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Effect of IBA Concentrations and Length of Hardwood Cuttings on Rooting Performance of Pomegranate (*Punica granatum* L.) cv. Bedana

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A B S T R A C T

An experiment was conducted to study the effect of IBA concentrations and length of hardwood cuttings on rooting performance of pomegranate. The present study was carried out at the Horticulture Research Farm, Andro, Central Agricultural University, Imphal, Manipur during the month of July to November, 2018. The experiment was laid out in factorial randomized block design (FRBD) with two factors viz., IBA concentrations (1000 ppm, 2000 ppm, 3000 ppm & 4000 ppm) and length of hardwood cuttings (15 cm, 20 cm and 25 cm) with three replications. The results of the investigation indicated that I_3L_3 (IBA 3000 ppm with 25 cm cutting length) proved to be the best treatment in terms of number of root per rooted cutting (25.57), root fresh weight (1.24 g), root dry weight (0.79 g) and rooting percentage (79.15 %). However, the maximum length of roots (24.53 cm) was recorded best under I_3L_1 (3000 ppm with 15 cm cutting length).

Introduction

Pomegranate (*Punica granatum* L.) of the family Punicaceae is native from Iran to the Himalayas in Northern India, cultivated and naturalized over the whole Mediterranean region since ancient times (Facciola, 1990). Pomegranate has been cultivated for thousands of years and is considered to be one of the first fruit species to be domesticated (Still, 2006). Pomegranate can be propagated by stem cuttings, layering and grafting. Propagation through cuttings is the best and less expensive methods of its propagation (Upadhyay and Badyal, 2007). The success in stem cutting multiplication of fruits crops depend upon some factors such as condition of the mother plant, part of the tree, age of the tree from where the cuttings are made, as well as time of planting, rainfall, humidity, rooting media, care while planting and after care etc. (Frey *et al.*, 2006). Krieken *et al.*, (1993) mentioned that IBA might enhanced the rooting capacity in apple by increasing of internal free IBA, or synergistically modify the action of IAA or due to synthesis of endogenous IAA. Mansour (1968) reported that rooting of pomegranate cutting occurred

easily under mist all the year round, especially after IBA treatment with 3000 ppm.

The present investigation was carried out with the following objectives: 1.To find out the best concentrations on rooting parameters 2. To evaluate the suitable length of hardwood cuttings on rooting parameters and 3. To find out the interaction effect of IBA concentrations and length of hardwood cuttings on rooting parameters.

Materials and Methods

The experiment was conducted at the Horticulture Research Farm at Andro, Central Agricultural University, Imphal, Manipur, during the month of July to November, 2018. Different length of hardwood cuttings were collected from the healthy trees of one year old plants and planted into the polybags after treated with different level of IBA concentrations by quick dip method for 20 seconds.

The experiment was carried out in Factorial Randomized Block Design (FRBD) with three replication. Treatment comprises of 4 different concentrations of IBA (1000 ppm, 2000 ppm, 3000 & 4000 ppm) 3 different length of hardwood cuttings (15 cm, 20 cm & 25 cm). Twenty number of cutting were planted per treatments. Therefore, 720 number of cuttings were used in the experimental field.

Treatment Details

T_1 = 1000 ppm (I_1) + 15 cm (L_1)
T_2 = 1000 ppm (I_1) + 20 cm (L_2)
T_3 = 1000 ppm (I_1) + 25 cm (L_3)
T_4 = 2000 ppm (I_2) + 15 cm (L_1)
T_5 = 2000 ppm (I_2) + 20 cm (L_2)
T_6 = 2000 ppm (I_2) + 25 cm (L_3)
T_7 = 3000 ppm (I_3) + 15 cm (L_1)
T_8 = 3000 ppm (I_3) + 20 cm (L_2)
T_9 = 3000 ppm (I_3) + 25 cm (L_3)
T_{10} = 4000 ppm (I_4) + 15 cm (L_1)
T_{11} = 4000 ppm (I_4) + 20 cm (L_2)
T_{12} = 4000 ppm (I_4) + 25 cm (L_3)

Length of Root (cm)

The longest root of each selected cutting were measured at the end of experimental trial with the help of measuring scale and the mean value were calculated.

Number of roots per rooted cuttings

The number of primary roots per cuttings were observed after planting at 150 days and average number of primary roots per cutting were calculated.

Root fresh weight (g)

The fresh weight of root per cuttings were taken by using digital balance for each treatment and the mean value were calculated to express the fresh weight of the root in grams.

Root dry weight (g)

The dry weight of roots per cuttings were taken by using digital balance for each treatment after drying it in the hot air oven at 60^0 C and the mean value were calculated and the dry weight of the roots were expressed in grams.

Rooting Percentage (%)

Total number of rooted cuttings were recorded to calculate the rooting percentage by using the formula:

$$\text{Success \% of Rooting} = \frac{\text{Total number of rooted cuttings}}{\text{Total number of cuttings planted}} \times 100$$

Results and Discussion

Length of root

The data relating to the length of root (cm) per cutting as influenced by effect of IBA concentrations and lengths of hardwood cuttings is presented in table 1. It was observed that the treatment I_3 revealed the longest length of roots (21.56 cm), followed by I_2 (18.47 cm) while the shortest length of roots was revealed by I_1 (13.43 cm). Strydem and Hartman (1960) observed that increased in root length treated with IBA are due to the enhanced hydrolysis of carbohydrates, synthesis of protein, cell enlargement and cell division. Among the length of hardwood cutting, L_1 induced the longest length of root (19.18 cm) as compared to L_2 (17.02 cm) and the shortest length of roots was induced by L_3 (15.49 cm).The possible reason regarding the longest length of roots might be due to the facts that in L_1 (15 cm) cutting there were less number of roots as compared to L_3 (25 cm) cutting and thus the plant was in stress condition and to get more nutrients it force to elongates its roots. It is very effective in absorbing moisture and nutrient for the plant growth if the root length grows more downwards. Similar results was recorded by Shakir *et al.*, (2004) in wild olive cuttings. With regards to the interaction effect, I_3L_1 certified the longest length of root (24.53 cm) while I_1L_3 pronounced the shortest length of root (12.17 cm) per cutting which was statistically at par with I_1L_2 (13.27 cm).

Number of root per rooted cuttings

The data represent the number of roots per rooted cuttings as significantly influenced by the effect of IBA concentrations, length of hardwood cutting and their interaction effects is presented in table 2. A significant results on the production of roots per rooted cutting was observed with an increase in IBA concentrations. But it was also noticed that with further increased of IBA concentrations beyond 3000 ppm (I_3), the production of roots per rooted cutting decreases. The maximum number of roots (23.33) per rooted cutting was observed under I_3 as compared to I_2 (18.22) and minimum number of roots (12.17) per rooted cutting was revealed by I_1. The increase in number of root per rooted cutting may be due to the facts that's IBA helped to increase the cell division and their differentiation under the influence of rooting hormones, to enhanced hydrolysis of nutritional reserves resulting into increased root formation zone. This work were supported by the finding of Tripathi and Shukla (2004) in pomegranate, Reddy *et al.*, (2008) in fig, Ram et al.,(2005) in pomegranate cv. Ganesh and Kandhari. Similarly, number of roots per rooted cutting was increased with increasing the length of hardwood cutting. Cutting length of 25 cm (L_3) noticed the maximum number of roots (18.65) per rooted cutting as compared to cutting length of 20 cm (L_2) with (17.18) number of roots per rooted cutting and the minimum number of roots (15.83) per rooted cutting was induced by cutting length of 15 cm (L_1). The highest number of roots per rooted cutting might be due to the facts that more number of shoot per plant were present in 25 cm cutting as influenced by the IBA which is responsible for the growth of roots in higher quantity whereas it was less in 15 cm cutting. The present findings is in line with the works of Sohail *et al.*, (2014) in olive cutting. With respect to the interaction effect, I_3L_3 exhibited the maximum number of roots (25.57) per rooted cutting while I_1L_1 exhibited the minimum number of roots (10.73) per rooted cutting.

Root fresh weight

The data revealed that effect of IBA concentrations and length of hardwood

cuttings gave significant results on the root fresh weight is presented in table 3. Similarly, their interaction effect was also found to be significant. Root fresh weight was noticed to be increased with increasing levels of IBA concentrations till 3000 ppm (I_3), but it was also found to be decreases in root fresh weight if the levels of IBA concentration goes beyond 3000 ppm (I_3), wherein the maximum root fresh weight (1.23 g) was exhibited by I_3 as compared to I_2 (1.19 g) which was statistically at par with I_3 (1.23 g) and the minimum root fresh weight was found under I_1 (1.03 g). The possible reason regarding the maximum quantity of root fresh weight might be due to the facts that auxin is uses for the initiation and growth of roots with the help of reserved food materials already present in the stem cutting. Same finding was reported by Rajkumar *et al., (*2016) in stem cuttings of pomegranate. Similarly, root fresh weight was increased with increasing in length of hardwood cutting. The maximum root fresh weight (1.17 g) was exhibited by L_3 as compared to L_2 (1.16 g) which was statistically at par with L_3 (1.17 g) and the minimum root fresh weight was noticed under L_1 (1.10 g).

Table.1 Effect of IBA concentrations and length of hardwood cuttings on length of roots (cm)

IBA x Length	L_1	L_2	L_3	Mean
IBA $_1$	14.87	13.27	12.17	13.43
IBA $_2$	20.83	18.07	16.50	18.47
IBA $_3$	24.53	21.17	18.97	21.56
IBA $_4$	16.47	15.57	14.33	15.46
Mean	19.18	17.02	15.49	

SV	SE (d)	CD 0.05
IBA (I)	0.40	0.84
LENGTH (L)	0.35	0.73
I*L	0.70	1.45

Table.2 Effects of IBA concentrations and length of hardwood cutting on number of roots per rooted cuttings

IBA x Length	L_1	L_2	L_3	Mean
IBA $_1$	10.73	12.03	13.73	12.17
IBA $_2$	17.13	18.37	19.17	18.22
IBA $_3$	21.23	23.20	25.57	23.33
IBA $_4$	14.23	15.13	16.13	15.17
Mean	15.83	17.18	18.65	

SV	SE (d)	CD 0.05
IBA (I)	0.29	0.60
LENGTH (L)	0.25	0.52
I*L	0.50	1.05

Table.3 Effects of IBA concentrations and length of hardwood cutting on roots fresh weights (g)

IBA x Length	L_1	L_2	L_3	Mean
IBA $_1$	0.93	1.06	1.09	1.03
IBA $_2$	1.17	1.19	1.20	1.19
IBA $_3$	1.21	1.23	1.24	1.23
IBA $_4$	1.11	1.13	1.15	1.13
Mean	1.10	1.16	1.17	

SV	SE (d)	CD 0.05
IBA (I)	0.02	0.05
LENGTH (L)	0.02	0.05
I*L	0.03	0.06

Table.4 Effects of IBA concentrations and length of hardwood cutting on roots dry weights (g)

IBA x Length	L_1	L_2	L_3	Mean
IBA $_1$	0.42	0.60	0.65	0.56
IBA $_2$	0.69	0.70	0.73	0.71
IBA $_3$	0.76	0.77	0.79	0.77
IBA $_4$	0.66	0.67	0.68	0.67
Mean	0.63	0.69	0.71	

SV	SE (d)	CD 0.05
IBA (I)	0.03	0.06
LENGTH (L)	0.02	0.05
I*L	0.05	0.10

Table.5 Effects of IBA concentrations and length of hardwood cutting on rooting percentage (%)

IBA x Length	L_1	L_2	L_3	Mean
IBA $_1$	63.50	64.80	65.12	64.48
IBA $_2$	71.38	73.09	75.96	73.48
IBA $_3$	77.15	78.09	79.15	78.13
IBA $_4$	65.56	69.08	70.19	68.28
Mean	69.40	71.27	72.61	

SV	SE (d)	CD 0.05
IBA (I)	0.47	0.97
LENGTH (L)	0.41	0.84
I*L	0.81	1.68

The maximum root fresh weights might be due to the facts more number of root per rooted cutting were observed in L_3 (25 cm) cutting as compared to L_1 (15 cm) cutting.

The present findings is in line with the works of Sohail *et al.,* (2014) in olive cutting. With regard to the interaction effect, I_3L_3 provided the maximum root fresh weight (1.24 g) whereas I_1L_1 gave the minimum root fresh weight (0.93 g).

Root dry weight

The date represent the effect of IBA concentrations, length of hardwood cutting and their interaction effect had produced a significant impact on the root dry weight (g) is presented in table 4. The root dry weight registered positive impact with increasing in the levels of IBA concentrations till 3000 ppm (I_3), but it was also recorded to have a negative impact if it goes beyond the levels of IBA 3000 ppm (I_3). The maximum root dry weight (0.77 g) was pronounced by I_3 as compared to I_2 (0.71 g) which were statistically at par with I_3 (0.77 g) and I_4 (0.67 g) and the minimum root dry weight was found under I_1 (0.56 g). The possible condition regarding the maximum quantity of root dry weight might be due to the facts that auxin is uses for the initiation and growth of roots with the help of reserved food materials already present in the stem cutting. Similar finding was reported by Rajkumar *et al.,*(2016) in stem cuttings of pomegranate.

Among the length of hardwood cuttings, the root dry weight also increased with increasing the length of hardwood cuttings. L_3 exhibited the maximum root dry weight (0.71 g) as compared to L_2 (0.69 g) which was statistically at par with L_3 (0.71 g) while the minimum root dry weight (0.63 g) was produced by L_1. The maximum root dry weights might be due to the facts more number of root per rooted cutting were observed in L_3(25 cm) cutting as compared to L_1 (15 cm) cutting. The present findings is in line with the works of Sohail *et al.,* (2014) in olive cutting. Between their interaction effect, I_3L_3 exhibited the maximum root dry weight (0.79 g) which were at par with I_3L_2 (0.77 g), I_3L_1 (0.76 g), I_2L_3 (0.73 g), I_2L_2 (0.70 g) and I_2L_1 (0.69 g) while the minimum root dry weight was exhibited by I_1L_1 (0.42 g).

Rooting percentage

Data recorded have produced a significant impact on the rooting percentage as influenced by effect of IBA concentration, length of hardwood cutting and their interaction effect is presented in table 5. Among the levels of IBA concentrations, I_3 induced the maximum rooting percentage (78.13 %) as compared to I_2 (73.48 %) and the minimum rooting percentage was induced by I_1 (64.48 %).Evidence also suggested that auxin might have increased rooting percentages, shorten the rooting period and ensured length of roots. (Hartmann *et al.,* (2002). Similarly, for the length of hardwood cuttings, L_3 produced the maximum rooting percentage (72.61 %), followed by L_2 (71.27 %) and the minimum rooting percentage was produced by L_1 (69.40 %). This might also be due to the facts that larger length of cutting have more amounts of reserved food materials already present inside the stem cutting which leads to the development of bigger rooting system. Similar finding was observed by Tchoundjeu and Leakey (1996) as larger cutting store more carbohydrate required for rooting. Interaction effect between the effect of IBA concentrations and length of hardwood cuttings,I_3L_3 induced the maximum rooting percentage (79.15 %) which was statistically at par with I_3L_2 (78.09 %) whereas the minimum rooting percentage was provided by I_1L_1 (63.50 %) which was statistically at par with I_1L_2 (64.80 %).

As per the results of this experiment, it can be concluded that effect of IBA concentrations and length of hardwood cuttings had a significant impacts on the rooting performance of pomegranate cutting. Among the various concentrations of IBA, I_3(3000

ppm) gave the best performance in terms of length of roots, number of root per rooted cutting, root fresh weight, root dry weight and rooting percentage. Among the length of hardwood cuttings, L_1 (15 cm) cutting length produced the longest length of root whereas the maximum number of root per rooted cutting, root fresh weight, root dry weight and rooting percentage were recorded under L_3(25 cm) cutting length. In regards to their interaction effect of IBA concentrations and length of hardwood cuttings I_3L_1 exhibited the longest length of roots whereas the maximum number of root per rooted cutting, root fresh weight, root dry weight and rooting percentage were observed under I_3L_3.

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