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The effects of various chemicals and PGR combinations on the survival and shooting characteristics of pomegranate cv. Bhagwa cuttings in various growth media conditions

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Abstract
Pomegranate (*Punica granatum* L.) is a major fruit crop in India's arid and semi-arid regions. In India, one of the commercial propagation methods for pomegranates is stem cutting. The purpose of this study was to see how well different growing media, chemicals, and PGR combinations worked in producing high-quality Pomegranate cuttings for commercial use. The work was performed at the Agriculture Farm, Lovely Professional University, Punjab from November 2021 to February 2022. The experiments were installed in a two factorial randomized block design (FRBD) with three replications and five cuttings per experimental unit. The work was done by cuttings treated with seven distinct chemical & PGR combinations and planted in four distinct rooting media which are placed in polythene bags. Cuttings treated with T18 (C4G2) produced the best results in terms of Sprouting percentage, Number of sprouts/cuttings, Survival percentage, Rooting percentage, Chlorophyll content, Leaf area, length of roots, diameter of the root, fresh weight of root, and dry weight of root. Other parameters such as the number of leaves per cutting, sprout length, and sprout diameter revealed that treatment combination T10 (C2G2) produced the best results.

Keywords: Pomegranate, cuttings, PGR's, chemicals, and media

Introduction
Pomegranate is widely regarded as a "Superfood" due to its high nutritional value. There is a lot of interest in cultivating pomegranates and a lot of competitiveness in the market because of the high costs. Pomegranate (*Punica granatum*) is a fruit that grows in tropical and subtropical climates of the world. Pomegranate cultivation covers 262.00 thousand ha area in India, with a production of around 3034.00 thousand MT (NHB 2018-19 3rd Advance Estimate). Pomegranate production in Maharashtra is the highest, followed by Karnataka, Andhra Pradesh, Gujarat, and Tamil Nadu. Vegetative propagation is the best way to propagate true-to-type plants. Pomegranate cutting propagation is the most convenient and cost-effective method of obtaining fully developed, stronger trees in a much shorter period of time. To reduce the high mortality of rooted cuttings under field conditions, it is highly desirable to build a healthy and well-developed root system for pomegranate tree field establishment through the use of appropriate plant growth regulators treatment. PGR's are chemical and biological agents that improve plant growth and productivity when used in small amounts at the appropriate growth stages of the plant. These are commonly used in agriculture to increase crop production. Indole-3-butyric acid (IBA), Boric acid, ascorbic acid (ASC), hydrogen peroxide (H2O2), and melatonin (MEL) have all been shown to improve pomegranate cutting rooting, root number, root length, and shoot length (Sarrou *et al*., 2014) [16]. The regulation of root apical meristem size, root hair elongation, lateral root development, and adventitious root formation are all important functions of auxin derived from IBA. NAA is a rooting agent that is used to multiply plants vegetatively from stem and leaf cuttings. Boron (Boric acid, B) is an essential and multi - purpose microelement for vascular plant development. Vitamin C (ascorbic acid (ASC)) is an antioxidant that also functions as an important substrate for the detoxification of reactive oxygen species (Smirnoff, 2000; Foyer and Noctor, 2011) [17, 6]. ASC can improve plant growth via photosynthetic activity, transpiration, oxidative potential, and photosynthetic pigments to improve abiotic stress tolerance (Qian *et al*., 2014) [14]. Hydrogen peroxide (H2O2) promotes healthy root growth due to the extra oxygen molecule.

As a result of the additional oxygen in hydrogen peroxide, the roots can absorb more nutrients, leading to faster, healthier, and more vigorous growth (Petri *et al*., 2003).

Ideal growth media provides physical strength (anchorage), keeps moisture content stable, and permits for gases exchange. It also helps the cuttings grow by providing rapid growth, metabolic activity, and development (Eed *et al*., 2015) [4]. Vermiculite has a quite low bulk density and a very high water-holding capacity. This substance also has a neutral pH, a high CEC, and trace amounts of potassium and magnesium. Although sand is used to increase porosity, small sand particles can become lodged in existing pore spaces, reducing aeration and drainage (Jacob D. *et al*., 2009) [7]. Farmyard manure is a natural fertiliser that helps to improve the soil structure. It expands the capacity of the soil to hold more water and nutrients. It also boosts the soil's microbial activity, which improves mineral supply and plant nutrition (Eklind, Y. *et al*., 2001) [5].

In light of these facts, the current research focuses on the use to propagate high-quality planting material by combining PGR, chemicals, and growing media in the right proportions.

Materials and Methods

Study area: The experiment took place at Punjab's Lovely Professional University's Agriculture Farm. The experimental site is located between 31° 15' 47" North longitude and 75° 41' 20" East latitude, with an elevation of 234 metres above mean sea level. During my research period, i.e., November 2021 to February 2022, this location experiences a wide range of temperature variations, ranging from 5°C to 27°C, the relative humidity ranges from 41 to 86 percent, and the average rainfall is in between 0 and 21.5 millimetres.

Methodology

In November, semi-hardwood stem cuttings with 3-4 functional buds were obtained from well-established healthy pomegranate cv. Bhagwa plants from Agriculture Farm, Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, Punjab. Four distinct growing medias [Soil + FYM (1:1) (G_1); Soil + Vermiculite (1:1) (G_2); Soil + Sand + FYM (1:1:1) (G_3); Soil + FYM + Vermiculite (1:1:1)) (G_4)] were prepared and filled in black-colored poly bags. After preparing growing media chemical and PGR combinations [Control (C_0); 1000 ppm NAA + 1000 ppm IBA (C_1); 750ppm IBA + 1.5% Boric acid (C_2); 750ppm IBA + 50ppm ASC (C_3); 500ppm NAA + 30ppm H_2O_2 + 500ppm IBA (C_4); 500ppm NAA + 50ppm ASC + 500ppm IBA (C_5) and 500ppm NAA + 1.5% Boric acid + 500ppm IBA (C_6)] were prepared in lab. After treating the cuttings in chemical and PGR combination, the cuttings were grown on Agriculture Farm in poly bags that filled with four various types of growing media.

Statistical design

The experiment was set up in a two-factorial randomised block design (FRBD) with three replications of each treatment combination, each with five cuttings. The data was analysed using industry-standard methods.

Results and Discussion

Survival Percentage

At 90DAP, the survival percentage of cuttings was calculated (Table1) and shown in Fig. 1. The maximum mean of survival of cuttings at 90DAP (96.67 percent) was found in treatment T18, which was the best treatment on Pomegranate cv. Bhagwa was followed by T10 and the least percentage of survival was recorded in T1. Sarrou *et al*., (2014) [16], and Ansari, K. (2013) [2] have already supported the aforesaid findings in pomegranate cuttings.

Table 1: Effect of chemicals and PGR combinations in various growth media conditions on survival percentage of pomegranate cv. Bhagwa cuttings

	C1	C2	C3	C4	C5	C6	C7	Mean G
G1	46.667	53.333	66.667	73.333	66.667	73.333	73.333	64.762
G2	80.000	73.333	90.000	66.667	86.667	66.667	66.667	75.714
G3	73.333	86.667	86.667	96.667	80.000	86.667	66.667	82.381
G4	66.667	73.333	86.667	53.333	66.667	73.333	66.667	69.524
Mean C	66.667	71.667	82.500	72.500	75.000	75.000	68.333	

Factors	C.D.	SE(d)	SE(m)
Factor(G) = Growing media	5.632	2.801	1.981
Factor(C) = chemicals and PGR combinations	7.451	3.706	2.621
Factor(G X C)	14.901	7.412	5.241

Sprouting percentage

The sprouting percentage of cuttings was calculated from 45 days after planting of cuttings in 15-day intervals (45DAP, 60DAP, 75DAP, 90DAP) and shown in Fig.1. T18 had the highest proportion of sprouted cuttings (77.50 percent) based on total mean data, and T10 had the second-highest readings (72.50 percent). In comparison, T1 had the lowest sprouting proportion (25.83 percent). Rajkumar *et al*., (2016) [15], Sarrou *et al*., (2014) [16], and Ansari, K. (2013) [2] have already supported the aforesaid findings in pomegranate cuttings.

Number of sprouts/cutting & Number of new leaves/cutting

The observations were made at intervals of 45, 60, 75, and 90 days and mean values shown in Fig.2. The number of sprouts & leaves on each cutting was counted, and the mean number of sprouts & leaves per cutting was calculated.

T18 (4.21) had the largest number of sprouts per cutting, and T10 had the second highest number of sprouts per cutting based on overall mean data (3.71). In comparison, T1 had the smallest number of sprouts per cutting (1.67). Based on total mean data from 45 to 90 DAP, T10 (21.75) had the largest number of leaves per cutting, while T16 had the second highest number of leaves per cutting (17.25). T21, on the other hand, had the least leaves per cutting (4.00). These findings are consistent with those of Panwar *et al*. (2001) [11] on Bougainvillea cuttings, Bhatt & Grassland (2001) [3] on Sesbania cuttings, and Kumar, S *et al*. (2020) [10] on pomegranate cuttings.

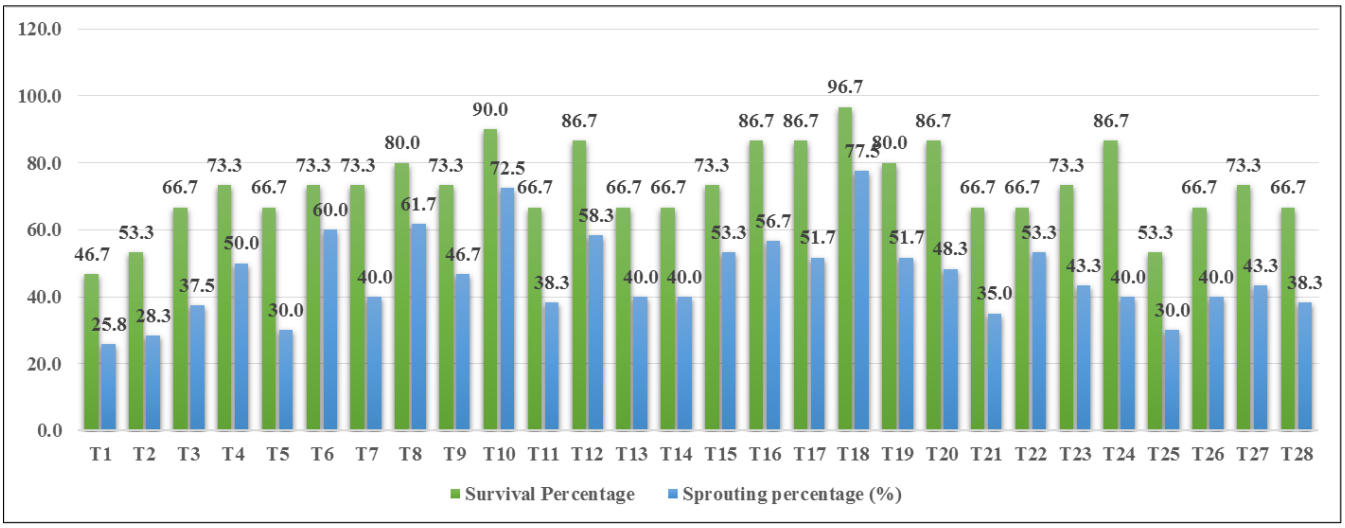

Fig 1: The impact of treatments on the percentage of survival & sprouting on overall mean values.

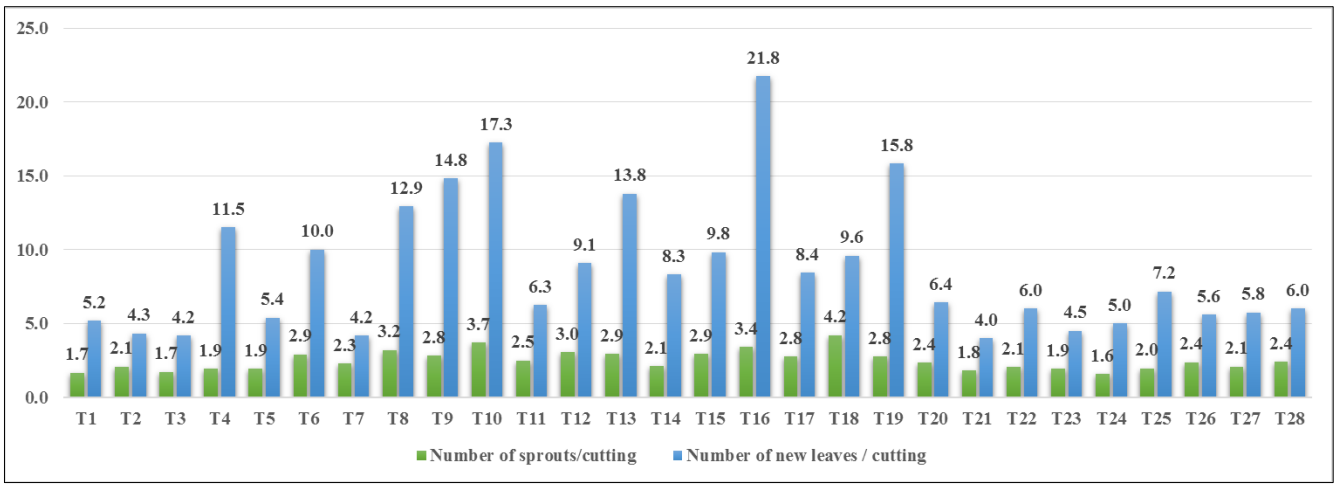

Fig 2: The impact of treatments on the number of sprouts & leaves per cutting on overall mean values.

Length & diameter of sprouts (cm)

The observations were made at intervals of 45, 60, 75, and 90 days and mean values shown in Fig.3. T10 (2.25cm) had the highest average length of sprout per cutting, while T16 had the second highest average length of sprout per cutting, based on overall mean data (2.23cm). T7, on the other hand, had the shortest average length of sprout per cutting (0.53). T10 (0.51cm) had the largest average diameter of sprout per cutting, while T18 had the second highest average diameter of sprout per cutting, based on overall mean data (0.48cm). T2, on the other hand, had the smallest average diameter of sprout per cutting (0.22cm). Bhatt & Grassland (2001) [3] and Kumar, S *et al*., (2020) [10] both supported the above findings.

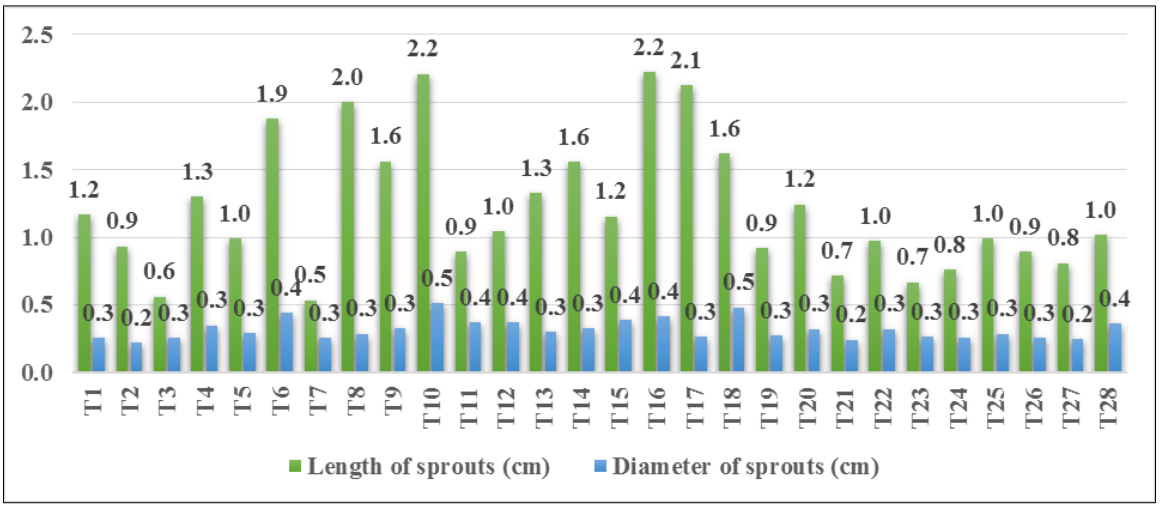

Fig 3: The impact of treatments on the Length & diameter of sprouts (cm) on overall mean values

Leaf area (cm2): On the basis of overall mean statistics, T18 (6.16 cm2) had the largest leaf area, whereas T17 had the second largest leaf area (5.96 cm2). T21, on the other hand, has the lowest leaf area value (1.03 cm2). Similar results were obtained in gooseberry by Sanabria *et al* (2014) [1]. These observations were shown in Fig.4.

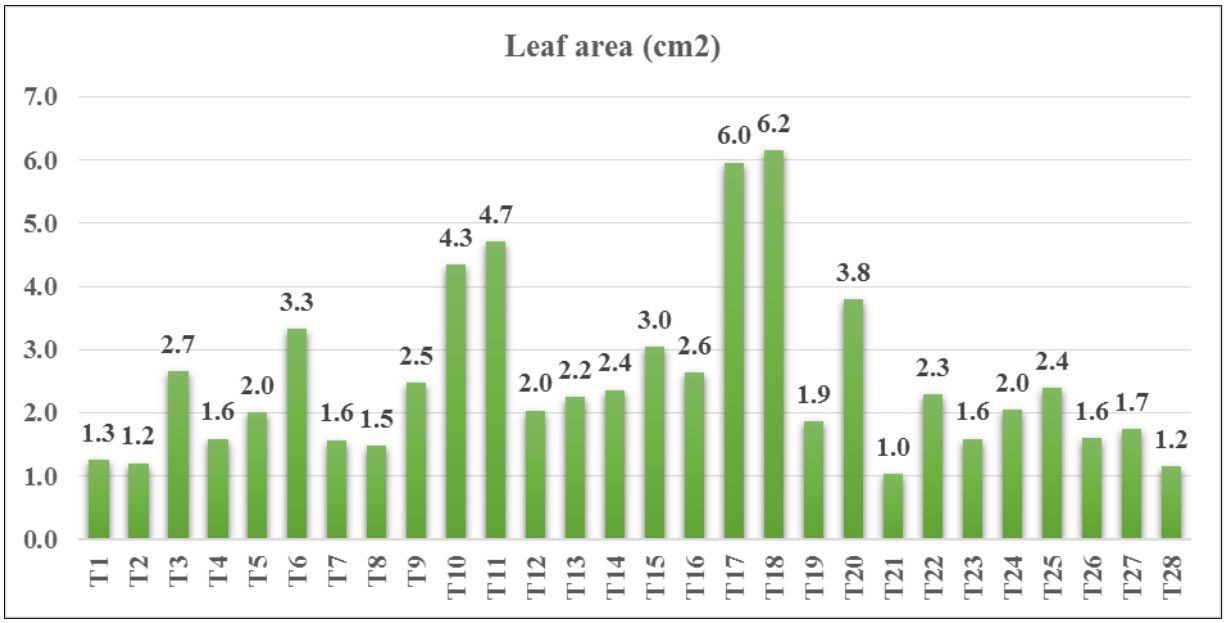

Fig 4: The impact of treatments on leaf area on overall mean values.

Chlorophyll content (mSPU)

According to the total mean data (Fig.5), the highest Chlorophyll concentration was found in T18 (41.77 mSPU), and the second highest Chlorophyll content was found in T6 (39.39 mSPU). T21, on the other hand, had the least amount of chlorophyll (23.98 mSPU). Khandaker, M. M., *et al*., (2022) [9] & Khandaker, M. M., *et al*., (2017) [8] on wax apple already supported the aforesaid findings.

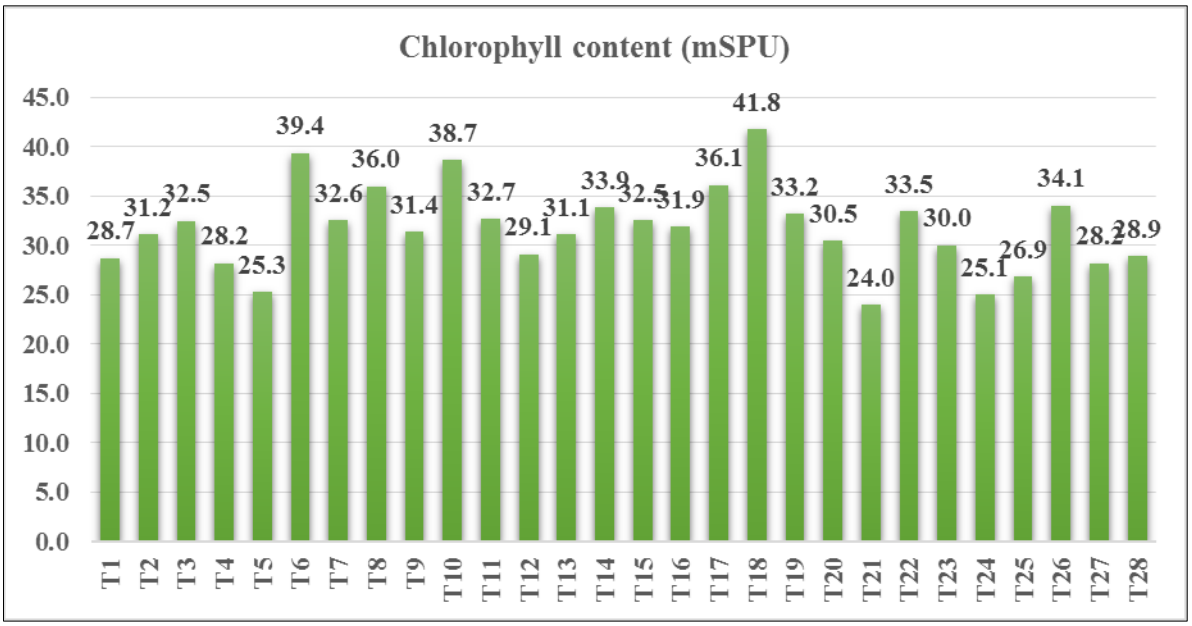

Fig 5: The impact of treatments on Chlorophyll content (mSPU) on overall mean values.

Bhagwa produced the highest sprouting percentage (77.5%), the highest number of sprouts cuttings (4.21), the highest leaf area (6.16cm2), and the highest chlorophyll content (41.77mSPU). The treatment of growing media soil + Vermiculite (1:1) with IBA 750ppm + Boric acid 1.5 percent (T10) on Pomegranate cv Bhagwa yielded the highest number of leaves per cutting (21.75), the highest average length of sprout per cutting (2.25cm), and the highest average diameter of sprout per cutting (0.51cm). while, in T1, the minimum sprouting percentage (25.83%), the minimum number of sprout cuttings (1.67), the minimum leaf area (1.03cm2), the minimum chlorophyll content (23.98mSPU), the minimum number of leaves per cutting (4.0) and the minimum length of sprout per cutting (0.53cm) in T7, and the minimum diameter of sprout per cutting (0.22cm) in T2.

Conclusion

The results of the experiment clearly reveal that treatment

T18 (NAA 500ppm + H2O2 30ppm + IBA 500ppm, Soil + Vermiculite) had the best results in terms of sprouting percentage (77.50%), no of sprouts/cutting (4.21), survival percentage (96.67%), rooting percentage (98.33%), chlorophyll content (41.77 mSPU), leaf area (6.16cm2), length of roots (4.67cm), diameter of root (3.00mm), fresh weight of root (3.45g) & dry weight of root (1.70g), followed by treatment T10. The results of this experiment can be used to propagate high-quality planting material by combining PGR, chemicals, and growing media in the right proportions.

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