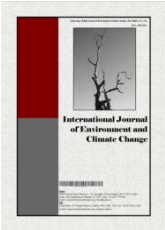

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Effect of IBA and Rooting Media on Hardwood Cuttings of Pomegranate (*Punica granatum* L.) CV. Bhagwa

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Authors' contributions

This work was carried out in collaboration among all authors. Authors DRT, HLB and RKJ designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SSL and LNM managed the analyses of the study. Author RCC managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was carried out during at Horticulture Farm, Rajasthan College of Agriculture, Udaipur, Rajasthan during 2018 (February to May) to work out the most suitable growing media and Indole-3 Butyric Acid concentration for producing the best quality cutting of Pomegranate. The experiment was laid out in a completely randomized design with a total of sixteen treatments replicated thrice. Result showed that the treatment combination (T_{13}) comprising Coco peat : Perlite : Vermiculite with 2000 ppm IBA recorded highest values in terms of length of cutting after survival (81.08 cm), percentage of rooted cuttings (97.78%), survival of rooted cuttings (93.78%), number of roots per cutting (41.50), length of longest roots per cutting (32.03 cm), fresh weight of root (2.25 g), sprouts per cutting (2.59), shoots per cutting (9.87), length of shoots per cutting (32.33 cm), leaves per rooted cuttings (145.40), leaves per longest shoot (29.99), fresh weight of shoot (16.67 g), root to shoot ratio (0.15) and survival percentage after shifting in poly bags (82.22).

Keywords: Pomegranate; semi hard wood cutting; IBA; potting media.

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1. INTRODUCTION

Pomegranate (*Punica granatum* L.) belongs to Punicaceae family and it is an arid and semi-arid fruit crop. Pomegranate prefers semi-arid mild temperature to sub-tropical climate and is naturally adapted to region with cool winters and hot summer. In India, pomegranate is grown almost all over the country and occupies considerable area of 2.62 lakh hectare with the annual production of 30.34 MT [1]. In India leading producer of pomegranate is Maharashtra [1]. Next to Maharashtra maximum pomegranate cultivation takes place in Karnataka, Gujarat, Andhra Pradesh and Rajasthan. At present Rajasthan state accounts 7.47 thousand hectares of the total area and 13.12 thousand MT of total production in India [1]. The prominent pockets where pomegranate is grown in Rajasthan are Jalore, Jodhpur, Bhilwara, Sirohi, Pali and Barmer. Maximum area of pomegranate is occupied by variety Bhagwa and other variety includes Ganesh and Mridula.

Pomegranate is propagated by sexual and asexual means. Propagation through seeds is popular in many parts of India, since it is easy but it shows a great variability with respect to tree vigour, precocity and quality of fruits due to cross pollination. Therefore, vegetative method of propagation is advocated in place of seed propagation to eliminate the high degree of variability. Vegetative propagation in pomegranate is utmost desirable to propagate true to type plants. Though, air layering is successful in pomegranate but it is expensive, cumbersome and it adversely affects the growth of the mother trees. Propagation of pomegranate by cuttings is the most convenient and cheapest method to obtain a fully developed and stronger tree in considerably less time [2]. Rooting medium plays an important role in rooting of cuttings and for further growth and development of cuttings. The medium should be sufficiently firm and dense to hold the cuttings in place during propagation. It also provides moisture and air to the base of cutting.

In order 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 enabling better field establishment of pomegranate trees by treating with suitable plant growth regulators. Indole Butyric Acid (IBA) is the synthetic plant hormone. It is active in inhibiting axillary bud break on developing shoots, and it stimulates the root initiation. It promotes cell elongation which helped to increase in root length. Apart from potential growth regulator, suitable medium for cutting establishment should have enough moisture and good aeration. Use of suitable rooting media and optimum concentration of IBA would help in rapid multiplication of pomegranate cuttings. Therefore, the present investigation was conducted to study the “Effect of IBA and Rooting Media on Hardwood Cuttings of Pomegranate (*Punica granatum* L.) cv. Bhagwa”.

2. MATERIALS AND METHODS

The present investigation was carried out during February to May, 2018 at Horticulture Farm, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan). The experiment was laid out in CRD (Completely Randomized Design), with thirty cuttings per replication. Sixteen treatments replicated thrice. The details of treatments given below.

Chart 1. Treatments details

T_1	Sand (Control)	T_9	Sand + Vermiculite + IBA 1500 ppm
T_2	Sand + IBA 1000 ppm	T_{10}	Sand + Vermiculite + IBA 2000 ppm
T_3	Sand+ IBA 1500 ppm	T_{11}	Coco Peat + Vermiculite + Perlite + IBA 1000 ppm
T_4	Sand + IBA 2000 ppm	T_{12}	Coco Peat + Vermiculite + Perlite + IBA 1500 ppm
T_5	Sand + Vermicompost+ IBA 1000 ppm	T_{13}	Coco Peat + Vermiculite + Perlite + IBA 2000 ppm
T_6	Sand + Vermicompost+ IBA 1500 ppm	T_{14}	Sand + Vermiculite + Perlite + IBA 1000 ppm
T_7	Sand + Vermicompost+ IBA 2000 ppm	T_{15}	Sand + Vermiculite + Perlite + IBA 1500 ppm
T_8	Sand + Vermiculite + IBA 1000 ppm	T_{16}	Sand + Vermiculite + Perlite + IBA 2000 ppm

Semi hard wood cuttings were taken from properly matured one year old shoots of uniform size (15-20 cm in length and 0.8 to 1.20 cm thickness). The basal part (1-2 cm) of the cuttings was dipped in the growth regulator solutions of IBA (1000 ppm, 1500 ppm and 2000 ppm concentrations) for 10 seconds. Subsequently they were air dried for 15 minutes and planted in poly bags containing respective rooting media up to a depth of 1-2 nodes. The rooting media around the base of the cutting was gently pressed to hold the cutting in right place, to eliminate air pockets and make sure that the base of the cutting was in good contact with the moist rooting media. A slant cut was given at the basal end of the cuttings to expose maximum cambium surface area for inducing effective rooting. The cutting transplanted under open condition and five sprouted cuttings were selected randomly from each treatment in each replication. These five cuttings were labeled and root, shoot and leaf parameters were recorded. The data were analysed by using completely randomized design [3].

3. RESULTS AND DISCUSSION

3.1 Root Parameters

It is clear from the data presented in Table 1 that highly significant influence on percentage of rooted cutting (97.78%) was recorded in cutting grown in mixture of Coco peat + Vermiculite + Perlite + 2000 ppm of IBA (T13) followed by T16 (95.56%), while lowest percentage of rooted cutting (89.22%) was recorded in cuttings grown in sand as control (T1) on pomegranate cv. Bhagwa. This might be due to release of phenolic compounds from the coco peat and also attributed to the beneficial physical characteristics of coco peat, vermiculite and perlite like aeration and water holding capacity and also encouragement of rooting ability of cutting through increasing number of root primordia in cuttings due to higher concentration of IBA. Similar results were obtained by Gautam et al. [4] in guava, Singh KK. [5] and Rajkumar et al. [6] in pomegranate. Similarly, the highest survival percentage of rooted cuttings (93.78%) was also recorded in cutting grown in Coco peat + Vermiculite + Perlite + 2000 ppm IBA (T13), while lowest (77.33%) in sand (T1). The cuttings grown in a mixture of Coco peat: Vermiculite: Perlite gave highest survival percentage might be due to incorporation of coarser materials into coco peat could improve the aeration status of medium and due to development of effective root system and increase in number and length of roots per cutting as influenced by the uptake of nutrients and water. The present results are in harmony with the findings of Upadhyay and Badyal [7], Gurjar and Patel [8] and Kaur and Kaur [9] in pomegranate.

The number of roots per cutting as influenced by the IBA and rooting media showed that maximum influence on number of roots per cutting (41.50) was recorded in cutting grown in Coco peat + Vermiculite + Perlite + 2000 ppm of IBA (T13), while lowest (17.33) in sand (T1). The cuttings grown in a mixture of Coco peat: Vermiculite: Perlite gave the maximum number of roots, might be due to presence of cytokinins in coco peat which encourages the induction of adventitious roots [10], along with auxins favours cell division resulting in more number of roots. Coco peat has a high water holding capacity which helps in high absorption of water and nutrients from the medium thereby increased the number of roots. The maximum number of roots was observed with IBA 2000 ppm which might be due to hormonal effect leading to accumulation of internal substances and their downward movement and these growth regulators also stimulate cambial activity involved in root initiation in many species. Similar findings were also observed by Ansari [11] and Rajkumar et al., [6] in pomegranate, Upadhyay and Badyal [7] in pomegranate and Singh et al. [5] in *Citrus limon*. However, the length of longest root per cuttings showed that highest significant influence of length of longest root per cuttings (32.03 cm) was recorded in cutting grown in Coco peat + vermiculite + perlite + 2000 ppm of IBA (T13) and minimum (15.56) in sand (T1). There was a progressive and significant increase in root length with increase in concentrations of IBA. Significantly maximum length of root was observed in cuttings treated with IBA 2000 ppm.

The fresh weight of the roots showed that highest significant influence of fresh weight of the roots (2.25 g) was recorded in cutting grown in mixture of Coco peat : Vermiculite : Perlite with 2000 ppm of IBA, whereas minimum fresh weight of the roots (1.34 g) recorded in sand. The maximum fresh weight of roots was recorded in cuttings grown in a mixture of Coco peat : Vermiculite : Perlite could be related to the better aeration and drainage conditions and water maintenance capability and in 2000 ppm IBA increase the number of roots and production of more number of roots. These findings are in accordance with the findings of Wahab et al. [12]

in guava, Khayyat et al. [13] in pothos; Moreno et al. [14] in cape gooseberry and Rajkumar et al. [6] in pomegranate.

3.2 Shoot Parameters

The data pertaining to the days to first sprouting are presented in Table 2 showed that minimum number of days required for first sprouting of cuttings (11.63) was recorded in cuttings grown in a mixture of Coco peat + Vermiculite + Perlite + 2000 ppm of IBA and significantly maximum number of days required for first sprouting (16.23) was observed in cuttings grown in Sand + Vermiculite + 1000 ppm IBA (T8). It might be due that media combination cocopeat : perlite: vermiculite alone had lower clay content, pH, compactness, which improve drainage, aeration, water holding capacity and highest nutrients uptake by root system and increase in the concentration of IBA significantly decreased the number of days to first sprouting of cuttings while earliness in sprouting might be due to better utilization of stored carbohydrates and nitrogen. Present findings are in conformity with the findings by Rajarama [15] in pomegranate, Srivastava et al. [16] in kiwi fruit and Damar et al. [17] in pomegranate. Further, the maximum sprouts per cutting (2.59) was observed in Coco peat + Vermiculite + Perlite + 2000 ppm of IBA and minimum sprout per cutting (1.55) in Sand + 1500 ppm IBA. This might be due to the fact that external application of auxins promotes growth and produce more favourable conditions for sprouting of dormant buds on the cutting. Similar findings were also obtained by Upadhyay and Badyal [7] and Manila et al. [18] in pomegranate.

The highest significant influence of shoots per cutting (9.87) was recorded in cutting grown in Coco peat + vermiculite + perlite + 2000 ppm of IBA while lowest shoots per cutting (5.93) in sand. Present findings indicated that cuttings grown in a mixture of Coco peat + Perlite + Vermiculite + 2000 ppm IBA showed maximum number of shoots which might be due to decomposition of lignins present in coco peat results in the formation of humic fractions. The cuttings treated with IBA 2000 ppm recorded greater number of shoots per cutting than the cuttings treated with IBA 1500 ppm which could be attributed to enhancement of physiological functions in the cuttings favourably at this concentration. Similar results were also reported by Singh et al. [19] in *citrus limon* and Kaur and Kaur [9] in pomegranate. Similarly, the maximum length of shoots per cutting (32.33) was recorded in cutting grown in mixture of Coco peat + Vermiculite + Perlite + 2000 ppm of IBA (T_{13}) followed by T_{12} (31.68), while minimum length of shoots per cutting (15.40) was recorded in sand as control (T_1) on pomegranate cv. Bhagwa. IBA @ 2000 ppm recorded the maximum number of roots per cutting enhanced the nutrient uptake and resulted in more photosynthate production. Food in the form of photosynthates provides required energy for cell division and cell elongation and it results in maximum shoot length. Present findings are in conformity with the findings of Parvez et al. [20] in peach and Batista et al. [21] in pomegranate.

The data pertaining to the leaves per rooted cutting and leaves per longest shoot are presented in Fig. 1 showed that that highest significant influence of leaves per rooted cutting (145.40) was recorded in cutting grown in mixture of Coco peat + Vermiculite + Perlite with 2000 ppm of IBA (T_{13}) while lowest leaves per rooted cutting (84.07) was recorded in sand as control (T_1) on pomegranate cv. Bhagwa. However, the maximum leaves per longest shoot (29.99) was accounted by application of Coco peat + Vermiculite + Perlite + 2000 ppm of IBA (T_{13}), while minimum leaves per longest shoot (13.80) was recorded in sand with IBA 1500 ppm (T_3) on pomegranate cv. Bhagwa. The maximum number of leaves was produced in cuttings grown in a mixture of coco peat: vermiculite and perlite might be due to superior root development in this medium. Maximum number of leaves was produced in cuttings treated with IBA 2000 ppm might be due to activation of shoot growth which probably increased the number of nodes that leads to development of more number of leaves. Present findings are in conformity with the findings by Upadhyay and Badyal [7], Manila et al. [18], Kaur and Kaur [9] in pomegranate and Singh K.K. [5] in pomegranate.

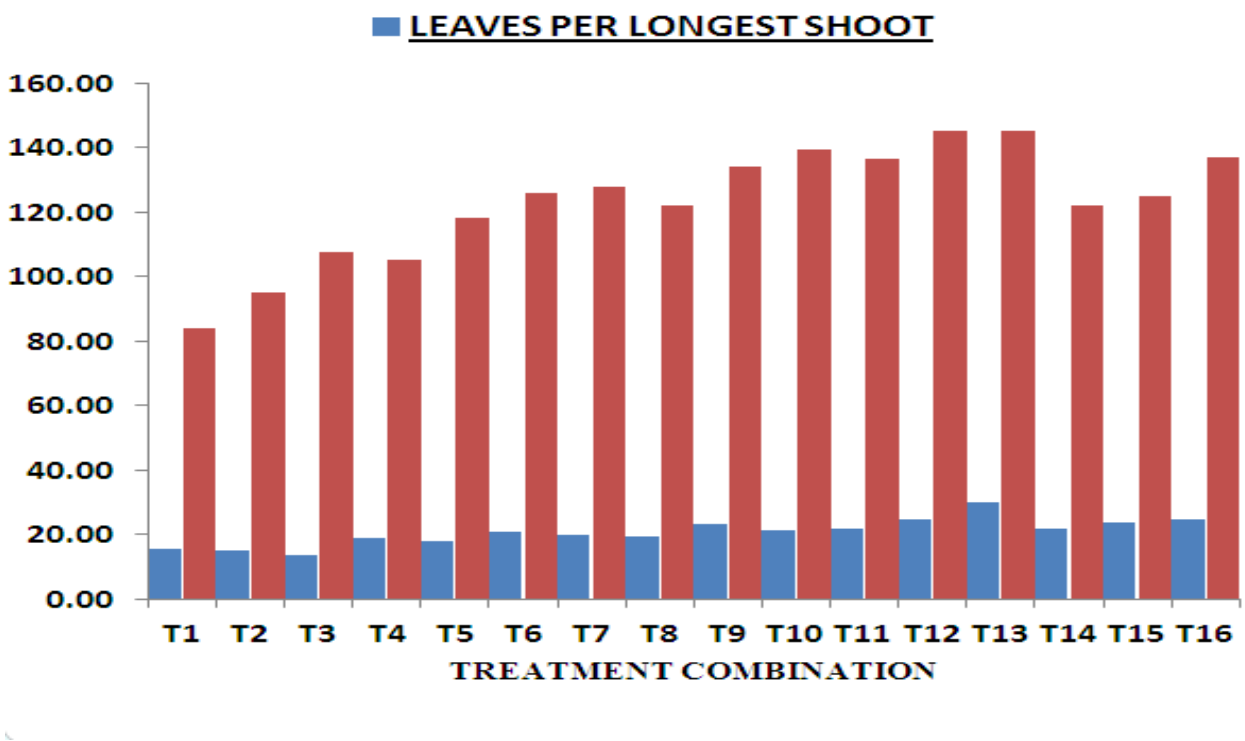
The data pertaining to the fresh weight of shoots and root to shoot ratio are presented in Table 2. The maximum fresh weight of shoots (16.67 g) and maximum root to shoot ratio (0.15) were recorded in cutting grown in Coco peat + Vermiculite + Perlite + 2000 ppm of IBA while minimum fresh weight of shoots (7.84 g) and minimum root to shoot ratio (0.05) were recorded in sand. This could be attributed to the fact that when cocopeat added to other media improves the aeration, water holding capacity, nutrient retention found to be essential in early growth of plants resulting in increased number of leaves, length and number of shoots which helps in

Table 1. Effect of IBA and rooting media on root parameters of Pomegranate cv. Bhagwa

Treatments	Percentage of rooted cuttings	Survival percentage of rooted cutting	Number of roots per cutting	Length of longest root per cutting (cm)	Fresh weight of roots (g)
T_1-Sand (control)	89.22	77.33	17.33	15.56	1.32
T_2 -Sand + IBA 1000 ppm	91.89	75.56	20.11	17.86	1.58
T_3- Sand + IBA 1500 ppm	94.44	78.55	22.78	19.75	1.58
T_4- Sand + IBA 2000 ppm	94.11	83.07	23.69	15.46	1.78
T_5- Sand + Vermicompost + IBA 1000 ppm	89.44	79.67	24.11	19.73	1.61
T_6- Sand + Vermicompost + IBA 1500 ppm	95.11	79.67	23.71	19.79	1.86
T_7 - Sand + Vermicompost + IBA 2000 ppm	90.89	85.22	25.44	20.50	1.93
T_8 - Sand + Vermiculite + IBA 1000 ppm	96.67	80.82	23.45	21.25	2.02
T_9- Sand + Vermiculite + IBA 1500 ppm	89.56	82.57	34.58	20.85	1.98
T_{10}- Sand + Vermiculite + IBA 2000 ppm	89.89	82.56	37.10	21.65	2.03
T_{11}- Coco peat + Perlite + Vermiculite + IBA 1000 ppm	95.56	87.78	39.19	27.76	2.12
T_{12} - Coco peat + Perlite + Vermiculite + IBA 1500 ppm	90.67	88.89	40.20	29.75	2.20
T_{13}- Coco peat + Perlite + Vermiculite + IBA 2000 ppm	97.78	93.78	41.50	32.03	2.25
T_{14}- Sand + Perlite + Vermiculite + IBA 1000 ppm	91.11	85.56	34.41	22.57	2.15
T_{15}- Sand + Perlite + Vermiculite + IBA 1500 ppm	92.22	83.33	36.46	24.88	2.21
T_{16}- Sand + Perlite + Vermiculite + IBA 2000 ppm	95.56	87.78	37.45	25.58	2.18
SEm±	1.97	1.96	0.70	0.68	0.04
CD (P= 0.05)	5.68	5.66	2.03	1.97	0.13

Table 2. Effect of IBA and rooting media on shoots parameters of Pomegranate cv. Bhagwa

Treatments	Days to first sprouting	Sprouts per cutting	Shoots per cutting	Lengh of shoots per cutting (cm)	Fresh weight of shoots (g)	Root to shoot ratio	Survival percentage after shifting in polybags (30 DAT)
T_1-Sand (control)	15.07	1.69	5.93	15.40	7.84	0.05	54.44
T_2 -Sand + IBA 1000 ppm	16.07	2.00	7.00	15.43	8.58	0.06	56.67
T_3- Sand + IBA 1500 ppm	15.83	1.55	8.00	17.25	10.68	0.07	57.78
T_4- Sand + IBA 2000 ppm	15.50	2.40	7.73	18.04	10.97	0.08	64.44
T_5- Sand + Vermicompost + IBA 1000 ppm	15.30	2.00	8.07	16.99	11.13	0.07	66.67
T_6- Sand + Vermicompost + IBA 1500 ppm	15.83	2.20	8.40	17.56	12.34	0.09	66.67
T_7 - Sand + Vermicompost + IBA 2000 ppm	15.97	2.40	9.00	20.39	14.01	0.09	73.33
T_8 - Sand + Vermiculite + IBA 1000 ppm	16.23	2.00	9.07	20.64	11.65	0.11	66.67
T_9- Sand + Vermiculite + IBA 1500 ppm	15.87	1.60	8.67	22.21	10.91	0.10	71.11
T_{10}- Sand + Vermiculite + IBA 2000 ppm	15.83	2.00	9.07	26.55	12.53	0.10	71.11
T_{11}- Coco peat + Perlite + Vermiculite + IBA 1000 ppm	14.03	2.00	9.27	31.12	15.45	0.15	74.44
T_{12} - Coco peat + Perlite + Vermiculite + IBA 1500 ppm	12.17	2.40	9.60	31.68	16.00	0.14	75.56
T_{13}- Coco peat + Perlite + Vermiculite + IBA 2000 ppm	11.63	2.59	9.87	32.33	16.67	0.15	82.22
T_{14}- Sand + Perlite + Vermiculite + IBA 1000 ppm	12.67	2.20	9.27	27.37	14.40	0.11	71.11
T_{15}- Sand + Perlite + Vermiculite + IBA 1500 ppm	12.53	2.00	9.27	28.24	14.21	0.12	71.11
T_{16}- Sand + Perlite + Vermiculite + IBA 2000 ppm	12.53	2.53	9.47	28.54	15.69	0.12	72.22
SEm±	0.35	0.09	0.32	0.82	0.30	0.00	2.58
CD (P= 0.05)	1.02	0.25	0.91	2.36	0.86	0.01	7.42



Fig, 1. Effect of IBA and rooting media on leaves per longest shoot and leaves per rooted cutting of pomegranate cv. Bhagwa

increase the fresh weight of shoots and ultimately higher root to shoot ratio. Present findings are in conformity with the findings by Ranawana and Eswara [22] in pineapple, Dahale et al. [23] in Fig and Singh [5] in pomegranate.

Further, the highest survival percentage after shifting in poly bags (82.22%) was recorded in cutting grown in Coco peat + vermiculite + perlite + 2000 ppm of IBA, while lowest Survival percentage after shifting in poly bags (54.44%) was recorded in sand Table 2. The cuttings grown in a mixture of Coco peat: Vermiculite: Perlite recorded the maximum field survival which might be due to high nutrient content, water holding capacity, good drainage and high porosity of coco peat which helps in better development of root system resulting in maximum percentage of survival of rooted cuttings. The cuttings treated with IBA 2000 ppm recorded maximum survival percentage of cuttings in polybag was mostly depended on root and shoot characters. These results are in concurrence with the findings of Kaur and Kaur [9], Kumari et al. [24] in pomegranate and Rajkumar et al. [6] in pomegranate.

4. CONCLUSION

The present study concluded that the treatment combination Coco peat + Perlite + Vermiculite with 2000 ppm IBA recorded highest values in terms of length of cutting after survival (81.08 cm), percentage of rooted cuttings (97.78%), survival of rooted cuttings (93.78%), number of roots per cutting (41.50), length of longest roots per cutting (32.03 cm), fresh weight of root (2.25 g), sprouts per cutting (2.59), shoots per cutting (9.87), length of shoots per cutting (32.33 cm), leaves per rooted cuttings (145.40), leaves per longest shoot (29.99), fresh weight of shoot (16.67 g), root to shoot ratio (0.15) and survival percentage after shifting in poly bags (82.22).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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