Research Articles

Indian Journal of Agricultural Sciences **85** (2): 166–70, February 2015/Article

Standardization of time of softwood grafting in mahua (*Bassia latifolia*) and khirni (*Manilkara hexandra*) under semi-arid environment of western India

SANJAY SINGH[1] and A K SINGH[2]

Central Horticultural Experiment Station, Vejalpur (Godhra), Panchmahals, Gujarat 389 340

Received: 26 October 2012; Revised accepted: 16 September 2014

ABSTRACT

The experiment was conducted during consecutive years of 2005-06 and 2006-07 at Central Horticultural Experiment Station (Central Institute for Arid Horticulture-ICAR), Vejalpur (Godhra), Panchmahal, Gujarat to standardize time of softwood grafting in mahua (*Bassia latifolia* Roxb.) and khirni (*Manilkara hexandra* (Roxb.) Dub.) under semi-arid environment of western India. Softwood grafting was carried out at monthly interval commencing from July to June during both the years. Sprouting was found to be the earliest in March (26 days in mahua and 27.4 days in khirni). Maximum time for bud sprouting was taken in the month of September (34.00 days) and November (33.50 days) in mahua and khirni respectively. The highest percentage of graft success was also noted in March, i.e. 70.00 % in mahua and 76.66 % in khirni, it was closely followed by July, August and June. Least percentage of success was noted in the month of September and November in mahua and khirni respectively. Length of sprout was also recorded highest in March after 180 days after grafting in both the crops (28 cm in mahua and 22 cm in khirni). Similar trend was recorded in respect of number and diameter of sprouts. Softwood grafted plants of mahua had higher number of leaves than khirni grafts, whereas it was found to be highest in the month of March in both the crops. Irrespective of scion and rootstock, the maximum accumulation of nitrogen and carbohydrate content was recorded in March, while it was found in lower concentration during December, January and February. Soft wood grafting in mahua may be followed during March, April and July, while March, July and August may be the appropriate time for grafting of khirni under semi-arid environment of western India.

Key words: *Bassia latifolia*, *Manilkara hexandra,* Sprouting, Success, Semi-arid environment, Soft wood grafting

Mahua (*Bassia latifolia* Roxb.) is an economically multipurpose tree of the family Sapotaceae. Its flowers, fruits and seed oil are consumed in various ways. The corolla commonly called as mahua flower is a rich source of sugar containing appreciable amount of vitamins and minerals and may be used for preparation of distilled liquors and potable spirits (Singh and Singh 2005). The oil obtained from kernel is used for edible purpose and permitted for preparation of vegetable oil. A wide range of variability occurs with regard to fruit size and quality owing to its seed propagation, which needs to be conserved and exploited (Singh and Singh 2005 and Singh *et al.* 2006). Khirni or rayan, botanically known as (*Manilkara hexandra* (Roxb.) Dub.) is an economically multipurpose under exploited tree of the family Sapotaceae. The tree is medium size, evergreen with spreading growth habit. It bears oval, sweet edible fruit with one or more seeds. It is commercially used as a rootstock for vegetative propagation of sapota in different parts of the country. The fruits of khirni are good source of sugars and vitamins. These are very hardy, highly heterozygous, cross-pollinated fruit crops and as such seedlings exhibit a wide range of variations, which aids in the selection of the superior desirable genotypes. Non-availability of elite planting materials is one of the main reasons for not getting desired level of popularity among the farmers. True to type propagules can be multiplied from elite trees that produce good quality fruits only by asexual methods. Of various methods of propagation, grafting is of paramount importance in fruit trees as it results the highest success and field establishment of jamun (*Syzygium cuminii* Skeels), custurd apple (*Annona squamosa* L.), aonla (*Emblica officinalis* Gaertn), tamarind (*Tamarindus indica* L.) and jackfruit (*Artocarpus heterophyllus* Lam.) (Chovatia and Singh 2000, Singh and Singh 2006, Ghosh *et al*. 2004, Srivastava *et al*. 2002, Roshan *et al*. 2008, Awasthi and Shukla 2003, Singh and Singh 2007 and Silvi *et al*. 2008). The time is considered to be the most vital factor that determines the success and establishment of the grafts. Systematic information in this regard is scanty, thus, the present investigation was undertaken to standardize the suitable time for softwood grafting under semi-arid environment of western India.

[1]Head(email:sanjaysinghicar@gmail.com),[2]Senior Scientist, Horticulture(aksbicar@gmail.com)

Table 1 Meteorological data during the course of investigation (pooled data of two years)

Months	Minimum temperature (Degree celsius)	Maximum temperature (Degree celsius)	Relative humidity at 8.30 AM (%)	Rainfall (mm)
July	16.43	27.52	91.00	487.50
August	15.72	27.26	89.98	408.75
September	15.85	27.69	83.75	260.75
October	15.26	28.49	64.93	17.20
November	11.49	25.38	66.98	
December	8.43	21.96	68.59	
January	15.30	26.61	81.35	
February	15.83	24.88	71.67	
March	21.92	33.74	65.27	
April	21.09	31.09	54.71	
May	21.79	32.36	57.38	
June	24.53	35.1	63.68	29.25

MATERIALS AND METHODS

The investigation was carried out at Central Horticultural Experiment Station, Vejalpur (Godhra), Panchmahal, Gujarat for two consecutive years of 2005-2006 and 2006-2007. The locally available seeds of mahua and khirni were sown in the polythene bags filled with soil and farmyard manure (2:1) for raising the rootstocks. The irrigation, weeding and other desired intercultural operations were done time to time. About 9-12 months old seedling of uniform size having stem of pencil thickness were used as rootstock. Softwood grafting through cleft method was carried out at monthly interval commencing from July 2005 to June 2007 and two years data were pooled. Scion shoots of promising types having desirable horticultural traits were used to perform the grafting. The experiment was laid out in completely randomized design with three replications and 20 plants in each replication was considered as unit. Data on sprouting were recorded soon after bud burst while success percent was recorded 3 months after grafting. Length and diameter of sprout, number of leaves and sprouts per plant were recorded at the interval of 90,120 and 150 days after grafting. Total nitrogen, protein and carbohydrate were determined by the methods advocated by AOAC (1980). Meteorological data (temperature, relative humidity and rainfall) were recorded during the course of investigation and mentioned in Table 1.

RESULTS AND DISCUSSION

The perusal of the data presented in Table 2 reveals that days required for bud sprouting differed significantly due to time of grafting. It was observed that the plants of mahua sprouted earliest in the month of March (26 days), closely followed by April, May, June, July and August. Similarly, grafted plants of khirni took least time to sprout in the month of March (27.40 days) closely followed by July, August and April. The maximum time for bud sprouting was taken in the month of September (34.00 days) and November (33.50 days) in mahua and khirni respectively. No bud sprouting took place in the month of November, December, January and February in mahua, however, it was noted nil in December and January in khirni. The delayed bud sprouting in the month of November might have caused due to low temperature and humidity and inadequate flow of cell sap. Temperature plays an important role in photosynthetic activity of the leaves (Syamal *et al.* 2013). Higher temperature during March, April, July and August has helped in early sprouting because of fast establishment of vascular connection with rootstock and scion as has been reported by Awasthi and Shukla (2003). Similar results were also obtained by Singh *et al.* (2007) in jamun and Singh and Singh (2007) in tamarind. The highest sprouting (73.25 % in mahua and 78.00 % in khirni) was recorded when grafting was done in March, closely followed by April, July and August. Plants recorded least sprouting per cent in September (9.25 %) and February (12.10 %) in mahua and khirni respectively. Two years pooled data

Table 2 Effect of time of soft wood grafting on bud sprouting, time taken for bud sprout and success percent

Treatment	Time taken for bud sprout (Days)		Bud sprout (%)		Success (%)	
	Mahua	Khirni	Mahua	Khirni	Mahua	Khirni
July	30.50	28.00	66.25(54.45)	73.00(58.69)	64.20(53.25)	71.25(57.54)
August	30.00	28.50	64.50(54.43)	72.10(58.12)	62.00(51.94)	70.00(56.79)
September	34.00	32.00	9.25(17.66)	68.00(55.55)	08.33(16.74)	66.10(54.39)
October	32.00	33.00	22.10(28.04)	63.50(52.83)	20.10(26.64)	62.00(51.94)
November	0.00	33.50	0.00(0.17)	54.00(47.29)	0.00(0.17)	50.00(45.00)
December	0.00	0.00	0.00(0.17)	0.00(0.17)	0.00(0.17)	0.00(0.17)
January	0.00	0.00	0.00(0.17)	0.00(0.17)	0.00(0.17)	0.00(0.17)
February	0.00	30.00	0.00(0.17)	12.10(20.36)	0.00(0.17)	10.00(18.44)
March	26.00	27.40	73.25(58.82)	78.00(62.03)	70.00 (56.79)	76.66(61.07)
APRIL	27.33	28.00	67.50(55.24)	54.10(47.35)	65.50(54.03)	52.50(46.43)
May	28.00	29.20	63.50(52.83)	58.00(49.60)	60.00(50.77)	56.00(72.00)
June	29.00	30.00	57.10(49.08)	74.10(59.41)	55.00(47.87)	62.00(58.05)
CD (P= 0.05)	2.11	2.89	3.55	3.56	2.14	2.14

Figures in parentheses are transformed values

Table 3 Effect of time of grafting on length of sprouts (cm)

Treatment	Mahua			Khirni		
	90 days	120 days	150 days	90 days	120 days	150 days
July	15.20	20.10	24.20	12.10	16.10	21.50
August	15.30	19.15	23.10	12.00	16.00	20.50
September	13.11	15.20	18.50	10.00	15.13	18.00
October	12.10	14.11	16.00	9.10	15.0	17.13
November	0.00	0.00	0.00	9.00	15.00	17.00
December	0.00	0.00	0.00	0.00	0.00	0.00
January	0.00	0.00	0.00	0.00	0.00	0.00
February	0.00	0.00	0.00	10.00	16.00	18.50
March	17.13	23.20	28.00	11.00	17.00	22.00
April	16.30	22.11	27.10	10.50	16.50	21.20
May	15.11	20.10	20.10	10.15	16.11	20.16
June	14.10	17.10	20.00	10.11	16.10	20.00
CD (P= 0.05)	1.11	1.20	1.25	1.13	1.11	1.58

Table 5 Effect of time of grafting on number of sprouts

Treatment	Mahua			Khirni		
	90 days	120 days	150 days	90 days	120 days	150 days
July	1.33	3.00	3.66	1.33	2.00	2.66
August	1.33	3.00	3.66	1.33	2.00	2.66
September	1.00	2.33	3.00	1.00	2.00	2.66
October	1.00	2.33	3.00	1.00	1.66	2.33
November	0.00	0.00	0.00	1.00	1.66	2.00
December	0.00	0.00	0.00	0.00	0.00	0.00
January	0.00	0.00	0.00	0.00	0.00	0.00
February	0.00	0.00	0.00	1.33	1.66	2.00
March	2.00	3.33	4.00	1.33	2.33	3.00
April	2.00	3.33	4.00	1.33	2.33	3.00
May	1.00	2.33	3.33	1.00	1.33	2.66
June	1.00	2.33	3.33	1.00	1.33	2.66
CD (P= 0.05)	NS	0.20	0.21	NS	0.10	0.12

NS, Non-significant

exhibited maximum percentage of graft success in the month of March (70.00% in mahua and 76.66% in khirni), closely followed by April, July and August. This finding is in agreement with the results of Chovatia and Singh (2000) and Singh *et al*. (2007) in jamun. Such a wide variation in sprouting and graft success may possibly be attributed due to wide variation in temperature and relative humidity during the period of study. These factors influence the sprouting and graft success (Awasthi and Shukla 2003 in tamarind and Singh *et al*. 2007 in jamun). Optimum temperature in March (21.92-33.74°C), April (21.09-31.09°C), July (16.43-27.52°C) and August (15.72-27.26°C) might have played an important role in early contact of cambium layers of stock and scion resulting in early callus formation and more success percent of grafts**.** During July and August, higher per cent of relative humidity also helped in production of more callus tissues in the grafts. Singh and Singh (2007) also reported that total nitrogen and carbohydrate content showed increasing trend during March-April and that must have equally contributed in union physiology of grafting. The data on growth parameters like length of sprout, diameter of sprout, number of leaves and sprout per plant were recorded at the interval of 90,120 and 150 days after grafting and in general plant growth increased with increasing days after grafting. The results presented in Table 3 reveal that the length of spouts of mahua was recorded maximum in March at 90 (17.13 cm), 120 (23.20 cm) and 150 (28.00 cm) days after grafting, closely followed by April, July, August and May whereas, it was recorded minimum in October. Similarly, the length of sprouts of khirni was recorded highest in March at 90 (11.00 cm), 120 (17.00 cm) and 150 (22.00 cm) days after grafting, closely followed by July and April, while it was recorded least in November.

The diameter of sprouts of mahua also exhibited similar

Table 4 Effect of time of grafting on diameter of sprouts (cm)

Treatment	Mahua			Khirni		
	90 days	120 days	150 days	90 days	120 days	150 days
July	0.44	0.61	0.75	0.49	0.58	0.68
August	0.44	0.60	0.75	0.49	0.58	0.68
September	0.42	0.58	0.72	0.46	0.56	0.65
October	0.40	0.56	0.71	0.45	0.56	0.65
November	0.00	0.00	0.00	0.44	0.54	0.64
December	0.00	0.00	0.00	0.00	0.00	0.00
January	0.00	0.00	0.00	0.00	0.00	0.00
February	0.00	0.00	0.00	0.48	0.57	0.68
March	0.45	0.65	0.81	0.50	0.60	0.69
April	0.45	0.64	0.80	0.50	0.60	0.68
May	0.40	0.60	0.78	0.48	0.59	0.66
June	0.40	0.58	0.73	0.48	0.58	0.65
CD (P= 0.05)	0.02	0.03	0.02	0.02	0.02	0.02

Table 6 Effect of time of grafting on number of leaves

Treatment	Mahua			Khirni		
	90 days	120 days	150 days	90 days	120 days	150 days
July	3.66	7.66	12.66	4.33	7.00	11.66
August	3.66	7.00	12.00	4.33	7.00	11.33
September	3.00	6.66	9.33	3.00	6.66	10.66
October	3.00	6.66	9.00	3.00	6.33	10.00
November	0.00	0.00	0.00	3.00	6.00	9.33
December	0.00	0.00	0.00	0.00	0.00	0.00
January	0.000	0.00	0.00	0.00	0.00	0.00
February	0.00	0.00	0.00	4.33	6.33	10.00
March	4.33	9.33	14.00	5.00	7.66	12.66
April	4.00	9.00	12.66	4.33	7.00	12.00
May	3.66	8.00	13.66	4.00	6.66	11.33
June	3.00	7.66	12.00	3.00	6.33	11.00
CD (P= 0.05)	0.56	1.21	1.25	0.43	0.70	1.10

Table 7 Biochemical constituents of scion and rootstocks at the time of grafting in mahua

Treatment	Total nitrogen (%)		Total carbohydrate (%)		C: N ratio		Protein (%)	
	Root stock	Scion	Root stock	Scion	Root stock	Scion	Root stock	Scion
July	0.39	0.34	12.30	11.00	31.54	32.35	2.44	2.13
August	0.39	0.37	12.10	11.10	31.03	30.00	2.44	2.31
September	0.33	0.25	12.50	11.20	37.88	44.80	2.06	1.56
October	0.30	0.24	12.20	11.00	40.66	45.83	1.88	1.50
November	0.30	0.24	12.10	11.00	40.33	45.83	1.88	1.50
December	0.29	0.22	11.40	10.40	49.31	47.27	1.81	1.38
January	0.32	0.27	11.20	10.10	45.00	37.41	2.00	1.69
February	0.39	0.25	11.60	1.20	29.74	40.80	2.44	1.56
March	0.47	0.40	13.10	12.00	27.84	30.00	2.94	2.50
April	0.40	0.30	12.11	12.00	30.28	35.29	2.50	2.13
May	0.39	0.35	12.10	10.90	31.03	31.14	2.44	2.18
June	0.35	0.29	12.30	11.00	35.14	37.93	2.19	1.81
CD (P= 0.05)	0.05	0.06	0.62	0.53	2.54	2.80	0.17	0.15

trend as the length of sprout, it was recorded maximum in March at 90 (0.45 cm), 120 (0.65 cm) and 150 (0.81 cm) days after grafting, closely followed by April and July, while it was noted least in October (Table 4). In khirni, the diameter of sprouts was recorded maximum in March at 90 (0.50 cm), 120 (0.60 cm) and 150 (0.69 cm) days after grafting, closely followed by April, July and August, while it was noted least in November. The number of sprouts also increased with increasing days after grafting (Table 5). In mahua, the maximum number of sprouts, i.e. 2.00, 2.33 and 4.00 was recorded at 90, 120 and 150 days after grafting respectively in March and April. Similarly in khirni, it was noted highest, ie 1.33, 2.33 and 3.00 at 90, 120 and 150 days after grafting respectively in March and April. it was closely followed by July and August. The least number of sprouts was recorded in September and October in mahua, while it was noted minimum in November in case of khirni.

The higher number of sprouts in the month of March, April, July and August may be because of optimum temperature and relative humidity prevailing during the period of grafting (Singh *et al.* 2007 in jamun). It is evident from Table 6 that the number of leaves ranged between 3.00 - 4.33, 6.66 - 9.33 and 9.00 –10.00 at 90,120 and 150 days after grafting in mahua respectively, while in khirni, it ranged between 3.00-5.00, 6.33-7.66 and 9.33-12.66 at 90, 120 and 150 days after grafting respectively. The highest number of leaves per plant was recorded in March at 150 days after grafting in mahua (14.00) and khirni (12.66). The least number of leaves at various stages (90, 120 and 150 days after grafting) was recorded in October in both the crops.

The quick and strong union formation, conducive environment, better nutrient uptake and ample growing period might have caused for higher plant growth and more number of leaves plant in the month of March, April, June, July and August. Singh and Singh (2006) and Awasthi and Shukla (2003) reported similar findings in jamun and tamarind under different agro climatic conditions. Favourable temperature and humidity helps in production of more callus tissues in the grafts of bael (Singh and Singh 2009), jamun (Mulla *et al.* 2011) and pomegranate (Singh and Jadhav 2012) under Uttar Pradesh, Maharashtra and

Table 8 Biochemical constituents of scion and rootstocks at the time of grafting in khirni

Treatment	Total nitrogen (%)		Total carbohydrate (%)		C: N ratio		Protein (%)	
	Rootstock	Scion	Rootstock	Scion	Rootstock	Scion	Rootstock	Scion
July	0.36	0.33	14.40	13.10	40.10	39.69	2.25	2.06
August	0.36	0.36	14.50	13.12	40.27	36.44	2.25	2.25
September	0.29	0.24	14.50	13.11	50.00	5462	1.81	1.50
October	0.28	0.23	14.10	13.10	50.35	56.95	1.75	1.40
November	0.27	0.23	14.10	13.10	52.22	56.95	1.68	1.43
December	0.26	0.21	13.40	12.40	51.53	59.04	1.65	1.31
January	0.27	0.27	13.20	12.00	48.88	44.44	1.68	1.68
February	0.35	0.24	13.10	12.10	47.42	50.41	2.18	1.50
March	0.45	0.39	15.00	14.10	33.33	35.89	2.81	2.43
April	0.40	0.33	14.51	13.10	36.27	39.69	2.50	2.06
May	0.39	0.32	14.00	12.80	35.89	40.00	2.43	2.00
June	0.34	0.29	14.10	13.00	41.47	44.82	2.12	1.81
CD (P= 0.05)	0.07	0.06	0.63	0.53	2.57	2.84	0.20	0.18

Karnataka conditions. Optimum temperature and water availability in month of July increases the rate of photosynthesis and leads to formation of more food materials that facilitate and improve the growth and development of the sprouts (Syamal *et al*. 2013).

The perusal of the data presented in Table 7 reveals that maximum nitrogen in rootstock (0.47%) and scion (0.40%) of mahua was recorded in March closely followed by August, while it was noted least in October and November. The total carbohydrate of rootstock (13.10 %) and scion (12.00 %) of mahua was noted maximum in March, closely followed by July and April. Similar trend was also observed with respect to protein content in scion and rootstocks of mahua. It is evident from the Table 8 that total nitrogen, total carbohydrate and protein content in scion and rootstock of khirni also exhibited similar trend as in case of mahua. The maximum nitrogen in rootstock (0.45%) and scion (0.39%) of khirni was recorded in March closely followed by August, while it was noted least in December. The total carbohydrate of rootstock (15.00 %) and scion (14.10 %) of khirni was noted maximum in March, closely followed by April and July. Similar trend was also observed with respect to protein content in scion (2.81 %) and rootstocks (2.43 %) of khirni being highest in March. Chovatia and Singh (2000) and Singh and Singh (2007) recorded similar findings in jamun and tamarind respectively. The higher per cent success was recorded during March, April, July and August indicating the positive role of nitrogen and carbohydrate in union physiology of grafting. Better nutrient uptake and faster plant growth of scion due to congenial temperature and humidity conditions in the month of March, July and August resulted in better graft success. Therefore, soft wood grafting in mahua may be followed during March, April and July, while March, July and August may be the appropriate time for grafting of khirni under hot semi-arid environment of western India.

REFERENCES

AOAC, Washington DC. 1980.*Official Methods of Analysis.* Association of Official Agricultural Chemists, Benjamin Franklin Station, Washington DC, USA.

Awasthi O P and Shukla N. 2003. Effect of time on success of soft wood grafting in tamarind (*Tamarindus indica* L.). *Range Management and Agro forestry* **24** (1): 31–4.

Chandra R and Jadhav V T. 2012. Grafting methods and time in pomegranate (*Punica granatum*) under semi-arid agro-climatic condition of Maharashtra. *Indian Journal of Agricultural Sciences* **82** (11): 990–2.

Chovatia R S and Singh S P. 2000. Effect of time on budding and grafting success in jamun (*Syzygium cuminii* Skeels). *Indian Journal of Horticulture* **57** (3): 255–8.

Ghosh S N, Manna S and Mathew B. 2004. Effect of season on success of grafting in custard apple under semi arid condition of West Bengal. *Horticulture Journal* **17** (1): 89–91.

Mulla B R, Angadi S G, Mathad J C, Patil V S and Mummigati U V. 2011. Studies on softwood grafting in jamun (*Syzygium cumini* Skeels). *Karnataka Journal of Agricultural Science* **24** (3): 366–8.

Roshan R K, Pebam M and Panhabhai D M. 2008. Effect of rootstock age and time of softwood grafting on grafting success of aonla. *Haryana Journal of Horticultural Sciences* **37** (1-2): 39–40.

Selvi R, Kumar N, Selvarajan M and Anbu S. 2008. Effect of environment on grafting success in jackfruit. *Indian Journal of Horticulture* **65** (3): 341–3.

Singh Sanjay and Singh A K. 2005. Studies on genetic diversity in mahua (*Bassia latifolia* Roxb.) under semi arid ecosystem of Gujarat. *Indian Journal of Agricultural Sciences* **75**:519–23.

Singh Sanjay, Singh, A K and Apparao V V. 2006. Genetic diversity in *chironji* (*Buchanania lanzan* Spreng) under semi arid ecosystem of Gujarat. *Indian Journal of Agricultural Sciences* **76**: 695–8.

Singh Sanjay and Singh A K. 2006. Standardization of method and time of propagation in jamun (*Syzygium Cuminii* Skeels) under semi arid environment of western India. *Indian Journal of Agricultural Sciences* **76**:142–5.

Singh, Sanjay and Singh A K. 2007. Standardization of method and time of propagation in Tamarind (*Tamarindus indica* L.) under semi- arid environment of western India. *Indian Journal of Horticulture* **64** (1): 45–9.

Singh Sanjay, Singh A K and Bagle B G. 2007. Propagating jamun successfully. *Indian Horticulture, November-December:* 31–3.

Srivastava A L, Singh H K and Singh I S. 2002. Studies on propagation of aonla (*Emblica officinalis* Gaertn). *Haryana Journal of Horticultural Sciences* **31** (3-4): 156–8.

Singh J K and Singh H K. 2009. Studies on propagation of bael (*Aegle marmelos* Correa). *Asian Journal of Horticulture* **4**: 164–6.

Syamal M M, Maurya V K and Joshi M. 2013. Effect of methods and time of propagation in bael under different growing conditions, India. *Indian Journal of Horticulture* **70**(1): 127–9.