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Effect of Time of Air Layering and IBA on Red Jamun (*Syzygium samarangense* L.) cv. Local

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ABSTRACT

The present experiment entitled "Effect of time of air layering and IBA on red jamun (Syzygium samarangense L.) cv. Local" was conducted during the year 2016 at Lalbaugh, Fruit Research Station, Department of Horticulture, Junagadh Agricultural University, Junagadh (Gujarat). The treatments comprised of different time of air layering (M_1- 1st May, M_2- 1st June, M_3- 1st July and M_4- 1st August) and different concentration of IBA (C_1 - Control, C_2- IBA 1000 ppm, C_3- IBA 1500 ppm and C_4- IBA 2000 ppm). There was sixteen treatments laid out in a Completely Randomized Block Design with factorial concept with three repetition. The observations of air layers were recorded before detachment of layers. In before detachment parameters, air layers prepared on the 1st August exhibited the minimum days of root initiation (18.6), maximum number of primary (7.32) and secondary roots (18.7) per layer at 45 days after layering, primary (9.88 cm) and secondary root length (7.03 cm), fresh weight (0.90 g) and dry weight of roots (0.33 g) per layer, number of shoots per layer (5.8), shoot length (8.3 cm) and rooted layer percentage (79.6). In case of different concentration of IBA, application of IBA 2000 ppm was also recorded minimum days of root initiation (18.1), maximum number of primary (7.88) and secondary roots (20.2) per layer, length of primary (9.88 cm) and secondary roots (7.14 cm), fresh (0.95 g) and dry weight (0.34 g) of roots per layer, number of shoot (6.0) per layer, shoot length (8.6 cm) and rooted percentage (83.2). Whereas, interaction effect of time of air layering and IBA, air layer prepared on 1st August along with IBA @ 2000 ppm resulted in minimum days of root initiation (16.5), maximum number of primary roots (10.87) and secondary roots (26.2) per layer, primary (11.6 cm) and secondary root length (7.59 cm), fresh weight (1.20 g) and dry weight of root (0.50 g) and rooted layer percentage (92.4).

***Key words*:** *Month of air layering, IBA, Red jamun, Local, August, ppm.*

INTRODUCTION

Syzygium samarangense L. is a plant species in the family Myrtaceae, native to an area that includes the Greater Sudan Islands, Malay Peninsula and the Andaman and Nicobar Islands, but introduced in prehistoric times to a wider area and now widely cultivated in the tropics. Common names in English include Bell fruit, Java apple, Semarang rose-apple and wax jambu.

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It is a tree growing to 12 m tall, with evergreen leaves 10–25 cm long and 5–10 cm broad, opposite, elliptic-oblong, coriaceous, within margin, pellucid dotted, strongly aromatic when bruised having short, crooked trunk, often branched near the base. The flowers are white, 2.5 cm diameter, with four petals and numerous stamens. The fruit is a bell-shaped, edible berry, with colors ranging from white, pale green, or green to red, purple, or crimson, to deep purple or even black, 4–6 cm long in wild plants. The flowers and resulting bell fruit are not limited to the axils of the leaves, and can appear on nearly any point on the surface of the trunk and branches. When mature, the tree is considered a heavy bearer, yielding a crop of up to 700 fruits.

A number of cultivars with larger fruit have been selected. In general, the paler or darker the color, the sweeter it is in Southeast Asia, the black ones are nicknamed "Black Pearl" or "Black Diamond", while the very pale greenish-white ones, called "Pearl", are among the highest priced ones in fruit markets. The fruit is often served uncut, but with the core removed, to preserve the unique bell-shaped presentation. In Malay peninsula, it is also used as bonsai plant as it grows well in pots and has thick trunk.

In India, bell fruits are found in East Godavari district of Andhra Pradesh near the dry land areas of Rajanagaram mandal mainly around Donthamuru village. In Telugu, these are called kammari kayalu. It is also found throughout Kerala where it is called as Champakka or Chambakka. It is mainly eaten as a fruit and also used to make pickles.

As per the USDA nutrient database, 100 g of edible red jamun contain 60 kcal, 15.6 g Carbohydrate (5% RDI), 0 g Fat, 0.7 g Protein (1% RDI), 14.3 mg Vitamin C (24% RDI), 19 mg Calcium (2% RDI), 0.2 mg Iron (1% RDI), 15 mg Magnesium (4% RDI), 17 mg Phosphorous (2% RDI), 14 mg Sodium (1% RDI). The flowers are astringent and used in Taiwan to treat fever and halt diarrhea. Investigators have found their principal constituent to be tannin. They also contain desmethoxymatteucinol, 5-O-methyl-4'-desmethoxymatteucinol, oleanic acid and B-sitosterol. They show weak antibiotic action against Staphylococcus aureus, mycobacterium smegmatis, and candida albicans.

The trees grow spontaneously from seed. Preferred types are reproduced by layering, budding onto their own rootstocks, or on to seedlings of S. *densiflorum*. The beautiful Wild Rose Apple of Malaya, which has edible flowers, undesirable fruits, but is not attacked by termites. Sometimes the Java apple is grafted on to the cultivated Rose Apple. Among all the method of propagation, air layering is one of the oldest technique which is cheapest, rapid and simple. It does not require any special techniques as in the case of grafting and budding. Roots are developed from the aerial part of a plant after the stem is girdled and enclosed in a moist rooting medium. This method is also known as chinese layerage, pot layerage, marcottage and goottee. The success in layering of red jamun and other fruit crops depends upon mother plants, time of layering, rainfall, humidity, temperature, rooting media, growth media, plant growth regulators and care at the time of removal of bark by ringing of shoots.

Layering involves an interruption of downward translocation of organic substances such as carbohydrates, auxins and other growth factors *viz*. protein, vitamins, hormones etc., from the leaves and shoot tips. These organic substances accumulate in the stem, where layering has been done and ultimately stimulate the rooting. The different organic media, water holding materials and plant growth regulators play an important role in rooting. Several organic media like poultry manure, vermicompost and FYM are used in air layering, which enhances rooting. Rooting media like sphagnum moss have higher moisture holding capacity with lighter weight, which enhance root formation[19].

Plant growth regulators are now widely used as an aid to plant propagation, particularly in the induction of rooting in cutting and air layering. Among different plant growth regulators, auxins are most effective as

a rooting aid. Although the natural auxin, IAA favours rooting in many species, several synthetic auxins like IBA and NAA are also found to be very effective than IAA, and widely used in commercial propagation. It is established fact that the IBA is the best root promoting plant growth regulator followed by NAA. The exogenous application of IBA induces rooting due to its ability to activate in cambium regeneration, cell division and cell multiplication. Root elongation is also noticed with the application of auxin[15]. Looking to the importance of plant growth regulators and rooting media in red jamun, the present experiment was entitled "Effect of time of air layering and IBA on red jamun (*Syzygium samaragense* L.) cv. Local".

MATERIALS AND METHODS

The present investigation "Effect of time of air layering and IBA on red jamun (*Syzygium samarangense* L.) cv. Local" was carried out at Lalbaugh, Fruit Research Station, Department of Horticulture, Junagadh Agricultural University, Junagadh (Gujarat, India) during 2016. The Junagadh in the state of Gujarat, is located at the foothills of the mount Girnar. The geographical coordinates of Junagadh are Longitude - 70° 28' East Latitude - 21° 31' North Junagadh stands at 107 meters above sea level. Climatically, Junagadh climate is characterized by fairly hot summer, moderate cold winter and more humid and warm monsoon with heavy rains. The maximum temperature rises up to 43.0^{0}C in the month of May (2016), minimum temperature recorded 11.7^{0}C in the month of December (2016). Monsoon starts from third week of June and last up to the second week of October (2016). Most of the rainfall is received from South West monsoon.

Fifteen years old healthy, well matured, uniform and vigorous red jamun plants were selected for the study which were planted at 10 × 10 m in square system of planting. After selection of plants, shoots of uniform age (one year old), growth (30 cm length) and pencil thickness were randomly selected for air layering. The experimental unit consisted of 20 layers in each treatment.

On the selected plants, about one year old shoots having an average diameter of 0.8 to 1.0 cm were tagged. The leaves were removed from selected shoots then removing a ring of bark about 2.5 to 3 cm long carefully by giving two circular cuts at both the ends of a ring with a sharp knife, at about 50 to 60 cm away from the tip of the shoot. The cambium layer was removed from ringed portion by rubbing it gently with fingers.

While plant growth regulators available in powder form, 1 mg of growth regulator dissolving in 50 ml of 95 percent absolute alcohol, then after adding required amount of distilled water, finally 1 ppm solution of growth regulators (1 mg/lit = 1 ppm) of 1 liter volume can be prepared. For preparation of IBA 2000 ppm stock solution, 2 g IBA powder was dissolved in 50 ml of 95 per cent absolute alcohol, then by adding distilled water, final volume of stock solution was prepared up to 1 liter. This stock solution was used to make 1500 ppm and 1000 ppm IBA solution by adding required amount of distilled water.

Before application of IBA, ringing was done to all selected shoots for experimentation. Each ringed shoot was treated with IBA by using hand spray and then moist sphagnum moss was wrapped as per the treatment. The treated air layers were covered with transparent polythene sheet (200 gauge, 15×15 cm) and tied tightly with plastic string.
The following treatments were applied during the course of investigation.

Time of Air layering (M)

I. 1st May (M_1)
II. 1st June (M_2)
III. 1st July (M_3)
IV. 1st August (M_4)

IBA Concentration (C)

I. Control (C_1)
II. IBA@ 1000 ppm (C_2)
III. IBA@ 1500 ppm (C_3)
IV. IBA@ 2000 ppm (C_4)

Treatment combination

M_1C_1	Air layering at 1st May + Without IBA
M_1C_2	Air layering at 1st May + IBA@ 1000 ppm
M_1C_3	Air layering at 1st May + IBA@ 1500 ppm
M_1C_4	Air layering at 1st May + IBA@ 2000 ppm
M_2C_1	Air layering at 1st June + Without IBA
M_2C_2	Air layering at 1st June + IBA@ 1000 ppm
M_2C_3	Air layering at 1st June + IBA@ 1500 ppm
M_2C_4	Air layering at 1st June + IBA@ 2000 ppm
M_3C_1	Air layering at 1st July + Without IBA
M_3C_2	Air layering at 1st July + IBA@ 1000 ppm
M_3C_3	Air layering at 1st July + IBA@ 1500 ppm
M_3C_4	Air layering at 1st July + IBA@ 2000 ppm
M_4C_1	Air layering at 1st August + Without IBA
M_4C_2	Air layering at 1st August + IBA@ 1000 ppm
M_4C_3	Air layering at 1st August + IBA@ 1500 ppm
M_4C_4	Air layering at 1st August + IBA@ 2000 ppm

For recording observations five randomly layers are selected in each treatment combination. Required observations were recorded from each repetition of different treatments and average value was calculated. The analysis of variance for experimental design was carried out for all the characters under study. The observation should be should be recorded before detachment of layers as per as appropriate procedure.

EXPERIMENTAL RESULT AND DISCUSION

The mean data on the before detachment parameters *viz*., days to root initiation, number of primary roots, number of secondary roots, length of primary roots, length of secondary roots, fresh weight of root, dry weight of root, number of shoot, shoot length and rooted layer percentage were significantly influenced by time of air layering and IBA. Interaction effect of time of air layering and IBA were also significantly found in all parameters except number of shoot and shoot lenght. For, brevity the entire result and discussion has been presented as under with possible explanation, available evidences and literature.

Effect of time of air layering

Data presented in Table 1 revealed that the red jamun air layers prepared on the 1st August (M_4) exhibited the minimum days of root initiation (18.6), maximum number of primary (7.32) and secondary roots per layer (18.7). In case of days of root initiation and secondary root per layer treatment 1st August (M_4) was found at par with treatment 1st July (M_3). Whereas, the maximum days of root initiation (20.7), minimum number of primary (4.64) and secondary roots per layer (13.1) was recorded in air layer prepared on 1st May (M_1). It might be due to the rooting in other months was affected due to environmental conditions in the shape of steady increasing in relative humidity from June to August and with temperature approaching down from high temperature of summer to moderate temperature of rainy and autumn season[2,17,10]. The time of air layering influenced significantly on length of primary and secondary root per layer at 45 days after air layering. The longest primary (9.88 cm) and secondary (7.03 cm) root was found in the air layer prepared on 1st August (M_4). It was at par with treatment 1st July (M_3) in both parameter. It might be due to the primary and secondary

root in other months was affected due to environmental conditions in the shape of steady increasing in relative humidity from June to August and with temperature approaching down from high temperature of summer to moderate temperature of rainy and autumn season[2,17].

Data presented in Table 2 the maximum fresh (0.90 g) and dry (0.33 g) weight of roots per layer was obtained with 1st August (M_4). It might be due to the availability of optimum environmental conditions during the period of root initiation and its growing periods[20,17,2]. Significantly the highest number of shoots per layer (5.8) and shoot length (8.3 cm) were noted in treatment 1st August (M_4), which was at par with the treatment 1st July (M_3) in both parameter. The minimum number of shoots (4.4) and shoot length (7.2 cm) were found in treatment 1st May (M_1). It might be due to favorable environmental condition during the month of August. The different time of air layering had significantly affected on rooted layer percentage. The maximum rooted layer percentage (79.6) was obtained with 1st August (M_4), which was at par with the treatment 1st July (M_3). It might be due to root formation on layers depend upon continuous moisture, good aeration and moderate temperature in rooting zone[17,2,10].

Effect of IBA concentration

Data presented in Table 1 the minimum days of root initiation (18.1), maximum number of primary (7.88) and secondary roots obtained per layer (18.2) were recorded in IBA @ 2000 ppm (C_4). The decreasing days of root initiation might be due to higher concentration of IBA the quantity of auxins reaching the cambial activity may be adequate for initiating root primordial, so the highest performance was seen at higher concentration of IBA[17]. The increasing primary and secondary roots might be due to the hormonal effect leading to accumulation of internal substances and their downward movement as well as, more cell division[13]. Moreover, accelerated rooting in the layering with the increased IBA concentration might be due to increased cell wall elasticity, which further may have accelerated cell division and in turns increased number of root up to certain level. This might be due to increase in carbohydrate and metabolic activities. The increase in the number of roots with increase in concentration of IBA was possibly due to the fact that, IBA influenced acceleration of the rate of initiation of root meristems and consequently production of greater number of roots[5,12,8,6,9]. The maximum length of primary (10.2 cm) and secondary (7.16 cm) roots obtained per layer at 45 days after air layering in IBA @ 2000 ppm (C_4) as rooting media It might be due to IBA promotes root length by influencing the synthesis of enzymes, which are concerned with the cell enlargement. The enzymes involved in cell enlargement process are triggered by the auxin at higher concentration[12,17].

Data presented in Table 2 significantly the maximum fresh (0.95 g) and dry (0.34 g) weight of roots per layer was registered, when red jamun air layer made with IBA @ 2000 ppm(C_4) but in case of dry weight it was at par with the treatment 1st July (M_3). In present study application of IBA @ 2000 ppm significantly increased the number of roots per layer and length of roots per layer which resulting into higher fresh and dry weight. It might be due to external application of auxin generally stimulate the movement of natural auxin and others materials in downward direction from the leaves and shoot tips, which accumulate at the incision made on the shoot resulting in the formation of roots with higher root fresh and dry weight[20,17,13,4,14].

With respect to IBA concentration, significantly the maximum number of shoot per layer (6.0) and shoot length (8.6 cm) were registered in the treatment IBA @ 2000 ppm (C_4). Whereas the minimum number of shoot (3.9) and shoot length (6.7 cm) were recorded in treatment Control (C_1). It might be due to high atmospheric humidity, low temperature, free from desiccating summer winds[7,3]. The significantly maximum rooted percentage (83.2) per layer was registered, when red jamun air layer made with IBA @ 2000 ppm (C_4). It might be due to significant

accumulation of carbohydrates in the root forming region of the layers and utilization of carbohydrates was greater in IBA treated layers[18,16,11].

Interaction effect of time of air layering and IBA

Data presented in Table 3 the treatment 1st August + IBA @ 2000 ppm (M_4C_4) was found more effective with respect to minimum days of root initiation (16.5), maximum number of primary roots per layer (10.87) and secondary root (26.2) Whereas, it was at par with 1st July + IBA @ 1500 ppm (M_3C_3) in days to root initiation and number of secondary roots. The maximum length of primary (11.6 cm) and secondary (7.59 cm) were also recorded with the treatment 1st August + IBA @ 2000 ppm (M_4C_4). It might be due to the balance between auxin and other constituents in plants tissues control organs formation and is the basis for rooting and root characters. This balance may be achieved by various combinations of environmental and chemical factors[1,17,10]. The interaction appeared to have significant effect on fresh and dry weight, where the treatment combination 1st August + IBA @ 2000 ppm (M_4C_4) recorded the maximum fresh (1.20 g) and dry (0.50 g) weight. An increased in fresh and dry weight of root per layer might be due to significantly increased in number of primary and secondary roots per layer and length of primary and secondary roots per layer resulting into higher fresh and dry weight of roots[20,17]. The treatment 1st August + IBA @ 2000 ppm (M_4C_4) recorded the maximum rooted layer percentage (92.4). However, it was at par with treatment 1st July + IBA @ 2000 ppm (M_3C_4).

Table 1: Effect of time of air layering and IBA on rooting parameters of red jamun air layers

Treatment	Days of root initiation (Days)	Number of primary roots	Number of secondary roots	Length of primary roots (cm)	Length of secondary roots (cm)
Time of air layering (M)					
M_1- 1st May	20.7	4.64	13.1	8.13	6.34
M_2- 1st June	20.1	5.00	13.5	8.40	6.62
M_3- 1st July	18.9	6.59	18.6	9.82	7.01
M_4- 1st August	18.6	7.32	18.7	9.88	7.03
S. Em±	0.2	0.09	0.23	0.11	0.07
C.D. at 5%	0.6	0.25	0.66	0.31	0.19
IBA Concentration (C)					
C_1- Control	21.9	3.43	9.71	7.38	6.19
C_2- IBA @ 1000 ppm	19.6	5.61	15.4	9.07	6.76
C_3- IBA @ 1500 ppm	18.8	6.63	18.7	9.58	6.89
C_4- IBA @ 2000 ppm	18.1	7.88	20.2	10.2	7.16
S. Em±	0.2	0.09	0.23	0.11	0.07
C.D. at 5%	0.6	0.25	0.66	0.31	0.19
Interaction (M x C**)**					
S. Em±	0.4	0.18	0.46	0.22	0.13
C.D. at 5%	1.1	0.51	1.32	0.63	0.38
C.V. %	3.4	5.19	4.97	4.16	3.37

Table 2: Effect of time of air layering and IBA on root parameters of red jamun air layers

Treatment	Fresh weight of root (g)	Dry weight of root (g)	Number of shoot per layer	Shoot length (cm)	Rooted layer (%)
Time of air layering (M)					
M_1- 1st May	0.56	0.17	4.4	7.2	65.8
M_2- 1st June	0.60	0.19	4.6	7.7	68.0
M_3- 1st July	0.86	0.30	5.6	8.2	79.0
M_4- 1st August	0.90	0.33	5.8	8.3	79.6
S. Em±	0.01	0.04	0.1	0.1	0.9
C.D. at 5%	0.03	0.12	0.2	0.3	2.7
IBA Concentration (C)					
C_1- Control	0.42	0.11	3.9	6.7	59.1
C_2- IBA @ 1000 ppm	0.72	0.21	5.0	7.7	73.0
C_3- IBA @ 1500 ppm	0.83	0.30	5.5	8.4	77.0
C_4- IBA @ 2000 ppm	0.95	0.34	6.0	8.6	83.2
S. Em±	0.01	0.04	0.1	0.1	0.9
C.D. at 5%	0.03	0.12	0.2	0.3	2.7
Interaction (M x C)					
S. Em±	0.02	0.008	-	-	1.9
C.D. at 5%	0.06	0.024	NS	NS	5.4
C.V. %	5.1	5.95	4.0	4.2	4.4

Table 3: Interaction effect of time of air layering and IBA on rooting and root parameters of red jamun air layers

Treatment	Days of root initiation (Days)	Number of primary roots	Number of secondary roots	Length of primary roots (cm)	Length of secondary roots (cm)	Fresh weight of root (g)	Dry weight of root (g)	Rooted layer (%)
M_1C_1	22.8	3.15	8.67	7.03	5.92	0.38	0.11	54.6
M_1C_2	20.5	4.33	13.5	8.00	6.48	0.52	0.14	66.3
M_1C_3	20.4	5.07	14.6	8.48	6.23	0.62	0.17	69.3
M_1C_4	19.3	6.00	15.7	9.01	6.73	0.73	0.24	72.3
M_2C_1	22.1	3.15	9.00	7.43	6.25	0.39	0.16	57.4
M_2C_2	20.1	5.05	14.0	8.33	6.54	0.57	0.15	67.3
M_2C_3	18.8	5.80	15.2	8.60	6.95	0.67	0.20	70.4
M_2C_4	19.1	6.00	16.0	9.23	6.75	0.77	0.26	76.4
M_3C_1	21.6	3.67	10.3	7.93	6.25	0.43	0.10	60.3
M_3C_2	19.1	6.02	16.5	9.60	6.93	0.85	0.31	78.5
M_3C_3	17.4	8.00	24.8	10.8	7.27	1.04	0.43	86.2
M_3C_4	17.3	8.67	22.8	10.9	7.57	1.10	0.37	90.8
M_4C_1	21.0	3.75	10.8	7.15	6.33	0.47	0.09	63.9
M_4C_2	18.5	7.05	17.6	10.3	7.09	0.93	0.33	80.1
M_4C_3	18.4	7.63	20.1	10.4	7.11	0.98	0.38	82.1
M_4C_4	16.5	10.87	26.2	11.6	7.59	1.20	0.50	92.4
S. Em+	0.4	0.18	0.46	0.22	0.13	0.02	0.008	1.9
C.D. at 5%	1.1	0.51	1.32	0.63	0.38	0.06	0.024	5.4
C.V. %	3.4	5.19	4.97	4.16	3.37	5.1	5.95	4.4

CONCLUSION

From the present study, it can be concluded that the among different time of air layering, air layer prepared on 1st August was found effective with respect to rooting characters. In case of IBA application, 2000 ppm IBA performed better for all root parameters before detachment. Regarding interaction between time of air layering and different concentration of IBA, air layer prepared on 1st August with IBA @ 2000 ppm was remained better for all root characters.

Based on investigation it can be concluded that, air layer prepared in month of August with treatment IBA @ 2000 ppm can be utilized for preparing healthy air layers of red jamun.

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