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Studies on Propagation Techniques and Economic Feasibility in Sapota [*Manilkara achras* (Mill.) Fosberg] Cv. Kalipatti under North Indian Conditions

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ABSTRACT

Background: The present investigation was carried out at Punjab Agricultural University, Regional Fruit Research Station, Bahadurgarh, Patiala during the year 2018-19 to standardize various propagation techniques and their commercial economic feasibility in sapota under North Indian conditions.

Methods: The, cultivar Kalipatti was used as scion and Khirni (*Manilkara hexandra*) as rootstock. The plants were propagated by different propagation techniques *viz*., wedge grafting, side grafting, tongue grafting, veneer grafting and inarching at monthly intervals from February to September**.**

Result: The maximum average graft survival was recorded in inarching (70.56%) followed by side grafting and veneer grafting. The plants grafted in June (63.33%) had the maximum average graft survival percentage followed by July (62.0%). The maximum benefit-cost ratio was worked out in side grafting followed by veneer grafting. Despite maximum graft survival in the inarching technique, the B:C ratio was less due to high input cost.

Key words: B:C ratio, Kalipatti, *Manilkara hexandra*, Propagation, Sapota.

INTRODUCTION

Sapota [*Manilkara achras* (Mill.) Fosberg] is an important commercial fruit crop grown in tropical and subtropical regions of India and it is native to South Mexico and Central America (Singh 1991). In India, it was introduced in 1898 in Maharashtra and now India is the global leader in sapota production and cultivated on an area of 79000 hectares with an annual production of 8.22 lakh MT (Anonymous, 2021). In biological terms sapota is propagated by both seeds and vegetative means. The seed propagation induces prolonged juvenility and slow growth rate which takes about 8-10 years to bear and even variable quality of the fruits which is not desired from the commercial production point of view, but on the contrary, vegetatively propagated plants are precocious in bearing ie within 4-5 years after planting (Kaur *et al.,* 2020). Hence sexual propagation can't be used for commercial nursery propagation and is limited to crop improvement programmes only, even also propagated by vegetative means having advantages over seed propagation as it maintains uniformity in the planting material (Sharma and Thapa, 2022). In general various methods practiced for sapota propagation are side, wedge, veneer, whip, tongue, cleft grafting, inarching and air layering. The success rate of propagation techniques also varies with climatic regions and conditions. The sapota propagated through veneer grafting in the months of September and November have a high success rate under South-Bengal conditions (Sandhu, 1991) whereas it was found ideal in the month of August, under Bapatala conditions of Andhra Pradesh (Srinivas, 2007). The work on standardisation of various propagation techniques along with different times has been carried out in different parts of the country but study on the cheapest and most efficient propagation techniques with time yet to be standardized under North Indian conditions for commercial nursery production, so because of above facts, this experiment was planned to identify most suitable time and propagation technique under North Indian conditions.

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MATERIALS AND METHODS

The research work studies propagation techniques and economic feasibility in sapota [*Manilkara achras* (Mill.) fosberg] cv. Kalipatti under north Indian conditions was carried out at Punjab Agricultural University, Regional Fruit Research Station, Bahadurgarh (Patiala) during 2018-19. Plants were multiplied by different propagation techniques *i.e.* veneer grafting, side grafting, tongue grafting, wedge

grafting and inarching in the months of February, March, June, July, August and September. The *Khirnee (Manilkara hexandra)* plants of pencil thickness having uniform growth and diameter were used as rootstock for propagation. The mature scion wood of cv. Kalipatti having pencil thickness was used for grafting. The grafting was done at a height of 20 cm from the ground level. The scions were pre-cured 10-15 days before grafting. In the case of tongue and wedge grafting, the scion was covered after grafting with the help of a polythene cap (26 × 7 cm) to avoid desiccation of the bud stick that aids in callus formation at graft union (Malo, 1967). The experiment was replicated thrice having 10 plants per replication. The graft survival percentage in different propagation techniques concerning time was recorded. The gross monetary returns in different propagation techniques *i.e.* wedge, side, tongue, veneer grafting and inarching were worked out keeping in view the consideration of various input costs *i.e.* cost of rootstock, scion, grafting and maintenance. The total expenditure, cost per plant, gross return, net return and benefit-cost ratio were calculated accordingly. The net return in different techniques was worked out by subtracting the total cost from the total gross return as per standard mathematical procedure.

RESULTS AND DISCUSSION

Percent graft survival

The survival percentage of graft in sapota varies with the technique and time. In this experiment, the average per cent graft survival among various propagation techniques varied from 38.89 to 70.56 per cent (Table 1). The maximum average graft survival percentage was recorded in inarching followed by side and veneer grafting *i.e.* 60.00 and 58.33 per cent, respectively whereas minimum graft success was recorded in tongue grafting while comparing different seasons of grafting, maximum average survival percentage *i.e.* 63.33 per cent was recorded in June followed by July, March and August. Whereas, the minimum graft survival was recorded in plants grafted during the month of February *i.e.* 41.33 per cent. The study further revealed that more success in the rainy months *i.e.* in June and July may be due to higher relative humidity and less fluctuation in the maximum and minimum temperature which is congenial for increased cell activity (Kalalbandi *et al.,* 2014; Singh and Bons, 2016). Pampanna *et al.* (2000) reported a maximum survival percentage in the month of May *i.e.* 60 per cent and a minimum in the month of January followed by February (6.67 and 10.00 per cent, respectively). Similar results were recorded by Singh *et al.* (1984) that the highest graft survival percentage was recorded in the month of June-July. The plants propagated by inarching resulted in significantly higher graft survival in the month of July followed by August. The higher success percentage in side and veneer grafting was done due to the retention of photosynthetic site *i.e.* leaves with rootstock during grafting to support the cambium layer formation in the graft union (Hussain and Bukhari, 1977). The low success in tongue-grafted plants was due to the excessive injury in the scion and stock while splitting and this leads to a high mortality rate (Mukherjee and Majumdar, 1961). The percent survival in the tongue grafting technique may be due to the more injury to the scion and stock while grafting and this leads to more exudation of the latex that forms a layer between the cambium of the stock and scion that leads to the least success percentage.

Economic parameters

The results regarding economic analysis for commercial nursery production of sapota by different propagation techniques are shown in Table 2. The result of the present study reveals that the average maintenance cost among various propagation techniques ranges from rupees 4550 to 7350. The maximum maintenance cost in inarching was due to more labor intensiveness. The total expenditure incurred on plant propagation ranged from Rs. 28050 to 44350 with a maximum in inarching due to involvement of high maintenance cost, cost of budding as well as cost of scion for grafting 1000 plants. The gross income calculated based on total saleable grafts ranged from Rs. 31120 in tongue grafting to Rs. 53680 in inarching but the net income was recorded maximum (Rs. 19950) inside grafting followed by veneer grafting *i.e.* 18590. The minimum net

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

Treatments/Month	Graft survival (%)						Mean
	February	March	June	July	August	September	
Wedge grafting	43.33^{fghi}	46.67^{efgh}	56.67^{cdf}	53.33^{def}	50.00^{efg}	36.67^{hij}	47.78^{d}
Side grafting	30.00^{j}	66.67^{abc}	73.33^{ab}	70.00^{ab}	66.67^{abc}	53.33^{def}	60.00^{b}
Tongue grafting	33.33^{ij}	50.00^{efg}	46.67^{efgh}	36.67^{hij}	36.67^{hij}	30.00j	38.89^{c}
Veneer grafting	36.67^{hij}	63.33^{bcd}	66.67^{abc}	73.33^{ab}	70.00^{ab}	40.00^{ghij}	58.33^{b}
Inarching	63.33^{bcd}	70.00^{ab}	73.33^{ab}	76.67^{a}	76.67^{a}	63.33^{bcd}	70.56^{a}
Mean	41.33^{b}	59.33a	63.33^{a}	62.00^{a}	60.00^{a}	44.67^{b}	
LSD ($p \leq 0.05$)	Treatment, (A): 4.61 Month, (B): 5.05 (A × B): 11.29						

return *i.e.* Rs. 3070 was in tongue grafting due to the least graft survival percentage.

The average benefit-cost ratio among all the propagation techniques is calculated based on data on net returns and total expenditure. The results further revealed that the maximum net benefit-cost ratio *i.e.* 0.71 was recorded in side grafting followed by veneer grafting (0.66) and least in the case of tongue grafting (0.11)

Table 2: Input cost in various propagation techniques in sapota cv. Kalipatti.

Treatments	Number of rootstock plants	Rootstock cost (Rs)	Cost of scion (Rs.)	Cost of budding (Rs.)	Maintenance cost (Rs.)	Total expenditure (Rs.)
Wedge grafting	1000	15000	5000	3500	4550	28050
Side grafting	1000	15000	5000	3500	4550	28050
Tongue grafting	1000	15000	5000	3500	4550	28050
Veneer grafting	1000	15000	5000	3500	4550	28050
Inarching grafting	1000	15000	15000	7000	7350	44350

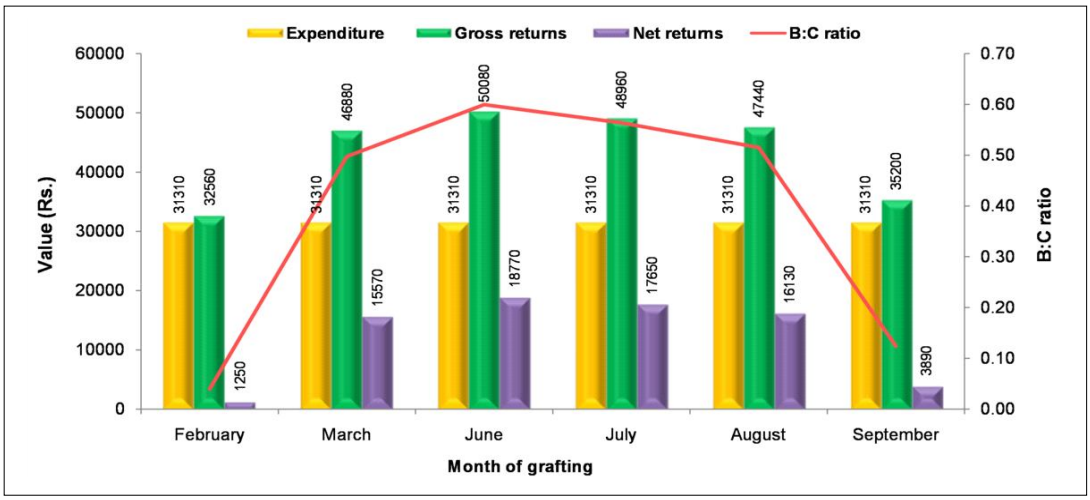


Fig 1: Gross returns, net returns and benefit-cost ratio of nursery production in sapota cv. Kalipatti as affected by month of grafting.

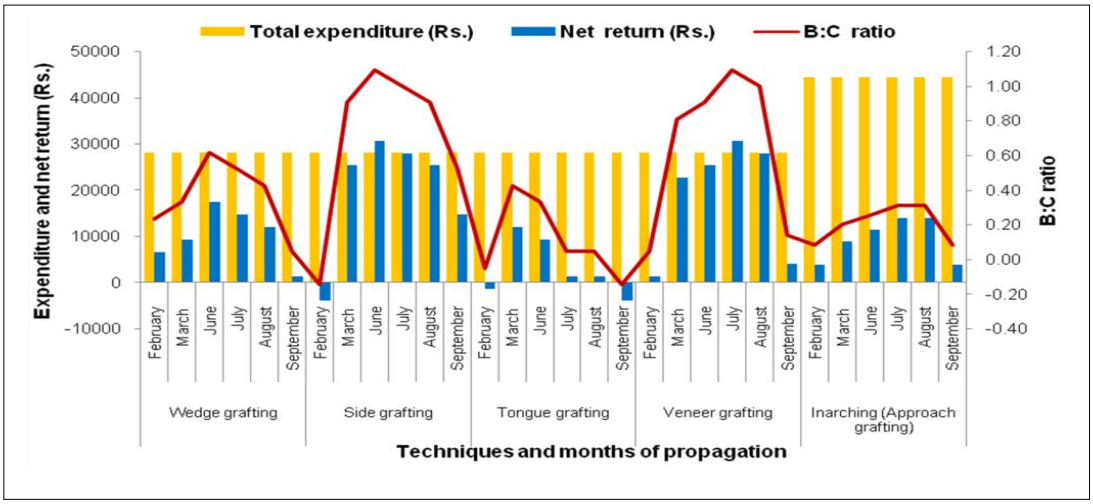


Fig 2: Interaction effect of technique and month of propagation in sapota cv. Kalipatti on gross returns, net returns and benefit-cost ratio.

followed by inarching and wedge grafting *i.e*. 0.21 and 0.36, respectively.

While comparing different times of propagation, the average benefit-cost ratio ranged from 0.04 to 0.60 with maximum values calculated for the month of June followed by July and August while the least average benefit-cost ratio was recorded for the month of February depending upon all the propagation techniques (Fig 1).

It is further evident from Fig 2 that the net return and benefit-cost ratio depending upon technique as well as month of grafting varied from Rs. -4050 to 30590 and -0.14 to 1.09, respectively. The highest net return and benefit-cost ratio were in plants propagated by side grafting during June and veneer grafting during July followed by plants grafted by side grafting during July and veneer grafting during August with net return and B:C ratio values of Rs. 27950 and 1.00, respectively. The net return was noted to be less than the total expenditure in plants propagated by tongue grafting during February and September and by side grafting during February with B:C ratio of -0.05 and -0.14.

Tanuja *et al.* (2017) experimented to analyze the effect of age and pre-curing time of scion and reported that net income and cost-benefit ratio ranged from Rs. 13500 to 18500 and 1.28 to 1.76, respectively depending upon the age of scion bud with highest values recorded in plants propagated using 3-month-old scion stick. While comparing the time of pre-curing, they further reported maximum net income and B:C ratio for plants grafted by 10 days pre-cured scion.

CONCLUSION

The results of the present experimental study conclude that for commercial nursery production under North Indian conditions, the sapota can be successfully propagated through side and veneer grafting during the months of June and July, respectively with a high survival percentage and more benefit-cost ratio.

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Disclaimers

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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