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Effect of Plant Growth Regulators on Hard Wood Cuttings of Pomegranate (*Punica granatum L.*)

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ABSTRACT

A study was carried out at Regional Agriculture Research and Development Center, Makandura, Gonawila to investigate the effect of plant growth regulators on the development of roots and shoots in hard wood cuttings of pomegranate (*Punica granatum.L*). When planting materials are considered the seedling plants of pomegranate are easy to establish as a propagation method. However, the major drawback of this method is the emergence of plants with diverse characters from the mother plant as a result of segregation due to open pollination. Vegetative propagation using stem cuttings is one of the remedies to get plants identical to the mother plant. Therefore, this study was aimed to identify the effect of hormone treatments and length of cuttings on the plant establishment. Indole-3 Butyric Acid and Naphthalene Acetic Acid were applied in different concentrations as growth regulators. Data were statistically analyzed using SAS1998 package. Indole -3 Butyric Acid 500 ppm+ 1% Borax recorded the highest survival percentage, rooting percentage, mean root length, number of roots per cutting, shoot length, and number of shoots.

KEYWORDS: Cuttings, Plant growth regulators, Pomegranate, Vegetative propagation

INTRODUCTION

Pomegranate (*Punica granatum.*L) which belongs to family Punicaceae is one of the popular fruits of tropical and subtropical regions of the world. It is extensively cultivated in Mediterranean region of India, China and Japan (Owais, 2010). In Sri Lanka pomegranate is widely grown in Hambantota, Puttalum, Mannar, Anuradhapura, Jaffna, and Monaragala districts (Anon, 2006a) as it is capable of growing in a wide range of soils and under drought conditions to some extent (Karimi and Iran 2011).

Pomegranate is largely used as a table fruit or salad and it has a high demand in local and export market as it is rich in Potassium, vitamin C, and antioxidants. They are a good source of sugars (14-16%), minerals (0.7-1.0%), and iron (0.3-0.7mg/100g) (Chundawat 1990).

Propagation of pomegranate is done by seeds, cuttings, and air layering. Although seed propagation is cheaper than other methods seedling plants show high variability with respect to tree vigor, precocity, and quality in seedlings as pomegranate has cross pollination ability (Sharma *et al.*, 2009). As pomegranate has been described variously as self pollinated, self and cross pollinated, highly cross pollinated or often cross pollinated; seedlings are not considered as a favorable propagation method (Mars, 2000). Although, air layering is successful it is often considered expensive. The other drawback of this method is weakening of mother plant when continuing the process and therefore, production of large amount of plants is not practical (Anon, 2006b). In Sri Lanka air layering could be done successfully only during Maha season at Kalpitiya area. The most convenient and cheapest method of obtaining fully developed stronger trees in considerably lesser time is by cuttings. 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 by treating with plant growth regulators (Sharma *et al.*, 2009). In addition, early fruiting can be achieved in rooted cuttings than in seedlings as the juvenile period is less. Therefore, this study was carried out to investigate the effect of plant growth regulators on growth and development of roots and shoots in hardwood cuttings.

MATERIALS AND METHOD

Location

This study was carried out at Regional Agricultural Research and Development Center, Makandura, situated in the low country intermediate zone (IL_{1a}) at an elevation of 30m above mean sea level from January to April 2013.

Planting Material Preparation

Variety *Nimali* was used for the study. Hard wood cuttings were used as planting materials of pomegranate. Cutting diameter was 1cm and the lengths were 20 cm (L1) and 30 cm (L2).

Preparation of Cuttings

Initially hard wood cuttings of 0.4 cm, 0.75 cm and 1 cm diameter were taken as planting material and they were planted in black polythene pots. Sand and compost in 1:1 ratio was used as the potting mixture. These cuttings were treated with deferent Indole-3, Butyric Acid (IBA) and Naphthalene acetic acid (NAA) concentrations (C1...C6) (Table 1). There were 10 replications for each treatment.

Table 1. The treatments of experiment

Treatments (Concentration+ Dipping time)
T1- Rootone (IBA 0.3%) (C1) + quick dip
T2- Root most-liquid type (C2) + 15 min
T3- Water(control)(C3) + 15 min
T4- NAA300ppm (C4) + 12 hrs
T5- IBA300ppm(C5) + 24 hrs
T6- IBA500ppm+ 1% Borax (C6) + 15 min

Treatments were decided based on literature of a study carried out in India using cultivar Ganesh (Sharma *et al.*, 2009). Initially three different diameters were tested in demonstration plots. Finally 1cm diameter hard wood cuttings were selected for further studies.

A new trial had to be established in a sand bed treated with recommended level of thiram as the cuttings were died out due to favorable condition for the growth of fungi created by high temperature (35.5^{0}C), high relative humidity (95%) and potting media (1:1 sand: compost).

Statistical Design

Randomized complete block design with two factor factorial design was used. Data were statistically analyzed using SAS1998 package.

Cuttings were planted in 4'×2'×1' sized raised sand beds containing sandy regosol soil (Kalpitiya) in the second week of February. Water and chemicals (Fungicides, Termicides) were added to maintain quality of the plants and the temperature was regulated in a preferable way. Temperature and relative humidity of inside and outside of the propagator was measured at weekly intervals.

Data Recording

The following parameters were recorded in each cutting.

Number of days for initial shooting, Number of shoots, shoots length, Number of leaves, Number of roots, Length of roots, and the survival percentage.

RESULTS AND DISCUSSION

Mean Root Length

The maximum root length of 63.66 cm was recorded with the application of IBA 500 ppm + 1% Borax treatment. Minimum root length was recorded in control that was 13.23 cm. A length of 50.42 cm was recorded in NAA 300 ppm. However, IBA 500 ppm+ 1% Borax and NAA 300 ppm treatments were significantly different from each other. The results tally with the results of (Sharma *et al.*, 2009). However, (Sharma and Dhillon1992) reported highest root length in pomegranate cuttings treated with low concentration of IBA 100 ppm soaked for 24 hrs. According to the results treatment IBA 300 ppm soaked for 24 hrs was recorded significantly similar effect for mean root length. According to cutting length, better root length of 37.54 cm was recorded in 20 cm length cuttings. But, both 20 cm and 30 cm cuttings were not significantly different from each other (Table 2).

Table 2. Mean root length

Treatment	Mean root length (cm)		
	L1	L2	Mean
C1	12.63	20.13	16.38 ^{c}
C2	4.23	49.78	27.26 ^{bc}
C3	13.04	13.42	13.23 ^{c}
C4	55.33	45.50	50.42 ^{ab}
C5	32.97	24.45	28.71 ^{bc}
C6	55.82	71.5	63.66 ^{a}
Mean	37.54 ^{a}	29.00 ^{a}	

LSD value- 29.08 (treatment), 16.78 (length)
Means in a column with the same letters are not significantly different at the 0.05 level.

Average Root Length of Cuttings

The results were indicated the highest average root length in C6. And C4 also gave considerably good results about average root length. Both two were having similar effect for root length. The other treatments were had same effect for root length, and significantly different from C4 and C6. According to the cutting length best length was 30 cm, and cutting length was not effect for root length (Table 3).

Table 3. Average root length

Treatment	Average root length		
	L1	L2	Mean
C1	0.51	0.62	0.56 [b]
C2	0.28	0.81	0.55[b]
C3	0.44	0.39	0.42 [b]
C4	0.67	0.83	0.75 [ab]
C5	0.78	0.44	0.62[b]
C6	0.90	1.22	1.06 [a]
Mean	0.6 [a]	0.72 [a]	

LSD value -0.398 (Treatment), 0.23 (length)
Means in a column with the same letters are not significantly different at the 0.05 level

Survival Percentage

Highest survival percentage of 0.65 was recorded in treatment of IBA 500 ppm + 1% Borax. NAA 300 ppm treatment also recorded good results for the survival percentage. That is 0.5. Better growth of root and shoot system increased the survivability of cuttings. But Rootone, Rootmost (liquid rooting hormone), NAA 300 ppm treatments and control recorded best results. But the results were not significantly different from each other. According to the cutting length, 30 cm length cuttings recorded best results for the survival percentage. The value was 0.47. But both length types were not significantly different from each other (Table 4). The possible explanation for these results are the better development of root system with good quality root and shoots parameters enabling the rooted cuttings to make better growth under field conditions after plantation and thereby accounted the highest field survivability (Sharma *et al.*, 2009).

Table 4. Survival percentage

Treatment	Survival percentage (%)		
	L1	L2	Mean
C1	50	40	0.45[ab](0.94 [ab])
C2	40	40	0.40[ab] (0.91 [ab])
C3	40	40	0.40[ab] (0.91 [ab])
C4	40	60	0.50[ab] (0.96 [ab])
C5	30	30	0.30[b] (0.86 [b])
C6	60	70	0.65[a] (1.04 [a])
Mean	43.33[a]	46.67[a]	

LSDVlue-0.(0.16),(Treatment),0.38,(0.092)(Length)
Transformed figures are √+0.5transformed values
Means in a column with the same letters are not significantly different at the 0.05 level

Mean Root Number of Cuttings

The results clearly indicated that the treatments of IBA 500 ppm +Borax 1% produced the maximum root number of 46.55. This result was obtained with the combination of IBA and Boron appears to enhance rooting through synergistic interaction with IBA.

The results of 45.25 were indicated by NAA 300 ppm treatment also, and both were significantly similar with each other. Because both hormones enhance rooting of pomegranate cuttings. According to the cutting length 29.8 was obtained in 20 cm length. But both length types were not affected for rooting significantly (Table 5).

Table 5. Mean root number per cuttings

Treatment	Mean root number		
	L1	L2	Mean
C1	16.60	16.40	16.50 [b]
C2	6.40	23.20	14.80[b]
C3	16.90	14.60	15.75 [b]
C4	53.80	36.70	45.25 [a]
C5	34.50	23.00	28.75 [ab]
C6	50.60	42.50	46.55 [a]
Mean	29.80 [a]	26.07 [a]	

LSD value-21.13(Treatments), 12.20(length)
Means in a column with the same letters are not significantly different at the 0.05 level

Number of Days for Shoot Initiation

According to the results IBA 500 ppm took 6.5 days for shooting. But liquid hormone took a lesser number of days for shooting. But according to the statistical analysis hormonal levels did not significantly effect on shoot initiation (Table 6).

Table 6. Number of days for shoot initiation

Treatment	Dates for shooting		
	L1	L2	Mean
C1	11.2	6.40	8.80 [a]
C2	5.00	3.50	4.00[b]
C3	4.90	9.00	6.95 [ab]
C4	9.50	9.00	9.25 [a]
C5	13.50	5.60	9.55 [a]
C6	8.30	3.90	6.10 [ab]
Mean	8.65 [a]	6.23 [b]	

LSD value-3.95(Treatment), 2.28(length)
Means in a column with the same letters are not significantly different at the 0.05 level

Shoots Length After 12 Days

After twelve days, highest shoot length of 159.75 mm was recorded in IBA 500 ppm + 1% Borax treatment and 20 cm length (141.52) of cuttings. Better growth of root system may response for better growth of shoots (Table 7).

Number of Shoots After 26 Days

Maximum number of shoots also clearly indicated by C6 and 30 cm length cuttings. But all the treatments and both types of lengths did not significantly affect the number of shoots. As the number of shoots depends on length of the stem in top soil layer all the cuttings were established 2 to 3 nodes under the ground out of the total length. Therefore, if length was increased shoot number was increased accordingly (Table 8).

Table 7. Shoot length after 12 days

Treatment	No. of shot length after 12 days		
	L1	L2	Mean
C1	90.00	105.00	97.50 [abc]
C2	112.50	133.80	116.90 [ab]
C3	96.80	123.00	109.90 [abc]
C4	25.50	76.30	50.90 [c]
C5	35.50	195.00	115.25 [ab]
C6	92.00	227.50	159.75 [a]
Mean	3.05 b	6.22 a	

LSD value-60.04(Treatment), 34.66(length)
Means in a column with the same letters are not Significantly different at the 0.05 level

Table 8. Number of shoots after 26 days

Treatment	Number of shoots		
	L1	L2	Mean
C1	4.00	5.10	4.55 [a]
C2	4.30	7.40	5.85 [a]
C3	3.80	4.10	3.95 [a]
C4	2.30	4.90	3.60 [a]
C5	1.10	6.10	3.60 [a]
C6	2.80	9.70	6.25 [a]
Mean	3.05 [b]	6.23 [a]	

LSD value-3.36(Treatments), 1.94(length)
Means in a column with the same letters are not significantly different at the 0.05 level

Number of Leaves after 26 Days

According to Table 9, maximum number of leaves was shown by C6 and 30 cm length cutting type. It was clearly shown that there was no any significant effect of hormone levels and cutting length for number of leaves. It was decided by number of shoots, time and other environmental conditions.

Shooting Percentage

There were no any significant effects on shooting (Table 10). All the treatments were clearly recorded considerably higher percentages. But L1 obtained lower and L2 obtained higher values.

Shooting ability was determined by amount of storage food, number of shoots that in the upper part of sand layer.

Rooting Percentage

Highest rooting percentage was also obtained in IBA 500 ppm+ 1% Borax (C6) treatment. That is 85%, Boron appears to enhance the rooting of pomegranate cuttings through a synergistic interaction with IBA. (Sharma *et al.*, 2009). The effect of this interaction seems to include in root initiation. The lowest value was recorded in Rootmost (liquid hormone) (C2). C6, C3 and C2 were significantly different with each other (Table 11). According to the cutting length L2 (30 cm) showed the highest value for rooting percentage.

Table 9. Number of leaves after 26 days

Treatment	No of leaves after 26 days		
	L1	L2	Mean
C1	22.60	15.50	19.05 [a]
C2	16.30	31.00	23.65 [a]
C3	23.30	16.90	20.10 [a]
C4	13.20	14.60	13.90 [a]
C5	4.40	23.70	14.05 [a]
C6	12.30	45.40	28.85 [a]
Mean	15.35 [b]	24.52 [a]	

LSD value-15.36(Treatment), 8.87(length)
Means in a column with the same letters are not significantly different at the 0.05 level

Table 10. Shooting percentage

Treatment	Shooting percentage (%)		
	L1	L2	Means
C1	100	90	95[a](1.2 [a])
C2	90	90	90[a](1.17[a])
C3	100	100	100[a](1.22[a])
C4	90	100	95[a] (1.2 [a])
C5	90	100	95[a](1.2 [a])
C6	90	90	
Means	93.33a(1.2[a])	95a(1.19[a])	

LSD - 0.1404(0.0727)(Treatment), 0.0811 (0.042)(Length)
Transformed figures are √+0.5transformed values
Means in a column with the same letters are not significantly different at the 0.05 level

Table 11. Rooting percentage

Treatment	Rooting percentage (%)		
	L1	L2	Means
C1	80	50	65[abc](1.04[abc])
C2	40	40	40[c] (0.91[c])
C3	50	60	55[bc] (0.99[bc])
C4	70	60	65[abc] (1.07[abc])
C5	80	50	65 [abc](1.04[abc])
C6	90	80	85 [a] (1.15[a])
Means	68.33 [a]	56.67 [a]	

LSD Value- 0.2883(0.1492)(Treatment), 0.166(0.0862)(Length)
Transformed figures are √+0.5transformed values
Means in a column with the same letters are not significantly different at the 0.05 level

CONCLUSIONS

According to the results the best hormonal combination is IBA 500 ppm + 1% Borax treatment as it showed the highest rooting percentage, total root length, No. of roots, survival percentage, shoot length number of shoots and number of leaves.

The best cutting length was 30 cm and 1cm diameter was suited for best quality planting materials.

There were no hormonal effects for number of days for shoot initiation, shoot number, shooting percentage, shoot length and number of leaves.

Further studies are needed with different varieties, temporal variation of shoot dormancy, and evaluation of rooted cuttings under field conditions.

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