International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 1768-1772

Received: 01-09-2018
Accepted: 05-10-2018

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Performance of sapota (*Manilkara achras*, Mill.) softwood grafts on precuring and different season

Shashi Ghritlahare and Ashutosh

Abstract
The experiment was conducted at Horticulture Research Station, Orissa University of Agriculture & Technology, College of Agriculture, and Bhubaneswar during 2016 - 2017. The treatment comprises of four grafting seasons (20th June, 20th July, 20th August and 20th September) and three scion precuring periods (0 days, 5 days and 10 days) have been tried in a Factorial Randomized Block Design with three replications. The results revealed that among the four grafting seasons, 20th July recorded the maximum growth of scion (2.64 cm and 4.69 cm at 60 and 120 DAG, respectively), incremental length of rootstock (0.63 cm), incremental diameter of scion (1.89 mm), number of leaves per graft (12.07) at 60 DAG, area of largest leaf (17.25 cm^2). In respect to different scion precuring periods, maximum growth of scion (2.61 cm and 4.69 cm) at 60 and 120 DAG, respectively, incremental diameter of scion (1.87 mm), number of leaves per graft (11.53) at 60 DAG, area of largest leaf (13.48 cm^2), were observed in 10 days precured scions. The combined effect of the above two factors had also significant influence on most of the parameters studied.

Keywords: sapota, precuring, softwood grafting

Introduction
Sapota (*Manilkara achras* Mill.) is one of the important fruit crops of tropical regions of the country. It prefers a warm and moist weather and grows both in dry and humid areas. It can tolerate salinity and water stress to a great extent. In sapota, various methods of propagation have been practiced with considerable success. Budding, air layering, approach grafting and softwood grafting are the methods of propagation followed in sapota. Softwood grafting on one year old rootstock seedling is simple, economical and can give considerable percentage of success (Amin, 1978) [2]. Therefore, softwood grafting has been considered as one of the most important vegetative methods of propagation in sapota. The different rootstocks used in propagation of sapota are khirni or rayan, Adam's apple, mahua, mee tree and star apple. Of all the rootstocks rayan or khirni, a tropical tree, is the most suitable for sapota and is extensively used as it has a very profuse root system. The ideal season of grafting in sapota is rainy season (July – September). Weather conditions play a prominent role on the success of grafting, influencing graft success and growth of grafted plant (Iqbal *et al*., 2004) [11]. Success, survivability and growth of grafts depend upon many other factors including variety, grafting method, time of grafting, age and precuring of scion, age of rootstock, leaf and node retention on rootstock and environmental conditions (Hartman *et al*. 1997) [10]. Precuring also plays an important role in the success of softwood grafting in sapota (Pampanna and Sulikeri, 2000) [21]. The present study was undertaken to see the effects of grafting season and scion defoliation period on the success of softwood grafting and survivability of grafts in sapota.

Materials and Methods
The experiment was carried out at the Horticulture Research Station, College of Agriculture, Orissa University of Agriculture & Technology, and Bhubaneswar during 2016-2017. The experiment was laid out in Factorial Randomized Block Design with twelve treatment combinations comprising of four different grafting season and three precuring periods. All treatments were replicated thrice. Potting mixture of soil and FYM with a ratio of 1:1 was used for raising seedlings of Khirnee rootstock for sapota softwood grafting. Khirnee seedlings of one year age raised in polybag were used as a rootstock for sapota softwood grafts. Healthy scion shoots free from pests and diseases were selected. Scion sticks were collected from the terminal shoot portions of sapota branches.

The leaves were removed leaving the petioles attached to the shoots. The scions were precured (allowed to remain on the plant) for varying periods of 0, 5 and 10 days, i.e. for P_1, P_2 and P_3, respectively. Precured scions of size 6-7 cm long were chosen. Softwood grafting was performed in four different grafting season (20th June, 20th July, 20th August and 20th September). The prepared grafts were shifted to the open condition and were maintained in good condition by removing off-shoots, polythene caps and polythene strip and controlling disease and pest. The data were collected on the following parameters: length of new scion growth, incremental length of rootstock, incremental diameter of scion, number of leaves per graft and area of largest leaf. The collected data on the different parameters of study were statistically analyzed to find out the significance of differences between the treatments and treatment combinations. The standard Errors of Mean and Critical Differences at 5 percent level of significance were calculated to comparing the mean values.

Results and Discussion

The results obtained from the present investigation are summarized below:

1. Length of new scion growth at 60 and 120 DAG

1.1 Effect of grafting season

A perusal of the data results show that July (S_2) grafts showed maximum growth of scion (2.64 cm and 4.69 cm at 60 and 120 DAG, respectively) followed by August (S_3) grafted plants whereas minimum length was observed in September (S_4) grafted plants (2.02 cm and 4.37cm, respectively). This may be due to the fact that in addition to photosynthates contribution towards the growth of the scion, it may be more helpful in month of July because of optimum temperature prevalence during the respective period resulting in good growth of scion as have been emphasized by Hartmann and Kester, 1972 [9]. Moreover, till the temperature gets lowered to arrest good vegetative growth, the July grafting gets longer duration in comparison to September grafting which might have produced longer significant incremental growth of scion. Kelasker *et al*. (1993) supported the present findings.

5.4.2 Effect of scion precuring

The observations confirm that precured scions defoliated 10 days before grafting (P_3) recorded maximum scion shoot length (2.61 cm and 4.65 cm) at 60 and 120 DAG. The results were in conformity with Dod *et al*. (1996) [7] and Jha and Brahmachari (2002), Dhakal and Hoda (1986) [6]. This might be due to the initiation of good cambial activity which might have resulted from defoliation (Hartman *et al*., 1997) [10]. This resulted in better shoot growth and maximum internodal length. The beneficial effects of precuring in terms of growth of mango grafts have been reported by Patil *et al*. (1983) [25]. Similarly, Kumar *et al*. (2012) [30] in guava reported that scions cured for 9 days gave better results in terms of graft height.

2.3 Interaction effect

Incremental new growth of scion was observed to be significant under the treatment S_2P_3 (2.72 cm and 4.73 cm, respectively) as the greater defoliation period of 10 days prior to grafting (P_3) caused the swelling and activation of buds leading to early sprouting and further gaining quick growth under favourable temperature range in the month of July (S_2). On the contrary, the lowest incremental scion growth in September at 60 and 120 DAG under 0 days of defoliation period (1.79 cm and 4.21 cm, respectively) may be due to unavailability of scions with active buds, decreased sap flow and lower humidity. These results are in agreement with those of Pathak *et al*., 1992 [24] and Awasthi *et al*., 2005 [3].

2. Incremental length of rootstock at 120 DAG

2.1 Effect of grafting season

The length of the rootstock was found to increase significantly with the treatment S_2 (0.63 cm) followed by S_3 (0.56 cm). The minimum (0.49 cm) length was reported in S_4. This can be explained by the fact that there was high physiological activity and good sap flow in the rootstock along with favourable temperature and relative humidity available for a comparatively longer period which was responsible for the increase in the length of the rootstock. Similar results have been described by Pathak *et al*. (1992) [24]

2.2 Effect of scion precuring

Different periods of scion precuring does not have any distinct effect on the length of the rootstock as the active buds due to longer defoliation period only affects the growth of the scion.

2.3 Interaction effect

There is no significant interaction effect of season of grafting and period of scion precuring on the length of the rootstock as observed at 120 DAG. It may be a fact that 120 days is a short period to assess any effect on the length of the rootstock.

3. Incremental diameter of scion at 120 DAG

3.1 Effect of season

The different seasons of grafting showed significant effect on the incremental diameter of the scion. The July grafted plants (S_2) (1.89 mm) exhibited significantly more diameter of the scion in comparison to other treatments. The reason for this may be ascribed to favourable temperature and relative humidity in the atmosphere leading to good radial growth of the scion. Similar result has been reported by Singh *et al*., 2012 in mango. July grafting gets a comparatively long period of high temperature and humidity before the winter sets in with lower values of the parameters which resulted in higher values of scion diameter. Such results are strengthened by the findings of Kelasker *et al*. (1993).

3.2 Effect of scion precuring

The maximum (1.87 mm) diameter was reported in P_3 (10 days of precuring) The significant higher values of scion diameter as reflected in the experimental findings could possibly be due to good cambial activity (Hartmann *et al*., 1997) [10] and active bud growth through swollen buds resulting from longer defoliation period of scion. These results have similarities with that of Reddy and Melanta (1988) [28].

3.3 Interaction effect

The interaction effect of grafting season and scion precuring did not affect significantly the diameter of the scion. The maximum diameter of scion was noticed in S_2P_3 (2.00 cm) and minimum in S_4P_1 (1.60 cm).

4. Number of leaves per graft after 60 days and 120 DAG

4.1 Effect of grafting season

The significant maximum number of leaves of 12.07 and 14.47 were recorded at 60 and 120 DAG, respectively with grafts performed on 20th July (S_2).The congenial weather

conditions prevailing during this grafting date triggered cell metabolic activity in the scions. Due to the development of more number of sprouts, more meristematic activity and better healing of grafts during this month resulted in more number of leaves on the scion. Nachegowda and Vasantha (1996) [19], Pampanna and Sulikeri (2000) [21] and Parmar *et al*. (2010) [22] while working in sapota, Chovatia and Singh (2000) [4] and Mulla *et al*. (2011) [18] in jamun, Jacob *et al*. (2001) [12] in mango and also found similar trends in their investigations.

4.2 Effect of scion precuring

A perusal of data shows that precured scions defoliated 10 days before grafting (P_3) recorded maximum number of leaves of 11.53 and 13.38 at 60 and 120 DAG, respectively. This might be due to the fact that earlier defoliated bud woods used for propagation were quite rich in carbohydrates and other stored food substances resulting in more active buds with more number of leaves (Mankar *et al*., 1999 and Tandel *et al*., 2009) [17, 32]. The above findings are in close agreement with that of Dambal *et al*. (1999) [5] and Patil *et al* (2012) [26] in sapota. Kumar *et al*. (2012) [30] in guava also reported that scions cured for nine days gave better results in terms of number of leaves.

4.3 Interaction effect

Number of leaves per graft at 60 and 120 DAG was found to be significant with respect to the interaction of grafting seasons and scion precuring periods. The maximum number of leaves was recorded in the treatment S_2P_3 (13.37 at 60 and 15.40 at 120 DAG) while the minimum was noticed in S_4P_1 (9.10 at 60 and 11.27 at 120 DAG). The reason ascribed for this may be the interaction of both suitable weather condition and active bud initiation due to accumulation of carbohydrates caused by defoliation of scion sticks prior to grafting operation resulting in more number of leaves. This experimental result was in conformity with that of Pujari and Magdum (1991) [27].

5. Area of largest leaf at 120 DAG

5.1 Effect of grafting season

July grafts showed the maximum area (17.25 cm^2) in the largest leaf. The expansion of leaves on the grafts may be attributed to the higher meristematic activity which helps in obtaining more leaf area. This may be due to more metabolic activity under favourable environmental conditions. The findings are in line with that of Alam *et al*. (2006) [1] in mango, Mulla *et al*. (2011) [18] in Jamun, and Maheshwari and Nivetha (2015) [16] in Jackfruit. Higher humidity level might have acted as a driving force for cell elongation and multiplication that favoured leaf area expansion. Similar opinion was expressed by Chovatia and Singh (2000) [4] and Gadekar *et al*. (2010) [8] in jamun, Palande *et al*. (2004) [20] in tamarind and Sivudu *et al*. (2014) [13] in mango.

5.2 Effect of scion precuring

An insight into the experimental data revealed that scion precuring caused significant variant results in the area of the largest leaf at 120 DAG. Maximum expansion of leaf area (13.48 cm^2) was seen in P_3 (10 days of precuring) and minimum leaf area (9.70 cm^2) in P_1 (0 days of precuring). This may be due to more accumulation of stored carbohydrates by long precured scion shoots causing area expansion of leaf. The findings are in line with that of Shama (2013) [29].

5.3 Interaction effect

Significant maximum result in leaf area (17.87 cm^2) was observed in 10 days precured scions with 20th July grafted plants. Such a result might be due to the positive impact of both the favourable environmental condition during July along with the long defoliation period (10 days) of leaf. Patel and Amin (1981) [23] support such a result with their experimental findings.

Table 1: Effect of season and scion precuring on length of scion growth at 60 DAG

Treatment	Length of new scion growth (60 DAG) (cm)			
	Scion precuring (P)			
Season of grafting (S)	0 day of Precuring (P_1)	5 days of Precuring (P_2)	10 days of Precuring (P_3)	Mean
20th June (S_1)	2.33	2.43	2.64	2.47
20th July (S_2)	2.56	2.63	2.72	2.64
20th August (S_3)	2.38	2.56	2.69	2.54
20th September (S_4)	1.79	1.86	2.40	2.02
Mean	2.27	2.37	2.61	2.42
	Season	Precuring	Interaction	
CD (P = 0.05)	0.09	0.08	0.16	

Table 2: Effect of season and scion precuring on length of scion growth at 120 DAG

Treatment	Length of new scion growth (120 DAG) (cm)			
	Scion precuring (P)			
Season of grafting (S)	P_1	P_2	P_3	Mean
20th June (S_1)	4.44	4.50	4.62	4.52
20th July (S_2)	4.65	4.68	4.73	4.69
20th August (S_3)	4.46	4.52	4.66	4.55
20th September (S_4)	4.21	4.33	4.57	4.37
Mean	4.44	4.51	4.65	4.53
	Season	Precuring	Interaction	
CD (P = 0.05)	0.66	0.06	0.11	

Table 3: Effect of season and scion precuring on incremental length of rootstock at 120 DAG

Treatment	Incremental length of rootstock (120 DAG) (cm)			
	Scion precuring (P)			
Season of grafting (S)	P_1	P_2	P_3	Mean
20th June (S_1)	0.51	0.53	0.54	0.53
20th July (S_2)	0.62	0.64	0.65	0.63
20th August (S_3)	0.53	0.55	0.61	0.56
20th September (S_4)	0.46	0.49	0.50	0.49
Mean	0.53	0.55	0.58	0.55
	Season	Precuring	Interaction	
CD (P = 0.05)	0.06	NS	NS	

Table 4: Effect of season and scion precuring on incremental diameter of scion at 120 DAG

Treatment	Incremental diameter of scion (120 DAG) (mm)			
	Scion precuring (P)			
Season of grafting (S)	P_1	P_2	P_3	Mean
20th June (S_1)	1.63	1.77	1.87	1.76
20th July (S_2)	1.73	1.93	2.00	1.89
20th August (S_3)	1.70	1.63	1.90	1.74
20th September (S_4)	1.60	1.67	1.70	1.66
Mean	1.67	1.75	1.87	1.76
	Season	Precuring	Interaction	
CD (P = 0.05)	0.11	0.09	NS	

Table 5: Effect of season and scion precuring on number of leaves per graft at 60 DAG

Treatment	Number of leaves per graft (60 DAG)			
	Scion precuring (P)			
Season of grafting (S)	P_1	P_2	P_3	Mean
20th June (S_1)	9.47	s9.90	10.67	10.01
20th July (S_2)	10.47	12.37	13.37	12.07
20th August (S_3)	10.27	10.90	12.43	11.20
20th September (S_4)	9.10	9.23	9.63	9.32
Mean	9.83	10.60	11.53	10.66
	Season	Precuring	Interaction	
CD (P = 0.05)	0.44	0.38	0.76	

Table 6: Effect of season and scion precuring on number of leaves per graft at 120 DAG

Treatment	Number of leaves per graft (120 DAG)			
	Scion precuring (P)			
Season of grafting (S)	P_1	P_2	P_3	Mean
20th June (S_1)	11.53	11.90	12.67	12.03
20th July (S_2)	12.80	15.20	15.40	14.47
20th August (S_3)	12.80	13.10	13.57	13.16
20th September (S_4)	11.27	11.43	11.87	11.52
Mean	12.10	12.91	13.38	12.79
	Season	Precuring	Interaction	
CD (P = 0.05)	0.37	0.32	0.64	

Table 7: Effect of season and scion precuring on area of largest leaf at 120 DAG

Treatment	Area of largest leaf (120 DAG) (cm^2)			
	Scion precuring (P)			
Season of grafting (S)	P_1	P_2	P_3	Mean
20th June (S_1)	6.24	7.79	12.10	8.71
20th July (S_2)	16.07	17.80	17.87	17.25
20th August (S_3)	10.85	12.95	14.95	12.91
20th September (S_4)	5.62	7.66	9.01	7.43
Mean	9.70	11.55	13.48	11.58
	Season	Precuring	Interaction	
CD (P = 0.05)	1.06	0.92	1.84	

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