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Effect of IBA (Indole-3-butyric acid) concentration on Success, Survival and Mortality of Pomegranate (*Punica garanatum* L.) Cutting

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A B S T R A C T

The experiment" was carried out during the year 2017-18 at Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani on pomegranate (*Punica granatum* L.) cv. Bhagwa". The cuttings were taken from hardwood cuttings arising on trees of pomegranate cv. Bhagwa during the month of July. Experiment was laid out in Factorial Randomized Block Designed (FRBD) with 18 treatments and 3 factors which are replicated trice and no. of cuttings per treatment are 40. Result revealed that, pomegranate cuttings of 1.5 cm diameter and 20 cm length when treated with IBA 3000 ppm concentration solution for 15- 20 second gives significantly highest success percentage of pomegranate cuttings (70.12 %) was observed in treatment T_1 *i.e.* (IBA 3000 ppm), highest survival percentage (68.59 %) was recorded in treatment T_1 *i.e.* (IBA 3000 ppm) and lowest mortality percentage (31.40 %) of pomegranate cuttings was observed in treatment T_1 *i.e.* (IBA 3000 ppm).

Introduction

Pomegranate (*Punica granatum* L.) belongs to family Punicaceae is native to Asia especially to Iran, Afghanistan and Himalayan region. It is a shrub that naturally tends to develop multiple trunks and has a bushy appearance. When domesticated, it is grown as a small tree that grows up to 5m, leaves have an oblanceolate shape with an apex and acuminate base. Mature leaves are green, entire, smooth and hairless; the flowers can appear solitary, pairs or cluster. In the most cases, the solitary flowers will appear as spurs along the branches while the clusters are terminal (Levin, 2006). Fruit is globular, possessing a smooth outer rind with juicy arils (Mars, 2000). The Bhagwa variety of pomegranate has attractive glossy red thick skin with high TSS this is very popular among the farmers and is cultivated in large area because of the good shelf life, effective skin and aril colour and tolerant to fruit cracking (Sheikh, 2002). The Bhagwa variety have good export potential major breakthrough in the cultivation of pomegranate such as resting period, use of plant hormone and pruning of plants to obtain better size fruit have contributed in increasing quality of pomegranate fruit to meet the preference of consumers in domestic and international market.

Pomegranate could be propagated either sexually by seeds or vegetatively using stem cuttings and sometimes as layers or suckers or by grafting (Hartmann *et al.*, 1997). However, in commercial propagation stem cuttings are widely used. (Antakya Hatay, 2009). Grafting and layering of pomegranate trees is rarely done, because many different types of grafts have not been successful enough for use in commercial production. Tissue culture is another method of production that calls for the growth of plant in a sterile environment using tissue seed, or cuttings. (Abdul Rehman and Al-Wasel, 1999).

Sprouting and rooting ability of cuttings is mainly depends upon the physiological maturity of the shoot and conditions where cuttings have been planted for sprouting and subsequent rooting (Purohit and Shekrappa, 1985) and various internal and external factors like seasons and concentration of endogenous and exogenous phytohormones (Arya *et al.*, 1994). Plant growth regulators improve the rooting of cutting by stimulating the production of adventitious roots. Went (1934) first postulated that auxins initiate adventitious root formation in stem cuttings.

IBA is the most promising growth regulator inducing rooting quickly. Exogenous application of IBA accelerates the rate of rooting, increases final rooting percentage and number of roots. However, relatively high concentrations of IBA have been reported to be inhibitory to rooting (Leakey, 1990). It promotes root initiation, number of roots and shoots growth in number of ornamental and fruits plants. The rooting medium can have a major influence on the rooting capacity of cuttings (Hartmann *et al.*, 2002).

Materials and Methods

The experiment" was carried out during the year 2017-18 at Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani on pomegranate (*Punica granatum* L.) cv. Bhagwa". Treatment Details:

Factors:					
Factor A: Length of cutting		**Factor B: Diameter of cutting**		**Factor C: IBA concentration**	
L_1:	10 cm	D_1:	1 cm	T_1:	3000 ppm
L_2:	15 cm	D_2:	1.5 cm	T_2:	4000 ppm
L_3:	20 cm			T_3:	5000 ppm

Observation recorded

The experiment was replicated thrice with 40 cuttings in each treatment and a total of (2250) cuttings were tested. Five sprouted cuttings were selected randomly from each treatment of each replication. All given observations were recorded at intervals of 30, 60 and 90 days after planting.

Success percentage

Percent success was counted 60 days after planting by counting the number of cuttings established and the results were expressed in percentage. It can be calculated by using following formula.

$$\text{Success percentage (\%)} = \frac{\text{No. of live cuttings}}{\text{Total No. of cuttings}} \times 100$$

Survival percentage

Survival percentage was counted 90 days after planting by counting the number of cuttings established and the results were expressed in percentage.

Mortality percentage

Mortality percentage was counted 90 days after planting by counting the number of cuttings dead and the results were expressed in percentage.

Results and Discussion

The results obtained during the experiment were recorded and analysed statistically, presented under appropriate headings, sub-headings and discussed with available literature.

Success percentage

The effect diameter of cutting (D), length of cutting (L), IBA concentrations (T) and their interactions on success percentage of pomegranate cuttings presented in Table 1.

Effect of cutting diameter (D)

Significantly highest success percentage (70.67 %) was recorded in treatment D_2 *i.e.* (1.5 cm diameter) and lowest (65.13 %) was observed in D_1 *i.e.* (1 cm diameter).

Effect of cutting length (L)

Significantly, highest success percentage (70.85 %) was recorded with L_3 *i.e.* (20 cm length) and treatment L_2 *i.e.* (15 cm length) recorded lowest (68.29 %) success percentage. might be due to the fact that, large sized cuttings might have got sufficient food material and hormones leading to more survival (Kaur and Kaur 2018).

IBA concentration (T)

With respect to IBA concentrations, significantly highest success percentage of pomegranate cuttings (70.12 %) was observed in treatment T_1 *i.e.* (IBA 3000 ppm) and significantly lowest success percentage (67.60 %) was recorded with treatment T_2 *i.e.* (IBA 4000 ppm). This might be due to IBA which regulate different aspects of growth and development of plant in terms of cell division, cell elongation and differentiation which leads to formation of great quantity of roots and shoots making great plant and higher plant survival (Davis 1996).

Interaction effect of (L×D)

The interaction of length and diameter of cutting shows significant variation on success percentage. Significantly, highest success percentage (75.98 %) was recorded in interaction of L_3D_2 *i.e.* (length 20 cm and diameter 1.5 cm) and lowest success percentage (61.48 %) was observed in interaction of L_1D_1 *i.e.* (length 10 cm and 1 cm diameter).

Interaction effect of (T×D)

Significantly, highest success percentage (72.87 %) was recorded in interaction of T_1D_2 *i.e.* (IBA 3000 ppm and 1.5 cm diameter) which was at par with interaction of T_3D_2 (71.32 %) and lowest success percentage (60.65 %) was observed in interaction of T_3D_1 *i.e.* (IBA 5000 ppm and 1 cm diameter).

Interaction effect of (T×L)

The interaction of T_1L_3 *i.e.* (IBA 3000 ppm and 20 cm length) recorded significantly highest success percentage (75.43 %), which was followed by interactions of T_3L_3 (72.51 %) and T_1L_2 (69.10 %), while the lowest success percentage (62.10 %) was observed in interaction of T_2L_1 *i.e.* (IBA 4000 ppm and 10 cm length). However, the interaction effect of IBA concentrations, diameter and length of cuttings (T×D×L) do not show significant variation on success percentage of pomegranate cuttings.

Table.1 Effect of cutting size and IBA concentration on success and survival percentage of pomegranate cuttings

Treatments	Success percentage	Survival percentage
	90DAP	90DAP
Diameter of cutting (D)		
D_1	65.13 (40.96)	63.60 (39.78)
D_2	70.67 (45.27)	69.14 (44.04)
S.E N±	1.03	1.03
C.D. at 5%	3.09	3.09
Length of cutting (L)		
L_1	64.57 (40.57)	63.03 (39.38)
L_2	68.29 (43.17)	66.76 (42.00)
L_3	70.85 (45.62)	69.31 (44.36)
S.E N±	1.15	1.15
C.D. at 5%	3.45	3.45
IBA concentration (T)		
T_1	70.12 (44.94)	68.59 (43.68)
T_2	67.60 (42.82)	66.06 (41.59)
T_3	68.98 (43.89)	67.45 (42.66)
S.E N±	1.15	1.15
C.D. at 5%	3.45	3.45
Interaction (L x D)		
L_1D_1	61.48 (38.23)	59.95 (37.10)
L_2D_1	68.21 (43.11)	66.67 (41.93)
L_3D_1	65.71 (41.54)	64.17 (40.31)
L_1D_2	67.65 (42.90)	66.12 (41.66)
L_2D_2	68.37 (43.23)	66.84 (42.06)
L_3D_2	75.98 (49.70)	74.45 (48.40)
S.E N±	1.18	1.18
C.D. at 5%	3.54	3.54
Interaction (T x D)		
T_1D_1	67.37 (42.62)	64.84 (41.44)
T_1D_2	72.87 (47.27)	71.34 (45.93)
T_2D_1	67.37 (42.74)	65.84 (41.48)
T_2D_2	67.82 (42.89)	66.28 (41.70)
T_3D_1	60.65 (37.53)	59.12 (36.42)
T_3D_2	71.32 (45.67)	69.78 (44.49)
S.E N±	1.18	1.18
C.D. at 5%	3.55	3.55

* figures in parenthesis indicate the arc sine values

Interaction (L x T)	**90DAP**	**90DAP**
T_1L_1	65.85 (41.63)	64.31 (40.45)
$T_1 L_2$	69.10 (43.87)	67.56 (42.69)
$T_1 L_3$	75.43 (49.34)	73.90 (47.92)
$T_2 L_1$	62.10 (38.80)	60.56 (37.58)
$T_2 L_2$	68.18 (43.06)	66.65 (41.87)
T_2L_3	64.60 (40.94)	63.06 (39.83)
T_3L_1	65.76 (41.27)	64.23 (40.11)
$T_3 L_2$	67.60 (42.58)	66.06 (41.43)
$T_3 L_3$	72.51 (46.58)	70.98 (45.32)
S.E N±	1.04	1.04
C.D. at 5%	3.12	3.12
Interaction (T x D x L)		
$T_1D_1L_1$	61.02 (37.95)	59.73 (36.93)
$T_1D_1L_2$	70.43 (44.98)	68.90 (43.77)
$T_1D_1L_3$	71.69 (46.02)	69.00 (43.52)
$T_1D_2L_1$	72.12 (46.52)	68.52 (43.95)
$T_1D_2L_2$	67.76 (42.76)	66.23 (41.60)
$T_1D_2L_3$	80.43 (53.73)	78.90 (52.23)
$T_2D_1L_1$	62.26 (38.34)	58.12 (37.07)
$T_2D_1L_2$	67.58 (42.18)	65.56 (41.01)
$T_2D_1L_3$	73.76 (47.70)	72.23 (46.76)
$T_2D_2L_1$	63.93 (39.26)	61.40 (38.09)
$T_2D_2L_2$	69.26 (43.95)	67.73 (42.73)
$T_2D_2L_3$	71.26 (45.47)	69.73 (44.27)
$T_3D_1L_1$	61.93 (38.41)	60.40 (37.30)
$T_3D_1L_2$	67.10 (42.18)	65.56 (41.01)
$T_3D_1L_3$	52.93 (31.99)	51.40 (30.96)
$T_3D_2L_1$	69.60 (44.13)	68.06 (42.92)
$T_3D_2L_2$	68.10 (42.99)	66.70 (41.86)
$T_3D_2L_3$	76.26 (49.89)	74.73 (48.71)
S.E N±	4.30	4.30
CD at 5%	NS	NS
Treatment details		
D_1-Diameter 1 cm	L_1- Length 10 cm	T_1- 3000 ppm IBA
	L_2- Length 15 cm	T_2- 4000 ppm IBA
D_2-Dimeter 1.5 cm	L_3- Length 20 cm	T_3- 5000 ppm IBA

* figures in parenthesis indicate the arc sine values

Table.2 Effect of cutting size and IBA concentration on mortality percentage of pomegranate cuttings

Treatments	Mortality percentage
	90DAP
Diameter of cutting (D)	
D_1	36.39 (21.45)
D_2	30.85 (18.03)
S.E N±	1.03
C.D. at 5%	3.09
Length of cutting (L)	
L_1	36.96 (21.80)
L_2	33.23 (19.44)
L_3	30.68 (17.97)
S.E N±	1.15
C.D. at 5%	3.45
IBA concentration (T)	
T_1	31.40 (18.38)
T_2	33.93 (19.92)
T_3	32.28 (18.56)
S.E N±	1.15
C.D. at 5%	3.45
Interaction (L x D)	
L_1D_1	40.04 (23.73)
L_2D_1	33.32 (19.49)
L_3D_1	35.82 (21.12)
L_1D_2	33.87 (19.86)
L_2D_2	33.15 (19.39)
L_3D_2	25.54 (14.82)
S.E N±	1.18
C.D. at 5%	3.54
Interaction (T x D)	
T_1D_1	34.15 (20.04)
T_1D_2	28.65 (16.71)
T_2D_1	34.35 (20.25)
T_2D_2	33.71 (19.75)
T_3D_1	40.87 (24.21)
T_3D_2	29.21 (17.12)
S.E N±	1.18
C.D. at 5%	3.55

* figures in parenthesis indicate the arc sine values

Interaction (L x T)	**90DAP**
T_1L_1	35.69 (21.01)
$T_1 L_2$	32.44 (18.96)
$T_1 L_3$	26.10 (15.16)
$T_2 L_1$	39.44 (23.38)
$T_2 L_2$	33.35 (19.49)
T_2L_3	29.02 (16.88)
T_3L_1	35.76 (21.00)
$T_3 L_2$	33.93 (19.85)
$T_3 L_3$	28.25 (17.52)
S.E N±	1.04
C.D. at 5%	3.12
Interaction (T x D x L)	
$T_1D_1L_1$	40.27 (23.84)
$T_1D_1L_2$	31.10 (18.16)
$T_1D_1L_3$	31.00 (18.13)
$T_1D_2L_1$	31.48 (18.18)
$T_1D_2L_2$	33.77 (19.77)
$T_1D_2L_3$	21.10 (12.19)
$T_2D_1L_1$	41.88 (23.96)
$T_2D_1L_2$	34.44 (20.15)
$T_2D_1L_3$	27.77 (16.13)
$T_2D_2L_1$	38.60 (22.79)
$T_2D_2L_2$	32.27 (18.84)
$T_2D_2L_3$	30.27 (17.62)
$T_3D_1L_1$	39.60 (23.38)
$T_3D_1L_2$	34.44 (20.15)
$T_3D_1L_3$	48.60 (29.10)
$T_3D_2L_1$	31.94 (18.62)
$T_3D_2L_2$	33.30 (19.56)
$T_3D_2L_3$	24.27 (13.26)
S.E N±	4.30
CD at 5%	NS

Treatment details

D_1-Diameter 1 cm	L_1- Length 10 cm	T_1- 3000 ppm IBA
	L_2- Length 15 cm	T_2- 4000 ppm IBA
D_2-Dimeter 1.5 cm	L_3- Length 20 cm	T_3- 5000 ppm IBA

* figures in parenthesis indicate the arc sine values

Survival percentage

The results on survival percentage of pomegranate cutting presented in Table 1. As influenced by diameter of cutting (D), length of cutting (L), IBA concentrations (T) and their interactions.

Effect of cutting diameter (D)

The results revealed that, cutting diameter D_2 *i.e.* (1.5 cm diameter) recorded highest survival percentage (69.14 %) whereas lowest survival percentage (63.60 %) was observed in D_1 *i.e.* (1 cm diameter).

Effect of cutting length (L)

Among the length of cuttings, the highest success percentage (69.31 %) was recorded with L_3 *i.e.* (20 cm length) and lowest success percentage (63.03 %) was found in L_1 *i.e.* (10 cm length). This might be due to better development of root system with good quality root and shoot parameters enabling the rooted cuttings to make better growth and there by accounted the highest survivability. Sharma *et al.,* (2009).

IBA concentration (T)

The results indicate that IBA concentration have positive effect on survival percentage of pomegranate cutting. Significantly, highest survival percentage (68.59 %) was recorded in treatment T_1 *i.e.* (IBA 3000 ppm) and lowest survival percentage (66.06 %) was observed in T_2 *i.e.* (IBA 4000 ppm). Davis (1996). This might be due to the fact that, IBA hormones have shown to regulate different aspects of growth and development of plant in terms of cell division, elongation and differentiation which leads to formation of great quantity of roots and shoots making great plant and higher plant survival.

Interaction effect of (L×D)

The interaction of length and diameter of cutting shows significant effect on survival percentage. Significantly, highest survival percentage (74.45 %) of cutting was observed in interaction of L_3D_2 *i.e.* (length 20 cm and diameter 1.5 cm) and lowest percentage (59.95 %) was observed in interaction of L_1D_1 *i.e.* (length 10 cm and diameter 1 cm).

Interaction effect of (T×D)

Significantly highest survival percentage (71.34 %) of pomegranate cuttings was observed in interaction of T_1D_2 *i.e.* (IBA 3000 ppm and 1.5 cm diameter) which was followed by interactions of T_3D_2 (69.78 %). whereas lowest survival percentage (59.12 %) was observed in interaction of T_3D_1 *i.e.* (IBA 5000 ppm and 1 cm diameter).

Interaction effect of (T×L)

The interaction effect of length of cutting and IBA concentration on survival percentage shows significant variation. The interaction T_1L_3 *i.e.* (IBA 3000 ppm and 20 cm length) recorded significantly highest survival percentage (73.90 %) which was followed by the interaction of T_3L_3 (70.98 %) while lowest survival percentage (60.56 %) was observed with interaction of T_2L_1 *i.e.* (IBA 4000 ppm and 10 cm length). However, the interaction of IBA concentrations, length and diameter of cuttings (T×D×L) do not show significant variation on survival percentage of pomegranate cuttings.

Mortality percentage

The present study shows significant variation on mortality percentage in response to diameter of cutting (D), length of cutting (L), IBA concentrations (T) and their interactions are presented in Table 2.

Effect of cutting diameter (D)

The result obtained from the study revealed that, lowest mortality percentage (30.85 %) was recorded in D_2 *i.e.* (1.5 cm diameter) and highest mortality percentage (36.39 %) was observed in D_1 *i.e.* (1 cm diameter).

Effect of cutting length (L)

The length of cutting had significant effect on mortality percentage. The lowest mortality percentage (30.68 %) was observed in treatment L_3 *i.e.* (20 cm length) and highest mortality percentage (36.96 %) was observed in L_1 *i.e.* (10 cm length). this might be due to large sized cuttings, which are less liable to desiccation in comparison to small sized cuttings consequently, the former resulted in lowest mortality, Rana and Sood (2012).

IBA concentration (T)

Significantly, lowest mortality percentage (31.40 %) of pomegranate cuttings was observed in treatment T_1 *i.e.* (IBA 3000 ppm) and highest (33.93 %) was recorded with treatment T_2 *i.e.* (IBA 4000 ppm).

Interaction effect of (L×D)

The interaction of length and diameter of cutting on mortality percentage was found to be significant. Significantly lowest mortality percentage (25.54 %) was recorded with interaction of L_3D_2 *i.e.* (length 20 cm and 1.5 cm diameter) and highest mortality percentage (40.04 %) was observed in interaction of L_1D_1 *i.e.* (length 10 cm and 1 cm diameter).

Interaction effect of (T×D)

Significantly, lowest mortality percentage (28.65 %) of pomegranate cuttings was recorded in interaction of T_1D_2 *i.e.* (IBA 3000 ppm and 1.5 cm diameter) which was followed by interactions of T_3D_2 (29.21 %) whereas highest mortality percentage (40.87 %) was observed by interaction of T_3D_1 *i.e.* (IBA 5000 ppm and 1 cm diameter).

Interaction effect of (T×L)

The interaction of T_1L_3 *i.e.* (IBA 3000 ppm and 20 cm length) was recorded significantly lowest mortality percentage (26.10 %) which was statistically at par with interaction of T_3L_3 (28.25 %) and highest mortality percentage (39.44 %) was observed by interaction of T_2L_1 *i.e.* (IBA 4000 ppm and 10 cm length). However, the interaction effect of IBA concentrations, length and diameter of cuttings (T×D×L) was found to be non significant on mortality percentage of pomegranate cuttings.

This might be due to the fact that, large sized cuttings might have got sufficient food material and hormones leading to more survival.

Similarly, it also might be due to better development of root system with good quality root and shoot parameters enabling the rooted cuttings to make better growth and there by accounted the lowest mortality at 90 DAP. Similar result was also reported by Sharma *et al.,* (2009).

In conclusion, the pomegranate cuttings of 1.5 cm diameter and 20 cm length when treated with IBA 3000 ppm concentration solution for 15- 20 second gives significantly highest success percentage of pomegranate cuttings (70.12 %) was observed in treatment T_1 *i.e.* (IBA 3000 ppm), highest survival percentage (68.59 %) was recorded in treatment T_1 *i.e.* (IBA 3000 ppm) and lowest mortality percentage (31.40 %) of pomegranate cuttings was observed in treatment T_1 *i.e.* (IBA 3000 ppm).

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