Himachal Journal of Agricultural Research 43(1): 48-53 (2017)

Standardization of summer grafting dates in apple under polyhouse conditions in mid-hill areas of Himachal Pradesh

N.D. Negi and S.K. Upadhyay
Department of Horticulture and Agroforestry
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062, India.
Corresponding author: nanak_negi@yahoo.co.in

Received: 21.05.2017; Accepted:17.06.2017

Abstract

Almost all the temperate fruit plants are grafted during dormant season or early spring including apple, however, in a preliminary studies carried-out at CSKHPKV, Palampur revealed that apple plants can be grafted during active growing season under protected conditions. Keeping in view, the present study was thus carried out to standardize the different summer grafting dates in apple cultivar Scarlet Gala onto seedling rootstocks under polyhouse conditions with the aim to reduce nursery production duration and to ensure the regular supply of plants to the growers. For this study, a tongue grafting was performed during summer months (May, June and July) on different dates. Among various dates, tongue grafting performed on June 12, 22 and July 1 gave 100 percent bud take success with proper wound healing of graft unions. The plants grafted on June 12 attained maximum height (71.17 cm) at the end of growing season however; it was statistically at par with plants grafted on June 22 and July 1. Similarly, the number of laterals and root length was also found maximum in plants grafted on these dates. The various foliar characteristics of the plants were also significantly affected by grafting dates. The leaf area, fresh and dry weight of leaf and number of leaves per plant were observed maximum in those plants which were having vigorous growth with more number of lateral shoots. In conclusion results showed that tongue grafting performed in second week of June to first week of July is the best time for performing summer grafting in apple under polyhouse conditions in mid hill areas of Himachal Pradesh when both components (scion and rootstocks) are in active growing stage. Further, this technique can be applied for quick multiplication of nursery plants of apple for reducing nursery production duration under polyhouse conditions provided the availability of scion wood in mother orchards during grafting operations.

Key words: Summer grafting, tongue grafting, polyhouse, active growing season, laterals, bud take, mid hills.

Apple is being grown in all the continents of the world, however, major apple producing countries are from European continent and Russia is leading apple producer followed by China and India is world's fifth largest apple producer. In India, it is being cultivated in J&K, HP, UK and Arunachal Pradesh, Nagaland, Sikkim and TN up to lesser extent. It occupies an area of 319.20 thousand ha with annual production of about 2133.0 thousand MT (Anonymous, 2016). There has been manifold increase in area under fruit production in India but we are still lagging much behind in terms of productivity when compared with other fruit growing countries (Srivastava*et al.*, 2017).Although, low productivity of fruits including apple in India is attributed by various factors but non-availability of quality planting materials is one of the major factors associated to it. As per preliminary estimation for area expansion programme in horticulture and for replacement of senile old orchards in a phased manner about 50 lakh plants of elite varieties preferably on clonal/standard seedling root stocks is required in different Himalayan states like Jammu & Kashmir, Himachal Pradesh, Uttarakhand, North Eastern States. Therefore, to meet this ever increasing demand and to ensure regular supply of planting materials to the growers there is a need to switch over from conventional method of nursery production to advance methods besides micropropagation.

At present, all the temperate fruit plants including apple are being multiplied either budding

or grafting onto seedling or clonal rootstocks and the grafting operation is performed either in winter or early spring with dormant scion wood but budding is done during the late growing season (July, August, or early September) Leonard and John (2005). However, there are no scientific research devoted to success of grafting apple during active growing season except in a study by Negi and Upadhyay (2015) where they had reported that semi-hardwood grafting in apple was possible under polyhouse conditions and could be a viable method of propagation in apple under mid-hill conditions of Himachal Pradesh. Whereas, in sub-tropical and tropical fruits like; wood apple (Raghavendra *et al.* 2011), jamun (Malik *et al.* 2013) and in sapota by Pujari *et al.* (1991) have successfully demonstrated the softwood grafting techniques. Further, Jose and Valasalakumari (1991) standardized the epicotyl and softwood grafting in jackfruit (*Artocarpus heterophyllus*). Similarly, Madalageri *et al.* (1991) propagated jamun by softwood wedge grafting technique.

Generally, temperate fruit plants are being multiplied conventionally through grafting or budding methods either onto seedling or clonal rootstocks it process that takes complete two years to produce a nursery plant. Since all the seedlings in one year does not attains graftable thickness and gets either wasted or they take further one more year to attain graftable size and thickness under normal field conditions. So there is a need to invent new techniques to reduce this time and to minimize the wastage of seedlings. Therefore, considering the commercial and economic point of view, the present experiment was conducted to standardize the summer grafting dates in apple cultivar Scarlet Gala on seedling rootstocks under polyhouse conditions in mid-hill areas of HP with main objective to reduce the nursery production duration and to ensure regular supply the planting materials of apple to the growers within a year.

Materials and Methods

The experimental site is situated at 32° 5'55.05"N latitude, 76°32'32.94"E and 1239 m above mean sea level at the Department of Horticulture, CSKHPKV, Palampur, India. For this study, the seedlings of crab apple which were left out during grafting operation carried out in February 2013 due to lesser thickness were planted in a well prepared nursery beds in a tunnel type ordinary polyhouse, EW oriented and cooling fans were mounted for cooling. The seedlings were planted at 15x 15 cm distance in four rows and after every fourth row a space of 60 cm was left for doing intercultural operations. Almost all the seedlings attained graftable thickness in May. On these rootstocks, tongue grafting was performed in May (6, 23 and 30), June (6, 12 and 22) and July (1, 9, 15, 23 and 29) with scion cultivar Scarlet Gala.On each grafting dates 30 plants were grafted and the experiment was replicated thrice with 10 plants in each replication in randomized block design (RBD). The scion wood was obtained from mother trees at the time of grafting and care was taken that the scions were healthy, not succulent and semi-hard in condition (Negi and Upadhyay, 2015).

The observations on percent bud take, number of days taken to sprout, plant height (cm), number of lateral branch per plant, internode length (cm), radial growth (above and below graft union), and root length (cm) were taken at the end of growing season. Similarly, various foliar characteristics like; leaf area (cm^2), leaf number and weight (fresh and dry) were also recorded as per standard methods. The data were analyzed by using Assex, an MS-DOS based program and CPCS1 software at 0.05 % rejection level.

Results and Discussion

Number of days taken for sprouting and grafting success

The data pertaining to number of days taken for sprouting and the bud take success are presented in Table 1 and Fig 1 & 2 reveal that apple cultivar Scarlet Gala responded significantly to various summer grafting dates, with varying degrees of success and number of days taken for sprouting. The sprouting of scion buds after grafting varied significantly among different grafting dates however, the study on callus formation was not carried out in this study. Seedlings grafted on May 30, took average 7.67 days for sprouting followed by July 1 and 15 (8.67 days respectively). Whereas, the plants grafted on May 6 took maximum days for sprouting (17.67 days). Oguz *et al.* (2008) in a histological investigation on graft formation of Nectarine cultivars grafted on to Pixy rootstock revealed that there was a low callus formation in scion as compared to rootstock in 15 days after grafting. In

this study the scion used were in active growing stage which might be the reason of early sprouting and the reserve materials present in the scion were responsible for sprouting. Similar results were also observed by Negi and Upadhyay (2015) when semi-hardwood scions were grafted in September under polyhouse conditions.

The total failure of summer grafting was not observed however, the success rate varied among different dates and it was recorded between 77.78 to 100 percent (Table 1). Hundred per cent grafting success were observed in plants grafted on June 12, 22, July, 1, 15 and 29 and lowest (77.78 %) bud take success was recorded in plants grafted on May 23. Similarly the survival of plants was recorded by just counting the number of grafted plants survived and percentage of survival success was calculated. It was recorded between 89.77 per cent (grafted on May 6) to 100 per cent (grafted on June 6, 22 and July, 9 and 15 respectively) at the end of growing season.

Plant growth and development

The grafted plants had marked difference in plant height and it was noted that plants grafted on June 12 attained maximum (71.71 cm) average height at the end of growing season (Table 2) but was found statistically at par with those grafted on June, 22 and July 1 (66.06 cm and 65.71 cm, respectively). The heights attained by plants grafted on these dates were salable and considered optimum for sale. The maximum plant height gained by plants grafted on these dates may be attributed to early callusing followed by vascular connection with normal metabolic activities. In many studies, workers have elaborated various reasons for growth of scion after grafting like, environmental conditions, physiological stage of the grafting components, method of grafting and stionic combinations of genotypes but in this study method and stionic combination were same only grafting dates were different.

The lateral growths were not pinched off and kept as such till the end of growing season and it was observed that the grafting dates exerted significant effect on number of laterals per plant (Table 2). It varied from no lateral branching to 2.33 branches per plant and was found maximum (2.33 branch/plant) in plants grafted on July, 1 and 9 respectively. Another important growth factor after successful grafting is the internodal length which is directly associated with vigor of the plant. In this study also the plants having maximum growth had more internodal length (Table 2) and it varied from minimum of 1.65 cm to maximum 2.45 cm in plants grafted on July, 29 and June, 12 respectively. Similarly, other growth

Table 1. Effect of different grafting dates on days taken for sprouting, bud take success (%) and survival success (%) under polyhouse conditions

Parameters / Grafting dates	No of days taken to sprout	Bud take success (%)	Survival success (%)
May, 6	17.67	79.17	89.47
May, 23	11.67	77.78	93.65
May, 30	7.67	80.00	95.71
June, 6	10.67	83.33	100.00
June, 12	10.33	100.00	96.83
June, 22	11.00	100.00	100.00
July, 1	8.67	100.00	98.15
July, 9	10.67	80.00	100.00
July, 15	8.67	100.00	100.00
July, 23	11.00	85.71	98.15
July, 29	11.00	10.00	96.30
SEm±	0.51	1.77	2.58
CD(P=0.05)	1.06	3.70	5.62

Figure1. Effect of different grafting dates on bud take success (%) in apple under polyhouse conditions

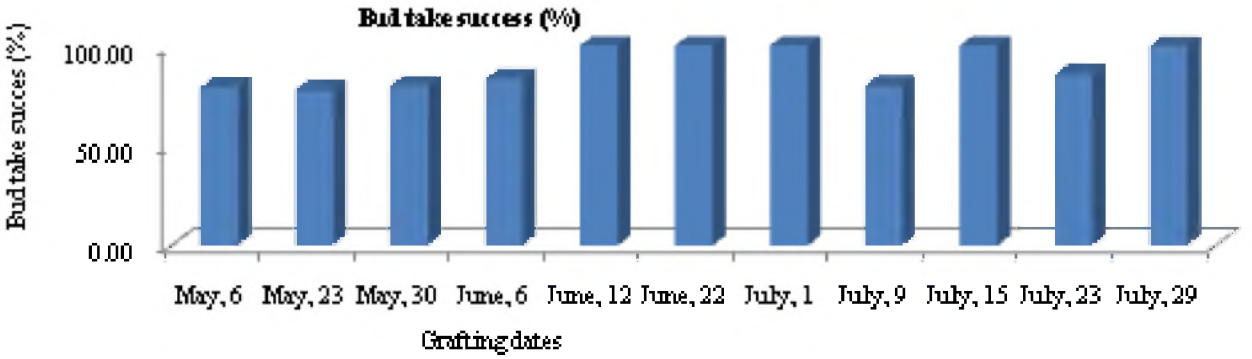
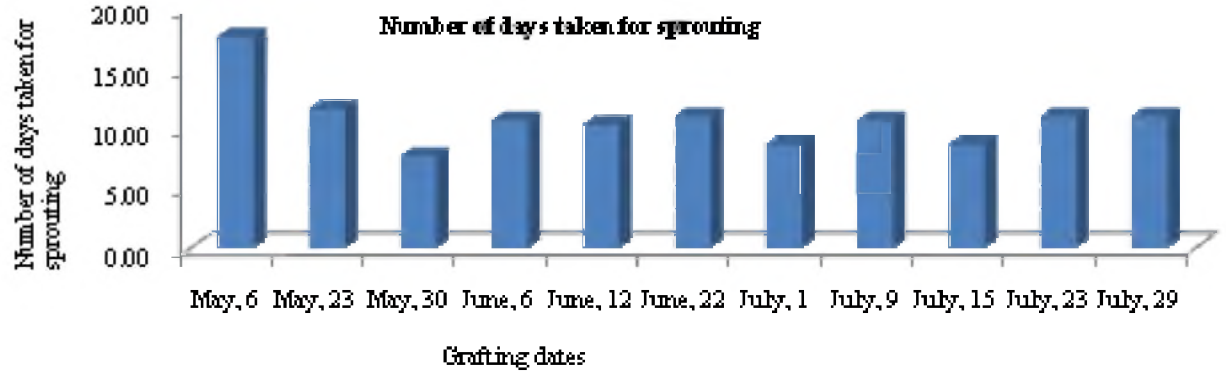


Figure 2. Effect of different grafting dates on time taken for sprouting in apple under polyhouse conditions



parameters like girth of plants above and below graft union also showed significant variation among different grafting dates (Table 2). It has been reported that extreme of difference in plant girth below and above graft union may lead to graft failure or incompatibility by various workers. Shah *et al.* (2017) in budding experiment on stone fruits and Verma *et al.* (2012) in grapes. Hence, it becomes important to record the radial growth of scion and stock and it was found maximum in plants grafted on July 1 (6.90 and 7.17 mm) and minimum in plants which were grafted in July 23 and 29 respectively. However, there was a marked variation in scion and rootstock girth but no abnormal growth was observed at graft unions and wound healing was visible normal without any abnormal gall or knot formation, which was an indication of graft failure as described by Simon *et al.* (2007) in histological evaluation of early graft compatibility in *Uapaca kirkiana* Muell Arg. scion/stock combinations.

After the secession of growth in December, grafted plants were uprooted and representative plants were observed for root growth and development (Table 3). The average root length was recorded 25.85 cm, 25.78 cm and 24.80 cm in plants grafted on June, 12, 22 and in July, 1 respectively in decreasing order and the tongue grafting performed during last week of July had minimum average root length (11.45 cm).The root growth was found more in plants which had vigorous aerial growth with more number of laterals shoots (Table 2).

Foliar characteristics

The foliar status of plants is also an indicator of plant health, and in this study also; these parameters were found significantly influenced by grafting dates based on analysis of variance at 5 % level of significance (Table 3). Number of leaves per plant, leaf area and leaf weight were also found significantly affected by different summer grafting dates. The differences in qualitative and quantitative foliar characteristics in grafted plants with respect to different grafting dates might be due differences in callusing and wound healing duration. However, various workers, while working on different stionic combination in fruit plants had reported that the scion having vigorous growth had more leaf area, internode length and grafted plant height in grapes by Verma *et al.* (2012) in apple, Negi and Upadhyay (2015) and in *Prunus nepalensis* L. by Patel *et al.* (2015).

From the present investigations, it can be concluded that besides grafting in apple during dormant season or early spring it can be successfully grafted during active growing season under polyhouse conditions without giving any pre-conditioning treatments to the scion woods. Tongue grafting in apple during summer months (Second week of June to first week of July) is a viable method to reduce the duration of nursery production time in apple under protected structures in mid-hill areas of Himachal Pradesh provided the availability of scion wood in mother orchards.

Table 2. Effect of different grafting dates on plant height, number of laterals, internode length, radial growth and root length under polyhouse conditions

Parameters / Grafting dates	Plant height (cm)	Number of laterals/plant	Inter node length (cm)	Radial growth (mm)		Root length (cm)
				Above graft union	Below graft union	
May, 6	51.06	1.67	2.10	5.26	6.72	20.25
May, 23	53.71	2.00	2.07	5.53	6.67	21.27
May, 30	50.89	2.00	2.06	5.63	6.81	20.40
June, 6	58.87	2.00	2.06	4.80	6.19	21.30
June, 12	71.17	2.00	2.45	5.51	6.23	25.85
June, 22	66.06	2.00	2.19	4.66	5.19	25.78
July, 1	65.71	2.33	2.22	6.91	7.17	24.80
July, 9	54.75	2.33	2.10	5.22	5.53	21.86
July, 15	38.71	1.33	1.70	4.56	5.17	14.43
July, 23	32.94	1.33	1.83	4.23	5.11	14.00
July, 29	28.35	1.00	1.65	4.97	5.78	11.45
SE m±	2.56	0.48	0.15	0.49	0.57	1.21
CD(P=0.05)	6.53	1.00	0.32	0.83	1.19	2.52

Table 3. Effect of different grafting dates on leaf area, number of leaves and fresh and dry weight of leaf under polyhouse conditions

Foliar characteristics / Grafting dates	Leaf area (cm^2)	Number of leaves /plant	Leaf weight (g)/leaf	
			Fresh	Dry
May, 6	32.32	29.33	5.85	2.59
May, 23	31.14	30.50	5.65	2.43
May, 30	30.20	30.83	6.26	2.59
June, 6	32.87	32.17	4.42	1.85
June, 12	31.75	30.17	7.13	3.09
June, 22	32.77	30.33	6.04	3.14
July, 1	31.96	30.33	8.05	3.53
July, 9	32.92	29.67	4.18	1.78
July, 15	20.63	17.50	3.58	1.58
July, 23	21.42	18.17	3.67	1.59
July, 29	21.77	16.17	4.91	2.13
SE m±	1.74	2.21	1.38	0.56
CD (P=0.05)	3.64	4.72	2.88	1.17

References

Anonymous. 2016. Horticultural Statistics at a Glance 2016. Horticulture Statistics Division, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture GOI.173 p.

Jose M and Valasalakumari PK. 1991. Standardization of technique of epicotyl and softwood grafting in Jack (*Artocarpus heterophyllus*). South Indian Horticulture **39**:164-267.

Leonard P Stoltz and John Strang. 2005. Reproducing fruit trees by graftage: Budding and grafting. UK Cooperative Extension Service. University of Kentucky, Collage of Agriculture.HO-39.1-8.

Madalageri MB, Patil VS and Nalwadi UG. 1991. Propagation of jamun by softwood wedge grafting. My Forest **27**: 176-178.

Malik Mohsin Abbas, Muhammad Afzal Javed, Saeed Ahmad, Naseem Sharif and Mazz Aziz 2013. Studies on different softwood grafting techniques in Jamun, *Euginea jambolana*. Journal of Agricultural Research **51** (2): 169-174.

Negi ND and Upadhyay SK. 2015. Preliminary studies on the semi-hardwood grafting techniques in apple under polyhouse conditions. Himachal Journal of Agricultural Research **41** (2):180-183.

Oguz Dolgun, Ekmel Tekintas F and Engin Ertan. 2008. A histological investigation on graft formation of some nectarine cultivars grafted on Pixy rootstock. World Journal of Agricultural Sciences **4** (5): 565-568.

Patel RK, Basu L, Bidyut C Deka and Deshmukh NA. 2015. Standardization of grafting time and methods in *sohiong* (*Prunus nepalensis* L.): an underutilized fruit under mid hills of meghalaya. Hort Flora Research Spectrum **4** (4): 366-369.

Pujari K H and Magdum M B. 1991.Studies on softwood grafting in sapota.**In**: National Seminar on Optimization of Productivity and Utilization of Sapota, Navasari, Gujarat, Oct., 8-15.

Shah Rafiq Ahmad , Sharma Arti, Wali VK, Parshant Bakshi, Rakesh Kumar and Rucku Gupta. 2017. Response of budding methods and time on bud success and budding growth of peach (*Prunus persica*) on different rootstocks. Indian Journal of Agricultural Sciences **87** (5): 669-676.

Raghavendra VN, Angadi SG , Allolli TB, Venugopal CK and Mummigatti UV. 2011. Studies on soft wood grafting in wood apple (*Feronia limonia* L.). Karnataka Journal of Agricultural Sciences **24** (3): 371-374.

Simon A Mug' omba, Elsa S du Toit, Festusk Akinnifesi and Helena M Venter. 2007. Histological evaluation of early graft compatibility in *Uapaca kirkiana* Muell Arg. scion/stock combinations. Hort Science **42**(3):736-736

Srivastava KK , Singh DB, Dinesh Kumar, Singh SR, Sharma OC and Shiv Lal. 2017. Effect of planting densities and varieties on yield and yield associated characters of apple (*Malus* × *domestica*) on semi-dwarfing rootstock. Indian Journal of Agricultural Sciences **87** (5): 593-596.

Verma SK, Singh SK, Hare Krishna and Patel VB. 2012. Comparative performance of different grafting techniques in grapes cv. Pusa Urvashi. Indian Journal of Horticulture **69** (1):13-19.