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Effect of different rooting hormone on cuttings of pomegranate (*Punica granatum*) under protected condition in Prayagraj agro-climatic conditions

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Abstract
The present investigation entitled "Effect of different rooting hormone on cuttings of Pomegranate (*Punica granatum*) under protected condition in Prayagraj agro-climatic conditions" was conducted at shade net, Horticulture research farm, Department of horticulture, Naini agriculture college, SHUATS, Prayagraj (U.P.) during the academic year 2022-24. Plant growth hormones combination treatments include T_0 (Control), T_1 (IBA @ 2000 ppm + PG @ 3000 ppm), T_2 (IBA @ 2000 ppm + PG @ 4000 ppm), T_3 (IBA @ 2000 ppm + PG @ 5000 ppm), T_4 (IBA @ 2000 ppm + PG @ 6000 ppm), T_5 (IBA @ 3000 ppm + PG @ 3000 ppm), T_6 (IBA @ 3000 ppm + PG @ 4000 ppm), T_7 (IBA @ 3000 ppm + PG @ 5000 ppm), T_8 (IBA @ 3000 ppm + PG @ 6000 ppm) T_9 (IBA @ 4000 ppm + PG @ 3000 ppm) T_{10}(IBA @ 4000 ppm + PG @ 4000 ppm) T_{11} (IBA @ 4000 ppm + PG @ 5000 ppm) T_{12} (IBA @ 4000 ppm + PG @ 6000 ppm). The root, shoot parameters and survival percentage on transplanting of the cuttings of each treatment was done up to 90 days and all the observations were recorded at every 30 days interval. The root length (cm) and shoot length (cm) were recorded highest in the treatment T_7 during research which were (15.08 cm) and (52.68 cm) respectively. Days of first shoot initiation and Days of first leaf initiation had increasing trend during research work and lowest days recorded (6.59) and (7.02) in T_7 treatment respectively at 15 days. On the basis of our experimental findings, it is concluded that the T_7 (IBA @ 3000 ppm + PG @ 5000 ppm) was found to be best in the terms of days to first shoot initiation, days to first leaf initiation, shoot lengths, number of leaves, number of new shoots, root lengths, fresh weight of roots, dry weight of roots. After the transplantation of the Pomegranate cuttings, T_7 (IBA @ 3000 ppm + PG @ 5000 ppm) was found to be best in the terms of number of new shoots, shoot length, number of new leaves. In terms of rooting percentage and earliness of shooting, T_7 (IBA @ 3000 ppm + PG @ 5000 ppm) was found to be best. The survivability or the establishment percentage found to be the highest in T_7 (IBA @ 3000 ppm + PG @ 5000 ppm). It is also concluded that the best treatment of Pomegranate cuttings for Prayagraj agro-climatic conditions was found to be T_7 (IBA @ 3000 ppm + PG @ 5000 ppm) for establishment.

Keywords: Pomegranate, cuttings, IBA (Indole-butyric-acid), phloroglucinol

Introduction
Pomegranate (*Punica granatum* L.) belongs to Punicaceae family and it is a semi-arid fruit crop (De Candolle, 1967) Pomegranate prefers mild temperature and sub-tropical climate and is naturally adapted to a region with cool winters and hot summer. Pomegranate is deciduous in subtropics and evergreen in the tropics. The Pomegranate is widely considered to have been originated in Iran and cultivated since ancient time throughout Iran, India and the arid region of South- East Asia, Malaysia, East Indies and United States.

Pomegranate is a small, hardy and bushy plant and is deciduous in interior and desert regions, but in coastal areas may shed only a portion of its leaves in winter. The Pomegranate plant is more or less spiny, having small, narrow, oblong leaves with short stems. The leaves of the pomegranate tree are glossy, measuring about 3 to 8 centimeters (1.2 to 3.1 inches) in length.

Pomegranate trees produce striking, funnel-shaped flowers that are typically bright red or orange-red in colour. The flowers are borne singly or in clusters at the tips of branches and have prominent, frilly petals.

Pomegranate flowers are hermaphroditic, containing both male and female reproductive organs, and are highly attractive to pollinators such as bees.

Flowers are 6 cm in diameter, calyx campanulate with 5-lobes, petals 5- wrinkle, stamens numerous and ovaries inferior.

The most iconic feature of the pomegranate tree is its fruit, which is a large, round berry filled with juicy arils. The fruit typically ranges in diameter from 5 to 12 centimeters (2 to 5 inches) and has a tough, leathery rind that ranges in color from yellow-orange to deep red.

Phloroglucinol a relatively unknown compound, phloroglucinol (1,3,5-trihydroxybenzene), which is a degradation product of Phloridzin, has growth- promoting properties.

Phloroglucinol is a colorless to pale yellow crystalline solid with a slightly sweet taste. It is highly soluble in water, ethanol, and ether, showcasing its versatility as a solvent or reactant in numerous chemical processes. Natural sources of Phloroglucinol include fruits like apples and strawberries, as well as medicinal herbs such as willow bark and cinchona bark. Its occurrence in these sources has historically led to its extraction and utilization in traditional medicine practices.

Phloroglucinol increases shoot formation and somatic embryogenesis in several horticultural and grain crops. When added to rooting media together with auxin, phloroglucinol further stimulates rooting, most likely because phloroglucinol and its homologues act as auxin synergists or auxin protectors.

Naphthaleneacetic acid (NAA) stands as a pivotal phytohormone, playing a significant role in regulating various aspects of plant growth and development. As a synthetic auxin, NAA mimics the natural auxins produced by plants, exerting profound effects on processes such as cell elongation, root formation, fruit development, and tropic responses.

Plant growth regulator Indole-3-butyric acid (IBA) has been used for rooting of plant cuttings and other growth processes. As a potent auxin, IBA plays a crucial role in regulating processes such as root initiation, adventitious rooting, vascular differentiation, and fruit development. Solutions of IBA are used for rooting of plant cuttings, transplanting of rooted plants, and to improve grafting. Concentrations used for rooting are from 10 ppm to 20000 ppm IBA.

Materials and Methods

The present investigation entitled "Effect of different rooting hormone on cuttings of Pomegranate (*Punica granatum*) under protected condition in Prayagraj Agro-climatic conditions" was carried out at Department of horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology of Sciences (SHUATS), Prayagraj (U.P), Latitude 25.4137 N and Longitude 81.8491 E. during the summer season of the year 2023-24. The cuttings were gathered from the Chandrashekhar Azad Park, Prayagraj, Uttar Pradesh, India. For research purpose, the cuttings were taken in uniform length, pencil width from healthy branches. 15-20 cm long hardwood cuttings taken from 1-2 years old plant using the tool, Secateur.

The treatment combinations are as follows: T_0 (control), T_1 (IBA @ 2000 ppm + Phloroglucinol @ 3000 ppm), T_2 (IBA @ 2000 ppm + Phloroglucinol @ 4000 ppm), T_3 (IBA @ 2000 ppm + Phloroglucinol @ 5000 ppm), T_4 (IBA @ 2000 ppm + Phloroglucinol @ 6000 ppm), T_5 (IBA @ 3000 ppm + Phloroglucinol @ 3000 ppm), T_6 (IBA @ 3000 ppm + Phloroglucinol @ 4000 ppm), T_7 (IBA @ 3000 ppm + Phloroglucinol @ 5000 ppm), T_8 (IBA @ 3000 ppm + Phloroglucinol @ 6000 ppm), T_9 (IBA @ 4000 ppm + Phloroglucinol @ 3000 ppm), T_{10} (IBA @ 4000 ppm + Phloroglucinol @ 4000 ppm), T_{11} (IBA @ 4000 ppm + Phloroglucinol @ 5000 ppm), T_{12} (IBA @ 4000 ppm + Phloroglucinol @ 6000 ppm). The data were recorded at 30 days after planting, 60 days after planting, 90 days after planting and 30 days after transplanting. With 3 replications in Randomized Block Design (RBD).

Results and Discussion

Root parameters: Root parameters viz., root length, fresh weight of roots, dry weight of roots were recorded. The observations which was recorded during the experiment period on the evaluation of different plant hormones on cuttings of Pomegranate. The effect of different plant hormones on plant's roots of Pomegranate cuttings is very obvious and consistent. There was significant difference among the impact of the different plant hormones on plant root's length, fresh weight of roots and dry weight of roots at 30, 60, 90 days after planting and 30 days after transplanting with maximum plant's roots on IBA @ 3000 ppm + PG @ 5000 ppm with (15.08 cm in length, 5.87 g in fresh weight, 0.43 g in dry weight) respectively, followed by IBA @ 3000 ppm + Phloroglucinol @ 4000 ppm with (14.83 cm in length, 5.65 g in fresh weight, 0.40 g in dry weight) respectively. The data on the number of adventitious roots per cutting as influence by the combination of growth hormones are presented in (Table 1).

Auxin is a phytohormone that has been shown to be associated in the process of root growth rooting and plays a vital role in root development. Ou Yang *et al.*, 2015 [16] stated that IBA is one of the most widely used and effective auxins for promoting root growth for cuttings, besides from IAA and NAA. The IBA concentration required for root initiation depends on type of cuttings that we have taken and at what time the cuttings planted and also various other rooting materials are used. Mostly the efficiency of root is influenced by length of the cuttings, diameter and the interconnection between length and diameter of the cuttings. Sharma *et al.*, 2004 [3] reported in his experiment that IBA 500 ppm + Borax treatment at 1% resulted in in semi-hard wood and hardwood cuttings, max rooting was 64.99 percent and 78.33 percent, respectively. The various growth regulators have a considerable effect on the amount of days it took for cuttings to sprout and to reach 50% sprouting, but IBA 2000 ppm induced the earliest sprouting.

Shoot parameters: IBA concentration and Phloroglucinol concentration had a significant influence on the shoot parameters per cuttings in Pomegranate at 30 DAP, 60 DAP, 90 DAP and 30 DAT. The data presented here indicated that rooting hormone had a significant effect on the days of first shoot initiation, days to first leaf initiation, shoot length, no. of leaves, no. of new shoots.

Days to first shoot initiation: The Pomegranate cutting treated with IBA @ 3000 ppm + PG @ 5000 ppm recorded least no. of days for the first shoot initiation (6.59) and maximum was recorded in control (12.32). This may be because of the well-drained media in combination with the treatment, having higher nutrient holding capacity mainly potassium and magnesium which is ideal for better shoot advancement in pomegranate cutting. This result is in consonance with Manila *et al.* (2017) [17] in pomegranate and Rajkumar *et al.* (2017) [18] in pomegranate

Days to first leaf initiation: The Pomegranate cutting treated with IBA @ 3000 ppm + PG @ 5000 ppm recorded least no. of days for the first leaf initiation (6.89) and maximum was recorded in control (14.27). This might be due to the development of more sprout, meristematic region for quick leaf initiation or it could be due to the activity and better sprouting of cutting under this treatment, as well as vegetative growth, which could have been due to enacted physiological process by stimulating factor in the metabolism and growth of the cutting.

Shoot length: The Pomegranate cutting treated with IBA @ 3000 ppm + PG @ 5000 ppm produced maximum shoot length (26.83, 42.38, 52.68) and minimum was recorded in control (17.68, 33.06, 42.82) in the time period of 1 MAP, 2MAP, 3MAP. This conductive effect of growth hormones combination on water holding capacity, porosity, soil aeration and delivering ample amount of nutrient particularly nitrogen and micro nutrient for protein synthesis, cell reproduction, good root and shoot growth over soil alone Chopde *et al.* (1999) in custard apple. Metabolism cannot be neglected due to its physiological importance.

No. of leaves: The Pomegranate cutting treated with IBA @ 3000 ppm + PG @ 5000 ppm produced maximum no. of leaves (9.08, 12.78, 16.87) and
minimum was recorded in control (5.85, 8.47, 10.89) in the time period of 1 MAP, 2MAP, 3MAP. Increased in number of leaves might be mainly due to corresponding increase in plant height (Govind and Chandra, 1993 [8] in khasi mandarin), Bhat *et al*. (2004) [3] in pomegranate, Navjot and Kahlon (2007) [20] in pomegranate, Sharma *et al.* (2004) [3] in pomegranate and Rathwa *et al.* (2017) [20] in pomegranate.

No. of new shoots: The Pomegranate cutting treated with IBA @ 3000 ppm + PG @ 5000 ppm produced maximum number of shoots (4.98, 8.37, 13.28) and minimum was recorded in control (1.27, 5.05, 8.94) in the time period of 1 MAP, 2MAP, 3MAP. This could be attributed to favourable temperature, humidity, Oxygen and suitable growth hormone combinations. These mentioned growth hormones are responsible for improved metabolic activities and development which up scaled shoot initiation. This result is supported by Ali (2014) [1] in guava, Kour (2009) [12] in pomegranate and Yeboah *et al*. (2009) [21] in Shea.

Survival percentage on transplanting: The effect of different hormones on Survivality % of Pomegranate cuttings is very obvious and consistent. There was significant difference among the impact of the different treatment combinations on Survivality % during the course of the experiment after transplanting with maximum Survivality % in T_7 (IBA @ 3000 ppm + PG @ 5000 ppm) with (88.78) respectively, followed by T_6 (IBA @ 3000 ppm + PG @ 4000 ppm) with (82.69) which were significantly superior over T_{10} (IBA @ 4000 ppm + PG @ 4000 ppm) with (77.04) and minimum was recorded in T_0 (control) with (48.27). This could be because good growth hormones combinations that increased nutrient uptake and further develop plant structure which increased overall plant development and maintain the cell turgidity, cell elongation and increased respiration at optimum level, resulting in favourable root initiation in cuttings and lower mortality. Good soil environment cause soil aggregation, which may increase organic matter availability as well as phosphorus absorption, permeability and air flow in the rhizosphere. This result is similar with the finding of Singh *et al*. (2014) [13] in pomegranate and Gholap and Polara (2015) [7] in mango.

The evaluation of different hormones on the cuttings of Pomegranate (*Punica granatum*) treated with different treatment combinations for survivability percentage is critical to ascertain their adaptability and resilience to various environmental conditions. By subjecting the cuttings to rigorous field trials and stress tests, growers can determine their ability to withstand factors such as drought, pests, diseases, and extreme temperatures. The cutting exhibiting higher survivability percentages indicate greater vigour, robustness, and potential for long-term orchard establishment. Understanding survivability percentages also aids in selecting hormones suitable for specific agro-climatic zones, optimizing resource allocation, and mitigating risks associated with crop failure. Ultimately, prioritizing the hormone treatments with superior survivability enhances the sustainability and success of Pomegranate cultivation endeavours.

Table 1: Effect of IBA and PG on root parameters of Pomegranate cuttings

Effect of IBA and PG on root Parameters				
Notion	**Treatment combination**	**Root length (cm)**	**Fresh weight of root (g)**	**Dry weight of root (g)**
T_0	Control	9.12	2.47	0.17
T_1	IBA @ 2000 ppm + Phloroglucinol @ 3000 ppm	10.50	3.59	0.29
T_2	IBA @ 2000 ppm + Phloroglucinol @ 4000 ppm	11.81	3.60	0.32
T_3	IBA @ 2000 ppm + Phloroglucinol @ 5000 ppm	11.78	4.51	0.30
T_4	IBA @ 2000 ppm + Phloroglucinol @ 6000 ppm	11.63	4.73	0.37
T_5	IBA @ 3000 ppm + Phloroglucinol @ 3000 ppm	13.65	4.77	0.39
T_6	IBA @ 3000 ppm + Phloroglucinol @ 4000 ppm	14.83	5.65	0.40
T_7	IBA @ 3000 ppm + Phloroglucinol @ 5000 ppm	15.08	5.87	0.43
T_8	IBA @ 3000 ppm + Phloroglucinol @ 6000 ppm	13.78	3.71	0.35
T_9	IBA @ 4000 ppm + Phloroglucinol @ 3000 ppm	13.40	4.69	0.32
T_{10}	IBA @ 4000 ppm + Phloroglucinol @ 4000 ppm	12.94	3.68	0.27
T_{11}	IBA @ 4000 ppm + Phloroglucinol @ 5000 ppm	12.36	4.64	0.23
T_{12}	IBA @ 4000 ppm + Phloroglucinol @ 6000 ppm	11.96	4.57	0.20
	F- test	S	S	S
	SEd	0.36	0.02	0.01
	CD	1.08	0.06	0.03
	CV	2.16	0.10	0.05

Table 2: Effect of IBA and PG on shoot parameters of pomegranate cuttings

Notion	Treatment Combination	Days to first shoot initiation	Days to first leaf initiation	Shoot length (cm)	No. of leaves	No. of new shoots	Survival percentage
T_0	(control)	12.32	14.27	42.82	10.89	8.94	48.27
T_1	IBA @ 2000 ppm + PG @ 3000 ppm	9.87	12.37	44.81	12.35	9.03	53.35
T_2	IBA @ 2000 ppm + PG @ 4000 ppm	10.02	12.68	45.89	13.67	9.13	59.36
T_3	IBA @ 2000 ppm + PG @ 5000 ppm	9.78	13.72	46.52	13.89	9.53	66.45
T_4	IBA @ 2000 ppm + PG @ 6000 ppm	8.99	10.35	47.79	14.09	10.04	73.45
T_5	IBA @ 3000 ppm + PG @ 3000 ppm	8.23	11.26	44.94	13.62	10.16	74.27
T_6	IBA @ 3000 ppm + PG @ 4000 ppm	7.03	7.02	51.35	15.95	12.65	82.69
T_7	IBA @ 3000 ppm + PG @ 5000 ppm	6.59	6.89	52.68	16.87	13.28	88.78
T_8	IBA @ 3000 ppm + PG @ 6000 ppm	8.92	10.78	45.90	14.72	10.35	75.33
T_9	IBA @ 4000 ppm + PG @ 3000 ppm	10.08	9.86	49.48	14.76	11.23	69.99
T_{10}	IBA @ 4000 ppm + PG @ 4000 ppm	9.56	8.85	48.69	14.98	11.11	77.04
T_{11}	IBA @ 4000 ppm + PG @ 5000 ppm	9.32	9.17	47.47	15.05	11.15	67.34
T_{12}	IBA @ 4000 ppm + PG @ 6000 ppm	9.47	9.36	46.30	13.45	10.71	73.98
	F-test	**S**	S	S	S	S	S
	S-Ed	0.66	0.721	0.16	0.06	0.07	2.03
	CD	1.96	1.357	0.44	10.89	0.75	5.36
	CV	3.92	2.812	13.61	4.54	7.52	7.72

Conclusions

On the basis of our experimental findings, it is concluded that the T_7 (IBA @ 3000 ppm + PG @ 5000 ppm) was found to be best in the terms of days to first shoot initiation, days to first leaf initiation, shoot lengths, number of leaves, number of new shoots, root lengths, fresh weight of roots, dry weight of roots. After the transplantation of the Pomegranate cuttings, T_7 (IBA @ 3000 ppm + PG @ 5000 ppm) was found to be best in the terms of number of new shoots, shoot length, number of new leaves. In terms of rooting percentage and earliness of shooting, T_7 (IBA @ 3000 ppm + PG @ 5000 ppm) was found to be best. The survivability or the establishment percentage found to be the highest in T_7 (IBA @ 3000 ppm + PG @ 5000 ppm) It is also concluded that the best treatment of Pomegranate cuttings for Prayagraj agro-climatic conditions was found to be T_7 (IBA @ 3000 ppm + PG @ 5000 ppm) for establishment.

References

1. Ali SS. Effect of different media of cuttings on rooting of guava (*Psidium guajava* L.). European Journal of Experimental Biology. 2014;4(2):88–92.
2. Ansari K. Effect of different collecting time and different medium on rooting of pomegranate cv. Malas Torsh cuttings. Bulletin of Environment, Pharmacology and Life Sciences. 2013;2(12):164–8.
3. Bhat DJ, Farman HL, Sharma MK. Effect of chemicals and growth regulators on rooting of pomegranate (*Punica granatum* L.) cuttings. Horticultural Journal. 2004;17(1):41–7.
4. Bose TK, Mitra SK. Fruits tropical and subtropical. Naya Prakash; 1990. p. 616–37.
5. Cheema GS, Bhat SS, Naik FC. Commercial fruits of India with special reference to Western India. Mc Millan Co. Ltd; 1954.
6. Dutta P. Effect of growth regulators on air layering of sweet orange (*Citrus sinensis* L. Osbeck). Environment and Ecology. 2000;18(4):899–901.
7. Gholap SS, Polara ND. Effect of growing media and storage of stone on growth and development of mango (*Mangifera indica* L.) rootstock cv. Local. Horticulture Flora Research Spectrum. 2015;4(3):236–40.
8. Govind S, Chandra R. Standardization of suitable potting media for raising seedling of Khasi mandarin. Indian Journal of Horticulture. 1993;50:224–7.
9. Gurjar PKS, Patel RM. Effect of rooting media, type of stem cutting and growth regulator on rooting and growth of pomegranate cv. Ganesh. Bhartiya Krishi Anusandhan Patrika. 2007;22(1):62–6.
10. Sevik H, Guney K. Effects of IAA, IBA, NAA and GA3 on rooting and morphological features of *Melissa officinalis* L. Stem Cuttings. The Scientific World Journal. 2013;2013:909507. DOI: 10.1155/2013/909507.
11. Khalighi A, Padasht-Dehkaee MT. Effect of media produced by tree bark, tea waste, rice hull and *Azolla* as a substrate for peat, on growth and flowering of marigold (*Tagetes patula* "Golden Boy"). Iranian Journal of Agricultural Sciences. 2000;31(3):557–65.
12. Kour R. Influence of season of planting on propagation of pomegranate. The Asian Journal of Horticulture. 2009;4(1):253–4.
13. Singh KK. Effect of IBA concentrations on the rooting of pomegranate (*Punica granatum*) cv. Ganesh hardwood cuttings under mist house condition. Plant Archives. 2014;14(2) 0972-5210.
14. Ibrahim OHM. Developing air layering practices for propagation of *Dracaena marginata* Lam. utilizing phloroglucinol and seaweed extracts as IBA-synergists or alternatives. 2020; ISSN 2356-7864.
15. Singh VP, Misra DS, Mishra NK, Rai R. Effect of growing season, PGR and rooting media on survival of hardwood stem cuttings of lemon (*Citrus limon* Burm.) cv. Pant Lemon-1. Horticulture Flora Research Spectrum. 2015;4(4):347–350.
16. Ou Y, Wang SJ, Jiang L, Zheng B, Gu W. p53 Protein-mediated regulation of phosphoglycerate dehydrogenase (PHGDH) is crucial for the apoptotic response upon serine starvation. Journal of Biological Chemistry. 2015 Jan 2;290(1):457-466.
17. Manila, Tanuja, Rana DK, Naithani DC. Effect of different growing substrate on vegetative growth and rooting in pomegranate (*Punica granatum* L.) cv. "Kandhari" hardwood stem cutting under mist. Plant Archives. 2017;17(1):391-394.

18. Tamilselvan P, Nallusamy N, Rajkumar S. A comprehensive review on performance, combustion and emission characteristics of biodiesel fuelled diesel engines. Renewable and Sustainable Energy Reviews. 2017 Nov 1;79:1134-1159.
19. Navjot N, Kahlon PS. Studies on the propagation of pomegranate as influenced by season and shoot portion; c2007.
20. Rathwa SD, Vasava AA, Pathan MM, Madhira SP, Patel YG, Pande AM. Effect of season on physiological, biochemical, hormonal, and oxidative stress parameters of indigenous sheep. Veterinary world. 2017 Jun;10(6):650.
21. Yeboah MA, Appiah-Yeboah K. An examination of the cultural and socio-economic profiles of porters in Accra, Ghana. Nordic Journal of African Studies. 2009 Mar 31;18(1):21-.