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HJ Chaudhari
Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

BH Panchal
Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

SR Vasava
Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

CB Parmar
Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

Correspondence
HJ Chaudhari
Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

Effect of etiolation, wrapping materials and media on growth characteristics and survival of air layering in guava (*Psidium guajava* L.) cv. Allahabad Safeda

HJ Chaudhari, BH Panchal, SR Vasava and CB Parmar

Abstract
An experiment entitled "Effect of etiolation, wrapping materials and media on rooting and survival of air layering in guava (*Psidium guajava* L.) cv. Allahabad Safeda" was carried out at Horticultural Research Farm, Anand Agricultural University, Anand during June – November 2017. The experiment was laid out in completely randomized design (Factorial) with three factors i. e. etiolation, wrapping materials and media, with two levels in etiolation, two levels in wrapping materials and five levels in media, with three repetitions of each level. The results revealed that etiolation (E_1), black poly wrapper (W_1) and media (M_2) had significantly influenced on air layers shoot and root growth characters. Shoot characters viz, incremental length of shoots, incremental number of leaves, incremental number of branches were found to be significantly higher in treatment etiolation (E_1), black poly wrapper (W_1) and sphagnum moss media (M_2). With regards to root characters viz, maximum root length, number of primary and secondary root were recorded significantly higher in E_1, W_1, and M_2. Relative growth rates were observed significantly higher at 60 days in treatment E_1 and also at 30 and 60 days in treatment M_2. Survival percentage of air layers at detachment (45 days), 30 days and 60 days after planting found to be significant. The highest survival percentages (77.97%), Maximum root length (10.75 cm), number of primary and secondary roots (12.66 and 40.33 respectively) were recorded in treatment combination $E_1 \times M_2$ (etiolation and media). Based on this investigation etiolation with black poly wrappers (200 gauge) and use of sphagnum moss proved to be better for growth and survival of air layers of guava.

Keywords: Etiolation, wrapping materials, media, sphagnum moss

Introduction
Guava (*Psidium guajava* L.) is a native of Tropical America (from Mexico to Peru) and belongs to family Myrtaceae. Guava is the fourth important fruit crop after mango, banana and citrus. It is hardy in nature. It gives an assured crop even with very little care. It is cultivated in India since early 17th century. Guava is one of the most common fruits liked by the rich and the poor community and is popularly known as the "Apple of the tropics". The total area and production of guava in India is about 254 thousand hectares and 4.046 thousand MT respectively with average productivity of guava is 12.0 MT ha-1 in India (NHB, 2015). Madhya Pradesh state ranks first in productivity of guava with 37.6 MT ha-1. In Gujarat, guava occupies about 11.637 thousand hectares with production of 153.038 thousand MT with productivity of 13.03 MT ha-1 (DOH, Gandhinagar. 2015) [3]. It is grown mainly in Bhavnagar, Ahmedabad, Kheda and Bharuch districts of Gujarat state. Etiolation in plants occurs when they are grown in either partial or a complete absence of light. Etiolation may reduce the production of lignin, thus instead of forming lignin phenolic metabolic may be channeled to enhance root initiation. Polythene wrappers have properties which in some respects makes it similar to the outer skin of plants. It is water proof, transmits light and allows gaseous exchange of oxygen and carbon-dioxide and low transmission of water vapour. Two colours of polythene wrappers i.e. black and white will be used at the time of operation. The rooting media used in air layers, must be sufficiently firm and dense to hold the air layers during rooting and it must retain enough moisture so that watering does not have to be too frequent. Sphagnum moss has higher moisture holding capacity with lighter weight, which enhances root formation.

Materials and Methods

Present investigation was conducted at Horticulture Research Farm, Anand Agricultural University, Anand, from June-November during the year 2017. The experiment was laid out in a Completely Randomized Design (Factorial) with twenty (20) treatment combinations and replicated thrice. Twelve years old healthy, well matured, uniform and vigorous 60 guava trees were selected for the study from the guava orchard which was planted at 6× 6 m in square system. After selection of plants, shoots of uniform age (one-year old), growth (50 to 60 cm length) and pencil thickness were randomly selected for air layering. The experimental unit consisted of 30 shoots in each treatment. Etiolation process before 30 day of air layering black polythene wrapping was done and then followed ringing. Etiolation was carried out during the month of June. Two colours of polythene wrappers i.e. black and white (200 gauges) were used at the time of operation. Various rooting media viz., soil and sphagnum moss was used for rooting on air layering. Initially sphagnum moss was soaked in water for about one hour before use and then a small quantity of sphagnum moss was applied to cover the ring of the shoot. The leaves were removed from the base of the selected shoot and then it was ringed by removing bark of about 2.5 to 3 cm carefully by giving two circular cuts with a sharp knife at about 45 to 60 cm below the top end of the shoots and the exposed portion was rubbed. All the open rings were wrapped with media followed by polythene wrapper and kept for rooting. Air layering was carried out during the month of July. The rooted air layers were separated from the parent plants after emergence of roots in three stages to reduce the shock of sudden separation at 45 days after air layering. Air layering separation was carried out during the month of September. Black polythene bags of 6" × 8" size were filled with soil. One air layer of the guava was dibbled at about 2 to 3 cm depth in each polythene bag. For each replication 600 polyphone bags were filled and kept in net house having 75% green shed net. The treatments comprised of two levels of etiolation i.e. (E_0) without etiolation (under dark condition) and (E_1) with etiolation (under light condition) as well as two levels of wrapping materials (W_1) Black poly wrapper (200 gauge) and (W_2) Transparent poly wrapper (200 gauge) with five level of growing media (M) viz., M_1- Soil, M_2-Sphagnum moss, M_3- Sphagnum moss + Soil (1:2), M_4- Sphagnum moss + Soil (1:1), M_5- Sphagnum moss + Soil (2:1). Five air-layers were selected from each treatment i.e. fifteen from all three replications for observation at the time of detachment of air-layers. Observations were recorded in respect to root length, fresh weight of shoot, dry weight of shoot at the time of detachment. While, at detachment, 30 and 60 days after planting observed incremental length of shoots, incremental number of leaves, incremental number of branches and relative growth rates at 30 and 60 DAP.

The data were then analyzed according to the method given by Panse and Sukhatme (1978) [8] for the factorial randomized block.

Results and Discussion

Effect of Etiolation

The perusal of data showed the significant effect of etiolation on growth characteristics and survival percentage (Table 1 & 2). Layering after 45 days at the time of detachment etiolation (E1) recorded maximum root length (7.67), number of primary roots (7.73), secondary roots (24.03). While, 30 and 60 days after planting (E_1) observed maximum incremental length of shoots (4.89 cm and 5.87 cm, respectively), incremental number of leaves (9.80 and 6.26, respectively) and incremental number of branches (3.14 and 2.30, respectively). Relative growth rate (0.220 g/day) was observed at 60 days after planting in treatment E_1. While, at detachment, 30th and 60th days after planting (E_1) observed maximum survival percent of rooted layers (64.98%, 59.80% and 56.36%, respectively). This might be due to the etiolation treatment of shoot improved further regeneration capacity of layers. Etiolation may reduce the production of lignin, thus instead of forming lignin phenolic metabolites may be channeled to enhance root initiation ultimately increase the number of shoot. Similar results were also obtained by Dhua and Sen (1984) [2] in guava, Singh and Jain (1996) [12] in guava, Wangchu *et al.* (2017) [16] in guava and Kumari *et al.* (2017) [6] in guava.

Effect of wrapping materials

The data presented in (Table 1 & 2) revealed that layering after 45 days at the time of detachment wrapping material (W_1) recorded maximum root length (7.45cm), number of primary roots (7.30), numbers of secondary roots (23.16). While, at 30 and 60 days after planting (W_1) recorded maximum incremental length of shoots (4.77cm and 5.74cm, respectively), incremental number of leaves (9.50 and 6.41, respectively) and incremental number of branches (3.17 and 2.61, respectively). However, maximum survival percent of rooted layers (64.30%, 58.50% and 55.06%, respectively) was observed at detachment, 30 and 60 days after planting (W_1). This might be due to during the process of rooting; callusing occurs first and root primordia forms afterwards. For prompt callusing, proper concentration of carbohydrates in the branches used for air layering is essential. Hence, synthesized food material, including carbohydrates that accumulated in the plants may be benefitted for enhancing root formation. This result was in close conformity with finding of Sarkar and Ghosh (2006) [11] in guava, Singh (2002) [13] in guava, Kanpure *et al.* (2015) [4] in guava and Tyagi and Patel (2004) [15] in guava.

Effect of rooting media

Among the different media, sphagnum moss had significantly affected on root and shoot characters (Table 1 & 2). Layering after 45 days at the time of detachment media (M_2) recorded, maximum root length (10.31cm), number of primary roots (12.08), secondary roots (37.58). Whereas, 30 and 60 days after detachment (M_2) observed maximum incremental length of shoots (6.02 cm and 6.85 cm, respectively), incremental number of leaves (13.60 and 6.70, respectively), incremental number of branches (3.70 and 2.90, respectively). The maximum survival percent of rooted layers at detachment (45 days), 30 days and 60 days after planting in polybags were 75.25%, 74.00% and 71.66%, respectively. However, relative growth rate at 30day after planting was noted higher in M_5 (0.112 g/day) which was at par with M_2 (0.104 g/days), however treatment M_2 recorded highest growth rate i.e 0.291 g/day than rest of treatments at 60 days after planting. This might be due to early initiation of roots, more number of roots, increase in root length, more number of leaves, etc. The higher number of leaves increase the photo synthesis and thereby accumulation of more carbohydrate, which assisted in promoting growth of air layers and survival of air layers. This results further get support from the findings of Singh *et al.* (2007) [14] in guava, Rymbai *et al.* (2012) [10] in guava and

Maurya *et al.* (2012) [7] in guava, Patel *et al.* (2012) [9] in pomegranate and Bhasal *et al.* (2009) [1] in guava.

Interaction effect of etiolation and rooting media

Etiolation and rooting media had significant effect on growth characteristics (Table 3). Treatment combination (E_1M_2) recorded maximum root length (10.75), number of primary roots (12.66), secondary roots (40.33) at the time of detachment i.e. 45 days after layering. Whereas, maximum incremental length of shoots (6.32 cm) at 0 to 30 days, survival percent of rooted layers (77.97%) at the time detachment was noted in E_1M_2. This beneficial interaction effect of treatment might be due to favorable environment created by combination of etiolation and sphagnum moss. Kadam and Slor (1974) reported same effect when sphagnum moss used as media in air layers. Similar results were reported by Rymbai and Reddy (2012) [10] in guava and Kunal and Syamal (2005) [5] in guava.

Table 1: Effect of etiolation, wrapping materials and media on root character and survival percentage in air layering of guava (*Psidium guajava* L.) cv. Allahabad Safeda

Treatments	Maximum root length (cm) at 45 days	Number of primary roots at 45 days	Number of secondary roots at 45 days	Survival percentage of layers		
				At detachment	At 30 days	At 60 days
Etiolation (E)						
E_0	6.85	6.43	20.33	61.80	54.80	51.80
E_1	7.67	7.73	24.03	64.98	59.80	56.36
S.Em. ±	0.07	0.12	0.24	0.19	0.25	0.31
C.D. at 5%	0.22	0.36	0.69	0.56	0.72	0.91
Wrapping materials (W)						
W_1	7.45	7.30	23.16	64.30	58.50	55.06
W_2	7.07	6.86	21.20	62.47	56.10	53.10
S.Em. ±	0.07	0.12	0.24	0.19	0.25	0.31
C.D. at 5%	0.22	0.36	0.69	0.56	0.72	0.91
Rooting media (M)						
M_1	4.25	3.08	9.75	50.59	38.50	33.58
M_2	10.31	12.08	37.58	75.25	74.00	71.66
M_3	5.77	4.75	14.50	57.43	49.25	45.58
M_4	7.29	6.66	21.16	64.31	58.41	55.00
M_5	8.67	8.83	27.91	69.35	66.33	64.58
S.Em. ±	0.12	0.20	0.38	0.31	0.40	0.50
C.D. at 5%	0.35	0.57	1.09	0.89	1.14	1.44
CV%	5.79	9.81	5.99	1.72	2.42	3.23
(E × M)	Sig.	Sig.	Sig.	Sig.	NS	NS
(W × M)	NS	NS	NS	NS	NS	NS
(E × W)	NS	NS	NS	NS	NS	NS
(E × W × M)	NS	NS	NS	NS	NS	NS

Note: - E_0 :- Without Etiolation, E_1 :- With Etiolation, W_1 :- Black poly wrapper (200 gauge), W_2 :- Transparent poly wrapper (200 gauge), M_1 :- Soil, M_2 :- Sphagnum moss, M_3 :- Sphagnum moss + Soil (1:2), M_4 :- Sphagnum moss + Soil (1:1), M_5 :- Sphagnum moss + Soil (2:1)

Table 2: Effect of etiolation, wrapping materials and media on shoot character in air layering of guava (*Psidium guajava* L.) cv. Allahabad Safeda

Treatments	Length of shoots at detachment (45 days)	Incremental length of shoots(cm)		Number of leaves at detachment (45 days)	Incremental number of leaves		Number of branches at detachment (45 days)	Incremental number of branches		Relative growth rate (g/day)	
		At 0 to 30 days (cm)	At 30 to 60 days (cm)		At 0 to 30 days	At 30 to 60 days		At 0 to 30 days	At 30 to 60 days	30 days	60 days
Etiolation (E)											
E_0	29.24	4.37(33.61)	5.37(38.98)	8.07	8.47	6.03(14.50)	1.90	2.90(4.80)	1.10(5.90)	0.091	0.197
E_1	28.49	4.89(33.38)	5.87(39.25)	8.07	9.80	6.26(16.06)	2.00	3.14(5.14)	2.30(7.44)	0.092	0.220
S.Em. ±	0.34	0.03	0.04	0.14	0.19	0.06	0.04	0.07	0.06	0.001	0.004
C.D. at 5%	NS	0.09	0.13	NS	0.56	0.17	NS	0.22	0.18	NS	0.013
Wrapping materials (W)											
W_1	29.01	4.77(33.78)	5.74(39.52)	8.17	9.50	6.41(15.91)	1.90	3.17(5.07)	2.61(7.68)	0.092	0.210
W_2	28.72	4.49(33.21)	5.49(38.70)	7.97	8.77	5.88(14.65)	2.00	2.87(4.87)	1.66(6.53)	0.091	0.207
S.Em. ±	0.34	0.03	0.04	0.14	0.19	0.06	0.04	0.07	0.06	0.001	0.004
C.D. at 5%	NS	0.09	0.13	NS	0.56	0.17	NS	0.22	0.18	NS	NS
Rooting media (M)											
M_1	28.15	2.61(30.76)	3.52(34.28)	8.50	4.60	5.60(10.20)	2.00	0.70(2.70)	1.20(3.90)	0.072	0.112
M_2	29.40	6.02(35.42)	6.85(42.27)	7.90	13.60	6.70(20.40)	1.90	3.70(5.60)	2.90(8.50)	0.104	0.291
M_3	29.05	4.10(33.15)	5.25(38.40)	7.87	6.70	5.80(12.50)	2.00	2.12(4.12)	1.93(6.05)	0.082	0.168
M_4	29.14	4.99(34.13)	6.04(40.17)	7.89	10.30	6.00(16.30)	2.00	2.31(4.31)	2.12(6.43)	0.088	0.221
M_5	28.59	5.43(34.02)	6.43(40.45)	8.1	11.60	6.60(18.20)	1.80	2.63(4.43)	2.41(6.84)	0.112	0.252
S.Em. ±	0.54	0.05	0.07	0.22	0.31	0.09	0.06	0.12	0.15	0.002	0.007
C.D. at 5%	NS	0.15	0.21	NS	0.89	0.27	NS	0.34	0.43	0.008	0.021
C.V%	6.59	4.05	4.65	9.60	11.82	5.41	11.46	11.96	11.43	10.745	12.588
(E × M)	NS	Sig.	NS	NS	NS	NS	NS	NS	NS	NS	NS

(W × M)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
(E × W)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
(E × W × M)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Interaction effect of etiolation and media on growth characteristics and survival percentage in air layering of guava (*Psidium guajava* L.) cv. Allahabad Safeda

Treatment	Root length (cm) at 45 days	Number of primary roots at 45 days	Number of secondary roots at 45 days	Incremental length of shoots(cm) At 0 to 30 days (cm)	Survival percentage of layers at detachment (45 days)
$E_0 M_1$	3.85	2.83	8.50	2.31	49.52
$E_0 M_2$	9.88	11.50	34.83	5.71	72.52
$E_0 M_3$	4.83	4.50	13.33	3.73	56.06
$E_0 M_4$	7.26	5.50	19.83	4.76	63.16
$E_0 M_5$	8.41	7.83	25.16	5.35	67.73
$E_1 M_1$	4.66	3.33	11.00	2.92	51.67
$E_1 M_2$	10.75	12.66	40.33	6.32	77.97
$E_1 M_3$	6.71	5.00	15.66	4.48	58.80
$E_1 M_4$	7.31	7.83	22.50	5.21	65.47
$E_1 M_5$	8.93	9.83	30.66	5.51	70.97
S.Em. ±	0.17	0.28	0.54	0.07	0.44
C.D. at 5%	0.49	0.81	1.55	0.21	1.27
C.V%	5.79	9.81	5.99	4.05	1.72

Conclusion

Thus from the above finding it may be concluded that guava can be successfully propagated by air layering with etiolation followed by wrapping materials and media. The results of present investigation suggest that for better growth and subsequent establishment of air layers of guava in net house, with etiolation followed by black poly wrappers and sphagnum moss are quite useful and best.

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