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Effect of season and scion precuring on softwood grafting in sapota (*Manilkara achras* Mill.)

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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 minimum days required for first bud sprouting (17.02) and maximum values in characters like percentage of graft success (79.22%), number of bud sprouts per graft (1.38). In respect to different scion precuring periods, minimum number of days taken for first bud sprouting (18.20), maximum values in characters like percentage of graft success (63.11%), number of bud sprouts per graft (1.38), 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) [1]. 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) [6]. 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) [5]. Precuring also plays an important role in the success of softwood grafting in sapota (Pampanna and Sulikeri, 2000) [13]. 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: Days required for first bud sprouting, percentage of initial and final graft success, number of bud sprouts per graft, length of largest leaf and breadth 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. Number of days taken for first bud sprouting

1.1 Effect of grafting season

The minimum days required for sprouting (17.02) was observed in S_2 (20th July) grafted plants whereas, the maximum days was noted (21.13) in S_4 (20th September) grafted plants. The earliest bud sprouting of S_2 (20th July) grafting might have been achieved due to the favourable temperature (32 ^{0}C) and relative humidity regime that prevailed during these grafting dates which triggered cell metabolic activity in the scion. The higher cell metabolic activity results in early sprouting of scion. Pampanna and Sulikeri (2000) [13] and Parmar *et al*. (2010) [15] in sapota also found similar trends in their investigations.

1.2 Effect of scion precuring

The character differed significantly by different precuring periods of scion. The observation demonstrated that scions defoliated 10 days before grafting took minimum number of days (18.20) for first bud sprouting. This might be due to the fact that defoliation causes an immediate rise in sucrose content of phloem sap of the shoots (Zimmerman, 1958) [24]. This helped in the movement of the solutes towards the shoot apex and thereby resulting in higher meristematic activity at the bud level, which was apparent from their swellings (Patil *et al*., 1984) [18]. Such result is in conformity with that of Jha and Shyamal (1995) [8]. This condition also helps in better sap flow and good callus formation due to stimulation of cambium division favouring better graft union (Maiti and Biswas, 1980) [11].

1.3 Interaction effect

The minimum days were recorded in S_2P_3 and the maximum days were observed in S_4P_1. The above results indicate that sapota grafting in July along with 10 days of precuring period showed minimum days taken for bud sprouting as compared to other treatment combinations which might be due to the decreasing temperature July onwards that slowed down the process of bud sprouting and higher meristematic activity at the bud level, which was apparent from their swellings (Patil *et al.*, 1984) [18].

2. Percentage of graft success at initial at 30 DAG and final stage at 60 DAG

2.1 Effect of grafting season

The maximum initial and final graft success of 85.56% and 79.22%, respectively were recorded in plants grafted on 20th July (S_2) followed by 20th August (S_3) with 82.44% and 77.00% while grafting on 20th September (S_4) gave minimum graft success of 78.89% and 70.89%, respectively. The higher success in July months may be attributed to higher percentage of relative humidity (92-80%) which is congenial for increased cell activity (Kalalbandi *et al*., 2014) [9]. Least graft success at initial and final stage (78.79% and 70.89%) during 20th September grafting might be due to both reduced temperature and atmospheric humidity. Physiological condition of rootstock and decreased sap flow in late September might have interfered with the graft union healing process. Similar results were obtained by Patel and Amin (1976) [16] and Singh *et al*. (2012) [23] in mango.

2.2 Effect of scion precuring

The initial and final graft successes were significantly highest (85.83 and 79.42%, respectively) in case of scion defoliation 10 days prior to grafting over 5 days defoliation (81.17 and 75.33%, respectively) and fresh defoliation (78.83 and 71.33%, respectively) treatments. The higher success with prior defoliated scions (P_3) as compared to that of freshly defoliated scions may be due to swelling of buds resulting in better sprouting in precured scions as explained by Dhandar (1985) [3]. Further, Ram and Bist (1982) [20] reported higher success percentage in precured scions compared with freshly defoliated scions. These results are corroborated with the research findings Jauhari and Singh (1970) [7], Patil *et al*. (1983) [19] Sarada *et al*. (1991) [22] and Pampanna and Sulikeri, 2001.

2.3 Interaction effect

Temperature and atmospheric humidity, the two most important climatic factors for healing of graft union, were in very favourable ranges in the treatment S_2P_3 where 10 days prior defoliation of scion could accumulate enough carbohydrate to achieve the maximum graft success at both initial and final stages. This result has also been emphasized by Padma and Reddy (1995) [15].

3. Number of bud sprouts at 30 DAG

3.1 Effect of grafting season

The number of bud sprouts was significantly influenced by different grafting seasons. Maximum number of bud sprouts are seen in S_2 (1.38) followed by S_3 (1.34) which are statistically at par with each other. Minimum number of bud sprout was reported in S_4 (1.18). This may be attributed to moderately high temperature coupled with high humidity, adequate supply of moisture and nutrients, fast cambial activity and high accumulation of carbohydrates in scion shoots and the sprouting of dormant bud observed during July month which contributed for the increased number of sprouts. These results are in agreement with Padma and Reddy (1995) [15] in mango grafts. The favourable temperature and relative humidity activate the cambium cells during monsoon. The new callus tissue arising out of the cambial region is composed of thin walled turgid cells which can easily desiccate and die off and relative humidity can protect such cells in the cambial region of the graft union (Hartmann and Kester, 1979) [5].

3.2 Effect of scion precuring

Maximum (1.38) number of bud sprouts was observed in P_3 and minimum (1.22) number of bud sprouts in P_1 which was at par with P_2 (1.27). The influence of curing of leaf on these parameters could be attributed to initiation of cambium activity which might have resulted from defoliation (Hartmann *et al*., 1997) [5]. Cured scions showed more vigour in terms of quantum of branches per scion when compared to non-cured scions. Higher vigour could be attributed to growth activity of buds of scion which get activated after defoliation. The importance and beneficial effects of scion treatment through defoliation on the sprouting success and growth of grafts have also been emphasized by Reddy and Melanta (1988) [21] and Dhakal and Hoda (1986) [2].

3.3 Interaction effect

In the sprouting of buds on a sapota scion stick apical dominance is often observed. But the role of climatic or other factors have not been conspicuous in promoting axillary buds in sapota for sprouting. Therefore, the effects of these factors have not been observed to be significant in promoting sprouting of many buds in a scion of sapota.

4. Length of largest leaf at 120 DAG

4.1 Effect of grafting season

The mean length of the largest leaf produced in the graft was significantly influenced by the months of grafting when observed at 120 DAG. Significantly maximum (8.91 cm) length of the largest leaf was recorded in S_2 followed by S_3 (7.88 cm) and minimum length was seen in S_4 (5.96 cm). It showed a definite pattern of growth among the treatments. It was found to be the maximum in the month of July which may be due to the synthesis of more photosynthates by more number of leaves. The amount of photosynthate is more during the longer duration of photosynthesis from July to the unset of winter resulting in size longer of leaves (Kelaskar *et al*., 1993) [10].

4.2 Effect of scion precuring

The highest (7.98 cm) length was reported in (P_3) 10 days precured scion sticks and the lowest (6.58 cm) in (P_1) freshly dettached scion sticks. The good performance of this treatment might have been due to the sufficient accumulation of food materials in the defoliated scion shoots and hence resulted in the growth and expansion of leaves. The beneficial effects of precuring in terms of growth of mango grafts have been reported by Reddy and Melanta (1988) [21] and Patil *et al*. (1983) [19].

4.3 Interaction effect

Maximum (9.30 cm) length of largest leaf was noticed to be significant under the treatment S_2P_3 as the greater defoliation period of 10 days before grafting (P_3) caused more accumulation of stored food materials under congenial weather parameters in July that influenced better leaf growth and higher photosynthetic activity leading to expansion of leaf tissues. These results are in agreement with those of Patel and Amin (1981) [17].

5. Breadth of largest leaf at 120 DAG

5.1 Effect of grafting season

A statistically significant result was obtained with the breadth of largest leaf in respect of various grafting seasons. S_2 (20th July) grafts showed maximum increment in the breadth of largest leaf. This may be due to synthesis of more photosynthates influenced by favourable temperature and relative humidity. Similar findings were reported in Patel and Amin (1981) [17].

5.2 Effect of scion precuring

Observation on breadth of largest leaf showed significant maximum results with 10 days precured scion grafts in this character as compared to other treatments. This may be due to the accumulation of sufficient amount of food material in the precured scion shoots which resulted in greater diameter of leaf. Similar finding was observed by Reddy and Melanta (1988) [21].

5.3 Interaction effect

An analysis of data indicated that the maximum width was noticed in the treatment S_2P_3 as compared to others. It may be due to the favourable environmental conditions along with the accumulation of sufficient amount of carbohydrate responsible for the quick growth and expansion of the leaves. Similar finding was noticed by Patil *et al*. (1983) [18].

Conclusion

From the results it can be concluded that the suitable time for softwood grafting in sapota with high graft success and good vegetative growth characters is 20th July. This is mainly achieved through favourable humidity, temperature, rainfall and bright sunny days which are suitable for successful graft union and subsequent growth. September 20th grafting achieved lower success as the environmental factors became less suitable. Longer precuring of scion with 10 days prior defoliation is more beneficial in terms of better graft success rate along with overall graft growth. This is achieved through better bud swelling, cambial activity and better accumulation of food reserve. Freshly detached scions resulted in poor graft vegetative characters. Therefore, 20th July along with 10 days leaf defoliation prior to grafting is recommended for achieving high success rate and subsequent growth in softwood grafting of sapota.

Table 1: Effect of season and scion precuring on number of days taken for first bud sprouting

Treatment	No. of days taken for first bud sprouting			
	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)	21.67	21.00	20.40	21.02
20th July (S_2)	18.87	16.60	15.60	17.02
20th August (S_3)	19.00	18.00	16.20	17.73
20th September (S_4)	22.00	20.80	20.60	21.13
Mean	20.38	19.10	18.20	19.23
	Season	Precuring	Interaction	
CD (P = 0.05)	0.56	0.48	0.97	

Table 2: Effect of season and scion precuring on the percentage of graft success at final stage

Treatment	Percentage of graft success at final stage (2 MAG)			
	Scion precuring (P)			
Season of grafting (S)	**P_1**	**P_2**	**P_3**	**Mean**
S_1	69.33 (56.39)	75.00 (60.01)	78.67 (62.52)	74.33 (59.64)
S_2	74.33 (59.57)	79.33 (62.97)	84.00 (66.45)	79.22 (63.00)
S_3	72.33 (58.28)	76.33 (60.89)	82.33 (65.18)	77.00 (61.45)
S_4	69.33 (56.38)	70.67 (57.21)	72.67 (58.28)	70.89 (57.29)
Mean	71.33 (57.66)	75.33 (60.27)	79.42 (63.11)	75.36 (60.34)
	Season	Precuring	Interaction	
CD (P = 0.05)	1.27	1.10	2.21	

Table 3: Effect of season and scion precuring on number of bud sprouts per graft

Treatment	Number of bud sprouts per graft (30 DAG)			
	Scion precuring (P)			
Season of grafting (S)	P_1	P_2	P_3	Mean
S_1	1.20	1.17	1.40	1.26
S_2	1.30	1.37	1.47	1.38
S_3	1.27	1.33	1.43	1.34
S_4	1.10	1.20	1.23	1.18
Mean	1.22	1.27	1.38	1.29
	Season	Precuring	Interaction	
CD (P = 0.05)	0.07	0.06	NS	

Table 4: Effect of season and scion precuring on the length of the largest leaf

Treatment	Length of largest leaf (120 DAG) (cm)			
	Scion precuring (P)			
Season of grafting (S)	P_1	P_2	P_3	Mean
S_1	5.63	6.13	7.63	6.47
S_2	8.30	9.13	9.30	8.91
S_3	7.17	8.10	8.37	7.88
S_4	5.23	6.03	6.60	5.96
Mean	6.58	7.35	7.98	7.30
	Season	Precuring	Interaction	
C.D.(P = 0.05)	0.29	0.25	0.50	

Table 5: Effect of season and scion precuring on breadth of largest leaf

Treatment	Breadth of largest leaf (120 DAG) (cm)			
	Scion precuring (P)			
Season of grafting (S)	P_1	P_2	P_3	Mean
S_1	1.83	2.13	2.60	2.19
S_2	3.17	3.23	3.30	3.23
S_3	2.50	2.63	3.03	2.72
S_4	1.77	2.10	2.27	2.04
Mean	2.32	2.53	2.80	2.55
	Season	Precuring	Interaction	
C.D.(P = 0.05)	0.15	0.13	0.26	

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