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STANDARDIZATION OF PROPAGATION TECHNIQUES IN SAPODILLA [*Manilkara achras* (Mill.) Fosberg] CV. KALIPATTI UNDER NORTH INDIAN CONDITIONS

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ABSTRACT

The present investigation was carried out at Punjab Agricultural University, Regional Fruit Research Station, Bahadurgarh, Patiala during 2018-19 with an objective to standardize propagation techniques and optimize time of grafting in sapota under North Indian Conditions. For this purpose, sapota cv. Kalipatti was used as scion and *Khirnee* (*Manilkara hexandra*) was used as rootstock. The plants were propagated by four different propagation techniques viz., veneer grafting, side grafting, tongue grafting and wedge grafting during the month of February to September at monthly intervals. The maximum graft survival was recorded in side grafting (62.22%) followed by veneer grafting (60.56%). The plants grafted during the month of June (61.67 %) had a maximum average graft survival percentage followed by July (59.17%). The plants multiplied by wedge grafting had maximum plant height (50.53 cm). The plants grafted by veneer technique recorded the maximum shoot length whereas minimum was recorded in tongue grafting. The maximum number of leaves per plant was recorded in tongue grafting followed by wedge grafting. The study concluded that side and veneer grafting are promising techniques when performed in the month of June and July, respectively.

Keywords: Kalipatti, Khirnee, Propagation techniques, Sapodilla

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Sapota [*Manilkara achras* (Mill.) Fosberg] is an important commercial tropical fruit crop that belongs to the family *Sapotaceae* and is native to South Mexico and Central America (Singh 1991). It was introduced in India during 1898 in Maharashtra. India leads globally in sapota production from an area of 1.07 lakh hectares (Anon 2018).

In general, sapota plants are propagated by both seeds and vegetative means. The sexual propagation induces heterozygosity and prolonged juvenility and slow growth rate which takes about 8-10 years to bear, but on contrary, grafted plants are precocious in bearing and flower within 4-5 years after planting. Hence sexual propagation can't be used for commercial purposes and limited to crop improvement programmes only. Sapodilla propagated by vegetative methods gives advantages over seed propagation as it reduces juvenility and maintains uniformity in the planting material. Among different rootstocks, khirni (*Manilkara hexandra*) is found most successful and is used for commercial plant propagation as it possesses high graft compatibility with sapota and plants produce fruits of excellent quality with high yield (Kaur *et al,* 2020). Several vegetative methods practiced for sapota propagation are side grafting, wedge grafting, veneer grafting, whip grafting, tongue grafting, cleft grafting, inarching and air layering. The success of propagation techniques varies with climatic factors. The sapota propagated through veneer grafting in the month of September and November have high success rate under South-Bengal conditions (Sandhu 1991) whereas it was found ideal in the month of August under Baptala conditions of Andhra Pradesh (Srinivas 2007). Though work on standardisation of various propagation techniques along with different time has been carried out in different parts of the country, the study on clonal multiplication by different propagation techniques along with time is yet to be standardized under North Indian conditions. Keeping in view this, the experiment was planned to identify most suitable propagation method and time of sapota propagation under Punjab conditions.

MATERIALS AND METHODS

The research work was undertaken at Punjab Agricultural University, Regional Fruit Research Station, Bahadurgarh (Patiala) during 2018-19. Plants were propagated by four different techniques i.e. veneer grafting, side grafting, tongue grafting and wedge grafting in the months of February, March, June, July, August and September. The *Khirnee* plants of pencil thickness having uniform growth and diameter were used as rootstock for propagation. The scion wood of cultivar *Kalipatti* of pencil thickness and length of 15 cm was used for grafting. The grafting was done

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at a height of 20 cm from the ground level. The bud sticks were pre-cured 10-15 days prior to grafting. In case of tongue and wedge grafting, the scion was covered with the help of polythene cap (26 x 7 cm) to avoid desiccation of the bud stick that aid in callus formation at graft union (Malo 1967). The experiment was replicated thrice having 10 plants per replication. The various experimental parameters such as graft survival percentage and growth parameters were recorded following standard procedures. The leaf area was measured with the help of leaf area meter and plant height was measured with measuring tape and expressed in cm^2 and cm, respectively. The experiment was laid out in Randomized Block Design (Factorial) for Analysis of Variance (ANOVA). The significant treatments were subjected to mean comparison using LSD ($p \leq 0.05$).

RESULTS AND DISCUSSION

Percent graft survival

The average graft survival percentage among various propagation techniques varied from 38.89 to 62.22 per cent (Table 1). The maximum survival percentage was recorded in side grafting followed by veneer grafting i.e. 60.56 per cent whereas minimum success for this parameter was recorded in tongue grafting. While comparing different seasons of grafting, maximum average survival percentage i.e. 61.67 per cent was recorded in June followed by July, March and August. Whereas, the lowest value for this parameter was recorded in plants grafted during the month of February i.e. 39.17 per cent. The higher success in the monsoon months i.e. in June and July considered to be due to higher relative humidity and minimum fluctuation in the maximum and minimum temperature which is congenial for increased cell activity (Kalalbandi *et al.,* 2014). The plants propagated by side grafting resulted in significantly highest graft survival percentage in the month of June followed by March and July. The maximum survival percentage in side and veneer grafting was due to the retention of vegetative tops i.e. leaves with rootstock during grafting to support the cambium layer formation in the union of grafts (Hussain and Bukhari 1977). The scion diameter also effect the graft survival in sapota and thick scion sticks with diameter of 5.02 result in maximum graft survival (Tanjua and Thippesha, 2016). The low success in tongue grafted plants may be due to the excessive injury to the scion and stock while splitting and this leads to more exudation of the latex that forms a layer between the cambium of the

Table 1. Effect of various propagation techniques and month of grafting on graft survival percentage in sapota cv. Kalipatti

Treatment	Months						
	February	March	June	July	August	September	Mean
Wedge grafting	43.33^{efgh}	46.67^{defgh}	56.67^{abcdef}	53.33^{bcdefg}	50.00^{cdefgh}	36.67^{fgh}	47.79^{b}
Side grafting	36.67^{fgh}	70.00^{abc}	76.67^{a}	70.00^{abc}	66.67^{abcd}	53.33^{bcdefg}	62.22^{a}
Tongue grafting	33.33^{gh}	50.00^{cdefgh}	43.33defgh	36.67^{fgh}	36.67^{fgh}	30.00^{h}	38.89^{c}
Veneer grafting	43.33^{efgh}	63.33^{abcde}	66.67^{abcd}	76.67^{a}	73.33^{ab}	40.00^{fgh}	60.56^{a}
Mean	39.17^{b}	57.50^{a}	61.67^{a}	59.17^{a}	56.67^{a}	40.00^{b}	
LSD ($p \leq 0.05$)				Treatment (A) : 2.45 Month (B) : 3.00 (A x B) : 6.00			

Table 2. Effect of various propagation techniques and month of grafting on duration of bud sprouting in sapota cv. Kalipatti

Treatments	Month						
	February	March	June	July	August	September	Mean
Wedge grafting	10.55^{hi}	10.22^{ij}	10.11^{j}	11.11^{fg}	9.67^{k}	11.78^{bc}	10.57^{c}
Side grafting	12.56^{a}	9.33^{kl}	9.22^{l}	11.33^{def}	11.33^{def}	12.56^{a}	11.06^{a}
Tongue grafting	10.78^{gh}	10.44^{hij}	10.33^{ij}	11.22^{ef}	10.11^{j}	11.67^{cd}	10.76^{b}
Veneer grafting	11.11^{fg}	9.22^{l}	9.67^{k}	11.56^{cde}	11.44^{cdef}	12.11^{b}	10.85^{b}
Mean	11.25^{b}	9.80^{d}	9.83^{d}	11.31^{b}	10.64^{c}	12.03^{a}	
LSD ($p \leq 0.05$)				Treatment (A) : 0.14 Month (B) : 0.21 (A x B) : 0.21			

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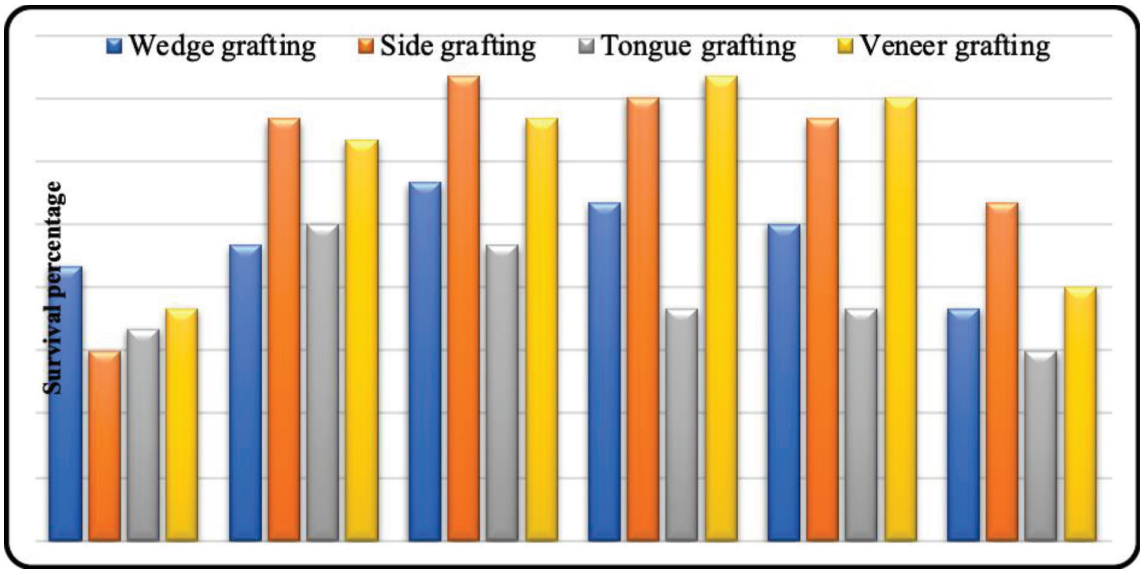


Fig. 1. Effect of various propagation techniques and month of grafting on graft survival percentage in sapota cv. Kalipatti

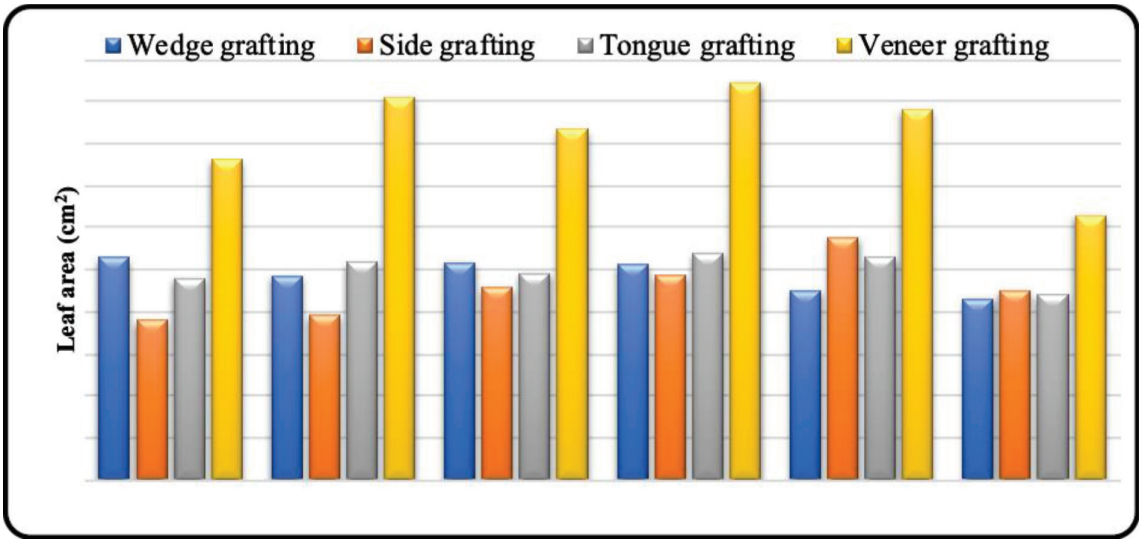


Fig. 2. Effect of various propagation techniques and month of grafting on leaf area (cm^2) 120 days after grafting in sapota cv. Kalipatti

Table 3. Effect of various propagation techniques and month of grafting on plant height (cm) in sapota cv. Kalipatti

Treatment	Month						
	February	March	June	July	August	September	Mean
Wedge grafting	56.44^{ab}	56.37^{ab}	55.33^{bc}	50.67^{d}	46.64^{e}	37.75^{gh}	50.53^{a}
Side grafting	47.89^{e}	58.43^{a}	50.66^{d}	40.61^{f}	47.45^{e}	39.27^{fg}	47.39^{c}
Tongue grafting	38.16^{gh}	54.38^{bc}	57.67^{a}	47.75^{e}	38.28^{gh}	37.07^{gh}	45.55^{d}
Veneer grafting	35.78^{e}	58.45^{a}	55.22^{bc}	53.22^{c}	46.36^{e}	36.30^{h}	49.22^{b}
Mean	47.07^{c}	56.91^{a}	54.72^{b}	48.06^{c}	44.68^{d}	37.60^{e}	
LSD (p≤0.05)				Treatment (A) : 0.91 Month (B) : 1.12 (A x B) : 2.23			

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Table 4. Effect of various propagation techniques and month of grafting on number of shoots per graft in sapota cv. Kalipatti

Treatment	Month						
	February	March	June	July	August	September	Mean
Wedge grafting	1.00	1.33	1.33	1.00	1.00	1.00	1.11
Side grafting	1.00	1.00	1.00	1.33	1.00	1.00	1.06
Tongue grafting	1.33	1.33	1.50	1.00	1.33	1.00	1.25
Veneer grafting	1.00	1.00	1.33	1.00	1.00	1.33	1.11
Mean	1.08	1.17	1.29	1.08	1.08	1.08	
LSD (p≤0.05)				Treatment (A) : NS Month (B) : NS (A x B) : NS			

stock and scion that leads to least survival percentage of scion.

Duration of bud sprouting

The duration of bud sprouting was calculated by the number of days taken from first to last bud sprout. The duration of bud sprout in all the techniques and times of grafting ranged from 10.57 to 11.06 and 9.80 to 12.03 days, respectively (Table 2). The plants grafted by side grafting took a significantly higher number of days for the completion of bud sprout (11.06 days) whereas lowest value was recorded in wedge grafted plants (10.57 days). The minimum duration for bud sprouting was recorded in the month of March (9.80 days) followed by June (9.83 days) and maximum in the month of September (12.03 days) followed by July (11.31 days). The results are in accordance with the findings of Singh and Bons (2016) who also reported maximum bud sprouts in propagated plants in September.

Plant height (cm)

The plant height in all the propagation techniques differed significantly with each other and varied from 45.55 to 50.53 cm (Table 3). The maximum plant height was recorded in wedge grafting followed by veneer grafting i.e. 49.22 cm whereas minimum in tongue grafting followed by side grafting i.e. 47.39 cm. The plant height was influenced by the time of propagation, which ranged from 37.60 to 56.91 cm. The plant height differed significantly in all the months except February and July. Maximum graft height was recorded in the month of March followed by June i.e. 54.72 cm but minimum average graft height i.e. 37.60 cm was recorded in the month of September. The plant height with respect to propagation technique and time ranged from 35.78 to 58.45 cm. The plants propagated by veneer technique in the month of March having maximum plant height followed by side grafting i.e. 58.43 cm but did not differ significantly. In wedge grafting, maximum plant height was recorded in the month of February followed by March whereas in tongue grafting maximum plant height was recorded in the month of June i.e. 57.67 cm. The results further reveal that in general in all the techniques minimum plant growth was recorded when the plants were propagated in the month of September due to low temperature in the following months.

Number of shoots

The mean number of shoots per graft among different techniques and time of propagation differed

Table 5. Effect of various propagation techniques and month of grafting on shoot length (cm) in sapota cv. Kalipatti

Treatment	Month						
	February	March	June	July	August	September	Mean
Wedge grafting	19.89^{defg}	20.03^{cde}	21.41^{ab}	18.87^{hi}	18.15^{ij}	17.63^{j}	19.33^{b}
Side grafting	20.58^{bcd}	20.55^{bcd}	20.66^{bcd}	19.92^{def}	18.70^{hi}	16.67^{k}	19.51^{b}
Tongue grafting	19.38^{efgh}	19.40^{efgh}	19.12^{fgh}	19.48^{efgh}	18.86^{hi}	19.17^{efgh}	19.23^{b}
Veneer grafting	20.87	20.47^{cd}	21.67^{a}	19.82^{defg}	19.02^{ghi}	18.75^{hi}	20.10^{a}
Mean	20.18^{b}	20.11^{b}	20.71^{a}	19.52^{c}	18.68^{d}	18.05^{e}	
LSD (p≤0.05)				Treatment (A) : 0.36 Month (B) : 0.44 (A x B) : 0.87			

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Table 6. Effect of various propagation techniques and month of grafting on number of leaves per graft in sapota cv. Kalipatti

Treatment	Month						
	February	March	June	July	August	September	Mean
Wedge grafting	16.23^{bc}	17.16^{ab}	13.38^{efg}	13.43^{efg}	12.42^{fgh}	13.63^{ef}	14.38^{a}
Side grafting	11.46^{hij}	15.73^{cd}	14.44^{de}	10.77^{ijk}	9.60^{k}	11.01^{ijk}	12.17^{b}
Tongue grafting	16.49^{abc}	17.83^{a}	17.47^{ab}	13.56^{ef}	11.66^{hi}	12.10^{ghi}	14.84^{a}
Veneer grafting	11.40^{hij}	14.44^{de}	16.55^{abc}	11.34^{hij}	10.16^{jk}	11.34^{hij}	12.54^{b}
Mean	13.84^{c}	16.28^{a}	15.46^{b}	12.27^{d}	10.96^{e}	12.02^{d}	
LSD (p≤0.05)				Treatment (A) : 0.57 Month (B) : 0.70 (A x B) : 0.69			

non-significantly. The average number of shoots per plant in different methods of propagation varied from 1.06 to 1.25. In tongue grafting, a higher number of shoots were recorded in comparison to other treatments. The plants grafted in the month of June had maximum number of shoots per graft followed by March i.e.1.17 (Table 4).

Shoot length (cm)

The average length of shoot among different techniques varied significantly and ranged from 19.23 to 20.10 cm (Table 5). The average maximum shoot length was found in the plants grafted by veneer and minimum in tongue grafting. The shoot length among different seasons of grafting varied from 18.05 to 20.71 cm. The plants grafted in the month of July having significantly maximum shoot length followed by February i.e. 20.18 cm and least shoot length was recorded in September followed by August i.e.18.68 cm. The least shoot growth of the plants grafted in the month of August and September may be due to decline in temperature during the following winter season which arrest the vegetative growth.

Number of leaves per graft

The number of leaves per plant were influenced significantly by different methods of propagation and varied from 12.17 to 14.84 inside and tongue grafting, respectively. The plants grafted with side and veneer grafting had a minimum number of leaves and were at par with each other. The more number of leaves may be due to more meristematic activity that leads to more leaf formation in wedge and tongue grafting. The findings are in accordance with Nachegowda and Vasantha (1996) and Pampana and Sulikeri (2000) in sapota. While comparing different months of grafting, the number of leaves varied from 10.96 to 16.28. The highest number of leaves per graft were recorded in March grafted plants and minimum in August.

Leaf area (cm^2)

The average leaf area in different propagation techniques varied from 22.85 to 41.03 cm^2. The plants grafted through veneer grafting having maximum leaf area followed by inarching i.e. 30.15 cm^2. The minimum leaf area was recorded in the plants propagated by side grafting followed by wedge grafting i.e. 24.31 cm^2. The leaf area in wedge, side and tongue grafting did not differ significantly with each other. While comparing different months of propagation, it was observed that average leaf area varied from 24.36 to 38.70 cm^2. The plants grafted in the month of June had maximum leaf area followed by July i.e. 31.09 cm^2. The average minimum leaf area was recorded in the plants grafted in the month of September i.e. 24.36 cm^2. This may be due to reduced leaf size i.e. leaf length and breadth.

Authors' contribution

Conceptualization of research work and Designing of Experiments (SK, RSB, DS); Execution of field experiments and data collection (SK); Analysis of data and interpretation (SK, RSB, DS); Preparation of manuscript (SK, RSB, GS).

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