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Influence of different time and method of propagation on success percentage of wood apple (*Feronia limonia* L.) var. PKM 1

V Hariharan, S Muthuramalingam, J Rajangam and K Venkatesn

Abstract
The present study on standardization of time and method of propagation in wood apple (*Feronia limonia* L.) was evolved during seven months *viz*., February, March, April, May, June, July and August with three different methods i.e., cleft grafting, softwood grafting and patch budding during the year 2021. The results of the study revealed that among the propagation methods, softwood grafting performed during the month of July registered early sprouting (6.20), maximum success percentage (96.60%), survival percentage (94.73%), number of sprouts (4.30cm) and total leaf chlorophyll (1.88 mg g^{-1}). At the same time maximum sprout length (26.78cm) was observed in patch budding during the month of August. From the experimental results it would be concluded that softwood grafting performed in July was found to be the best for wood apple multiplication.

Keywords: Multiplication, wood apple, methods, propagation

Introduction
Wood apple is an indigenous underutilized miracle fruit, which is from Rutaceae family and botanically called as *Feronia limonia* L. It gives pleasant aroma and flavor at ripen condition but unripen fruits are acidic (Das and Das, 2003) [4]. Elephant apple, monkey fruit, curd fruit, kathel are the other vernacular names of wood apple. It desires hot dry conditions for ideal flower and fruit production. The commercial fruit production starts after 15 years onwards (Sharma *et al.*,2014) [7]. Wood apples are occasionally grown in orchards but it commonly seen in fallow and barren lands, road sides, field edges and community lands. South East Asian countries gave more importance to wood apple for their excellent nutritive values. In our country Southern Maharashtra, Madhya Pradesh, Western Himalayas are the major hotspots of wood apple. Naturally it have a biotic and abiotic stress tolerance capacity and it is climatic resilient plant potentially withstand the extreme hot dry and wet conditions. Wood apple is a slow growing deciduous erect tree with upward branches, moderate sized, glabrous tree with thorny branches. The barks are firm, groove, scaly with spines. Leaves are alternate, glabrous, entire, dark colored, leathery, blunt at apex, slightly picks up the smell of lemon with dotted oily glands. Flowers are light red and greenish colour with 1.2 cm wide and borne in terminal or lateral shoots. Fruits are round to oval shape, hardy, woody, white to greyish color, 5-12.5 cm width and 6 mm of scurfy rind (Hiwale, 2015) [6]. Before the spring, trees shed their leaves and flowering starts with in February to March and it will continue up to last week of May.

Wood apple based beverages are have a tremendous potential and excellent thirst quenching ability. Because of its unique flavor and sour- sweet blend taste Indian people are consume raw fruits and also processed products like chutney, jam and jelly prepared from fruits (Morton, 1987) [11]. Wood apple have so many medicinal and Ayurveda properties which makes it a potential medicinal plant in India. In traditional Indian medicine, it cures many diseases such as asthma, diarrhea, tumors, wounds, hepatitis, cardiac debility (Dar *et al.*, 2013) [3]. According to Ray and Mazumdar (1988) [16] 100g weight of fruit pulp consists moisture (64.2%), fat (3.7%), minerals (1.9%), fiber (50%), carbohydrate (18.1%) protein (7.1%), calcium (0.13%), phosphorus (0.11%), iron (0.048%), riboflavin (0.17 mg), beta-carotene (0.61mg) and niacin (0.8mg). The juice extracted from young leaves it cures intestinal problems associated with worms and effectively control the piles. The wood apple fruits and seeds are possess the anti-diabetic antipyretic, anti-inflammatory and analgesic activity (Mishra *et al.*, 2009) [10].

Seed propagation is the most common method followed in wood apple, being a cross pollinated crop it can't produce a true-to-type and superior planting materials so, this method

propagation is discouraged. Vegetative propagation is the only solution to produce true -to-type and superior quality progenies. Wood apple also propagated by softwood grafting (Raghavendra *et al.,* 2011) [14] and patch budding (Angadi *et al.,* 2011) [1]. Due to different agro-climatic conditions method and time of propagation will vary from place to place. The time and method of propagation mainly depends on temperature, relative humidity and availability of planting materials. Therefore the present study was standardize the exact method and time of propagation in wood apple var. PKM 1 under Tamil Nadu conditions.

Materials and Methods

The research was conducted in the central nursery mist chambers at Department of Fruit Science, Horticultural College and Research Institute, Periyakulam. The research nursery is located in the tropical zones at the latitude of 10.1283^0 N and longitude of 77.5998^0E. During the year 2020-2021 the cleft grafting, softwood grafting and patch budding was done from February to August to find out the best time and method of grafting in wood apple var. PKM 1. Factorial Completely Randomized Design (FCRD) was adopted in this experiment with 21 treatment combinations and two replications. For each treatment and replications five plants were selected to evolve the growth and biochemical parameters. The growth parameters and biochemical like number of days taken for 1st sprouting, success percentage, survival percentage, number of sprouts, length of sprouts, number of leaves, leaf area and total leaf chlorophyll were recorded at 30,45, 60 days after the propagation work was completed. Dates on success percentage were recorded after 30 days of propagation and the other parameters were evolved after 60 days of propagation. The data were statistically analyzed following the method suggested by Panse and Sukhtame (2000).

Result and Discussion

1. Number of days taken for 1st sprouting

Different time and method of propagation significantly influenced the days taken for sprout emergence of wood apple (Table 1). Among the different method of propagation, softwood grafting recorded minimum (7.34) days for first sprout emergence. Early sprouting (8.86 days) was observed in July month propagated plants. Interaction of time and method of propagation also had a significant influence on early sprouting in wood apple. After 60 days of propagation, early sprouting (6.20 days) was recorded in softwood grafting performed during July it was on par with cleft grafting (8.09 days) during July month and the late sprouting (15.21 days) was observed in patch budding performed during the month of April. Early sprouting observed might be due to favorable climatic conditions present during propagation operation. More relative humidity reduce the transpiration from scion material which induce the early sprouting. The research findings show early sprouting in July month was agreed with Islam *et al.,* (2003) [7] in jackfruit and Mohit kumar *et al.,* (2017) [8] in guava.

Table 1: Influence of time, method of propagation and their effect on number of days taken 1st sprouting

Method of propagation	Time of propagation							
	February	March	April	May	June	July	August	Mean
Cleft grafting	8.56	9.11	9.29	8.80	8.46	8.09	8.38	8.67
Softwood grafting	7.86	8.19	8.57	7.25	6.82	6.20	6.53	7.34
Patch budding	14.17	14.80	15.21	13.78	13.43	12.30	13.29	13.85
Mean	10.19	10.70	11.12	9.94	9.57	8.86	9.40	
Factors	SE(d)				CD(p=0.05)			
Method of Propagation	0.03				0.07			
Time of propagation	0.05				0.11			
Interaction (M X T)	0.09				0.19			

2. Success percentage

The study results revealed that the maximum (89.28%) and minimum (69.50%) success percentage was recorded in softwood grafting and patch budding (Table 2). The effect of time on propagation was also significant with respect to success percentage of wood apple, the highest (85.60%) and lowest (71.56%) was documented during July and April months. Interaction of time and method of propagation significantly influenced the success percentage. After 60 days of propagation maximum success percentage (96.60%) was recorded in softwood grafting during the month of July and the minimum success percentage (62.59%) was recorded in patch budding during the month April. Because of sufficient food materials like carbohydrate, protein, nitrogen are present in scions and rootstocks and also moderate temperature (29 to 32 ^{0}C) and high relative humidity which helps better success percentage. The results are accordance with Gosh (2009) [5] in ber and Raghavendra *et al.,* (2011) [14] in wood apple.

Table 2: Influence of time, method of propagation and their interaction effect on success percentage in wood apple

Method of propagation	Time of propagation							
	February	March	April	May	June	July	August	Mean
Cleft grafting	76.44	71.80	69.90	75.66	78.02	85.02	81.75	76.94
Softwood grafting	87.73	86.16	82.21	88.72	90.29	96.60	93.28	89.28
Patch budding	67.55	66.33	62.59	71.18	71.41	75.19	72.26	69.50
Mean	77.24	74.76	71.56	78.52	79.90	85.60	82.43	
Factors	SE(d)				CD(p=0.05)			
Method of Propagation	0.26				0.54			
Time of propagation	0.40				0.83			
Interaction (M X T)	0.69				1.44			

3. Survival percentage

Effect of method of propagation on survival percentage recorded more survival percentage (87.16%) in softwood grafting which was on par with cleft grafting (74.69%). Time of propagation significantly influenced the survival percentage of wood apple plants (Table 3). During the months of July and April registered maximum (83.92%) and (68.44%) minimum survival rates. Interaction of time and method of propagation in wood apple recorded highest (94.73%) and lowest (59.70%) survival percentages in softwood grafting and patch budding during July and April. More survival rate might be due to greater compatability between scions and stocks, better callus formation and favorable environmental conditions which facilitates easy mobilization of food materials from stocks to scions. The experiment findings was supported by Muniyappan *et al.*, (2019) in jamun and Ravi Kumar *et al.* (2020) in jackfruit.

Table 3: Influence of time, method of propagation and their interaction effect on survival percentage in wood apple

Method of propagation	Time of propagation							
	February	March	April	May	June	July	August	Mean
Cleft grafting	74.04	69.92	67.51	73.54	76.57	82.88	78.43	74.69
Softwood grafting	86.20	84.18	78.11	86.78	87.71	94.73	92.41	87.16
Patch budding	64.80	63.56	59.70	68.73	69.65	74.15	70.02	67.23
Mean	75.01	72.55	68.44	76.35	77.97	83.92	80.28	
Factors	SE(d)				CD(p=0.05)			
Method of Propagation	0.34				0.71			
Time of propagation	0.52				1.08			
Interaction (M X T)	0.90				1.88			

4. Number of shoots

Different time and method of propagation had significant influence on number of shoots (Table 4). Among the different method of propagation, softwood grafting produced (4.24) shoots and patch budding produced (2.79) shoots. The effect of different time of propagation July month produce (3.61) shoots and April month produce (2.95) shoots. After 60 days of propagation, combination of time and method of propagation recorded maximum number of shoots (4.30) in softwood grafting during the month of July and the minimum number of shoots (2.95) in Patch budding during the month of April. Highest number of sprouts recorded in softwood grafting because of more numbers of active buds present in scions, better vascular connectivity between stocks and scion high carbohydrate accumulation with optimum temperature and more relative humidity. The findings of Shinde *et al.*,(2015) in Custard apple and Tanushree *et al.*,(2019) in jack fruit are supported the current research.

Table 4: Influence of time, method of propagation and their interaction effect on number of shoots in wood apple

Method of propagation	Time of propagation							
	February	March	April	May	June	July	August	Mean
Cleft grafting	3.50	3.25	3.15	3.40	3.52	3.74	3.57	3.44
Softwood grafting	3.83	3.78	3.65	4.02	4.14	4.30	4.24	3.99
Patch budding	2.39	2.25	2.06	2.48	2.51	2.79	2.66	2.44
Mean	3.24	3.09	2.95	3.30	3.39	3.61	3.49	
Factors	SE(d)				CD(p=0.05)			
Method of Propagation	0.01				0.03			
Time of propagation	0.02				0.04			
Interaction (M X T)	0.03				0.08			

5. Shoot length (cm)

Data presented on (Table 5) indicated that the patch budding produced (26.78cm) length shoots and the cleft grafting produced (15.46cm) length shoots. Among the different time of propagation August recorded maximum (24.70cm) shoot length followed by (22.68cm) length shoot in July. Sprout length significantly influenced by interaction of time and method of propagation, after 60 days of propagation patch budding and cleft grafting done at August and April months recorded maximum (26.78cm) and minimum (15.46cm) sprouts. The maximum sprouts might be due to ideal climatic condition during monsoon positively act on stock and scion which induce the shoot growth and also physiological process like photosynthesis and respiration directly correlated with shoot length. These results also corroborate the research findings of Archana *et al.*, (2018) in jack fruit patch budding.

Table 5: Influence of time, method of propagation and their interaction effect on sprout length (cm) in wood apple

Method of propagation	Time of propagation							
	February	March	April	May	June	July	August	Mean
Cleft grafting	18.11	17.13	15.46	16.53	17.49	19.84	22.88	18.20
Softwood grafting	20.44	18.74	15.96	17.12	21.66	23.52	24.45	20.27
Patch budding	20.57	18.05	16.84	23.94	21.81	24.69	26.78	21.78
Mean	19.70	17.97	16.08	19.19	20.32	22.68	24.70	
Factors	SE(d)				CD(p=0.05)			
Method of Propagation	0.18				0.39			
Time of propagation	0.28				0.59			
Interaction (M X T)	0.49				1.03			

6. Number of leaves

It is evident from the data (Table 6) that more number of leaves (30.02) produced in softwood grafting and less number of leaves (16.24) produced in patch budding. The effect of time of propagation had a significant results on number of leaves, August month produced maximum (26.93) number of leaves and April month produced minimum (19.42) number of leaves. The interaction of time and method of propagation respectively influenced the number of leaves, after 60 of propagation softwood grafting in August and patch budding in April month produced maximum (33.54) and minimum (12.93) number of leaves. Maximum shoot growth in softwood grafting might be due to congenial weather condition prevailing during monsoon period, good relationship between scions and stocks. Minimum number of leaves in patch budding because of less shoots number of shoots and unfavorable weather condition prevailing at April month. Rani *et al.*,(2015) [15] in guava and Muniyappan *et al.*, (2019) [12] in jamun are also confirmed the same research findings.

Table 6: Influence of time, method of propagation and their interaction effect on number of leaves in wood apple

Method of propagation	Time of propagation							
	February	March	April	May	June	July	August	Mean
Cleft grafting	23.72	20.98	19.22	23.22	24.44	25.69	27.74	23.57
Softwood grafting	28.51	28.03	26.12	29.67	31.69	32.61	33.54	30.02
Patch budding	15.37	13.77	12.93	16.30	17.45	18.38	19.51	16.24
Mean	22.46	20.92	19.42	23.06	24.52	25.56	26.93	
Factors	SE(d)				CD(p=0.05)			
Method of Propagation	0.14				0.29			
Time of propagation	0.22				0.45			
Interaction (M X T)	0.38				0.79			

7. Total leaf chlorophyll (mg g^{-1})

There were significant variation in total leaf chlorophyll based on different time and method of propagation (Table 7). After 60 days of propagation maximum total leaf chlorophyll (1.59) was observed in softwood grafting while, minimum total leaf chlorophyll (0.82) was observed in patch budding. Among the different months of propagation July month recorded maximum total leaf chlorophyll (1.42) at the same time April month recorded minimum total leaf chlorophyll (0.93). Significant effect was registered for time and method of propagation on total leaf chlorophyll. Response of softwood grafting after 60 of propagation was also found maximum total chlorophyll (1.88) in July month, meanwhile patch budding performed during April month found minimum total leaf chlorophyll (0.71). The research findings of Naik *et al.*, (2018) [13] in jack fruit and Rani *et al.*,(2015) [15] in guava were agreement with current research.

Table 7: Influence of time, method of propagation and their interaction effect on Total leaf chlorophyll (mg g^{-1}) in wood apple

Method of propagation	Time of propagation							
	February	March	April	May	June	July	August	Mean
Cleft grafting	1.14	0.84	0.80	1.02	1.21	1.38	1.22	1.08
Softwood grafting	1.53	1.46	1.29	1.59	1.63	1.88	1.77	1.59
Patch budding	0.77	0.74	0.71	0.83	0.84	1.02	0.85	0.82
Mean	1.14	1.01	0.93	1.14	1.22	1.42	1.27	
Factors	SE(d)				CD(p=0.05)			
Method of Propagation	0.01				0.02			
Time of propagation	0.01				0.03			
Interaction(M X T)	0.02				0.05			

Conclusion

Based on the experimental results obtained, it would be concluded that softwood grafting method performed during the month of July was found to be the best wood apple multiplication. Because of least standardized propagation techniques in wood apple propagation, farmers generally prefer to raise wood apple seedlings through seeds as it won't give superior and true-to-type planting materials and also farmers do not get good price for their produce. Hence, softwood grafting could be a better propagation technique for large scale multiplication of high quality planting materials, which will increase the yield, productivity, quality and income of the farmers.

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