



Effect of different growing media, Azotobacter and GA₃ on growth and survivability of transplanted air layers in Guava (*Psidium guajava* L.) C.V. Gwalior-27

Vijaya Singh Kushwah*, KV Singh, Amit Kumar, Vikash Kumar Sahu, Lokendra Gujar and Arvind Pate

*Department of Horticulture, College of Agriculture, RVSKVV, Gwalior, Madhya Pradesh, India

DOI: <https://doi.org/10.33545/2664844X.2021.v3.i2a.75>

Abstract

The present investigation entitled “Effect of different growing media, Azotobacter and GA₃ on growth and survivability of transplanted air layers in Guava (*Psidium guajava* L.) C.V. Gwalior - 27” was conducted at Experimental block, College of Agriculture, R.V.S.K.V.V., and Gwalior (M.P.) during the year 2020-2021. The experiment was laid out in Completely Randomized Design (CRD) with three replications. Among different treatments Soil + Vermicompost (2:1) + GA₃ 200 ppm + *Azotobacter* (0.5 ml) resulted in maximum survival percentage of air layers at DAT 135 (87.33%) followed by the treatment with Soil + Leaf mould (2:1) + GA₃ 200 ppm + *Azotobacter* (0.5ml) (77.43%). This treatment also enhanced the growth as well as root parameters of air layers, No. of Sprouts at 15 DAT (8.67), No. of leaves (37.00), Stem length (28.33 cm), and Stem thickness (16.20 mm), Number of primary roots (10.00), Number of secondary roots (21.67), and Length of primary roots (11.97 cm), Length of secondary roots (8.73 cm), Diameter of primary roots (3.27mm), Diameter of secondary roots (2.00 mm), Fresh weight of primary roots (1.84 g), Fresh weight of secondary roots (0.79 g) at 135 DAT. It may be concluded that Soil +Vermicompost (2:1) + GA₃ 200 ppm + *Azotobacter* (0.5 ml) was found best for highest survivability percentage and enhanced root parameters followed by Soil + Leaf mould (2:1) + GA₃ 200 ppm + *Azotobacter* (0.5 ml).

Keywords: Guava (*Psidium guajava* L.), vermicompost, GA₃, azotobacter, survivability

Introduction

Guava (*Psidium guajava* L.), native to Mexico, Central America and belongs to the family Myrtaceae. It is also known as “apple of tropics” and “poor man’s apple”, is a popular fruit crop in India. It can be grown in tropical and subtropical climate and it is adopted for diverse soil and agro climatic conditions. It is relatively precocious and prolific in fruit bearing nature, could give highly remunerative for crop production. The guava is highly nutritious, it has a rich source of vitamin ‘C’ and the content of Vitamin ‘C’ in fruits vary from 95.75 to 239.00 mg 100⁻¹ g in cultivars of guava. Guava is the fifth important fruit crop of India after Banana, Mango, Citrus, and Papaya with an area of 276 thousand hectares contribute to total annual production of 4253 million tons and productivity of 14.96 MT/hac (Horticulture at a glance 2018). India is the leading producer of guava in the world.

The total area, production and productivity of Guava in Madhya Pradesh is 139 Ha, 2920 MT, and 19.58 MT/hac respectively (Anon.). It has been used in traditional medicine in many cultures throughout Central America, the Caribbean, Africa and Asia. It is used for inflammation, diabetes, hypertension, wounds, pain relief, fever, diarrhea, rheumatism, lung diseases and ulcers. In the state guava is commercially propagated through air layering as it is an economical and effortless method of propagation.

The plant growth regulators are organic substances (other than nutrients), which in minute amount promote, inhibit or otherwise modify any physiological process in plants. Thus, the use of PGRs has resulted in some outstanding achievements in several fruit crops with respect to growth, yield and quality.

Gibberellin is a very potent hormone whose natural occurrence in plants controls their development. Gibberellins are in the third place with 17% share among the most commonly used herbal hormones within the natural plant growth regulators. It regulates growth; application of very low concentrations can have profound effect.

GA₃ is the most commonly used Gibberellin; it has number of effects on plant growth and development. It can stimulate rapid stem and root growth, induce mitotic division in the leaves of some plants and increase seed germination rates. Gibberellins are known to influence both cell division and cell enlargement (Adams *et al.*, 1975) [1].

Biofertilizers are substances that contain living microorganisms. Biofertilizers also synthesize some biologically active substances including some phytohormones such as auxin, thereby stimulating plant growth. Bio-fertilizers containing beneficial bacteria and fungi improve soil chemical and biological characteristics, phosphate solubility and agricultural production (El-Habbasha *et al.*, 2007; Yosefi *et al.*, 2011) [8, 11]. Bio-fertilizers comprised of nitrogen fixers, phosphate and potash solubilizers. (Ezz *et al.*, 2011) [7]. Because it is the most important for plant production and soil health in general as they play an important and complex role in plant growth components of crops by way of various biochemical activities in the soil such as increases the soil fertility naturally, add nutrients through the natural processes biological N fixation, solubilizing phosphorus, the availability of nutrients by their biological activity and uptake of nutrients.

Hence, it is a matter of great interest to find out the best concentration of the growth regulators and suitable biofertilizer for growing media and treatment which can induce better survival of guava air layers after detachment.

Materials and Methods

Experimental site

The experiment was conducted at Experimental block, Department of Horticulture, College of Agriculture, R.V.S.K.V.V. Gwalior, Madhya Pradesh India. The experiment was conducted during the year 2020-2021. The experimental site is situated at 26° 13' N latitude and 78° 14' E longitudes at an altitude of 211.5 m above Mean Sea Level in Gird belt.

Planting material

Eight years old plants of Guava *cv.* Gwalior-27 were selected for this research work.

Preparation of growing media

In the experiment, the layers were detached in November and subjected to various treatments after treating the growing media with nano-silver @ 35 ml/L of water. 120 kg sterilized Soil was taken by removing small stones and pebbles. Soil and Vermicompost were mixed in the ratio 2:1 by volume and Soil and Leaf mould were mixed in the ratio 2:1 by volume, after that biofertilizer i.e., *Azotobacter* @ 0.5 ml per poly bag is mixed.

Preparation of GA₃ solution

S. No.	Solution prepared		GA ₃ powder
	Concentration	Volume	
1.	100 ppm	1 lit	100 mg
2.	150 ppm	1 lit	150 mg
3.	200 ppm	1 lit	200 mg

Detachment of air layers

Air layers were detached by making a cut just below the lowest end of the ring surface with the help of sharp secateurs. The air layers were brought under shade after detachment and their polyethylene were removed gently without hurting the roots.

Preparation and planting of air layers in poly bags

The air layers were detached from eight year old mother plants and unwrapped from polyethylene thereafter. They were cut into equal length (15 cm) and made entirely leafless before planting. Initially leafless air layers were dipped into the solution of Copper oxychloride for fungus control after that the layers were dipped in different concentrations of GA₃ solution for about two minutes and then planted in the prearranged growing media filled poly bags thereafter. After the planting of detached air layers, the poly bags were placed in open conditions and individually irrigated. The sizes of the polybags were 15 x 10 cm.

Observations recorded

For the present study, 21 air layers of guava (*Psidium guajava* L.) *cv.* Gwalior-27 per treatment were randomly selected and replicated thrice. The observations were recorded from 5 air layers that were selected randomly and tagged in each replication. The observations were determined and their means were worked out for statistical analysis.

Growth Parameters

Stem length (cm)

The stem length was measured with the help of meter scale at 45, 90 & 135 days after their planting. The average of five selected air layers in each treatment were computed and presented in cm.

Stem thickness (mm)

The stem diameter was measured with Digital Vernier Calipers at monthly intervals 45, 90 & 135 days after planting and expressed in mm. The average of five selected layers in each treatment was recorded.

Plant survival percentage

The air layers were planted in the polyethylene bags and it was observed that whether the layers were established in the

polyethylene bags after transplanting or not. The survival percentage of air layers was calculated by the following formula-

$$\text{Survival \%} = \frac{\text{Total no. of survived layered plants} \times 100}{\text{Total no. of layered plants}}$$

Root Parameters

Number of primary roots

Five rooted layers were randomly sampled from each treatment. The polythene sheet was removed carefully using forceps and care was taken to avoid damage to roots. Number of primary roots was counted in each layer, averaged and expressed in number.

Number of secondary roots

The same five roots were used for primary roots used for counting for secondary roots. The polythene sheet was removed carefully using forceps and care was taken to avoid damage to roots.

Length of primary roots (cm)

Five rooted transplanted layers were randomly sampled from each treatment. The polythene sheet was removed carefully using forceps and care was taken to avoid damage to roots. With the help of scale length of primary roots was measured from the collar region to the tip of primary root in centimeters (cm).

Length of secondary roots (cm)

The layers which were used for the measurement of length primary roots, the same were used for the length of secondary roots. The care was taken while measuring the length so that roots did not get hurt. The length was measured with the help of scale in centimeters (cm).

Diameter of primary roots (mm)

Five roots per layer were selected randomly and their diameter was taken with the help of Digital Vernier Calipers and average was calculated and expressed in mm.

Diameter of secondary roots (mm)

The five roots per layer were selected randomly and their diameter was taken with the help of Digital Vernier Calipers and average was calculated and expressed in mm.

Fresh weight of primary roots (g)

The fresh weight of primary roots was measured with the help of digital weighing balance from randomly selected five layers from each treatment and each replication, averaged and expressed in numbers.

Fresh weight of secondary roots (g)

The fresh weight of secondary roots was also measured with the help of digital weighing balance from randomly selected five layers from each treatment and each replication, averaged and expressed in numbers.

Results and discussion

Growth parameters

Number of sprouts

The data recorded for number of sprouts recorded at 15 DAT is presented in table1. It is perceptible from the observations recorded that, the maximum no. of sprouts (8.67) were recorded under treatment T₄ (Soil +Vermicompost (2:1) + GA₃ 200 ppm + *Azotobacter* (0.5ml). The improvement in no. of days taken in

number of sprouts with application of Vermicompost and leaf mould might be due to better moisture holding capacity and availability of major and micro nutrients due to favorable soil conditions. The present investigation findings are in accordance with earlier reports in recorded by Slakins *et al.*, (1973) [21], Tyagi and Patel (2004) [22], Singh *et al.*, (2007) [20], Rolaniya *et al.*, (2018) [13], Dawar *et al.*, (2020) [6].

Number of leaves: The data regarding number of leaves at 45, 90 and 135 DAT is presented in table1. The maximum number

of leaves (20.33, 28.67 and 37.00) was found in treatment T₄ (Soil + Vermicompost (2:1)+ GA₃ 200 ppm + *Azotobacter* (0.5 ml)) over control and other treatments. The similar findings were also reported by Bhandulkar *et al.*, (2017) [3] results reported that Vermicompost with *Azotobacter* had significantly greater effect on no. of leaves, Singh *et al.*, (2007) [20], Rymbai *et al.*, (2012) [15], Damar *et al.*, (2014) [5] and Muthia *et al.*, (2015) [9].

Table 1: Effect of *Azotobacter*, GA₃ and growing media on number of sprouts and Number of leaves

Treatment Details		Number of sprouts at 15 DAT	Number of leaves		
			45 DAT	90 DAT	135 DAT
T ₀	Soil (Control)	2.33	14.33	21.67	32.00
T ₁	Soil + Vermicompost (2:1)	3.33	16.33	25.33	33.33
T ₂	Soil + Vermicompost (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	4.67	17.33	26.67	34.67
T ₃	Soil + Vermicompost (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	5.33	18.67	27.33	35.67
T ₄	Soil + Vermicompost (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	8.67	20.33	28.67	37.00
T ₅	Soil + Leaf mould (2:1)	2.67	15.33	25.00	32.67
T ₆	Soil + Leaf mould (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	4.00	16.67	25.67	34.33
T ₇	Soil + Leaf mould (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	5.00	17.67	24.67	36.33
T ₈	Soil + Leaf mould (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	6.00	19.33	27.00	36.67
S.E m ±		0.430	1.171	0.949	1.128
CD at 5%		1.279	3.478	2.821	3.351

Stem length (cm)

The data observed for stem length (cm) at 45, 90 and 135 DAT is presented in table 2. The maximum stem length (cm) (18.00, 24.00 and 28.33) was recorded under treatment T₄ (Soil +Vermicompost (2:1) + GA₃ 200 ppm+ *Azotobacter* (0.5ml). Soil, vermicompost, leaf mould, GA₃ and *Azotobacter* were appreciably affected the shoot parameters, Sevik *et al.*, (2013) [18] the results of study showed that GA₃ application has a considerable effect on stem height, Bhandulkar *et al.*, (2017) [3] obtained highest plant height media containing Vermicompost (22.54cm), Kashyap *et al.*, (2019) [11], and recorded findings are

significantly superior than Singh *et al.*, (2007) [20] Rajpoot *et al.*, (2012) [12].

Stem thickness (mm)

The data contemplated for stem thickness (mm) at 45, 90 and 135 DAT is presented in table 2. The table clearly demonstrate that the maximum stem thickness (mm) (8.03, 12.77 and 16.20) was recorded under treatment T₄ (Soil +Vermicompost (2:1) + GA₃ 200 ppm+ *Azotobacter* (0.5ml). Similar findings for the above experiment are in agreement with Bhandulkar *et al.*, (2017) [3], Rajpoot *et al.*, (2012) [12], Canli *et al.*, (2008) reported that overall stem thickness of pears seedlings significantly affected by GA₃ treatments.

Table 2: Effect of *Azotobacter*, GA₃ and growing media on Stem length and Stem thickness

Treatment Details		Stem length (cm)			Stem thickness (mm)		
		45 DAT	90 DAT	135 DAT	45 DAT	90 DAT	135 DAT
T ₀	Soil (Control)	12.97	17.50	21.00	5.00	7.63	12.00
T ₁	Soil + Vermicompost (2:1)	14.83	20.00	24.00	5.80	8.90	13.50
T ₂	Soil + Vermicompost (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	15.67	22.60	24.83	6.50	10.03	14.50
T ₃	Soil + Vermicompost (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	16.67	23.50	23.50	6.92	11.03	15.50
T ₄	Soil + Vermicompost (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	18.00	24.00	28.33	8.03	12.77	16.20
T ₅	Soil + Leaf mould (2:1)	13.90	19.50	22.43	5.50	8.50	13.03
T ₆	Soil + Leaf mould (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	14.80	21.00	25.10	6.00	9.50	14.13
T ₇	Soil + Leaf mould (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	16.33	23.00	26.57	6.80	10.43	15.07
T ₈	Soil + Leaf mould (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	17.53	23.90	27.67	7.50	12.33	15.73
S.E m ±		0.499	0.513	1.501	0.573	0.824	0.807
CD at 5%		1.483	1.525	4.461	1.702	2.447	2.396

Plant survival (%)

The data inferred for plant survival (%) at 45, 90 and 135 DAT is presented in table3. It is observable from the experiment that, numerous treatments had significant effect on the plant survival (%). The table clearly shows that the maximum survival percentage of air layers (87.33%) was recorded under treatment T₄ (Soil +Vermicompost (2:1) + GA₃ 200 ppm+ *Azotobacter* (0.5ml). This may be due to pre treatment of GA₃ in plant improved root and shoot growth. Furthermore, Wang *et al.*,

(1995) demonstrated that application of GA₃ can promote xylem and phloem production, provided and elevated IAA at cambial region. This results in reduced mortality of transplanted air layers and hence increased the survivability percentage, ultimately gave higher ceaselessness to layers.

The equivalent results were also reported by Ramteke (1998) [14], Singh *et al.*, (2007) [20], Rajpoot *et al.*, (2012) [12], Damar *et al.*, (2014) [5], Kashyap *et al.*, (2016) [10], Dawar *et al.*, (2020) [6].

Table 3: Effect of biofertilizer, GA₃ and growing media on plant survival (%)

	Treatment Details	Plant survival (%)		
		45 DAT	90 DAT	135 DAT
T ₀	Soil (Control)	80.50	72.07	64.57
T ₁	Soil + Vermicompost (2:1)	83.13	76.00	68.60
T ₂	Soil + Vermicompost (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	85.03	80.20	72.43
T ₃	Soil + Vermicompost (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	88.53	83.07	76.00
T ₄	Soil + Vermicompost (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	93.33	90.00	87.33
T ₅	Soil + Leaf mould (2:1)	82.07	74.10	68.10
T ₆	Soil + Leaf mould (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	84.00	79.50	70.13
T ₇	Soil + Leaf mould (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	87.00	82.60	75.00
T ₈	Soil + Leaf mould (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	89.00	83.83	77.43
S.E m ±		2.042	1.892	1.965
CD at 5%		6.068	5.622	5.839

Root parameters**Number of primary roots**

The observations recorded for number of primary roots at 45, 90 and 135 DAT is presented in table 4. The higher number of primary roots in air layers (5.00, 7.33 and 10.00) was recorded under treatment T₄ (Soil + Vermicompost (2:1) + GA₃ 200 ppm + *Azotobacter* (0.5ml)).

Number of secondary roots

It is manifested from the present study that, the maximum number of secondary roots in air layers (14.33, 18.00 and 21.67) was recorded under treatment T₄(Soil + Vermicompost (2:1) + GA₃ 200 ppm + *Azotobacter* (0.5ml)).

Table 4: Effect of *Azotobacter*, GA₃ and growing media on number of primary and secondary roots

Treatment Details	Number of Primary roots			Number of Secondary roots			
	45 DAT	90 DAT	135 DAT	45 DAT	90 DAT	135 DAT	
T ₀	Soil (Control)	2.00	4.33	6.67	9.33	12.67	15.33
T ₁	Soil + Vermicompost (2:1)	2.67	5.33	7.33	10.33	15.00	18.00
T ₂	Soil + Vermicompost (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	3.67	6.00	7.00	11.00	16.67	19.33
T ₃	Soil + Vermicompost (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	4.33	6.67	8.33	12.67	17.33	20.00
T ₄	Soil + Vermicompost (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	5.00	7.33	10.00	14.33	18.00	21.67
T ₅	Soil + Leaf mould (2:1)	2.33	4.67	7.67	9.67	14.33	16.00
T ₆	Soil + Leaf mould (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	3.33	5.67	8.33	11.00	15.67	18.67
T ₇	Soil + Leaf mould (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	4.00	6.33	8.90	12.33	16.33	19.67
T ₈	Soil + Leaf mould (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	4.67	7.00	9.00	13.67	17.00	20.33
S.E m ±		0.544	0.351	0.648	1.024	0.981	1.054
CD at 5%		1.617	1.044	1.926	3.044	2.916	3.132

Length of primary roots (cm)

The data collected for length of primary roots (cm) at 45, 90 and 135 DAT is presented in table 5. The maximum length of primary roots (cm) (8.60, 9.20 and 11.97) was observed under treatment T₄ (Soil +Vermicompost (2:1) + GA₃ 200 ppm+ *Azotobacter* (0.5ml)). The above result is in accordance with earlier reports in Rolaniya *et al.*, (2018) [13] with root length 28.24 cm in grape, Damar *et al.*, (2014) [5] in pomegranate

(10.36cm), Bhandulkar *et al.*, (2017) [3] with root length of 2.77 cm.

Length of secondary roots (cm)

The observed data for length of secondary roots (cm) at 45, 90 and 135 DAT is displayed in table 5. The maximum length of secondary roots (cm) (6.17, 7.60 and 8.73) was observed in treatment T₄(Soil +Vermicompost (2:1) + GA₃ 200 ppm+ *Azotobacter* (0.5ml)).

Table 5: Effect of biofertilizer, GA₃ and growing media on length of primary and secondary roots (cm)

Treatment Details	Length of primary roots (cm)			Length of secondary roots (cm)			
	45 DAT	90 DAT	135 DAT	45 DAT	90 DAT	135 DAT	
T ₀	Soil (Control)	3.20	4.67	6.87	3.00	4.10	4.70
T ₁	Soil + Vermicompost (2:1)	5.40	6.57	8.50	4.00	5.13	6.07
T ₂	Soil + Vermicompost (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	6.53	8.53	9.57	4.50	6.10	7.17
T ₃	Soil + Vermicompost (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	7.50	8.80	10.50	5.47	6.80	7.80
T ₄	Soil + Vermicompost (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	8.60	9.20	11.97	6.17	7.60	8.73
T ₅	Soil + Leaf mould (2:1)	3.67	6.00	7.77	3.53	3.70	5.17
T ₆	Soil + Leaf mould (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	6.03	7.10	9.13	4.20	5.70	6.40
T ₇	Soil + Leaf mould (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	7.10	8.13	10.17	5.13	6.53	7.50
T ₈	Soil + Leaf mould (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	8.07	9.07	10.67	5.87	7.13	8.50
S.E m ±		1.056	0.885	0.985	0.668	0.810	0.811
CD at 5%		3.139	2.628	2.928	1.986	2.406	2.409

Diameter of primary roots (mm)

The data recorded for diameter of primary roots at 45, 90 and 135 DAT is presented in table 6. The thickest primary roots (mm) (2.13, 2.53 and 3.27) were recorded under treatment T₄

(Soil +Vermicompost (2:1) + GA₃ 200 ppm+ *Azotobacter* (0.5ml)).

Diameter of secondary roots (mm)

The recorded observations for diameter of secondary roots at 45, 90 and 135 DAT is presented in table 6. The maximum diameter of secondary roots (mm) (1.20, 1.37 and 2.00) were recorded in treatment T₄(Soil +Vermicompost (2:1) + GA₃ 200

ppm+ *Azotobacter* (0.5ml). The above results are in agreement with earlier reports in Rolaniya *et al.*, (2018)^[13], Damar *et al.*, (2014)^[5], Bhandulkar *et al.*, (2017)^[3], Dawar *et al.*, (2020)^[6].

Table 6: Effect of biofertilizer, GA₃ and growing media on diameter of primary and secondary roots (mm)

Treatment Details		Diameter of primary roots (mm)			Diameter of secondary roots (mm)		
		45 DAT	90 DAT	135 DAT	45 DAT	90 DAT	135 DAT
T ₀	Soil (Control)	0.30	1.20	1.37	0.57	0.83	1.32
T ₁	Soil + Vermicompost (2:1)	1.30	1.53	1.73	0.83	1.03	1.40
T ₂	Soil + Vermicompost (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	1.47	1.80	2.53	0.84	1.08	1.27
T ₃	Soil + Vermicompost (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	1.80	2.17	2.90	1.00	1.10	1.44
T ₄	Soil + Vermicompost (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	2.13	2.53	3.27	1.20	1.37	2.00
T ₅	Soil + Leaf mould (2:1)	1.03	1.40	1.67	0.67	0.73	1.07
T ₆	Soil + Leaf mould (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	1.40	1.73	2.40	0.93	0.94	1.20
T ₇	Soil + Leaf mould (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	1.77	2.10	2.83	0.93	1.14	1.42
T ₈	Soil + Leaf mould (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	1.90	2.30	3.10	1.07	1.21	1.80
S.E m ±		0.340	0.278	0.426	0.110	0.107	0.180
CD at 5%		1.011	0.825	1.267	0.327	0.318	0.535

Fresh weight of primary roots (g)

The calculated data for fresh weight of primary roots (g) at 45, 90 and 135 DAT is presented in table 7. The maximum fresh weight of primary roots (g) (1.38, 1.51 and 1.84) were observed in treatment T₄ (Soil +Vermicompost (2:1) + GA₃ 200 ppm+ *Azotobacter* (0.5ml). The above results are in accordance with earlier reports in Ramteke *et al.*, (1998)^[14], Rymbai *et al.*, (2012)^[16], Rolaniya *et al.*, (2018)^[13], Damar *et al.*, (2014)^[5], Muthia *et al.*, (2015)^[9] showed that GA₃ has significantly

superior impact on fresh weight of primary roots in *Ceriops decandra*.

Fresh weight of secondary roots (g)

The observations for fresh weight of secondary roots (g) at 45, 90 and 135 DAT is presented in table 7. It is detectable from the research findings that, the maximum fresh weight of secondary roots (g) (0.49, 0.58 and 0.79) were recorded under treatment T₄(Soil +Vermicompost (2:1) + GA₃ 200 ppm+ *Azotobacter* (0.5ml).

Table 7: Effect of biofertilizer, GA₃ and growing media on fresh weight of primary and secondary roots (g)

Treatment Details		Fresh weight of primary roots (g)			Fresh weight of secondary roots (g)		
		45 DAT	90 DAT	135 DAT	45 DAT	90 DAT	135 DAT
T ₀	Soil (Control)	0.49	0.72	0.90	0.20	0.28	0.40
T ₁	Soil + Vermicompost (2:1)	0.93	1.06	1.20	0.30	0.36	0.43
T ₂	Soil + Vermicompost (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	1.21	1.26	1.37	0.35	0.43	0.51
T ₃	Soil + Vermicompost (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	1.27	1.31	1.47	0.43	0.49	0.62
T ₄	Soil + Vermicompost (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	1.38	1.51	1.84	0.49	0.58	0.79
T ₅	Soil + Leaf mould (2:1)	0.54	0.81	1.00	0.28	0.32	0.36
T ₆	Soil + Leaf mould (2:1) + GA ₃ 100 ppm + <i>Azotobacter</i> (0.5 ml)	1.08	1.15	1.26	0.32	0.40	0.49
T ₇	Soil + Leaf mould (2:1) + GA ₃ 150 ppm + <i>Azotobacter</i> (0.5 ml)	1.23	1.30	1.42	0.39	0.47	0.55
T ₈	Soil + Leaf mould (2:1) + GA ₃ 200 ppm + <i>Azotobacter</i> (0.5 ml)	1.32	1.40	1.63	0.47	0.51	0.68
S.E m ±		0.088	0.057	0.041	0.033	0.019	0.021
CD at 5%		0.261	0.170	0.123	0.097	0.056	0.061

References

- Adams PA, Montague MJ, Tepfer M, Rayle DL, Ikuma H, Kaufman PB. Effect of gibberellic acid on the plasticity and elasticity of Avena stem segments. *Plant Physiology*. 1975;56(2):757-760.
- Anonymous. National Horticulture database. National Horticulture Board. Govt. of India, Gurgaon, India, 2018. <http://www.nhb.gov.in>
- Bhandulkar K. Impact of Indole butyric acid and bioinoculant on survivability of transplanted air layered plants of guava (*Psidium guajava* L.) M.Sc. thesis department of Horticulture, RVSKVV Gwalior, 2017.
- Canli FA, Orhan H. Effects of Foliar Gibberellic Acid Applications on Vegetative Growth of Pear, Apple and Cherry Seedlings *International Journal of Natural and Engineering Sciences*. 2009;3(1):95-98.
- Damar Dina, Barholia AK, Lekhi R, Haldar A. Effect of growth regulators and biofertilizers on survival of pomegranate (*Punica granatum* L.) stem cuttings. *Plant Archives*. 2014;14:347-350.
- Dawar IS, Sharma TR, Nagar OP, Pal S. Effect of Different Rooting Media for Rooting Success and Survivability of Marcottage in Pomegranate (*Punica granatum* L.) C.V. Bhagwa. *Int. J Curr. Microbiol. App. Sci*. 2020;9(12):1858-1867.
- Ezz TM, Aly MA, Saad MM, El-Shaieb F. Comparative study between bio- and phosphorus fertilization on growth, yield, and fruit quality of banana (*Musa* spp.) grown on sandy soil. *J Saudi Soc. Agric. Sci*. 2011.
- El-Habbasha SF, Hozayn M, Khalafallah MA. Integration effect between phosphorus levels and bio- fertilizers on quality and quantity yield of faba bean (*vicia* 180 fabal.) in newly cultivated sandy soils. *Research journal of Agriculture and Biological Sciences*. 2007;3(6):966-971.
- Muthia G, Arumugam, Arunprasath. Growth Performance of *Ceriops decandra* propagules as influenced by PGR and #8211; A conservation effort. *Journal of Plant Stress Physiology*. 2015;1(1-5):10.5455.
- Kashyap A, Lekhi R, Raghuwanshi KS, Jatav P, Agrawal S. Interaction effect of different rooting media and IBA concentration on growth and survivability of air layers in acid lime, *Bhartiya Krishi Anushandhan Patrika*. 2016;31(1):39-41.

11. Kashyap A. Effect of Bio-fertilizer and IBA on photosynthesis efficiency and weight of leaf in air layered guava (*Psidium guajava* L.) cv. Gwalior-27. Ph.D Thesis, Rajmata VijayarajeScindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh (India), 2019.
12. Rajpoot M. Effect of IBA and bio fertilizers augmented growing media on air layered plant of guava (*Psidium guajava* L.) cv. Gwalior 27 M.Sc. thesis department of horticulture RVSKVV Gwalior, 2012.
13. Rolaniya MK, Bairwa M, Khushbu, Sarvanan S. Effect of Plant Growth Regulators (IAA, IBA, GA3) on Rooting of Hardwood Cutting of Grape (*Vitis venifera* L.) cv. Thompson Seedless. Journal of Pharmacognosy and Phytochemistry. 2018;7:398-400.
14. Ramteke NH, Verma RM, Damke MM, Patil VS, Panchbhai DM. Studies on propagation in guava (*Psidium guajava* L.) under Akola conditions. PKV Research Journal. 1998;22(2):180-182.
15. Rymbai H, Reddy GS. Effect of IBA, time of layering and rooting media on air layers and plantlets survival under different growing nursery conditions in guava. Indian Journal of Horticulture. 2010;67:99-104.
16. Rymbai H, Sathyanarayana Reddy G, Reddy KCS. Effect of cocopeat and sphagnum moss on guava air layers and plantlets survival under open and polyhouse nursery. Agric. Sci. Digest. 2012;32(3):241-243.
17. Shaikh N, Ramteke SD, Mane AV, Pethe UB, Urkude V. Studies On Effect Of Different Propagation Media On Growth And Survival Of Clove (*Syzygium aromaticum* L. *Meer*) Seedlings. International Journal of Agriculture Sciences. 2018;10(19):7328-7330.
18. Sevik H, Güney K. Effects of IAA, IBA, NAA, and GA3 on rooting and morphological features of *Melissa officinalis* L. Stem cuttings. The Scientific World Journal, 2013. 10.1155/2013/909507.
19. Sharma A. Application of Chemical and Biofertilizers on Growth and Biomass Production of *Madhuca latifolia* (Mahua) Seedlings International Journal of Bio-Science and Bio-Technology. 2014;6(4):25-32.
20. Singh P, Chandrakar J, Singh AK, Jain V, Agrawal S. Effect on rooting in guava cv. Lucknow-49 through PGR and organic media under Chhattisgarh condition. Acta Horticulturae. 2007;7(35):197-200.
21. Slakins V. Hormonal relationship in mycorrhizal development. Academic Press, London, Orland. 1973, 231-298.
22. Tyagi SK, Patel RM. Effect of growth regulators on rooting of air layering of guava (*Psidium guajava* L.) cv. Sardar. Orissa J. Hort. 2004;32(1):58-62.
23. Vessey JK. Plant growth promoting rhizobacteria as bio fertilizers. Plant and soil. 2003;255:571-586.
24. Yosefi K, Galavi M, Ramrodi M, Mousavi SR. Effect of bio-phosphate and chemical phosphorus fertilizer accompanied with micronutrient foliar application on growth, yield and yield components of maize (Single Cross 704). Aust. J Crop Sci. 2011;5(2):175-180.