contains seven different bacteria species, including *Penicillium bilaii*, *Bacillus megaterium*, *Azospirillum brasilense*, and *Arthrobacter viscosus*, *Azotobacter vinelandii*, *Azotobacter chroococcum*, and *Pseudomonas* spp. (5000 and 10000 ppm). These were tested for rooting in semi-woody cuttings of the cultivar passion fruit var. 'Possum Purple'. The *Passiflora* cuttings of the 'Possum Purple' cultivar successfully rooted four and a half months after planting. The results indicated that the lowest rooting rate was observed in indole-3-butyric acid (IBA) treatments. Conversely, perlite emerged as the most effective rooting medium for 'Possum Purple' cuttings. The application of 5000 ppm microbial fertilizer led to a higher root thickness compared to other treatments. However, there were no statistical differences among treatments regarding the longest and average root length in the rooting media. Based on the findings, the concentration of 5000 ppm microbial fertilizer and the use of perlite as a rooting medium is recommended for achieving the highest rooting levels and seedling quality.

Key words: *Passiflora edulis* Sims., IBA, Microbial fertilizer, Perlite, Vermiculite.

INTRODUCTION

There are more than 500 *Passiflora* species, and most of them can be utilized for various purposes such as fresh consumption, industrial processing, ornamental uses, and medicinal applications (Faleiro *et al*., 6). Passion fruit (*Passiflora edulis* Sims) is the most important species grown, and it can be commercially cultivated under tropical, semitropical, and subtropical climate conditions. The global production of passion fruit was recorded at approximately 1.5 million tonnes in 2017 (Altendorf, 2). Brazil, Colombia, and Indonesia stand out as the most important producers, followed by Ecuador, Australia, and New Zealand. Passion fruit, native to Brazil, enjoys high popularity in the country, to the extent that domestic supply struggles to meet demand. Brazil's total production volume reached nearly 1 million tonnes in 2017, with a year-on-year growth of about 3 per cent (Altendorf, 2). Passion fruit can be propagated through sexual and asexual methods. Propagation by seeds results in high genetic variation due to cross-pollination (Bakir and Saddam, 3). Moreover, plants propagated from seeds do not bear fruit in the same year. Therefore, for commercial propagation, Passiflora is primarily propagated vegetatively.

Grafting and cutting are standard methods for vegetative propagation. However, compared to grafting, cutting has demonstrated lower labour costs (Salomao *et al*., 12) and requires less time for rootstock growth. Consequently, seedlings can be obtained in a much shorter duration through cutting. There are several factors influencing the rooting rate and root quality in passion fruit propagation through cuttings. These factors include species, mother plant health, physiological stage of the mother plant, time of cutting collection, cutting length, cutting age, cutting type, rooting media, hormones and their doses for rooting, and environmental factors such as temperature and humidity levels (Salomao *et al*., 12; Pires *et al*., 10; Bemkaireima *et al*., 4; Faleiro *et al*., 6; Gomes *et al*., 7; Joseph and Sobhana, 8). Investigating passion fruit propagation in cultivated areas becomes crucial due to the challenges in importing saplings from international markets. Various studies have focused on the propagation of *Passiflora* species through cuttings. Salomao *et al*. (12) examined different *Passiflora* species and found that the maturity stage of cuttings is a significant factor in rooting, with semi-wooden cuttings showing better results. Bemkaireima *et al*. (4) explored the impact of different IBA concentrations on rooting,

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suggested 750 ppm as optimal for *Passiflora edulis* var. *Edulis* Sims. Likewise, Joseph and Sobhana (8) recommended using cuttings with four nodes and 800 ppm NAA treatment for *P. edulis* Sims. However, Ryals *et al.* (11) observed variations in auxin concentration effects across different passion fruit species. Limited studies focus on substrates for *Passiflora* rooting, but Boboc *et al*. (5) recommended vermiculite and IBA 1000 ppm for *P. quadrangularis* and *Passiflora caerulea* cuttings.

Biostimulators, like root biostimulators, positively affect rooting and contribute to sustainable agriculture (Nardi *et al*., 9). In addition to biostimulators, microbial fertilizers present a cost-effective and environmentally sustainable alternative for rooting compared to hormones. This study aims to determine the effects of different IBA and microbial fertilizer concentrations and combinations, using perlite and vermiculite as growth media, on rooting and root quality parameters.

MATERIALS AND METHODS

The experiment was conducted in a greenhouse under mist conditions. The passion fruit cultivar ‘Possum Purple’ served as the plant material, with semi-woody cuttings of 20 cm in length and three nodes collected in early April. Rooting media included perlite and vermiculite. Rooting inducers examined were indole-3-butyric acid (IBA) and a commercial microbial fertilizer (Best-doll) containing seven bacteria species: *Penicillium bilaii*, *Bacillus megaterium*, *Azospirillum brasilense*, *Arthrobacter viscosus*, *Azotobacter vinelandii*, *Azotobacter chroococcum*, and *Pseudomonas* spp. (with a total of 2×10^7 cfu/ml). The study included two IBA concentrations (750 and 1500 ppm) and two microbial fertilizer concentrations (5000 and 10000 ppm), tested individually. Additionally, a combination of IBA at 750 ppm and microbial fertilizer at 5000 ppm was assessed. Cuttings were immersed in the respective solutions for 10 sec and then planted in the growth media. The greenhouse misting system was set to 10 sec every 15 min. during the experiments. The study took place in an environment with a temperature ranging from 24 to 28°C and approximately 80% humidity. Measurements related to rooting and root quality parameters were collected 150 days post-planting. Parameters measured included rooting rate (%), number of primary roots, longest root length (cm), average root length (cm), and average root thickness (mm).

The experimental design was a Completely Randomized Block Design with three replicates, each consisting of 10 cuttings. Pairwise comparisons were conducted using the Least Significant Difference test (LSD) with a statistical significance level of $P \leq 0.05$.

RESULTS AND DISCUSSION

The growth media, treatments, and their interactions were statistically significant in influencing the rooting rate of passion fruit cuttings (Table 1). The highest rooting rate, 90%, was recorded in the treatment with 10000 ppm microbial fertilizer, while the lowest rate, 25%, was observed in the 1500 ppm IBA treatment. One possible explanation for the superior performance of the cuttings treated with biofertilizer is its inclusion of living microorganisms that aid in root system development, as suggested by Singh *et al.* (13). Teixeira *et al.* (14) also reported that plant growth-promoting rhizobacteria (PGPR) treatment could enhance rooting by stimulating plant growth and auxin production. Previous studies on the effect of different IBA treatments indicated optimal concentrations at 500 ppm and 750 ppm (Pires *et al*., 2011; Bemkaireima *et al*., 4). Our findings align with these studies, showing lower rooting rates in the 1500 ppm IBA treatment. We attribute this to the survivability of cuttings being compromised during the dipping process, especially with the use of semi-woody cuttings. In terms of rooting media, perlite demonstrated the highest rooting rate (72.2%), while vermiculite exhibited the lowest (55.56%) (Table 1). Bakir and Saddam (3) highlighted that cutting treated with 3000 ppm IBA and planted in March had the highest survival rate, root number, root length, shoot, and leaf numbers. However, Alexandre *et al.* (1) found no effect of auxin treatment on rooting, suggesting that genotype variability is a crucial factor in rooting outcomes. Ryals *et al*. (11) recommended tailoring hormone use based on *Passiflora* species. The statistical significance of media and treatment interactions extended to the primary root number of passion fruit cuttings (Table 2). Among treatments, the highest number of primary roots (22.94) was observed with the 750 ppm IBA treatment, followed by the 1500 ppm IBA treatment (19.39). While the primary root number varied among the tested growth media, perlite consistently yielded higher results compared to vermiculite (Table 2).

While the IBA treatment showed better results in terms of the primary root number, contrary to the rooting rate, it suggests that further investigations into lower concentrations of IBA treatment may yield more beneficial results in future rooting studies. The highest root number was observed in the combined treatments of 750 ppm IBA and 5000 ppm microbial fertilizer compared to other treatments, indicating that IBA plays a more effective role in root number development than microbial fertilizer. Bakir and Saddam (3) also noted improvement in root number with a 3000 ppm IBA treatment, which is consistent with our study. Optimal results for root numbers were seen in the perlite media, aligning with its effect on the rooting

Table 1. The effect of different treatments and media on rooting rate (%) in passion fruit cuttings.

Treatment	Medium		Treatment Mean
	Perlite	Vermiculite	
Control	90.00 A*	63.33 B	76.67 b**
750 ppm IBA	53.33 BC	30.00 D	41.67 d
1500 ppm IBA	26.67 D	23.33 D	25.00 e
5000 ppm microbial fertilizer	90.00 A	83.33 A	86.67 ab
10000 ppm microbial fertilizer	93.33 A	86.66 A	90.00 a
750 ppm IBA + 5000 ppm microbial fertilizer	80.00 A	46.67 C	63.33 c
Media Mean	72.22 a**	55.56 b	
LSD at 5% Medium × Treatment: 15.888 LSD 5% Treatment:11.234 LSD 5% Medium: 6.486			

*Media × treatment means with the same capital letters is not significantly different (P < 0.05).
**Means with the same letter in treatment and media are not significantly different (P < 0.05).

Table 2. The effect of different treatments and media on primary root number in passion fruit cuttings.

Treatment	Medium		Treatment Mean
	Perlite	Vermiculite	
Control	8.12 EF*	3.69 F	5.90 d**
750 ppm IBA	23.76 A	22.12 AB	22.94 a
1500 ppm IBA	22.96 AB	15.83 BCD	19.39 ab
5000 ppm microbial fertilizer	10.19 DEF	6.56 EF	8.37 d
10000 ppm microbial fertilizer	14.17 CDE	5.13 F	9.65 cd
750 ppm IBA + 5000 ppm microbial fertilizer	18.70 ABC	10.97 DEF	14.81 bc
Media Mean	16.31 a**	10.70 b	
LSD 5% Medium × Treatment: 7.690 Treatment: 5.438 Medium: 3.140			

*Media × treatment means with the same capital letters is not significantly different (P < 0.05).
**Means with the same lowercase letter in treatment and media are not significantly different (P < 0.05).

rate. The statistically significant interaction between media and treatment supports this finding, although the impact of rooting media alone was not statistically significant for root length (Table 3). The longest root length was observed in the control group and the 5000 ppm microbial fertilizer treatment at 20.44 cm, while the lowest length was recorded in the 1500 ppm IBA treatment at 10.47 cm. Root length varied between 16.51 cm and 16.73 cm in the experiment (Table 3). Notably, the control group exhibited the longest root length, even surpassing the IBA treatment with the highest root number. These results suggest a negative correlation between the root number and the longest root length. The research findings indicate that the longest root length and average root length are more directly affected by treatments than rooting media. Although the interaction between rooting media and treatment was statistically significant, the rooting media effect alone was not statistically significant for average root length. The treatment of 5000 ppm microbial fertilizer yielded the highest average root length, while the lowest length was observed in the 1500 ppm IBA treatment at 6.81 cm. Average root length showed differences between 10.59 cm and 10.72 cm based on the rooting media (Table 4). Boboc (Oros) *et al*. (5) suggested that vermiculite and the treatment with IBA 1000 ppm significantly influence the length and number of roots in *P. caerulea* and *P. quadrangularis*, although differences may be species-dependent.

The media and treatment interactions, along with the effects of treatments and media, were found to be statistically significant for the average root thickness of passion fruit cuttings (Table 5). The highest average root thickness, with a 1.04 mm diameter, was recorded with the 5000 ppm microbial fertilizer treatment, while the lowest thickness, measuring 0.81 mm, was observed in the 750 ppm IBA treatment. Across the examined rooting media, the average root diameter ranged between 0.87 mm and 0.96 mm. Consistently, the treatment with 5000 ppm microbial fertilizer resulted in the longest root length, average root length, and root thickness. In contrast, all IBA treatments exhibited lower

Table 3. The effect of different treatments and media on the longest root length (cm) in passion fruit cuttings.

Treatment	Medium		Treatment Mean
	Perlite	Vermiculite	
Control	17.81 ABC*	23.06 A	20.44 a**
750 ppm IBA	14.24 BCD	12.58 CD	13.41 bc
1500 ppm IBA	13.01 CD	7.93 D	10.47 c
5000 ppm microbial fertilizer	19.68 ABC	21.19 AB	20.44 a
10000 ppm microbial fertilizer	17.90 ABC	18.84 ABC	18.37 ab
750 ppm IBA+5000 ppm microbial fertilizer	16.48 ABC	16.78 ABC	16.63 ab
Media Mean	16.51***	16.73	
LSD 5% Medium × Treatment: 7.915 Treatment: 5.597 Medium: N.S. ***			

*Media × treatment means with the same capital letters is not significantly different (P < 0.05).
**Means with the same lowercase letter in treatment is not significantly different (P < 0.05).
***N.S.: Non-significant

Table 4. Average root length (cm) of passion fruit cuttings as affected by different treatments and media.

Treatment	Medium		Treatment Mean
	Perlite	Vermiculite	
Control	11.09 ABC*	14.33 A	12.71 ab**
750 ppm IBA	8.89 BCD	8.15 CD	8.52 cd
1500 ppm IBA	8.20 CD	5.43 D	6.81 d
5000 ppm microbial fertilizer	13.18 A	14.11 A	13.65 a
10000 ppm microbial fertilizer	12.52 AB	11.27 ABC	11.90 ab
750 ppm IBA+5000 ppm microbial fertilizer	10.44 ABC	10.27 ABC	10.35 bc
Media Mean	10.72**	10.59	
LSD 5% Medium × Treatment: 4.197 Treatment: 2.968 Medium: N.S.***			

*Media × treatment means with the same capital letters is not significantly different (P < 0.05).
**Means with the same lowercase letter in treatment is not significantly different (P < 0.05).
***N.S.: Non Significant

Table 5. Root thickness (mm) in *Passiflora* cuttings as influenced by different treatments and media.

Treatment	Medium		Treatment Mean
	Perlite	Vermiculite	
Control	0.89 CDE*	0.90 CDE	0.89 bcd**
750 ppm IBA	0.89 CDE	0.77 DE	0.81 d
1500 ppm IBA	0.90 CDE	0.74 E	0.82 cd
5000 ppm microbial fertilizer	1.07 AB	1.00 ABC	1.04 a
10000 ppm microbial fertilizer	1.10 A	0.91 BCD	1.01 ab
750 ppm IBA+5000 ppm microbial fertilizer	0.97 ABC	0.89 CDE	0.93 abc
Media Mean	0.96 a**	0.87 b	
LSD 5% Medium × Treatment: 0.163 Medium: 0.116 Treatment: 0.066			

*Media × treatment means with the same capital letters is not significantly different (P < 0.05).
**Means with the same lowercase letter in treatment and media are not significantly different (P < 0.05).

root thickness compared to the control group. Limited studies focus on the effect of rooting media on *P. edulis* rooting. In our investigation, perlite media yielded superior results for several examined parameters.

In conclusion, based on the rooting rate and studied root quality parameters, we recommend the use of perlite as the rooting media and the application of a 5000 ppm microbial fertilizer concentration as the treatment for the successful rooting of passion fruit cuttings.

AUTHORS' CONTRIBUTION

The conceptualization and experimental design of the research work (HG, BB), execution of field and laboratory studies and data collection (LA, BB.) and statistical analysis and preparation of the manuscript (HG, LA).

DECLARATION

The authors declare that they do not have any conflict of interest.

ACKNOWLEDGEMENT

The authors thank the Scientific and Technical Research Council of Turkey (TUBITAK) for financial support for this research project (Project No. TUBITAK-115O124). The authors thank Serkan Tokgöz, Department of Plant Pathology, University of Nebraska, Lincoln/USA and Dr Tomas Ayala-Silva, USDA Agricultural Research Service: Mayaguez, PR, for their critical reviews of the manuscript.

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Received : February 2024; Revised : February 2024; Accepted : March 2024