Biological Forum – An International Journal **13(2): 17-23(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Standardization of Pomegranate (*Punica granatum* L.) Propagation through Cuttings

G. Siva Koteswara Rao*[*], I.A. Bisati[1], Umar Iqubal[1], S.A. Bhat[2], S.A. Mir[3] and F.U. Khan[4]

*[*1]Division of Fruit Science, SKUAST-K, Shalimar, Srinagar-190025, (Jammu and Kashmir), India.*
[2]Division of Basic Sciences and Humanities, SKUAST-K, Shalimar, Srinagar-190025, (Jammu and Kashmir), India.
[3]Division of Agricultural Statistics, SKUAST-K, Shalimar, Srinagar-190025, (Jammu and Kashmir), India.
[4]Division of Floriculture & Landscape Architecture,
SKUAST-K, Shalimar, Srinagar-190025, (Jammu and Kashmir), India.

(Corresponding author: G. Siva Koteswara Rao)*
(Received 12 March 2021, Accepted 25 May, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The study was conducted to know the effect plant growth hormones on rooting ability of pomegranate cuttings and this study was carried out in division of fruit science block at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir. This experiment comprised of five concentrations of IBA viz., 0, 2000, 3000, 4000, 5000 ppm and ten pomegranate varieties viz., Chawla, Nabha and Kandhari Kabuli, Ichakdana, Bhagwa, Arakta, Muskat, Mridula, P- 23 and Jodhpur Red in a randomized complete block design with five replications. The results revealed that different concentrations of IBA and varieties showed significant effect on rooting and other root growth parameters. The maximum percentage of rooting was observed when cuttings treated with 5000 ppm IBA in all the varieties, however the variety of Chawla (62.24%) recorded maximum rooting percentage than other varieties. In case of varietal performance the variety Chawla, Nabha and Kandhari Kabuli showed significant results with respect to all root parameters. The study concluded that cuttings treated with 5000 ppm IBA showed significant results than other treatments.

Keywords: Pomegranate, Propagation, IBA, Root number and Root length

INTRODUCTION

Pomegranate (*Punica granatum* L.) is one of important dry land fruit crop in India it belongs to the family punicaceae. In India, it comes well in all climatic conditions and maximum area present in Maharastra, Karnataka, Andhra Pradesh, Rajasthan and some parts of Himachal Pradesh, Jammu and Kashmir and Uttarakhand (Pandey *et al*., 2008). Genarally, pomegrante is propagated through seed and vegetative methods such as softwood, semi- hardwood and hardwood cutting, layering and grafting (Hartmann *et al*., (1997; Melgarejo *et al*., 2008; Polat and Caliskan, 2009). Tissue culture is also one method of production of the plants in a protected environment but higher polyphenol content leads to the failure of rooting (Abdelrahman and AI-Wasel, 1999: Hartmann *et al*., 1997).

Vegetative propagation especially by cuttings is the most commercially viable, convenient, and cost-effective method of obtaining true-to-type plants in pomegranate and other horticultural crops. Internal factors such as genetic material, stored nutrition, and hormones in the stems influence the rooting percentage and survival of cuttings and external factors such as pruning, fertilisation, irrigation, environment, age of cuttings and external hormone application plays the key role in rooting of pomegranate. Application of plant growth hormones such as auxins, cytokinins enhance the rooting percentage in various horticultural crops (Melgarejo *et al*., 2008; Saroj *et al*., 2008; Polat and Caliskan, 2009).

Among the hormones auxins are play the greatest impact on root formation in cuttings, especially IBA induce rooting in cuttings and in air layers because it promotes active cambium regeneration, cell division, elongation and cell multiplication (Rymbai and Reddy 2010). Plants produce natural auxin in young shoots and leaves, but the synthetic auxin should be used for successful rooting to prevent cuttings death (Kasim and Rayya, 2009).

Pome and stone fruits have traditionally become important fruit crops in temperate ecosystems. However, recent days pomegranate is becoming an alternative fruit crop for temperate regions due to drought hardiness and offers immense potential to grow under marginal lands and capacity to tolerate frost and alkaline conditions as changing scenario of climatic conditions. The physiological conditions of the parent plant, cutting type, planting time, rooting medium, and rooting hormone and other factors affect the rooting response of pomegranate (Polat and Caliskan, 2009).

Keeping in view the present investigation was carried out to assess the performance of different varieties along with different concentration of IBA application on rooting potential in pomegranate in temperate conditions.

MATERIALS AND METHODS

The present investigation was carried out at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus Srinagar to determine the effect of different IBA concentrations (0, 2000, 3000, 4000, 5000 ppm) and varietal impact on rooting potential of ten pomegranate varieties viz., Chawla, Nabha, Kandhari Kabuli, Ichakdana, Bhagwa, Arakta, Muskat, Mridula, P- 23 and Jodhpur Red under temperate conditions of Kashmir. From each variety cuttings were taken in the month of March from one year old matured shoots having diameter of 0.8 cm to 1.2 cm and 20 cm in length with 4-5 buds each. The slanting cut was made at the basal end just below the bud and at apical end just above the bud. The basal end of the cuttings was given a slant cut to expose maximum absorbing surface for maximum rooting. The IBA concentrations were prepared by dissolving the hormone powder in ethanol and few drops of NH_4OH were added to avoid precipitation of the hormone.

The collected cuttings were dipped in solution of Benlate as a protective measure for fungal infection. Then the basal portion of the cuttings were dipped for 30 sec with the prepared IBA concentrations and with water as a control treatment. The experiment was carried out in open field conditions by using Randomized Complete Block Design (RCBD) with five replications. There are 50 treatment combinations of different growth regulator concentrations and varieties and 15 cuttings were used in each treatment and the total (50×15) 750 cuttings were used including cuttings of control. The percentage of rooted cuttings, survival percentage, number of roots, root length, fresh weight and dry weight of roots were taken as observations and recorded three months after planting of cuttings. The data was analyzed using computer software programmed by the method of variance outlined by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

A. Percentage of rooted cuttings

The percentage of rooted cuttings affected by IBA concentrations and pomegranate varieties and their interactions are shown in (Table 1). It was observed that the percentage of rooted cuttings varied significantly among the varieties. However, Chawla variety (47.66%) recorded maximum percentage of rooting which was at par with the variety Nabha (47.19 %) than other varieties. it may be due to the high concentration of IBA facilitates higher carbohydrate assimilation and it leads to the early rooting. In case of among different IBA levels maximum rooting (42.80 %) was observed in cuttings treated with IBA 5000 ppm, while the lowest (19.16 %) was observed in cuttings treated with water. It could be attributed to the increasing concentrations of IBA resulting in the optimization of carbohydrates and other rooting metabolite levels ultimately enhances the percentage of rooting in pomegranate (Melgarejo *et al*., 2000). The interaction between cultivar and growth regulator had a significant impact on rooting percentage (Table 1). The highest percentage of rooting was observed in treatment combination of Chawla along with IBA 5000 ppm (62.24 %) which was at par with cv. Nabha treated with IBA 5000 ppm (59.86), and the lowest was observed in control treatment. This could be due to the high genetic variation with respect to rooting ability of the cultivars.

Table 1: Effect of variety and plant growth regulator concentrations on percentage of rooted cuttings (%) in pomegranate.

Variety (V)	IBA Concentration (C)					
	0 ppm	**2000 ppm**	**3000 ppm**	**4000 ppm**	**5000 ppm**	**Mean**
Arakta	20.16 (4.59)	23.12 (4.90)	25.84 (5.18)	31.19 (5.67)	36.72 (6.14)	**27.40 (5.30)**
Mridula	14.34 (3.91)	19.85 (4.56)	23.49 (4.94)	23.93 (4.99)	32.76 (5.80)	**22.87 (4.84)**
Muskat	19.23 (4.49)	23.29 (4.92)	27.84 (5.37)	29.27 (5.50)	34.62 (5.96)	**26.85 (5.25)**
Ichakdana	16.99 (4.24)	25.91 (5.18)	36.63 (6.13)	43.73 (6.68)	48.29 (7.01)	**34.31 (5.85)**
Chawla	27.84 (5.37)	43.98 (6.70)	48.30 (7.01)	55.96 (7.54)	62.24 (7.95)	**47.66 (6.91)**
Bhagwa	19.80 (4.55)	28.76 (5.45)	37.02 (6.16)	40.54 (6.44)	43.71 (6.68)	**33.96 (5.86)**
Kandhari Kabuli	25.99 (5.19)	48.06 (7.00)	50.54 (7.17)	52.42 (7.30)	55.27 (7.50)	**46.45 (6.83)**
Nabha	25.48 (5.14)	46.20 (6.87)	51.58 (7.25)	52.84 (7.33)	59.86 (7.80)	**47.19 (6.88)**
Jodhpur Red	10.06 (3.32)	15.04 (4.00)	20.04 (4.58)	20.40 (4.62)	23.87 (4.98)	**17.88 (4.30)**
P- 23	11.72 (3.56)	18.77 (4.44)	20.96 (4.68)	25.90 (5.18)	30.74 (5.63)	**21.61 (4.70)**
Mean	**19.16 (4.44)**	**29.29 (5.40)**	**34.22 (5.85)**	**37.61 (6.13)**	**42.80 (6.55)**	

C.D (p≦0.05) *Figures in parenthesis indicate square root values

Variety (V)	1.13
IBA concentration (C)	0.80
V × C	2.53

Different studies have established that rooting initiation in hard wood/semi-hard wood cuttings of pomegranate increased with the increasing concentration of IBA from 2000 ppm to 12000 ppm (Panda and Das, 1990; Gosh *et al*., 1988; Hamooh, 2005; Barde *et al*., 2010).

B. Survival percentage

The highest survival percentage of rooted cuttings was observed in variety Chawla (80.21 %) which is significantly higher than the remaining varieties (Table 2). In case among different IBA levels highest success percentage (82.34 %) was observed in the cuttings treated with 5000 ppm IBA, while the lowest percentage (68.16 %) was observed in cuttings treated with water (table 2). It may be due to the development of an effective root system and an increase in the number and length of roots per cutting as a result of nutrient and water uptake (Rajeswara Reddy *et al*., 2008). The growth regulator treatments used in this study had a significant interaction with varieties (table 2). Cuttings of variety Chawla treated with IBA 5000 ppm had the highest percentage of survival (87.75 %), followed by cuttings of the same cultivar treated with IBA 4000 ppm (86.43) and the lowest (50.58) in variety Jodhpur Red (control). In rooted cuttings, the remaining treatments had a survival rate ranging from 53.55-86.22. Cutting success may be attributed to high carbohydrate reserves per cutting and optimal IBA concentration. The same factors resulted in the highest number of shoots and roots per cutting and the longest root length, which contributed to a high survival percentage (Purohit and Shekharappa, 1985). These findings were in accordance with (Rajkumar *et al*., 2016) and (Sharma *et al*., 2009) in pomegranate.

Table 2: Effect of variety and plant growth regulator concentrations on survival percentage of rooted cuttings (%) in pomegranate.

Variety (V)	IBA Concentration (C)					
	0 ppm	**2000 ppm**	**3000 ppm**	**4000 ppm**	**5000 ppm**	**Mean**
Arakta	74.47 **(**8.68**)**	76.00 **(**8.77**)**	79.00 **(**8.94**)**	80.41 **(**9.02**)**	82.74 **(**9.15**)**	**78.88 (8.91)**
Mridula	63.27 **(**8.01**)**	66.01 **(**8.18**)**	70.26 **(**8.43**)**	76.37 **(**8.79**)**	80.37 **(**9.02**)**	**71.25 (8.49)**
Muskat	70.87 **(**8.47**)**	73.57 **(**8.63**)**	77.43 **(**8.85**)**	80.36 **(**9.02**)**	81.83 **(**9.10**)**	**76.81 (8.81)**
Ichakdana	71.57 **(**8.51**)**	78.45 **(**8.91**)**	80.13 **(**9.00**)**	82.47 **(**9.13**)**	84.02 **(**9.22**)**	**79.32 (8.95)**
Chawla	70.09 **(**8.43**)**	74.77 **(**8.70**)**	82.02 **(**9.11**)**	86.43 **(**9.35**)**	87.75 **(**9.42**)**	**80.21 (9.00)**
Bhagwa	74.45 **(**8.68**)**	77.55 **(**8.86**)**	78.69 **(**8.92**)**	81.50 **(**9.08**)**	82.95 **(**9.16**)**	**79.02 (8.94)**
Kandhari Kabuli	74.10 **(**8.66**)**	77.51 **(**8.85**)**	79.84 **(**8.99**)**	83.03 **(**9.16**)**	85.16 **(**9.28**)**	**79.92 (8.99)**
Nabha	72.26 **(**8.55**)**	76.41 **(**8.79**)**	80.71 **(**9.03**)**	84.56 **(**9.25**)**	86.22 **(**9.33**)**	**80.03 (8.99)**
Jodhpur Red	50.58 **(**7.18**)**	53.55 **(**7.38**)**	63.92 **(**8.05**)**	68.43 **(**8.33**)**	74.79 **(**8.70**)**	**62.25 (7.93)**
P- 23	60.01 **(**7.81**)**	70.60 **(**8.46**)**	71.75 **(**8.53**)**	72.06 **(**8.54**)**	77.59 **(**8.86**)**	**70.40 (8.44)**
Mean	**68.16 (8.30)**	**72.44 (8.55)**	**76.55 (8.78)**	**79.56 (8.97)**	**82.34 (9.12)**	

C.D (p≦0.05) *Figures in parenthesis indicate square root values

Variety (V)	1.32
IBA concentration (C)	0.93
V × C	2.95

C. Number of roots per cutting

The data (Table 3) clearly showed that cuttings of variety Chawla produced significantly more number of roots (18.98) than the remaining varieties. Irrespective of the cultivar tested, IBA at 5000 ppm (20.50) significantly increased the average number of roots compared to IBA at 2000 ppm (15.50), IBA 3000 ppm (16.99), IBA 4000 ppm (18.73). In this study, there was a significant interaction between cultivars and IBA concentrations (Table 4). Cuttings of variety Chawla treated with 5000 ppm IBA produced significantly more roots (24.97). The next best treatment combinations was cuttings of Nabha treated with IBA 5000 ppm (23.80), while Jodhpur had the lowest number of roots (10.42). The maximum number of roots was observed with IBA 5000 ppm in variety Chawla, which could be due to hormonal effects causing internal substance accumulation and downward movement. This is due to the fact that auxin promotes cell division, elongation, and differentiation of cambial initials into root primordia, as well as mobilization of reserve food material to root initiation sites, resulting in a greater number of roots per cutting (Sharma, 1999). These findings are in agreement with those of Polat and Caliskan (2009), who found that pomegranate cuttings of cultivar 31-N-01 treated with IBA @1000 ppm produced more number of roots than the control. The findings are in accordance with those of Sharma *et al.* (2009), who found the highest number of roots in cv. Ganesh was treated with IBA 500 ppm + Borax 1%.

Table 3: Effect of variety and plant growth regulator concentrations on mean number of roots per cutting in pomegranate.

Variety (V)	IBA Concentration (C)					
	0 ppm	**2000 ppm**	**3000 ppm**	**4000 ppm**	**5000 ppm**	**Mean**
Arakta	13.10	17.00	18.14	20.06	20.44	**17.75**
Mridula	12.86	14.44	13.66	13.90	19.87	**14.94**
Muskat	13.91	14.50	16.90	18.10	20.42	**16.76**
Ichakdana	13.20	18.80	19.18	20.55	21.08	**18.56**
Chawla	12.10	14.83	19.50	23.51	24.97	**18.98**
Bhagwa	14.72	16.86	17.66	20.32	20.68	**18.05**
Kandhari Kabuli	15.25	16.70	18.66	21.39	21.38	**18.67**
Nabha	12.80	17.12	19.19	21.58	23.80	**18.90**
Jodhpur Red	10.42	11.01	13.15	13.47	14.80	**12.57**
P- 23	12.42	13.80	13.87	14.42	17.55	**14.41**
Mean	**13.08**	**15.50**	**16.99**	**18.73**	**20.50**	

C.D (p≦0.05) *Figures in parenthesis indicate square root values

Variety (V)	0.65
IBA concentration (C)	0.46
V × C	1.47

D. Average root length (cm)

Root length was significantly differed in varieties of pomegranate under this study (Table 4). The root length was maximum in rooted cuttings of variety Chawla (19.28) than remaining varieties. Minimum root length was reported in variety Jodhpur Red (14.37). Among plant growth regulator treatments, IBA 5000 ppm recorded significantly highest root length (20.11) followed by IBA 4000 ppm (18.30) as against lowest root length was observed in control (13.80). Among the interactions, maximum roots length (24.76) was observed in cuttings of variety Chawla treated with IBA 5000 ppm followed by 5000 ppm (22.99) in variety Nabha, where as minimum root length was reported in variety P-23 (11.00) i.e. control (Table 4). This might be due to an early initiation of roots at higher concentrations of IBA and therefore more utilization of the nutrients due to early formation of the roots (Ajaykumar, 2007). Singh (2014) also reported the similar result i.e. maximum average root length per cutting in variety. Ganesh treated with 5g L^{-1} of IBA. The increase in root length with IBA at higher concentrations may be attributed to its primary physiological effect which is known to promote the elongation of cells in the apical region (Singh e*t al*., 2009). Damar *et al.* (2014) obtained similar results by using 2000 ppm IBA in pomegranate.

Table 4: Effect of variety and plant growth regulator concentrations on average root length (cm) per cutting in pomegranate.

Variety (V)	IBA Concentration (C)					
	0 ppm	**2000 ppm**	**3000 ppm**	**4000 ppm**	**5000 ppm**	**Mean**
Arakta	13.74	14.90	16.71	18.02	18.97	**16.47**
Mridula	12.66	13.89	14.95	16.29	17.95	**15.15**
Muskat	13.73	15.40	16.58	17.13	18.42	**16.25**
Ichakdana	14.34	15.72	17.05	18.90	21.69	**17.54**
Chawla	15.99	17.25	17.97	20.43	24.76	**19.28**
Bhagwa	14.83	15.94	17.90	18.85	19.76	**17.45**
Kandhari Kabuli	14.53	15.52	18.16	19.72	21.74	**17.93**
Nabha	16.00	17.44	18.22	20.70	22.99	**19.07**
Jodhpur Red	11.17	13.14	14.43	15.89	17.22	**14.37**
P- 23	11.00	12.83	16.22	17.07	17.66	**14.95**
Mean	**13.80**	**15.20**	**16.82**	**18.30**	**20.11**	

C.D (p≦0.05) *Figures in parenthesis indicate square root values

Variety (V)	0.72
IBA concentration (C)	0.50
V × C	1.61

E. Length of longest root per cutting (cm)

Regardless of the growth regulator concentrations used, the difference in length of longest root per cutting is due to varieties was found to be significant during the course of study. The roots of variety Nabha cuttings (14.13) were longer than remaining varieties Arakta (12.34), Mridula (11.05), Muskat (11.93), Ichakdana (12.86), Chawla (12.92), Bhagwa (12.51),Kandhari Kabuli (12.52), Jodhpur Red (9.78), P-23 (10.69). There was a progressive and significant improvement in root length of both cultivars with highest concentrations of growth regulators. Maximum length of root (13.89)

was observed when the cuttings were treated with IBA 5000 ppm. However, minimum response of this parameter observed in control (10.34).

The interaction values showed varietal variation in different IBA concentrations to average root length. Significantly more root length (19.68) was recorded in variety Nabha with 5000 ppm of IBA followed by IBA 4000 ppm treatment on same variety (15.31). The minimum root length was observed in variety Jodhpur Red (8.72) i.e. control (Table 5). The action of auxin activity, which may have caused hydrolysis and translocation of carbohydrates and nitrogenous substances towards the base of cuttings and resulted in accelerated cell division and cell elongation in a suitable environment, may be attributed to the reason for recording longest root in cv. Nabha (Singh *et al*., 2003). Another reason could be the early formation of roots and increased utilization of the reserved food materials by the treated cuttings (Ghatnatti, 1997). Early findings on pomegranate propagation reported by Panda and Das (1990), Dhillon and Sharma (1992), Polat and Caliskan (2009), and Seiar (2017) are in accordance with with the current study's findings.

Table 5: Effect of variety and plant growth regulator concentrations on length of longest root (cm) in pomegranate cuttings.

Variety (V)	IBA Concentration (C)					
	0 ppm	**2000 ppm**	**3000 ppm**	**4000 ppm**	**5000 ppm**	**Mean**
Arakta	10.02	12.74	12.80	13.07	13.10	**12.34**
Mridula	10.23	10.36	10.44	11.40	12.80	**11.05**
Muskat	10.51	10.60	12.65	12.82	13.07	**11.93**
Ichakdana	11.56	12.31	12.86	13.14	14.46	**12.86**
Chawla	10.59	12.65	12.85	13.26	15.29	**12.92**
Bhagwa	11.20	12.39	12.75	12.99	13.24	**12.51**
Kandhari Kabuli	10.80	11.89	12.95	13.09	13.89	**12.52**
Nabha	10.42	12.54	12.72	15.31	19.68	**14.13**
Jodhpur Red	8.72	8.92	10.22	10.43	10.63	**9.78**
P- 23	9.40	10.29	10.48	10.51	12.78	**10.69**
Mean	**10.34**	**11.47**	**12.07**	**12.60**	**13.89**	

C.D (p≤0.05) *Figures in parenthesis indicate square root values

Variety (V)	0.47
IBA concentration (C)	0.33
V × C	1.06

F. Fresh weight of roots (g)

Varieties had a significant impact on the fresh weight of roots (Table 6). Cuttings of variety Nabha produced the maximum fresh weight of roots (1.95 g) than cuttings of the other cultivars. In variety Jodhpur Red, the minimum fresh weight of roots (1.24 g) was reported. The fresh weight of roots increased as PGR concentration increased. Cuttings treated with IBA 5000 ppm had the highest fresh weight of roots (1.91 g), followed by IBA 4000 ppm (1.77 g), and control had the lowest (1.28 g).

The interaction between cultivars and plant growth regulator concentrations had a significant difference in effect. The maximum fresh weight of roots was observed in variety Nabha with IBA 5000 ppm (2.95 g), while the lowest was observed in cv. in cuttings of Jodhpur Red (1.14 g) i.e. control (table 6). The varietal and climatic differences during the study in relation to chemical regimes were reflected in producing heavier roots which inturn increased fresh weight of roots. This might also be due to reserved food in the cuttings (Singh *et al*., 2013).

Table 6: Effect of variety and plant growth regulator concentrations on fresh weight of roots (g) in pomegranate cuttings.

Variety (V)	IBA Concentration (C)					
	0 ppm	**2000 ppm**	**3000 ppm**	**4000 ppm**	**5000 ppm**	**Mean**
Arakta	1.20	1.35	1.53	1.59	1.67	**1.47**
Mridula	1.22	1.32	1.28	1.31	1.60	**1.34**
Muskat	1.32	1.35	1.45	1.56	1.62	**1.46**
Ichakdana	1.40	1.42	1.49	2.20	1.99	**1.70**
Chawla	1.46	1.58	1.25	2.40	2.87	**1.91**
Bhagwa	1.36	1.43	1.47	1.64	1.78	**1.53**
Kandhari Kabuli	1.28	1.44	1.51	1.74	1.82	**1.55**
Nabha	1.19	1.38	1.54	2.69	2.95	**1.95**
Jodhpur Red	1.14	1.16	1.26	1.29	1.38	**1.24**
P- 23	1.22	1.30	1.29	1.30	1.49	**1.32**
Mean	**1.28**	**1.37**	**1.40**	**1.77**	**1.91**	

C.D (p≤0.05) *Figures in parenthesis indicate square root values

Variety (V)	0.22
IBA concentration (C)	0.16
V × C	0.51

The increase in the number and length of roots has had a direct impact on the fresh weight of roots. The findings are consistent with those of Seiar (2017), who obtained maximum fresh weight of roots with IBA 1500ppm + NAA 1000 ppm. The findings are similar to those of (Kamboj *et al.*, 2017) and (Hakim *et al*., 2018) on pomegranate propagation.

G. Dry weight of roots (g)

The amount of dry matter accumulated in the roots of pomegranate cultivars varied significantly in this study. The dry matter content of roots harvested from cuttings of cv. Nabha was higher (0.94 g) than in the remaining cultivars (Table 7). The minimum dry weights of roots in cv. Jodhpur Red were reported (0.29 g). Among plant growth regulator treatments, IBA 5000 ppm had the highest dry weight of roots (0.91 g), followed by IBA 4000 ppm (0.64 g), with the lowest dry weight being recorded in the control (0.37 g). Among the interactions, the maximum dry weight of roots (1.70 g) was observed in Nabha cuttings treated with IBA 5000 ppm, followed by cv. Chawla (1.61 g) with the same concentration and the least dry weight of roots reported in cv. Jodhpur Red (0.25 g), i.e. the control (Table 7). This could be because the cultivar contained more stored carbohydrates, which when combined with IBA increased the number of roots, resulting in higher root dry matter accumulation. Similarly, (Seiar, 2017) reported maximum dry weight roots with IBA 1500 ppm + NAA 1000 ppm. The current findings are consistent with the findings of (Hakim *et al.*, 2018) on pomegranate propagation.

Table 7: Effect of variety and plant growth regulator concentrations on dry weight of roots (g) in pomegranate cuttings.

Variety (V)	IBA Concentration (C)					
	0 ppm	**2000 ppm**	**3000 ppm**	**4000 ppm**	**5000 ppm**	**Mean**
Arakta	0.33	0.39	0.41	0.42	0.50	**0.41**
Mridula	0.26	0.31	0.43	0.38	0.47	**0.37**
Muskat	0.32	0.35	0.38	0.40	0.49	**0.39**
Ichakdana	0.43	0.45	0.47	0.85	1.54	**0.75**
Chawla	0.45	0.50	0.71	0.90	1.61	**0.83**
Bhagwa	0.41	0.44	0.46	0.47	0.53	**0.46**
Kandhari Kabuli	0.34	0.38	0.65	0.70	1.52	**0.72**
Nabha	0.46	0.51	0.57	1.48	1.70	**0.94**
Jodhpur Red	0.25	0.26	0.30	0.31	0.36	**0.29**
P- 23	0.32	0.34	0.37	0.35	0.40	**0.35**
Mean	**0.37**	**0.40**	**0.44**	**0.64**	**0.91**	

C.D (p≦0.05) *Figures in parenthesis indicate square root values

Variety (V)	0.06
IBA concentration (C)	0.04
V × C	0.13

CONCLUSION

Based on the findings, we can conclude that with increase in IBA concentration, there will be increase in the rotting of hard wood cuttings and the rooting ability will be also depend on the varieties. From this experiment we can concluded that among the varieties Chawla, Nabha and Kandhari kabuli performed better in almost all root parameters followed by cvs. Ichakdana, Bhagwa, Arakta, Muskat, Mridula, P-23 and Jodhpur Red. The results showed that varieties Chawla, Nabha and Kandhari Kabuli were found to be the best suited for propagation under temperate conditions. Pre-treatments such as girdling and etiolation in combination with root promoters and their effect on rooting could be tried. Use of different types of bio fertilizers with different rooting hormones could be tried for the improving the rooting percentage in pomegranate cuttings.

Acknowledgement: The author is thankfulness to all the Faculty members of SKUAST-K, Shalimar for their kind support and help, especially the Division of Fruit Science and Division of Basic Sciences and Humanities for providing the facilities to carry out this study.

REFERENCE

Abdelrahman, S. and AI-Wasel, A. (1999). *In vitro* clonal propagation of AI-Belehi pomegranate (*Punica granatum* L.). *Journal of King Saud University of Agricultural Sciences*, *11*: 3-14.

Ajaykumar, S. J. (2007). Studies on propagation of phalsa (*Grewia subinaequalis*) by cutting. M. Sc. Thesis. University of Agricultural Sciences, Dharwad.

Barde, P., Tiwari, R., Kanpure, R. N., Baghel, B. S. and Kumawat, B. R. (2010). Effect of biofertilizers and growth regulators on rooting and growth of pomegranate cuttings. *Ann Plant Soil Res.*, *12*(1): 46-47.

Damar, D., Barholia, A. K., Lekhi, R. and Haldar, A. (2014). Effect of growth regulators and biofertilizers on survival of pomegranate (*Punica granatum* L.) stem cuttings. *Plant Arch.*, *14*(1): 347-50.

Dhillon, W. S. and Sharma, K. K. (1992). Effect of IBA on rooting of cuttings in pomegranate. *Journal of Research Punjab Agricultural University*, *29*(3): 350-353.

Ghatnatti, S. A. (1997). Studies on propagation of *Duranta plumeri Jacq*. Var. Goldiana by stem cuttings with growth regulators under mist. M. Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Gosh, D., Bandopadhyay, A. and Sen, S. K. (1988). Effect of NAA and IBA on adventitious root formation in stem cuttings of pomegranate (*Punica granatum* L.) under

intermittent mist. *Ind Agri*., *32*(4): 239-43.

Hakim, A., Jaganath, S., Honnabyraiah, M. K., Mohan Kumar, S., Anil Kumar, S. and Dayamani, K. J. (2018). Effect of biofertilizers and auxin on total chlorophyll content of leaf and leaf area in pomegranate (*Punica granatum* L.) cuttings. *International Journal of Pure and Applied Bioscience*, *6*(1): 987-991.

Hamooh, B. T. (2005). Vegetative propagation of pomegranate (*Punica granatum* L.) an arid region fruit tree. *J Met Environ Arid Land Agric Sci*., *16*: 15–23.

Hartmann, H. T., Kester, D. E., Davies, F. T. and Geneve, R. L. (1997). Plant Propagation: Principles and Practices. 6th Edn, Prentice-Hall, New Delhi, India, ISBN: 9780132061032 pp. 770.

Kamboj, S., Singh, K., Singh, S. and Navdeep, G. (2017). Effect of Indole Butyric Acid on rooting and vegetative parameters of pomegranate (*Punica granatum* L.). *International Conference on Recent innovations in Science, Agriculture, Engineering and Management* pp. 103-108.

Kasim, N.E. and Rayya, A. (2009). Effect of different collection times and some treatments on rooting and chemical interminal constituents of bitter almond hardwood cutting. *J. Agri. Biol. Sci., 5*: 116-22

Melgarejo, P., Martinez, J., Martinez, J.J. and Sanchez, M. (2008). Preliminary survival experiments in transplanting pomegranate. in: *Production, processing and marketing of pomegranate in the Mediterranean region*: Advances in Research and Technology CIHEAM Publication, Europe pp. 163-167.

Panda, J.M. and Das, R.C. (1990). Regeneration of pomegranate stem cuttings treated with IAA and IBA under intermittent mist. *Orissa Journal of Horticulture*, *18*: 32-37.

Pandey, A., Tomer, A. K., Bhandari. D. C. and Pareek, S. K. (2008). Towards collection of wild relatives of crop plants in India. *Genetic Resources and Crop Evolition*. *55*(2): 187-202.

Panse, V. G. and Sukhatme, P. V. (1978). Statistical method of Agricultural workers, ICAR Publication. New Delhi. 381.

Polat, A.A. and Caliskan, O. (2009). Effect of indole-butyric acid (IBA) on rooting of cutting in various pomegranate genotypes. *Acta Horticulture*, *818*: 187-192.

Purohit, A. G. and Shekharappa, K. E. (1985). Effect of type of cutting and IBA on rooting of hardwood cuttings of pomegranate. *Indian Journal of Horticulture, 42*: 30-36.

Rajeswara Reddy, K. V., Pulla Reddy, Ch. and Goud, P. V. (2008). Effect of auxins on the rooting of fig (*Ficus carica* L.) hardwood and semi hardwood cuttings. *Indian Journal of Agricultural Research, 42*(1): 75–78.

Rajkumar, Gora, J. S., Kumar, R., Singh, A., Kumar, A. and Gajender (2016). Establishment, survival and growth of pomegranate cuttings with different concentrations of indole butyric acid and rooting substrates. *Ecology, Environment and Conservation, 22*: 321-327.

Rymbai, H. and Reddy, G. S. (2010). Effect of IBA, time of layering and rooting media on air-layers and plantlets survival under different growing nursery conditions in guava. *Indian J Hort., 67*: 99-104.

Saroj, P. L., Awasthi, O. P., Bhargava, R. and Singh, U. V. (2008). Standardization of pomegranate propagation by cutting under mist system in hot arid region. *Indian Journal of Horticulture, 65*(1): 25-30.

Seiar, A. Y. (2017). Effect of growth regulators on rooting of cuttings in pomegranate (*Punica granatum* L.) cv. Bhagwa. *Journal of Horticultural Sciences, 11*(2): 156-160.

Sharma, N., Anand, R. and Kumar, D. (2009). Standardisation of pomegranate (*Punica granatum* L.) propagation through cuttings. *Biological Forum- An International Journal, 1*: 75-80.

Sharma, S. (1999). Effect of type of cuttings IBA and time of planting on rooting of cuttings in pomegranate (*Punica granatum* L.) cv. Ganesh. M. Sc. Thesis. GNDU Amritsar.

Singh, A. K., Rajesh, S., Mittal, A. K., Singh, Y. P. and Shiva, J. (2003). Effect of plant growth regulators on survival rooting and growth characters in long pepper (*Piper longum* L.). *Progressive Horticulture, 35*: 208-211.

Singh, K. K. (2014). Effect of IBA concentrations on the rooting of pomegranate (*Punica granatum* L.) cv. Ganesh hardwood cuttings under mist house condition. *Plant Archives*, *14*(2): 1111-1114.

Singh, K. K., Choudhary, T. and Prabhat, K. (2013). Effect of IBA concentrations on growth and rooting of *Citrus limon* cv. Pant Lemon cuttings. *Biosciences and Agriculture Advancement Society, 2*(3): 268-270.

Singh, P.C., Shukla, H.S. and Katiyar, P.N. (2009). Effect of indole butyric acid and p-hydroxybenzoic acid on regeneration of litchi cultivars through air layering. *Ann Hort., 2*(2): 194-196.

How to cite this article: Koteswara Rao, G. Siva, Bisati, I.A., Iqubal, U., Bhat, S.A., Mir, S.A. and Khan, F.U. (2021). Standardization of Pomegranate (*Punica granatum* L.) Propagation through Cuttings. *Biological Forum – An International Journal*, *13*(2): 17-23.