



Effect of Different Growing Media and IBA Concentrations on Shoot Attributes and Survival Percentage of Pomegranate (*Punica granatum* L.) cuttings cv. Bhagwa

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ABSTRACT: The availability of quality and uniform planting material is a key pre-requisite for successful pomegranate cultivation. Vegetative propagation through hardwood cuttings is widely adopted; however, its success largely depends on the use of appropriate of rooting media and plant growth regulators. The present investigation was conducted during the year 2023–2024 at the Nursery, Department of Agriculture, Khalsa College, Amritsar, to study the effect of different growing media and Indole-3-butyric acid (IBA) concentrations on sprouting, survival, and shoot growth of pomegranate (*Punica granatum* L.) cv. Bhagwa. The cuttings were treated with IBA (1000, 1500 & 2000ppm) and planted in various growing media combinations, including soil alone and soil mixed with perlite, vermiculite, cocopeat, and vermicompost (1:1). The experiment was laid out in a Randomized Block Design with sixteen treatments and replicated thrice. The results revealed that application of IBA 2000ppm in combination with soil + vermicompost (1:1) recorded maximum sprouting percentage, number of shoots, shoot length, number of leaves, leaf area per plant and reduced days to sprouting compared to other treatments and control. Treatments involving vermiculite also performed better than cocopeat and soil alone. The study concluded that higher IBA concentration coupled with nutrient-rich rooting media significantly improves the propagation success of pomegranate cuttings under nursery conditions.

Keywords: Pomegranate, IBA, growing media, hardwood cuttings, vegetative parameters, sprouting.

INTRODUCTION

Pomegranate (*Punica granatum* L.) an arid and semi-arid fruit crop, is a member of the Punicaceae family also known as ‘Seeded Apple’ or ‘Chinese Apple’. It is described as nature’s power fruit, used in folklore medicine for the treatment of various diseases (Moneim and Abdel 2012). The edible part (arils) of pomegranate is an excellent source of polysaccharide, vitamins, fatty acids, minerals, organic acid, soluble solid and dietary fibres (Fadavi *et al.*, 2006). Maharashtra is the leading producer contributing 115.39 hectare area and 1436.05 MT production followed by Gujarat, Karnataka, Andhra Pradesh, Madhya Pradesh, Rajasthan, Telangana, Chhattisgarh, Tamil Nadu and Himachal Pradesh. (MAFW 2023-2024). The pomegranate plant is well adapted to climates characterized by hot summers and cold winters and thrives best under mild, semi-arid conditions rather than humid subtropical environments. In contemporary fruit cultivation, the availability of uniform and quality planting material is fundamental for

establishing productive orchards. Seed propagation in pomegranate results in considerable variability due to genetic segregation, leading to non-uniform growth and yield. Hence, vegetative propagation methods are preferred to maintain true-to-type plants and desirable horticultural traits. Among vegetative methods, propagation through stem cuttings is the most widely adopted technique due to its simplicity, low cost, rapid multiplication rate, and minimal requirement for technical expertise compared to grafting, budding, or layering (Anjali *et al.*, 2023). However, the success of rooting in stem cuttings is influenced by several factors, including the physiological condition of the mother plant, type and position of cutting, planting season, temperature, humidity, rooting media, and the application of plant growth regulators.

The discovery of auxins marked a major advancement in vegetative propagation practices. Plant growth regulators are organic compounds that modify physiological processes in plants when applied in small quantities and are readily absorbed and translocated

within plant tissues (Rolaniya and Saravanan 2018). Auxins such as Indole-3-butyric acid (IBA), Indole-3-acetic acid (IAA), and Naphthalene acetic acid (NAA) are extensively used to enhance root initiation and development in cuttings. Among these, IBA has been consistently reported as the most effective growth regulator for inducing early and profuse rooting in hardwood cuttings of several fruit crops (Sheikh *et al.*, 2022). Hartmann (1997) also emphasized that auxins play a pivotal role in root initiation by stimulating cell division and differentiation at the basal portion of cuttings.

Numerous studies have demonstrated the beneficial effect of IBA on sprouting, survival, and shoot growth parameters. Rolaniya and Saravanan (2018) reported that hardwood cuttings treated with IBA exhibited minimum days to sprouting. Similar findings were reported by Kaur and Singh (2022) in pomegranate cv. Bhagwa, where IBA treatments significantly reduced sprouting time. Anjali *et al.* (2023) further confirmed that IBA application resulted in early sprouting and improved shoot and root characters in pomegranate hardwood cuttings. Sheikh *et al.* (2022) also observed enhanced rooting and survival in fig cuttings treated with IBA, highlighting its broad applicability across fruit crops.

Along with growth regulators, the selection of suitable rooting media is equally important for successful propagation. Rooting media influence moisture availability, aeration, nutrient supply, and physical support for developing roots. Several studies have reported superior performance of soilless and enriched media combinations. Similar positive effects of vermiculite, cocopeat, and vermicompost-based media on rooting and vegetative growth have been reported in pomegranate, grape, guava, fig, and acid lime by several researchers (Prajapati *et al.*, 2017; Manila *et al.*, 2017; Tanwar *et al.*, 2020).

Apart from its horticultural significance, pomegranate is valued for its medicinal and industrial importance. The stem and root contain alkaloids used in the treatment of diarrhoea and dysentery (El-Shaarawy and Nahapetian 1983). The fruit rind possesses high tannin content, widely utilized in leather tanning industries, while seed oil has desirable physicochemical properties for industrial use (Anjali *et al.*, 2023). These diverse uses further emphasize the need for large-scale propagation of healthy and uniform planting material.

In view of the increasing demand for quality nursery plants and the variability in response to growth regulators and rooting media, there is a need for systematic evaluation of IBA concentrations and growing media combinations. Therefore, the present investigation was undertaken to study the effect of Indole-3-butyric acid and different growing media on sprouting, survival, and shoot growth parameters of pomegranate hardwood cuttings, with the aim of identifying the most effective propagation technique under nursery conditions.

MATERIAL AND METHODS

The experiment was conducted during 2023–2024 at the Nursery, Department of Agriculture, Khalsa College, Amritsar, Punjab, India (31°38' N latitude, 74°52' E longitude; 234 m above mean sea level) under semi-humid climatic conditions. Hardwood cuttings of pomegranate cv. Bhagwa (15–20 cm length, pencil thickness, 3–6 buds) were prepared from healthy mother plants during the second week of January and planted in 7 × 7 inch polybags with two-thirds of the cutting inserted into the growing media. The basal portions of cuttings were quick-dipped (5–10 second) in Indole-3-butyric acid (IBA) solutions (1000, 1500, & 2000ppm) and planted in different growing media combinations. The treatments consisted of:

T ₁	:	IBA 1000 ppm + soil + perlite (1:1)
T ₂	:	IBA 1500 ppm + soil + perlite (1:1)
T ₃	:	IBA 2000 ppm + soil + perlite (1:1)
T ₄	:	IBA 1000 ppm + soil + vermiculite (1:1)
T ₅	:	IBA 1500 ppm + soil + vermiculite (1:1)
T ₆	:	IBA 2000 ppm + soil + vermiculite (1:1)
T ₇	:	IBA 1000 ppm + soil + cocopeat (1:1)
T ₈	:	IBA 1500 ppm + soil + cocopeat (1:1)
T ₉	:	IBA 2000 ppm + soil + cocopeat (1:1)
T ₁₀	:	IBA 1000 ppm + soil + vermicompost (1:1)
T ₁₁	:	IBA 1500 ppm + soil + vermicompost (1:1)
T ₁₂	:	IBA 2000 ppm + soil + vermicompost (1:1)
T ₁₃	:	IBA 1000 ppm + soil
T ₁₄	:	IBA 1500 ppm + soil
T ₁₅	:	IBA 2000 ppm + soil
T ₁₆	:	Soil alone (control)

The experiment was laid out in a Randomized Block Design with three replications. Light irrigation was applied at 3–5 day intervals and standard nursery practices were followed. Observations on shoot parameters (days to first sprouting, sprouting percentage, number of shoots, shoot length, number of leaves per cutting, and total leaf area) and root parameters (number of roots per cutting, root length, fresh and dry root weight, and survival percentage) were recorded up to 120 days after planting. The data were analyzed statistically using analysis of variance (ANOVA) under RBD, and treatment means were compared using Tukey's post-hoc test at 5% level of significance using SPSS software (version 30.0).

RESULTS AND DISCUSSION

Days taken for sprouting

The data presented in Table 1 revealed that the number of days taken for sprouting of pomegranate cuttings was significantly influenced by different growing media and IBA concentrations. The minimum days for sprouting (33.36 days) were recorded with the application of IBA (2000ppm) + soil + vermicompost (1:1) which was statistically superior to all other treatments. It was followed by IBA 2000 ppm + soil + vermiculite (1:1) registering 34.63 days. However, the maximum days

taken for sprouting (44.28 days) were observed under control. The early sprouting with higher IBA concentrations combined with vermicompost or vermiculite may be attributed to enhanced hormonal activity and improved moisture availability, which favoured rapid bud break. These observations are in conformity with the findings of Ali *et al.* (2003) in guava, Kaur (2009); Damar *et al.* (2014); Rolaniya and Sarvanan (2018) in pomegranate and Sheikh *et al.* (2022) in fig.

Sprouting percentage

Sprouting percentage differed significantly among the treatments, indicating that the combined effect of IBA concentration and rooting media. The highest sprouting percentage (69.28%) was recorded with the application of IBA (2000ppm) + soil + vermicompost (1:1), which was statistically at par with IBA (2000ppm) + soil + vermiculite (1:1) which register sprouting percentage to 68.95 per cent. Treatments involving vermicompost and vermiculite consistently recorded higher sprouting percentages compared to cocopeat and soil alone. The lowest sprouting percentage (26.70%) was observed under control. The superior performance of vermicompost and vermiculite-based media may be due to improved aeration, nutrient availability, and moisture retention, which enhance rooting success and bud emergence. The results of present outcomes are corroborating with the findings of Ranpise and Patil (2022) in grapes, Patel *et al.* (2020); Manila *et al.* (2017) in pomegranate.

Number of shoots per cutting

The number of shoots per cutting was significantly improved with the application of different growing media and IBA concentrations. At 60 days after planting of pomegranate cuttings, the maximum number of shoots per cutting (6.05) was recorded with the application of IBA (2000ppm) + Soil + Vermiculite (T_6) treatment. It was followed by treatment (T_{12}), (T_5), (T_{11}) and (T_{10}) which recorded 5.80, 5.51, 5.18 and 5.03 number of shoots per cutting, respectively. However, minimum number of shoots (2.88) were recorded in control treatment (T_{16}). Similarly at 90 days after planting of cuttings, maximum number of shoots (9.52) per cutting were noted with the application of IBA (2000ppm) + Soil + Vermiculite (T_6). It was closely followed by treatment (T_{12}), (T_5) and (T_4) which recorded 8.65, 8.63 and 8.30 number of shoots per cutting, respectively. These treatments stood at par with each other. However, minimum number of shoots (5.51) were recorded under control treatment (T_{16}). Likewise, at 120 days after planting of cuttings, maximum number of shoots (12.28) per cutting were recorded with the application of IBA (2000ppm) + Soil + Vermiculite treatment (T_6). It was followed by treatment (T_{12}) and (T_5) which recorded 11.85 and 11.71 number of shoots per cutting, respectively. These treatments stood at par with each other. However, minimum number of shoots (8.27) were recorded under control treatment (T_{16}). The increased shoot production under higher IBA concentrations may

be attributed to enhanced cell division and differentiation, while nutrient-rich media such as vermicompost supported sustained shoot growth. The present findings in pomegranate cuttings cv. Bhagwa are in close conformity with the findings of Damar *et al.* (2014); Rajkumar *et al.* (2017); Tanwar *et al.* (2020) in pomegranate.

Shoot length per cutting

Shoot length per cutting varied significantly among treatments, indicating the beneficial effect of IBA and rooting media. The maximum shoot length (12.35 cm) was recorded in IBA 2000 ppm + soil + vermicompost (1:1), which was statistically superior to all other treatments, followed by IBA 2000 ppm + soil + vermiculite (1:1) (11.50 cm), while the minimum (5.11 cm) was observed in the control. Increased shoot elongation at higher IBA concentration may be attributed to enhanced cell division and elongation due to better root development, resulting in higher uptake of water and nutrients and greater photosynthate production (Shahab *et al.*, 2013; Upadhyay and Badyal 2007). Vermicompost and vermiculite provided a favourable physical environment, optimum moisture and improved nutrient availability, particularly nitrogen, which supports protein synthesis and vegetative growth and lowers the C:N ratio, thereby promoting early and vigorous shoot growth (Suhane, 2007; Kumar and Ponnuswami 2013). The results are in conformity with the findings of Kaur and Kaur (2017) in pomegranate and Sudarjat *et al.* (2018) in dragon fruit.

Number of leaves per cutting

The number of leaves per cutting was significantly influenced by both IBA concentration and growing media. The maximum number of leaves (112.48) was recorded with the application of IBA (2000ppm) + soil + vermicompost (1:1) which was statistically superior to all other treatments. It was followed by IBA (2000ppm) + soil + vermiculite (1:1) which recorded 103.67 number of leaves per cutting. The minimum number of leaves (50.72) was noted under control. The higher leaf production under vermicompost-based treatments may be attributed to improved nutrient availability and better root development, resulting in enhanced photosynthetic capacity. IBA treated cuttings resulted in longer, healthier roots that aid in the absorption of water and nutrients, significantly impacting the cutting's ability to produce more leaves. This result is in consonance to that of Govind and Chandra (1993) in khasi mandarin, Bhat *et al.* (2004); Navjot and Kahlon (2007); Rathwa *et al.* (2017) in pomegranate.

Leaf Area

Leaf area differed significantly among the treatments, reflecting the influence of rooting media and IBA concentration on leaf expansion. The maximum leaf area (23.83 cm²) was recorded with the application of IBA (2000ppm) + Soil + Vermiculite treatment (T_6) which stood at par with treatment (T_{12}), (T_5), (T_{11}), (T_4) and (T_{10}) which recorded 23.66, 23.16, 21.83, 21.81, 21.66 cm² leaf area of pomegranate per cutting, respectively.

However, minimum leaf area (12.03 cm²) was noted under control treatment (T₁₆). Increased leaf area under vermicompost and vermiculite treatments may be attributed to improved nutrient uptake and better moisture retention, which promote leaf expansion and overall vegetative growth. The possible reason for increase in leaf area with the help of IBA was due to

production of more roots which increased nutrient uptake and aerial growth of the plants resulted in highest leaf area (Ismail and Asghar 2007). The present findings in pomegranate cuttings cv. Bhagwa are in close conformity with the findings of Panchal *et al.* (2014) in khirni, Kaur and Kaur (2017) in fig, Hakim *et al.* (2018) in pomegranate and Narula and Kaur (2018) in plum.

Table 1: Effect of different growing media and IBA concentrations on shoot parameters of pomegranate cuttings cv. Bhagwa.

Treatments	Days taken for sprouting	Sprouting percentage	Number of shoots per cutting	Shoot length (cm) per cutting	Number of leaves per cutting	Leaf area (cm ²)
T ₁ – IBA (1000ppm) + Soil + Perlite (1:1)	38.30 ± 0.27 ^e	46.48 ± 0.17 ^d	9.56 ± 0.11 ^{cd}	8.32 ± 0.05 ^d	63.76 ± 0.84 ^{bcde}	18.01 ± 1.32 ^{bcd}
T ₂ – IBA (1500ppm) + Soil + Perlite (1:1)	37.58 ± 0.30 ^{de}	54.62 ± 0.27 ^{ef}	10.34 ± 0.86 ^{de}	9.43 ± 0.10 ^e	65.89 ± 1.44 ^{cdef}	18.35 ± 1.04 ^{cd}
T ₃ – IBA (2000ppm) + Soil + Perlite (1:1)	36.64 ± 0.33 ^{cd}	58.51 ± 0.23 ^g	10.41 ± 0.70 ^e	9.51 ± 0.11 ^e	71.92 ± 0.64 ^{def}	19.31 ± 0.76 ^{de}
T ₄ – IBA (1000ppm) + Soil + Vermiculite (1:1)	38.18 ± 0.23 ^e	60.44 ± 0.19 ^{gh}	10.63 ± 0.16 ^{ef}	10.46 ± 0.03 ^f	94.84 ± 1.46 ^{hi}	21.83 ± 0.59 ^{def}
T ₅ – IBA (1500ppm) + Soil + Vermiculite (1:1)	37.52 ± 0.25 ^{de}	62.66 ± 0.12 ^{hi}	11.71 ± 0.05 ^{gh}	10.72 ± 0.13 ^f	96.33 ± 2.0 ^{hi}	23.16 ± 0.76 ^{ef}
T ₆ – IBA (2000ppm) + Soil + Vermiculite (1:1)	34.63 ± 0.11 ^b	68.95 ± 0.26 ^{jk}	11.85 ± 0.63 ^{gh}	11.50 ± 0.02 ^g	103.67 ± 6.06 ^{ij}	23.65 ± 1.25 ^f
T ₇ – IBA (1000ppm) + Soil + Cocopeat (1:1)	42.21 ± 0.20 ^{fg}	45.51 ± 0.37 ^d	8.38 ± 0.15 ^a	5.25 ± 0.09 ^{ab}	54.29 ± 1.73 ^{ab}	15.02 ± 1.01 ^a
T ₈ – IBA (1500ppm) + Soil + Cocopeat (1:1)	42.08 ± 0.54 ^{fg}	48.46 ± 0.22 ^d	8.45 ± 0.11 ^a	5.69 ± 0.21 ^{ab}	54.52 ± 0.95 ^{ab}	15.38 ± 0.76 ^a
T ₉ – IBA (2000ppm) + Soil + Cocopeat (1:1)	43.01 ± 0.89 ^{gh}	53.72 ± 0.15 ^e	8.51 ± 0.32 ^a	6.35 ± 0.05 ^b	61.59 ± 0.97 ^{bcd}	16.29 ± 0.76 ^{ab}
T ₁₀ – IBA (1000ppm) + Soil + Vermicompost (1:1)	38.51 ± 0.19 ^e	57.48 ± 0.17 ^{fg}	10.48 ± 0.37 ^e	9.67 ± 0.07 ^e	76.34 ± 1.52 ^{fg}	21.64 ± 1.75 ^{def}
T ₁₁ – IBA (1500ppm) + Soil + Vermicompost (1:1)	36.42 ± 0.32 ^c	65.69 ± 0.08 ^{ij}	11.29 ± 0.18 ^{fg}	11.47 ± 0.02 ^g	86.71 ± 2.33 ^{gh}	21.86 ± 1.60 ^{ef}
T ₁₂ – IBA (2000ppm) + Soil + Vermicompost (1:1)	33.36 ± 0.16 ^a	69.28 ± 0.33 ^k	12.28 ± 0.31 ^h	12.35 ± 0.10 ^h	112.48 ± 11.46 ⁱ	23.83 ± 1.60 ^f
T ₁₃ – IBA (1000ppm) + Soil	43.45 ± 0.22 ^{hi}	28.09 ± 3.95 ^a	8.61 ± 0.14 ^a	7.37 ± 0.02 ^c	57.71 ± 1.99 ^{abc}	14.90 ± 0.36 ^a
T ₁₄ – IBA (1500ppm) + Soil	42.36 ± 0.29 ^g	32.69 ± 0.07 ^b	8.70 ± 0.26 ^{ab}	7.45 ± 0.08 ^c	62.85 ± 1.71 ^{bcd}	15.04 ± 1.37 ^a
T ₁₅ – IBA (2000ppm) + Soil	41.30 ± 0.05 ^f	36.41 ± 0.50 ^c	9.43 ± 0.34 ^{bc}	8.54 ± 0.03 ^d	73.53 ± 1.11 ^{ef}	17.34 ± 0.57 ^{abc}
T ₁₆ – Soil (control)	44.28 ± 0.26 ⁱ	26.70 ± 0.18 ^a	8.27 ± 0.16 ^a	5.11 ± 0.04 ^a	50.72 ± 0.53 ^a	14.03 ± 2.64 ^a

One way ANOVA followed by Tukey's post hoc test was applied for comparing different treatment means in columns followed by different letters shows significant difference at p≤0.05.

CONCLUSION

The present investigation clearly demonstrated that both IBA concentration and growing media significantly

Gurrula et al.,

influence the sprouting behaviour and shoot growth of pomegranate hardwood cuttings cv. Bhagwa. Among the different treatment combinations, application of IBA (2000ppm) + soil + vermicompost (1:1) proved to be the most effective, as it resulted in minimum days taken for sprouting and maximum sprouting percentage, number of shoots per cutting, shoot length, number of leaves, and leaf area. Treatments involving soil + vermiculite also

showed superior performance over cocopeat-based media and soil alone. In contrast, untreated cuttings planted in soil (control) recorded the poorest performance for all growth parameters. From the results of the present investigation, it may be concluded that treating the cuttings with IBA at 2000 ppm and planting them in a soil + vermicompost (1:1) medium is the most suitable combination for successful and large-scale propagation of pomegranate cv. Bhagwa under nursery conditions. This treatment promotes early sprouting, improves survival percentage and produces healthy, vigorous shoot growth, thereby ensuring the production of uniform and quality planting material.

FUTURE SCOPE

The present experiment has demonstrated that the sprouting and vegetative growth of pomegranate hardwood cuttings cv. Bhagwa are significantly influenced by IBA levels and increasing media. It may still be enhanced, though, by carrying out further study to optimize propagation techniques under various agroclimatic situations. In order to compare their relative ability to enhance roots and survival, future studies can evaluate additional growth regulators of plant development, such as NAA and IAA, both alone and in combination. Second, to improve aeration and nutrient availability, different rooting medium such peat moss, sand, and compost-based media should be investigated. Long-term field testing of propagated plants and controlled experiments such as mist chambers or poly houses would provide a better knowledge of plant establishment, growth performance, and plant production.

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