REVIEW
OF
LITERATURE
Chapter 2 REVIEW OF LITERATURE

The Present investigation entitled "Effect of Time and Budding Methods in Guava (Psidium guajava L.) Cultivars under Valley Conditions of Garhwal" was carried out during 2005 and 2006 at Horticultural Research Centre, HNB Garhwal University, Srinagar, (Garhwal) Uttarakhand (India). The success of propagation methods, however, depends on the time of budding, prevailing environmental condition and location of experimental site as studied by different researchers. The present review is, thus, an attempt altogether to present the results of the work done on propagation with special references to different budding methods (‘T’ budding, patch budding and chip budding) and time of budding operations and being presented under the appropriate headings in the chapter.

2.1 Effect of time

Khattak et al. (2002) investigated the performance of chip budding in guava cv. Safeda at monthly intervals from 15 April to 15 September and recorded maximum sprouting (81.00%) and survival rate (73.30%) from 15 June operation, while the maximum shoot length (23.3 cm) was obtained with 15 April. While in another study, Aulakh (1998) reported that the maximum percentage of successful plants (95.60%) and shoot length (46.60 cm) was obtained, when patch budding was done of 14 June closely followed by budding on 29 June in guava cv. Allahabad Safeda, whereas the minimum percentage of budded plants (25.00%) and shoot length (18.70 cm) was recorded on 29 July, followed by 15 May.

Mehrotra and Gupta (1984) found that the highest success of budding (70.12%) on guava cv. L-49 was achieved when the seedlings were budded during May, which was closely followed by June (68.75%) and July budding (60.0%). The budding success during May, June and July was at par with each
other but significantly superior to April (43.75%), August (42.50%) and September (33.75%) months. The success was found to be the highest (82.5%) in May, followed by 80.00% in June and the lowest in September (38.80%). Scions were patch budded on 1-year-old seedlings at monthly interval from April, 15 upto September, 15 (Gupta and Mehrotra, 1985). Gautam (1990) reported that summer propagation using veneer grafting in mid July achieved in highest success (90%), followed by patch budding (35%) and chip budding (20%) in walnut at Simla, HP conditions.

Rao et al. (1984) also observed that the June was optimum time for budding of guava in terms of budding success percentage (74.00%), while Pandey et al. (1981) found May to August as the most suitable time for the propagation of ber, however, the highest budding success (90.00%) and the maximum growth of scion (71.90 cm) were obtained with June budding. Pandey and Prasad (1980) also reported that the time of budding affects the success significantly, consequently June budding resulting in higher success (91.97%) followed by May budding.

According to Singh et al. (1976), bael propagation is the best in June and July, being 100%, followed by May by means of patch budding as compared to chip and T- budding. Moreover, the maximum growth of scion (42.9 cm) was also found to be the highest with patch budding done in July.

Patch budding done during the period from May to August gave good success in aonla (63.00% to 98.80%), bael (66.60% to 97.70%) and ber (84.00% to 96.70%), however, in guava April-June appeared to be favourable. Further, lesser time for bud sprouting (19.8 to 37.5 days) was reported during May and June (Dhar and Chaturvedi, 1976). In aonla, cent percent success was found under patch budding method during June, July and August as reported by Nand (1962). Patch budding performed on 2 July took the maximum number of days (25.67) for bud sprouting, whereas annular
budding performed on 19 August took the minimum days (5.67) for bud sprouting was investigated by Komanic (1964) in walnut.

Pathak and Srivastava (1973) obtained 80-90% bud take and 60.00 to 70.00% budding success in the month of July in apple.

Singh and Pandey (1998) reported the best time of guava propagation by patch budding in July with 65.00% success, followed by August (55.70%), whereas, February, March, April, May and June resulted in poor success. Budding performed in June and July significantly reduced the time taken for sprouting and attaining growth suitable for transplanting.

Moti et al. (1976) obtained that the May budding gave the maximum success in guava and aonla, whereas June budding proved to be the best for remaining four fruit crops, i.e; bael, ber, jack fruit and mango. On an average, patch budding done during the period from May to August gave good to high success in aonla (63.00% to 98.80%), bael (66.60% to 97.70%) and ber (84.00 to 96.70%) whereas in guava, April-June appeared to be favourable, with the range of success from 71.6 to 98.30% during 1970 and 1971. On the whole, June budding gave maximum success in all the fruits, except aonla and guava in which May was found to be the optimum. Under Hissar conditions Tripathi and Kumar (2004) found that budding performed during last week of July in bael showed better response with respect to bud take (70.00%), bud sprout (62.20%) and survival (62.20%) followed by second week of August giving 63.30%, 52.20% and 46.60% success, respectively. The maximum length (34.23 cm) and diameter of bud sprout (5.49 mm) after 120 days were achieved during July and September.

Propagation of guava cv. Allahabad Safeda by T-grafting and chip budding was investigated 6 times beginning from April 15 at monthly interval upto September 15 by Khattak et al. (2001). They observed the maximum sprouting (93.33%) in T-grafting on July 15. After a year, shoot length (24.00 cm) was prominent in chip budding and shorter one (17.94 cm) in T-grafting.
The highest success rate (86.7%) was obtained in T-grafting on July 15. Chip budding also gave better survival of budded plants (80.0%) on June 15.

Survival of budded plants shows that July 15 got the maximum success of 81.66%. The second best month was June 15 where 76.66% of success was noted.

In Jamun cv. Paras Local at Junagarh (Gujrat), Chovatia and Singh (2000) observed early bud sprouting in grafted plants (16 days) as compared to budded plants (18.27 days), and the number of days required for bud sprouting decreased from February to July with the minimum days taken in June and July. In additional, budding gave higher success than grafting with the best performance in June- July.

Joolka and Rindhe (2000) discovered that June-July budding has the highest success percent in pecan nut and higher proportion of saleable plants were obtained by chip budding (98.56%) which was attributed to the optimum temperature and relative humidity prevailing during the period and rapid sap flow in stock and scion favouring the healing process.

Ananda et al. (1999) observed the highest percentage of bud-take success (96.25%), linear growth (136.48 cm), and radial growth of scion (8.52 mm) and rootstock (9.83mm) during mid February. While mid- March gave the maximum number of laterals (1.0), whereas the highest number of saleable plants (94.14) was recorded during October month in apple.

The investigation carried out for the determining effect of time of budding on propagation of lasoda by Singh et al. (2003). In this studies, almost all the parameters showed better response to July- August budding than September budding. The highest percentage of budding success at 90 days after budding was recorded at 15 august (95.59%) followed by 30 July (85.33%) and the lowest at 30 September (10.66%). The maximum three sprouts were recorded both at budding on 15 July and 15 August, while budding done on 15 August gave highest sprout length (15.66 cm).
maximum number of leaves per sprout was obtained at 15 July and 15 August (6.33) whereas minimum at 30 September (4.66). Bhullar et al. (1980) reported that the best time of budding in kinnow mandarin was found to be in March, April and October months of the year. The maximum budding success (95.00%) was found in the month of March with patch budding whereas, budding success in April (85.0 to 90.0%) and October (95.0% and 80.0%) was obtained when seedlings were budded by T-grafting.

The findings of the study conducted by Dwivedi et al. (2000) indicate that the 14 and 21 August have given the best results in terms of sprouting (88.30%), bud-take success (81.60%) and linear growth (24.70 cm) in apricot under cold arid condition of Ladakh. The mean radial growth (0.64 cm) was recorded maximum with 7 August while Chandel et al. (1998) found that the maximum mean sprouting (57.00%) and bud-take success (54.00%) were recorded when budding was done on July, 15, whereas the lowest mean sprouting (15.00%) and bud-take success (12.90%) was found on August 30 with T-budding in kiwi. June 15 gave the maximum linear (1.25 cm) and radial growth (0.98 cm) in the same method of budding. Bogdanov (1976) found that the optimum results for the apple cvs. Ural’skoe and Borovinka were obtained when budding was carried out on 25 July and 15 August.

Vegetative propagation of bael by different methods of budding was done at the Fruit Research Station, Basti during July, August, September and October, 1974 and March, April and June, 1975 to find out the most suitable time and method of budding by Singh et al. (1976). The maximum success (100%) was noted in June and July by patch budding. The highest linear growth was observed in July budding (42.90 cm) by this method. Fabourable humid conditions for good success and growth of sprouted buds have been emphasized by Hartmann and kester (1986) in bael.

Shukla et al. (2000) reported the better percent of success (53.33%, 52.10% and 50.99%) in cashew propagation in the month of October, August
and September, respectively. The maximum height (11.83 cm) of the plant was noted in the month of September, while August gave the highest number of leaves (10.19), closely followed by September (10.15), whereas Singh, et al. (1986) noted that budding performed in mid September (T₃) gave the highest percentage of success (95.30%), followed by mid August (92.0%). However, the minimum success was observed in mid October (75.75%), closely followed by mid June (T₁) with 87.50% budding in middle of September (T₃) took significantly less time (5.50 days) to sprout as compared to rest of the months.

Singh and Srivastava (1979) studied the propagation of mango by veneer grafting, budding, air-layering and inarching at the Central Mango Research Station, Lucknow, during 1975 to 1977. More success observed when all the operations were conducted during July and August, whereas November and December months resulted into very poor success. The highest success was achieved in inarching (96.00%), followed by veneer grafting (88-92%), whereas budding gave the lowest success. The study of Bhardwaj and Awasthi (1992) included two methods each of budding (patch and ring budding) and grafting (tongue and veneer grafting) and observed that patch budding in May gave 74.00% bud-take in comparison to 38 and 20 percent in July and August, respectively. Tongue grafting in March gave 80.00% bud-take against 14 and 10% in February and April, respectively. Veneer grafting gave no success, whereas bud-take in ring budding was 10.00%.

2.2 Effect of budding methods

Tripathi and Kumar (2004) proved that the patch budding is the best method for propagation of bael. The maximum bud sprout (62.20%) and survival (62.20%) was obtained when plants were budded by patch budding during last week of July. Kumar et al. (1994) also noted the best propagation method of bael with the maximum sprouting (96.66%) and survival (88.88%) in the month of May. Patch budding done at fifteen days interval by Aulakh
(1998) indicated the highest percentage of successful plants (95.60%), shoot length (46.60 cm) and stem diameter (2.30 cm) under patch budding method in guava cv. Allahabad Safeda. Antoun and Youssof (1979) obtained 90% bud-take with patch budding. As per the findings of Pandey and Prasad (1980) in aonla, patch budding gave the best results than chip and T-budding. The maximum growth of scion (46.80 cm) was recorded under patch budding.

Patch and shield budding at monthly intervals from April to September were compared for cv. Allahabad Safeda on Lucknow-49 seedling rootstocks. Patch budding proved superior, with maximum success (87.50%) in May. Sprouting was also most rapidly in May (18.75 days with patch budding and 23.75 days with shield budding). It looked longest with September budding. In general, patch budded plants were taller than shield budded when measured 45 days after budding (Kaundal et al., 1987). Patch and forkert method of budding and veneer method of grafting were tested in guava by Rao et al. (1984) and they observed the maximum success under patch budding than the forkert budding and veneer grafting. Kaundal and Deol (1990) designated a new method as modified ring budding (MRB), developed to overcome the problem of using different size rootstocks and shoots. This was compared with the overhial patch budding over 2 years using L-49 (Sardar guava) as rootstocks and Allahabad Safeda as the scion. Budding was carried out on the 15th day of the month from April to September. The mean success with MRB was 71.89-75.85% compared with patch budding (63.39 - 64.22%). The highest success with MRB (88.52 - 89.74%) was obtained in May and the lowest in September (52.45 - 60.36%).

In a study carried out by Kuden and Kaska (1991), the highest percentage of bud-take and the maximum length of shoot were reported in chip budding than T-grafting in temperate - zone - fruit nursery plants grown in subtropical areas. Ponchia et al. (1995) also found chip budding to be more successful for apple cvs. Golden Delecious, Fuzi and Florina grafted on M-9
or M-26 rootstocks over other methods used, i.e., triangular grafting, simple cleft grafting and T-budding. Nand (1962) reported that the cent percent success was found under patch budding method in aonla. Patch budding showed the maximum number of days (25.67) for bud sprouting, while annular budding exhibited the minimum days (5.67) for bud sprouting as investigated by Komanic (1964) in walnut and similar findings were recorded by Sharawat (1967) and Lal and Sharma (1986) for propagating walnut.

On comparing chip budding, T-budding and tongue grafting anatomically. Negi and Ananda (1997) revealed that graft union to be smooth with chip budding having rapid and more complete union formation ultimately giving higher percentage of strong saleable plants, while in tongue grafted plants even after infilling of callus between stock and scion, the parenchymatous cells still needed lignifications for proper strengthening of the grafts. Skene et al. (1983) studied the effect of chip budding in various fruit and ornamental trees and found that the chip budding gave a greatly improved bud- take as compared to T- budding further, a superior number and length of laterals in apple cv. Cox and pear cv. Conference, while in Tilia, high bud-take and proportion of tall maiden trees at the end of the following growing season were reported after chip budding compared to ‘T’ budding. Anatomically, the bud take percentage was high in chip budded plants due to the formation of excessive new xylem and better cambial activity as compared to other methods.

Investigation was carried out by Singh and Pandey (1998) to study the relative efficiency of two methods of budding, viz; patch and modified forkert and the best time of budding. It was observed that patch method gave higher success than modified forkert method, in respect of successful bud sprouting (65.00%) and minimum days taken for sprouting (36.10). Singh et al. (1976) noted that the highest percentage of success (72.10%) was found with patch budding in bael propagation, whereas chip budding gave the minimum
percent of success (33.70%). The maximum growth of the scion (25.40 cm) was recorded in patch budding followed by T and chip budding (17.60 and 16.20 cm) respectively.

Joolka and Rindhe (2000) obtained the highest proportion of saleable plants (98.32%) in chip budding, followed by forker t budding (98.32%) in pecan nut. It was the lowest (96.78%) in annular budding. Survival of the budded plants was significantly higher (33.68%) in forker t budding (32.16%), and chip budding had the lowest survival (5.87%). Sharma and Sharma (1981) observed only patch budding to be successful, whereas tongue grafting proved totally unsuccessful. In another study Dass and Melanta (1973) observed that the chip budding was more successful with 79.98 and 66.66% during both the years, respectively.

Negi (1995) obtained the maximum proportion of saleable plants in apple, almond and plum with chip budding, which may be attributed to greater linear and radial growth of grafted plants due to quick union formation, early bud sprouting and longer period of growth as compared to shield and angular budding at Solan condition. Howard (1973) recorded higher bud- take from chip than shield buds. They also reported that longer chip gave a higher percentage of bud- take than small chips or shields. Kuden et al. (1997) obtained more than 70% bud sprouting for both chip budding and whip grafting in temperate fruit crops with the plant height after one year ranging from 91.30 to 118.20 cm for chip budding and 74.50 to 115.20 cm for whip grafting.

Bhullar et al. (1980) observed that the patch budding showed the maximum success of 77.10 (95.00%), followed by T-budding 71.60 (90.00%) while in the month of October T-budding gave same success percent 77.10 (95.00%), with patch budding. Both these methods of budding proved better for bud take as compared to the flute method of budding. They also revealed that the period of August patch budding proved better than other two
methods. In general, patch budding gave better success than shield budding in all the fruits, reported by Moti et al. (1976). The maximum success through patch budding (during 1970) was recorded in aonla and guava (98.8 and 98.3% respectively), whereas the minimum in mango (80.0%). In shield budding, this variation was quite apparent where success ranged from 61.2% in mango to 83.3% in ber. During 1971, results were poor due to early onset of heavy rains.

Ananda et al. (1999) reported that chip budding performed during mid February to be much superior to tongue grafting during March, and T-budding performed during May, June and September in terms of bud-take success, growth of grafts and proportion of saleable plants. The maximum linear growth of scion and stock was obtained with chip budding during mid February and the highest proportion of saleable plants (94.14%) was observed with chip budding during mid February, recorded the second highest (89.16%) proportion of saleable grafts. Whereas after a year of operation Khattak et al. (2001) observed that highest shoot length (24.00 cm) was found prominent in chip budding as compared to T-budding (17.94 cm). In case of propagation methods chip budding gave better survival of budded plants (80.00%), whereas the maximum success rate (86.70%) was found in T-grafting. From economic point of view, chip budding is superior than T-grafting because as it is easy, quick and use of one bud instead of whole shoot in the operation.

Pareek and Purohit (2002) noted that the patch budding in March on Prosopis cineraria (Khejri) rootstock seedlings gave on an average 76% success. Budding success 12.00% and 25.00% was on P. alba and P. nigra, respectively. Sprouting of scion buds started 26-31 days after budding. The length of sprout ranged from 7-85 cm with an average of 25.39cm, and diameter ranged from 0.16-1.59cm (average, 0.608 cm), 4 month after budding.
Dwivedi et al. (2000) found that the highest mean sprouting (88.30%) and bud take (81.60%) in apricot, under cold arid condition of Ladakh, were recorded with shield method of budding done on 21 August, followed by in same method of budding with mean sprouting and bud-take success of 84.90% and 81.60%, respectively done on 14 August. The maximum linear growth (24.70 cm) was also found under shield budding whereas maximum radial growth (0.64 cm) was observed under patch budding.

Chandel et al. (1998) conducted the experiment to standardize the methods and time of grafting and budding in kiwi. The highest mean sprouting (98.00%) and bud-take success (96.00%) were recorded with tongue grafting, followed by chip budding with mean sprouting and bud take success 97.00 and 95.00%, respectively. However, thereafter very less bud-take success was observed in all the methods. The maximum linear (3.02 cm) and radial growth (1.30 cm) of grafts were recorded with chip budding.

Howard and Skene (1974) observed the use of chip budding to grafts four apple cvs. onto a range of commercially important rootstocks in various combinations produced large and more uniform one-year-old plants, with more and large lateral branches, compared with those raised by traditional shield budding using an upright T incision in the rootstock, at both East Malling and Long Ashton Research Stations. Chip budded plants showed the greatest amount of growth and shield budded plants exhibits the least in term of plant height, number of laterals and length of laterals produced.

The experiment was conducted at Field Research Laboratory, Leh, Ladakh, situated at an altitude of 11,50 feet above MSL to study the performance of chip budding in apricot performed at weekly interval from 7 January till 14 March during 1999 and 2000. Chip budding done on 28 February was most successful, resulted in the highest sprouting, bud-take success, linear growth and the maximum yield of saleable plants. Therefore, it
may be recommended for commercial propagation of apricot in cold arid region of Ladakh (Dwivedi et al., 2001).

The study was carried out to standardize the ideal duration and technique of budding for propagation of bael under North Indian conditions. The maximum sprouting and survival was found under patch budding, followed by modified ring method of budding from mid May to June. Whereas shield budding showed poor response at all stages (Pathak et al., 1994). Pathak, et al. (1991) also reported that patch method of budding is the best for large scale multiplication of aonla plants. It was observed that shield budding gave poor success with respect to sprouting and ultimate survival, while patch showed better response, followed by modified ring budding.

A research carried out at Govt. Fruit Nursery Farm, Jabban Dargai Malakand Agency during 2002-2003. Tree scion parts, i.e; apical, middle, basal and two grafting methods, i.e; side veneer and side T- grafting were studied. The maximum grafts take success (77.50%), survival percentage (27.90%) and saleable plants (97.60%) recorded in plants developed from middle scion part, whereas minimum of these parameters recorded by apical scion part. In grafting methods, the maximum scion length (81.80 cm), graft take success (75.00%), survival (34.40%) and saleable plants (95.70%) were observed in plants propagated through side veneer grafting.

Kumar et al. (2004) observed the four methods of propagation, viz; tongue grafting, chip budding, shield budding and annular budding in spur types cvs. of apple, tongue grafting showed maximum linear and radial growth of the scion as well as rootstock. The effect of propagation methods in respect of production of feather, tongue grafting resulted in to the maximum number and length of feather and height of feather emergence in both the cvs., viz.; Redspur and Wellspur. Dwivedi et al. (2000) noted that high success of sprouting (98.70%) was noted with tongue grafting, followed by cleft grafting performed on 7 February on the vegetative propagation of apricot (Prunus
*armeniaca* L.) through grafting in Ladakh. The maximum linear growth (167.00 and 164.00 cm) of the grafted plants also observed in these two methods, respectively, performed on same date.

Budding studies in papaya were conducted at the Fruit Research Farm, Institute of Agricultural Sciences, BHU, Varanasi during 1982, 83, 84 and 1985 to study the relative efficiency of two methods of budding, viz; shield and patch budding. It was observed that patch method of budding gave higher success percentage (31.70, 51.23, 69.98 and 87.63%) during 1982, 83, 84 and 1985, respectively. While minimum success percentage (22.40%) noted under shield budding during 1982. The minimum days taken for sprouting (7.75 days) in patch budding was found during 1985 (Singh *et al.*, 1986).