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Effect of Plant Growth Regulators and Growing Media on Rooting of Cuttings in *Punica granatum* L. cv. Bhagwa

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ABSTRACT

Background: When pomegranates are multiplied through seeds, germination leads to vigorous tree growth. However, the tree will not be exactly similar to its parent and the resultant fruit produced will be irregular in colour, size, juiciness and sweetness.

Methods: Soft-wood cuttings of Pomegranate cv. Bhagwa were planted in different growing media that were entitled G_1- Soil + FYM, G_2- Soil + Vermiculite, G_3- Soil + Sand + FYM and G_4- Soil + FYM + Vermiculite. These cuttings were treated with different combinations of 1-Naphthaleneacetic acid (NAA), Indole-3-butyric acid (IBA), Hydrogen peroxide (H_2O_2), Ascorbic acid (ASC) and Boric acid. Studies were carried out in a two-factorial randomized block design (FRBD) with 28 treatment permutations.

Result: Current research indicated that treatment T_{18} (NAA 500 ppm + H_2O_2 30 ppm + IBA 500 ppm, Soil + Vermiculite (1:1) worked out to be the best treatment as it exhibited superiority over other treatments. The results of this experiment can practically be implemented to propagate quality planting material by adopting these best results/treatments.

Key words: Chemicals, Growing media, PGR, Pomegranate, Propagation.

INTRODUCTION

Pomegranate (*Punica granatum* L.), a member of the Lythraceae family, is native to Iran and northern India, but it has long been grown and domesticated across the Caucasus and the Asian Mediterranean regions (Chandra *et al*., 2010). It is frequently cultivated in arid and semi-arid climates in tropical and subtropical regions and in India. Maharashtra, Karnataka and Gujarat have the largest area share of pomegranate cultivation. This fruit is rich in antioxidants (three times more than in green tea or red wine) and flavonoids and regular consumption helps to protect our body from free radical damage, diseases like cancer and decreases inflammation and lowers blood pressure, high cholesterol, oxidative stress, hyperglycemia (Primarizky *et al*., 2016).

Stem cuttings are commonly used to multiply plants. Various kinds of growing mediums like cocopeat, vermiculite and perlite, significantly enhance rooting in cuttings. These media directly impact the percentage of roots that root and the quality of the roots that are generated (Ansari, 2013). To get the intended outcomes, proper selection of rooting media should be prioritized to get the intended outcomes. Many organic and synthetic growth media, including compost, peat, or coconut coir, have been used as a suitable substitute for soil-based media for producing cuttings because soil-based media may be associated with rapid water loss (Gruda, 2019). Ideally, the rooting media should comprise 10 to 30% organic matter for water retention and should be sterile (Yilmaz *et al*., 2018; Romano *et al*., 2020). Use of chemicals including PGR also affects the rooting of cuttings to a greater extent. Hence this study was designed to evaluate the impact of different PGRs and growth media on rooting of pomegranate cuttings.

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MATERIALS AND METHODS

This study was conducted at Agriculture Farm, Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, Punjab during 2021-2022. The experiment was laid out in a two-factorial randomized block design (FRBD) with 28 treatment combinations and 3 replications.

Planting material and growing medium

Semi-hardwood cuttings of uniform size (10-15 cm long and 0.75-1.00 cm in diameter) with 3-4 buds were collected from well-established and healthy pomegranate cv. Bhagwa trees from Agriculture Farm, LPU, Phagwara in the month of November. These cuttings were planted in black polybags (5 × 7 inches) filled with different growing media (Fig 1). A total of 420 cuttings (5 cuttings per treatment) were planted in four different growing media that were designated as G_1- Soil + FYM (1:1), G_2- Soil + Vermiculite (1:1), G_3- Soil + Sand + FYM (1:1:1) and G_4- Soil + FYM + Vermiculite (1:1:1). Basal ends of all cuttings were treated with different combinations of 1-Naphthaleneacetic acid (NAA), Indole-3-butyric acid (IBA), Hydrogen peroxide (H_2O_2), Ascorbic acid (ASC) and Boric acid as per the treatment details.

Treatment details

Two factors were considered in the present study with different levels *viz*. Factor I (chemicals and PGRs) and Factor II (Growing media) as per the details mentioned below:

Factor I (Chemicals and PGR)	Factor II (Growing media)
C_0 = Distilled water	G_1 = Soil+ FYM (1:1)
C_1 = NAA 1000 ppm + IBA 1000 ppm	G_2 = Soil + Vermiculite (1:1)
C_2 = IBA 750 ppm + Boric acid 1.5%	G_3 = Soil + Sand + FYM (1:1:1)
C_3 = IBA 750 ppm + ASC 50 ppm	
C_4 = NAA 500 ppm + H_2O_2 30 ppm +IBA 500 ppm	
C_5 = NAA 500 ppm + ASC 50 ppm + IBA 500 ppm	
C_6 = NAA 500 ppm + Boric acid 1.5% + IBA 500 ppm	

The factors were interacted into 28 treatments for application to the pomegranate cuttings as mentioned below:

T_1	C_0G_1	T_{15}	C_3G_3
T_2	C_0G_2	T_{16}	C_3G_4
T_3	C_0G_3	T_{17}	C_4G_1
T_4	C_0G_4	T_{18}	C_4G_2
T_5	C_1G_1	T_{19}	C_4G_3
T_6	C_1G_2	T_{20}	C_4G_4
T_7	C_1G_3	T_{21}	C_5G_1
T_8	C_1G_4	T_{22}	C_5G_2
T_9	C_2G_1	T_{23}	C_5G_3
T_{10}	C_2G_2	T_{24}	C_5G_4
T_{11}	C_2G_3	T_{25}	C_6G_1
T_{12}	C_2G_4	T_{26}	C_6G_2
T_{13}	C_3G_1	T_{27}	C_6G_3
T_{14}	C_3G_2	T_{28}	C_6G_4

Observations and analysis

Observations were recorded at intervals of 15 days *i.e.*, 45, 60, 75 and 90 DAP on the percentage of sprouted cuttings, the number of leaves per cutting, the length and diameter of the sprouts, the extent of leaves, chlorophyll level and survival rate. Similarly, different root parameters including rooting percentage, root length per cutting, root diameter per cutting, fresh weight of the roots and dry weight of the roots were taken using standard formulas and procedures (Fig 1). ANOVA was used to statistically evaluate the data and critical difference values were calculated at a significance level of 5% for each degree of freedom.

RESULTS AND DISCUSSION

Sprouting percentage (%)

The combination of PGR's and growing media had significantly improved the sprouting in pomegranate cuttings. Those treated with NAA 500 ppm + H_2O_2 30 ppm + IBA 500 ppm + (Soil + Vermiculite, 1:1) (T_{18}) showed maximum sprouting percentages of 53.33%, 66.67%, 93.33% and 96.67% at 45, 60, 75 and 90 DAP and performed better compared to other treatment combinations. However, number of sprouts per cutting increased as the duration progressed (Table 1) and at 45 DAS, T_{10} (IBA 750 ppm + Boric acid 1.5%) + (Soil + Vermiculite (1:1) recorded maximum sprouts number per cutting (3.33) while at 60, 75 and 90 DAS, T_{18} may be considered as best treatment with 4.33. 4.67 and 4.83%, respectively. Under natural conditions, auxin concentration is on the higher side in the developing apex regions.

IBA and NAA concentrations helped the cuttings to get optimum roots for getting proper nutrition from growing media and hydrogen peroxide is a key messenger during photosynthesis and photorespiration, as well as during respiration (Shabala *et al*., 2016). H_2O_2 is an eco-friendly compound produced and acts as a signaling molecule mainly in plant cells during photosynthesis and photorespiration, with a smaller amount produced in respiration. Moreover, vermiculite offers an alternative to the soil as a growth medium because of its inert nature. It helps to retain the soil aeration and reduce compaction thereby retaining more water and nutrients that help in the growth of the seedlings and proliferation of the roots. The interaction effect of auxins along with the growing media vermiculite led to optimum availability of soil moisture and nutrients for the growing cuttings which in turn increased the number of sprouts. Similar findings have been reported by Ranpise *et al*. (2022) in grapes and Caporale *et al*., (2022) for pomegranates.

Number of leaves

Maximum number of leaves per cutting were observed in T_{16} (IBA 750 ppm + ASC 50 ppm) + (Soil + FYM + Vermiculite (1:1:1) *i.e.*, 12.33, 16.67, 19.33 and 20.67 at 45, 60, 75 and 90 DAP treatment (Table 1). IBA-treated cuttings resulted in longer, healthier roots that aid in the absorption of water and nutrients, significantly impacting the cuttings' ability to produce more leaves. There may be more roots, branches and plant height with IBA 750 ppm, which results in more leaves per cutting (Bowden *et al*., 2022; Maurya *et al*., 2022). The current findings are consistent with those of Kaushik *et al.* (2020) in pomegranate.

Table 1: Effect of different treatments on sprouting percentage (%) and avg number of new leaves/in pomegranate cutting cv Bhagwa.

Treatments	Sprouting percentage (%)					Average number of new leaves/cutting				
	45 DAP	60 DAP	75 DAP	90 DAP	Mean	45 DAP	60 DAP	75 DAP	90 DAP	Mean
T_1	6.67	20.00	46.67	53.33	31.67	1.33	4.67	5.33	9.33	5.17
T_2	6.67	13.33	40.00	46.67	26.67	1.33	4.00	4.67	6.00	4.00
T_3	6.67	13.33	66.67	66.67	38.33	0.67	1.33	6.00	8.67	4.17
T_4	26.67	33.33	60.00	73.33	48.33	10.00	10.67	11.33	14.00	11.5
T_5	0.00	20.00	53.33	60.00	33.33	0.00	5.33	6.67	8.89	5.22
T_6	46.67	53.33	73.33	80.00	63.33	5.00	6.33	10.00	18.67	10.00
T_7	6.67	13.33	53.33	73.33	36.67	0.67	2.00	4.00	8.67	3.83
T_8	46.67	53.33	60.00	93.33	63.33	6.67	11.00	11.33	22.67	12.92
T_9	20.00	26.67	66.67	73.33	46.67	11.00	15.00	16.67	17.33	15.00
T_{10}	60.00	66.67	73.33	86.67	71.67	12.33	16.67	19.33	20.67	17.25
T_{11}	13.33	26.67	40.00	66.67	36.67	0.67	5.67	6.00	12.67	6.25
T_{12}	33.33	40.00	73.33	93.33	60.00	7.33	5.00	10.67	13.33	9.08
T_{13}	20.00	26.67	40.00	53.33	35.00	11.00	13.33	15.33	17.17	14.21
T_{14}	20.00	26.67	40.00	66.67	38.33	6.67	7.33	8.00	11.33	8.33
T_{15}	40.00	46.67	53.33	80.00	55.00	7.00	9.67	11.33	8.67	9.17
T_{16}	33.33	40.00	66.67	93.33	58.33	20.67	21.00	22.00	23.33	21.75
T_{17}	20.00	26.67	80.00	93.33	55.00	3.67	5.33	7.33	14.67	7.75
T_{18}	53.33	66.67	100.00	100.00	80.00	5.00	5.33	7.33	14.00	7.92
T_{19}	20.00	26.67	93.33	93.33	58.33	10.67	12.67	17.33	20.00	15.17
T_{20}	13.33	26.67	60.00	100.00	50.00	1.33	6.33	8.00	10.00	6.42
T_{21}	6.67	20.00	40.00	60.00	31.67	0.67	2.67	6.00	6.67	4.00
T_{22}	33.33	46.67	66.67	66.67	53.33	2.00	4.00	6.67	11.33	6.00
T_{23}	13.33	20.00	66.67	73.33	43.33	2.00	3.33	4.00	8.00	4.33
T_{24}	6.67	13.33	46.67	73.33	35.00	0.67	1.33	4.67	12.00	4.67
T_{25}	0.00	20.00	40.00	53.33	28.33	0.00	7.33	8.67	12.67	7.17
T_{26}	20.00	26.67	40.00	60.00	36.67	2.00	3.00	4.67	10.67	5.08
T_{27}	20.00	26.67	66.67	80.00	48.33	1.33	3.33	5.33	12.00	5.50
T_{28}	6.67	33.33	53.33	66.67	40.00	1.33	4.67	5.33	11.33	5.67
C.D. Factor (A)	7.90	8.49	NS	9.58		2.23	2.04	NS	2.85	
C.D. of Factor (B)	10.45	11.24	18.09	12.67		2.95	2.70	3.01	3.78	
C.D. Factor (A × B)	20.91	22.48	NS	NS		5.91	5.41	6.01	7.56	

Table 2: Effect of different treatments on average length of sprouts and average diameter of sprouts (cm) in pomegranate cutting cv Bhagwa.

Treatments	Average length of sprouts (cm)					Average diameter of sprouts (cm)				
	45 DAP	60 DAP	75 DAP	90 DAP	Mean	45 DAP	60 DAP	75 DAP	90 DAP	Mean
T_1	0.27	1.20	1.47	1.73	1.17	0.05	0.19	0.30	0.37	0.23
T_2	0.2	0.73	0.87	1.93	0.93	0.07	0.20	0.33	0.43	0.26
T_3	0.17	0.27	0.63	1.17	0.56	0.17	0.20	0.30	0.37	0.26
T_4	0.8	1.00	1.60	1.80	1.30	0.27	0.37	0.51	0.58	0.43
T_5	0.00	0.97	1.23	1.75	0.99	0.00	0.28	0.37	0.47	0.28
T_6	0.87	1.07	1.37	4.20	1.88	0.27	0.38	0.45	0.57	0.42
T_7	0.27	0.30	0.63	0.93	0.53	0.13	0.19	0.33	0.50	0.29
T_8	1.23	1.67	2.03	3.07	2.00	0.25	0.28	0.37	0.50	0.35
T_9	1.12	1.20	1.70	2.23	1.56	0.25	0.28	0.33	0.50	0.34
T_{10}	1.77	1.93	2.33	2.80	2.21	0.29	0.38	0.52	0.63	0.46
T_{11}	0.20	0.67	1.03	1.67	0.89	0.10	0.37	0.47	0.58	0.38
T_{12}	0.68	0.90	1.20	1.40	1.05	0.22	0.30	0.34	0.55	0.35
T_{13}	0.97	1.17	1.40	1.77	1.33	0.23	0.25	0.30	0.38	0.29
T_{14}	0.87	1.40	1.57	2.40	1.56	0.23	0.30	0.37	0.60	0.38
T_{15}	0.88	1.03	1.20	1.50	1.15	0.28	0.34	0.37	0.48	0.37
T_{16}	1.70	1.90	2.37	2.93	2.23	0.37	0.45	0.48	0.62	0.48
T_{17}	1.30	1.57	2.03	3.60	2.13	0.19	0.27	0.30	0.40	0.29
T_{18}	0.97	1.30	1.73	2.47	1.62	0.24	0.25	0.33	0.47	0.32
T_{19}	0.22	0.90	1.13	1.43	0.92	0.15	0.27	0.28	0.37	0.27
T_{20}	0.20	0.97	1.33	2.47	1.24	0.1	0.31	0.41	0.47	0.32
T_{21}	0.33	0.73	0.77	1.03	0.72	0.07	0.23	0.37	0.41	0.27
T_{22}	0.57	0.63	0.90	1.80	0.98	0.17	0.20	0.35	0.45	0.29
T_{23}	0.20	0.43	0.57	1.47	0.67	0.05	0.20	0.37	0.43	0.26
T_{24}	0.27	0.30	0.60	1.87	0.76	0.13	0.20	0.37	0.45	0.29
T_{25}	0.00	1.10	1.37	1.50	0.99	0.00	0.23	0.32	0.57	0.28
T_{26}	0.27	0.80	0.97	1.5	0.89	0.13	0.22	0.25	0.38	0.24
T_{27}	0.27	0.53	0.90	1.53	0.81	0.10	0.17	0.30	0.37	0.23
T_{28}	0.27	1.00	1.30	1.50	1.02	0.11	0.37	0.53	0.68	0.42
C.D. Factor(A)	0.25	NS	0.32	0.50		0.07	NS	NS	0.08	
C.D. Factor(B)	0.33	NS	0.42	0.67		0.10	NS	NS	NS	
C.D. of (A × B)	0.66	NS	NS	1.34		NS	NS	NS	NS	

Table 3: Effect of different treatments on chlorophyll content (mSPU) and Survival and rooting parameters after 90 Days planting.

Treatments	Chlorophyll content (mSPU)					90 Days after planting					
	45 DAP	60 DAP	75 DAP	90 DAP	Mean	Survival percentage	Rooting percentage	Average (cm) length of roots/cutting	Avg dia. of thickest root/cutting	Fresh weight of root (gm)	Dry weight of root (gm)
T_1	8.10	28.73	32.30	37.27	26.60	53.33	60.00	1.09	1.67	2.33	1.27
T_2	6.60	19.27	37.67	39.83	25.84	46.67	66.67	1.87	1.57	2.66	1.29
T_3	9.10	14.03	39.50	42.40	26.26	66.67	80.00	1.46	1.5	1.99	1.19
T_4	8.40	14.8	28.27	35.63	21.78	73.33	73.33	1.27	1.17	2.29	0.84
T_5	0.00	31.27	32.80	33.87	24.48	60.00	66.67	2.03	1.83	1.93	1.30
T_6	29.37	33.08	43.00	44.57	37.68	80.00	80.00	4.63	1.50	2.55	1.00
T_7	7.87	21.87	39.27	41.00	27.50	73.33	73.33	1.37	1.50	2.81	1.21
T_8	35.63	36.63	34.63	38.07	36.24	93.33	93.33	2.93	1.67	1.94	1.40
T_9	27.33	31.93	32.13	33.57	31.24	73.33	73.33	2.70	2.00	2.00	1.13
T_{10}	30.00	35.17	37.57	41.60	36.08	86.67	86.67	3.23	2.83	2.20	0.98
T_{11}	7.07	22.37	37.80	40.43	26.92	66.67	73.33	1.21	1.67	2.46	1.13
T_{12}	21.30	23.67	26.53	30.83	25.58	93.33	93.33	1.70	1.67	1.75	0.93
T_{13}	19.10	23.93	32.10	36.83	27.99	53.33	66.67	2.03	1.50	2.20	0.95
T_{14}	23.63	26.73	35.70	38.03	31.03	66.67	66.67	3.17	1.17	2.50	1.00
T_{15}	19.73	32.50	34.97	38.60	31.45	80.00	80.00	1.47	1.17	2.51	1.05
T_{16}	28.03	28.30	31.47	33.27	30.27	93.33	93.33	3.27	1.40	2.45	1.17
T_{17}	29.70	33.97	37.90	40.87	35.61	93.33	93.33	4.37	1.50	1.83	1.00
T_{18}	23.47	36.57	46.6	48.50	38.78	100.00	100.00	2.67	2.00	3.45	1.63
T_{19}	16.43	28.43	38.53	41.27	31.17	93.33	93.33	1.54	1.50	2.47	0.62
T_{20}	7.13	34.37	34.9	40.07	29.12	100.00	100.00	2.60	1.67	1.61	1.17
T_{21}	5.97	18.27	25.27	29.65	19.79	60.00	66.67	1.43	1.83	2.28	1.17
T_{22}	15.37	16.17	37.2	40.63	27.34	66.67	73.33	2.07	1.53	2.73	0.98
T_{23}	8.10	21.10	33.27	37.73	25.05	73.33	73.33	1.44	1.83	2.14	1.31
T_{24}	5.83	12.47	26.23	33.63	19.54	73.33	80.00	2.04	2.00	2.06	0.96
T_{25}	0.00	30.67	32.67	36.73	25.02	53.33	60.00	3.53	1.50	2.20	1.00
T_{26}	21.33	31.17	34.17	40.10	31.69	60.00	73.33	1.27	2.17	2.43	0.92
T_{27}	8.70	19.83	33.17	36.00	24.43	80.00	80.00	1.67	1.67	2.04	1.30
T_{28}	7.80	31.30	34.87	37.37	27.83	66.67	66.67	1.53	1.50	2.14	0.90
C.D. (A)	5.34	NS	2.315	1.87		9.58	8.38	0.50	NS	7.72	NS
C.D. (B)	7.07	8.37	3.063	2.47		12.67	11.08	0.66	0.43	10.21	NS
C.D. (A × B)	14.14	NS	NS	4.94		NS	NS	1.32	NS	20.42	0.41

Shoot length

Treatment T_{10} (IBA 750 ppm + Boric acid 1.5%) + (Soil + Vermiculite (1:1) (Table 2) recorded maximum sprout length per cutting at 45, 60 and 75 DAP however at 90 DAP, treatment T_6 (NAA 1000 ppm + IBA 1000 ppm) + (Soil + Vermiculite (1:1) had the highest average length (4.20cm) of sprout per cutting. Boric acid was the most effective at inducing rooting and sprouting and the most beneficial to root and shoot growth (Bhatt and Grassland, 2001). It was observed that T_{10} (IBA 750 ppm + Boric acid 1.5%) + (Soil + Vermiculite (1:1) showed the highest average diameter (*i.e.*, 0.30 cm) of sprout per cutting. Data collected on 60 DAP, 75 DAP and 90 DAP revealed that T_{10} (IBA 750 ppm + Boric acid 1.5%) + (Soil + Vermiculite (1:1) had the maximum sprout's diameter (0.52cm, 0.53 cm and 0.70 cm, respectively) per cutting. Boric acid has been considered, the most effective in stimulating rooting and sprouting, as well as root and shoot growth (Bhatt and Grassland, 2001).

Leaf area

Leaf area was recorded maximum under treatment T_{10} (IBA 750 ppm + Boric acid 1.5%) + (Soil + Vermiculite (1:1) (0.82 cm^2) and (1.37cm^2) at 45 and 60 DAP (Table 2). However, at 90 DAP, T_{18} (NAA 500 ppm + H_2O_2 30 ppm + IBA 500 ppm) + (Soil + Vermiculite (1:1) had the highest leaf area (18.47 cm^2). Auxins like IBA and NAA encourage plant cell growth and elongation. It changes the plant wall plasticity during the elongation process, allowing the plant to grow upwards more easily (Küpers, 2020). The external application of H_2O_2 helped the cuttings to enhance physiological activities like photosynthesis, photorespiration, *etc*. (Caporale *et al*., 2022).

Chlorophyll content

Maximum chlorophyll content (35.63 mSPU) was recorded under treatment T_8. At 60 DAP, 75 DAP and 90 DAP, T_{18} showed maximum chlorophyll content *i.e*. 46.60 mSPU, 48.50 mSPU and 48.50 mSPU, respectively. Exogenously applied auxin significantly increased chlorophyll concentrations, according to Moustafa-Farag *et al.* (2020). Synthetic auxin increased chlorophyll fluorescence and stimulated chlorophyll synthesis (Khandaker *et al*., 2015) in wax apples. Under unfavourable conditions, H_2O_2 may protect chloroplast ultrastructure, allowing photosynthesis to continue (Kareem *et al*., 2022).

Survival percentage

The highest survival percentage (96.67%) was observed in treatment combination T_{18} followed by T_{10} with a 90.00% survival rate (Table 3). The survival of sprouted cuttings may be directly related to the production of adventitious roots. It's probable that the substantial carbohydrate reserves per cutting and ideal IBA and H_2O_2 concentrations account for the best survival rate. The maximum number of shoots and roots per cutting, as well as the longest root length, were produced under the same conditions, which also led to a high survival rate. It can be a result of the growth of a strong root system as well as an increase in length and the number of roots with the help of nutrients and water intake (Reddy *et al*., 2009).

Root length

Maximum root length per cutting (4.67 cm) and root diameter per cutting (3.00 mm) were observed in T_{18} (Table 3). Maximum length and diameter of the root might be linked to NAA, which may have triggered the hydrolysis and transport of carbohydrates and nitrogenous substances towards the base of cuttings, resulting in rapid cell division and cell elongation under a favourable environment. Another explanation might be the early emergence of roots and higher use of the food reserves provided for the treated cuttings. H_2O_2 is helped in photosynthesis and photorespiration. Vermiculite is a lightweight material that aids in rooting, water retention and root growth (Singh *et al*., 2022).

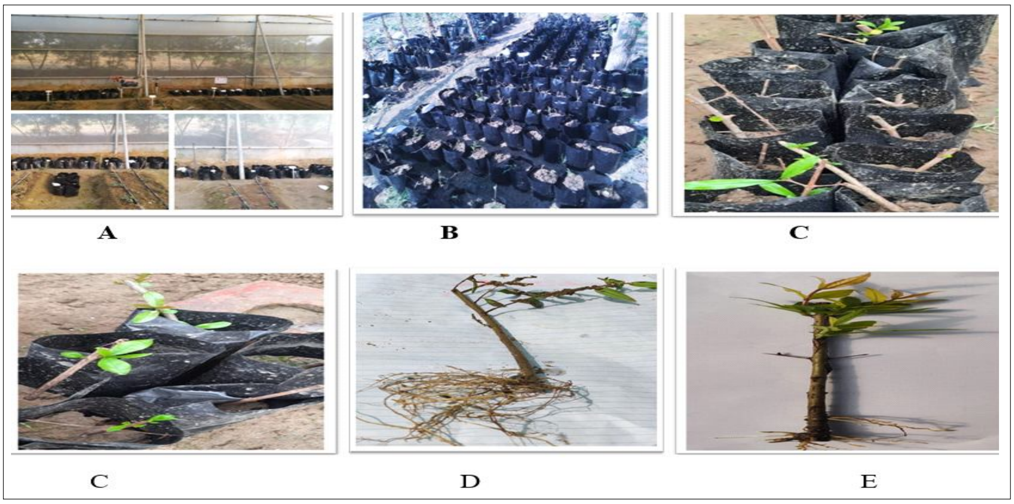

Fig 1: -A+B- Planting material and C+D+E-Sprouted cuttings.

Root weight

At 90 DAP, the highest root fresh weight per cutting (3.45 gm) was observed in T_{18}. The observed result could be due to a higher accumulation of photosynthates metabolites and nutrients during treatment. Increased root weight could be due to the production of more roots, longer roots and larger roots, all of which result in the production of heavier roots, resulting in increased root weight (Desta *et al*., 2021). Vermiculite provides a high nutrient-holding capacity and good air porosity can enhance root growth. These studies are consistent with those of Shabala *et al*. (2016) in pomegranate.

CONCLUSION

At specific concentrations, the root promoters performed significantly superior to other concentrations. Similarly, rooting media was also standardized based on the root and sprout growth parameters. It may be concluded cuttings treated with that NAA 500 ppm + H_2O_2 30 ppm + IBA 500 ppm (T_{18}) and planted in Soil + Vermiculite (1:1), may be considered the most effective treatment for rooting in pomegranate cv. Bhagwa.

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Conflict of interest

The authors have no declared conflict of interest.

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