The Pharma Innovation Journal 2022; 11(6): 1788-1792

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 1788-1792

www.thepharmajournal.com
Received: 09-02-2022
Accepted: 22-05-2022

Ankita Dhiman
Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry Nauni, Solan, Himachal Pradesh, India

Vishal S Rana
Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry Nauni, Solan, Himachal Pradesh, India

Gopal Singh
Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry Nauni, Solan, Himachal Pradesh, India

Shiv Kumar Shivandu
Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry Nauni, Solan, Himachal Pradesh, India

Corresponding Author:
Ankita Dhiman
Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry Nauni, Solan, Himachal Pradesh, India

Differential responses of top working methods for quality scion wood production in apple (*Malus* x *domestica* Borkh.)

Ankita Dhiman, Vishal S Rana, Gopal Singh and Shiv Kumar Shivandu

Abstract
A study was conducted to elucidate the effect of different top working methods for quality scion wood production of apple (*Malus* x *domestica* Borkh.)" in the Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) India in 2019-2020. The experiment was laid out in Randomized Block Design consisting of eleven treatments which were replicated thrice. Three grafting procedures *viz.*, tongue, cleft and bark performed at 1.0 m, 1.25 m and 1.5 m heights and two budding methods *viz.*, T-budding and chip budding done at 1 m height were utilized for evaluation of scion wood quality. The results revealed that the highest graft take success (93.27%), graftable scion wood (52.73%), internodal length, leaf chlorophyll content and number of graftable shoots were obtained in the plants top worked with tongue grafting at 1.25 m height. Whereas, diameter of scion above the graft/bud union were determined to be maximum in the plants top worked with cleft grafting at a height of 1 m. Therefore, top working done using tongue grafting at a height of 1.25 m resulted in maximaum scion wood development in apple.

Keywords: Apple, top working, scion wood

Introduction
Apple (*Malus* × *domestica* Borkh.) is the most ubiquitous crop in temperate areas and has been cultivated in the Asia and Europe from antiquity. It is originated in South West Asia and belongs to the family Rosaceae and sub-family Pomoidae. There are over 6000 regionally important landraces and cultivars across the world, but only few major cultivars dominating worldwide (Janick, 1974) [16]. In India, it was introduced in the middle of the nineteenth century, although it has acquired the position of the most significant temperate fruit with better economic returns. In India, the commercial cultivation of apple is largely confined to the states of Jammu & Kashmir, Himachal Pradesh and Uttarakhand which together account for 99 per cent of the total production (Chadha and Awasthi, 2005) [5]. However, its cultivation has been expanded to the states of Arunachal Pradesh, Sikkim, Nagaland, Meghalaya and Nilgiri hills of Tamil Nadu, where good climatic conditions exist (Singh and Sharma, 2017) [28].
Indian farmers cultivate 3,08,000 hectares of it, producing 27,34,000 metric tonnes annually (Anonymous, 2020a) [1]. Himachal Pradesh is known as the "Apple Bowl" of India because of its extensive horticultural production of apples. After Jammu and Kashmir, it is India's second-largest apple-growing region (Chadda, 2001) [6]. With a yield of 6,43,850 metric tonnes in the districts of Shimla, Kullu, Kinnaur, Sirmour, Lahaul Spiti, and Mandi, it is grown on an area of 1,14,144 hectares (Anonymous, 2020b) [2]. 90% of the apple cultivars grown in Himachal Pradesh belong to the Delicious family (Jindal *et al.*, 1992) [17]. Tongue grafting and T-budding are two of the most common methods of apple propagation in Himachal Pradesh. Many other apple propagation methods have also been tested and found to be successful. Nurserymen in Europe and the United States have adopted the chip budding method for propagating a variety of fruits because it is superior to conventional propagation techniques (Howard *et al*., 1974) [15]. It was in Hungary that Mukred and Hrotko (1989) [22] discovered that apple chip budding yielded the best results. A better upright growth pattern and greater yield were the results of chip budding as opposed to T-budding. Cleft and bark grafting are the two most common methods of grafting (Hartmann *et al.*, 1997) [13]. These two methods are used when the sap begins to flow in the spring. Apple cultivars that have been improved in other countries are currently being imported in large quantities. These cultivars are gaining in popularity among farmers because of their high fruit quality, regular bearing pattern and lower chilling requirements.

As a result, farmers have a strong desire for these cultivars. In addition, the ultimate success of apple orchard production is influenced by a wide range of factors. Superior plant material is required for success. For apples to thrive in the orchard, accurate identification of scion wood from known plants must be obtained and multiplied in order to make it accessible to the average orchardist. The current studies were conducted to determine the impact of top working techniques on the production of apple bud wood.

Material and Methods

The experiment on differential responses of top working methods for scion wood production in apple (*Malus* x *domestica* Borkh.) was conducted at Dr. YS Parmar University of Horticulture and Forestry in Nauni, Solan (H.P.) during 2019-2020. At an elevation of 1250 metres above mean sea level, the experimental apple orchard is located in Himachal Pradesh's zone II, a sub-temperate, sub-humid mid-hill region at latitude 30° 51' North and longitude 76° 11'. East. During the months of May and June, the weather is moderately hot and in December and January, the weather can be extremely harsh. Monsoon rains, which occur from June to September, account for the majority of annual precipitation in the region. A Randomized Block Design was used to set up the study, which consisted of eleven treatments that were replicated three times. Three different grafting techniques, tongue, cleft and bark performed at 1.0, 1.25, and 1.5 metre heights were used in combination with two budding techniques namely, T-budding and chip budding, at a height of one metre in this experiment, respectively. Jeromine was used as a scion which were top worked on Vance Delicious plants. Healthy, uniformly sized plants were used for this study. Scion sticks from the previous year's growth were collected from healthy and bearing trees and used for grafting purpose. At the time of budding, scion wood was collected from the current season's growth. Dehorning was performed on 25-year-old experimental trees in March at three different heights: one metre, 1.25 metres, and one and a half metres. Three grafting techniques were done in March, 2019 and two budding techniques were done in August of that same year. Each treatment was repeated three times in total, for a grand total of eleven treatment combinations. The following are the specifics of the experiment used in the current research:

T_1 = Tongue grafting at 1m height
T_2 = Tongue grafting at 1.25 m height
T_3 = Tongue grafting at 1.5 m height
T_4 = Cleft grafting at 1 m height
T_5 = Cleft grafting at 1.25 m height
T_6 = Cleft grafting at 1.5 m height
T_7 = Bark grafting at 1 m height
T_8 = Bark grafting at 1.25 m eight
T_9 = Bark grafting at 1.5 m height
T_{10} = T-budding at 1 m height
T_{11} = Chip budding at 1 m height

All the cultural procedures *viz*., staking, cutting of the polythene strips, de-suckering, watering, basin preparations, weeding etc., were done consistently in the designated experimental apple orchard. The data on graft/bud-take success (per cent), time taken for initiation of sprouting (days), internodal length (cm), leaf chlorophyll content (SPAD units), diameter of scion above graft/bud union (mm), number of non-graftable shoots, number of graftable shoots and graftable scion wood (percent) were recorded. Graft/bud-take success (per cent) was measured by method offered by Rafikul (2013) [23] and leaf chlorophyll content was recorded with Minolta SPAD-502 Chlorophyll meter. SPAD-502 is a simple, portable diagnostic tool which measures the relative chlorophyll contents of leaves with substantial time saving (Marquard and Tipton, 1987) [19]. The data collected from the experiments was calculated, evaluated and submitted to statistical analysis, where applicable, using the standard approaches as outlined by Gomez and Gomez (1984) [12]. Five per cent level of significance was applied to analyse different factors.

Results and Discussion

The data illustrated in Figure 1 that various top working methods had a substantial influence on graft/bud take success and graftable scion wood in apple. The highest graft/bud take success (93.27%) was achieved in treatment tongue grafting at 1.25 m height (T_2), which was statistically superior to all other treatments. While, the lowest graft/bud take success (69.37%) was reported in bark grafting at 1.5 m height (T_9), which was determined to be statistically at par with cleft grafting (75.48%) at 1.25 m height (T_6). The highest success gained by tongue grafting at a height of 1.25 m was attributable to the fact that tongue grafting was conducted on secondary shoots. The shoots utilized for top working were having pencil thickness. Thus, there was perfect interlocking between scion and stock leading in cambium matching and higher graft take success. These results are in agreement with the findings of Gautam and Banyal (2003) [10] who observed highest success in top working of walnut when tongue grafting was done on one-year old forced shoots. Dwivedi *et al.,* (2000) [9] also documented maximum graft success by tongue grafting technique in apricot. They reported superiority of tongue grafting over other methods, which might be because of favourable temperature and relative humidity prevailing during the period following grafting and rapid flow of sap in stock and scion which might have favoured the healing process and established the continuity of cambial and vascular tissues for better graft take. Similar results were previously reported by Bhardwaj (1983) [3], Mehta *et al.,* (2018) [20], Sharma and Dhillon (1981) [27] and Srivastava *et al.,* (2007) [29]. It was also noted that grafting effectiveness depended on appropriate alignment of parenchymatous tissues of both scion and stock and the expertise of grafters (Mng'omba *et al.,* 2010) [21]. Adequate aeration and auxins have a vital role in callus production and grafting success as described by (Rongting and Pinghai, 1993; Vahdati, 2000; Hartmann *et al.,* 2007 and Rezaee and Vahdati, 2008) [25, 30, 14, 24].

It is illustrated from Figure 2 that top working done using tongue grafting at 1.25 m height (T_2) led to the largest percentage of graftable scion wood (52.73 per cent), which was statistically at par with tongue grafting (51.14 per cent) at 1 m height (T_1) and tongue grafting (50.37 per cent) at 1.5 m height (T_3). However, the lowest percentage of graftable scion wood (38.94 per cent) were obtained in the plants top worked using cleft grafting at 1.5 m height (T_6) and was found to be statistically at par with cleft grafting (42.01 per cent) at 1.25 m height (T_5) and bark grafting (40.66 per cent) at 1 m height (T_7). These results are in conformity with the findings of Godeanu *et al.,* (2001) [11] who observed a positive association between the number of scion wood and the length and diameter of the mother branch. Similar findings were also achieved by Li *et al*., (1995) [18] who also reported increase in bud wood output owing to a larger number of shoots and increased shoot length.

The data depicted in Table 1 shown that various top working techniques significantly influenced the time taken for initiation of bud sprouting. The minimum days for initiation of bud sprouting was observed with chip budding (30.00 days) at 1 m height (T_{11}) which was found to be statistically at par with T-budding (32.67 days) at 1 m height (T_{10}). The maximum days for initiation of bud sprouting was observed with cleft grafting (51.33 days) at 1.5 m height (T_6) which was statistically at par with cleft grafting (48.33 days) at 1 m height (T_4), cleft grafting (51.33 days) at 1.25 m height (T_5) and bark grafting (48.67 days) at 1.25 m height (T_8). The results revealed that the minimum time for initiation of bud sprouting under budding methods may be due to the fact that in the month of August there are more rains and the water is helpful for cell enlargement and required for callus bridge formation (Zenginbal and Dolgun, 2014) [32]. These findings are in conformity with those of Dimri *et al*., 2005 [8] who reported budding done in July took minimum time for sprouting.

Maximum internodal length (2.55 cm) was recorded in the treatment T_2 *i.e.* tongue grafting at 1.25 m height which was substantially greater than all other treatments. Whereas, minimum internodal length (2.03 cm) was recorded in the treatment T-budding at 1m height (T_{10}) which was statistically at par with chip budding (2.09 cm) at 1 m height (T_{11}).

A perusal of data presented in Table 1 revealed that the leaf chlorophyll content in terms of SPAD value was significantly affected by various top working techniques in apple. Maximum leaf chlorophyll value (38.92) was obtained in the plants top worked by using tongue grafting at 1.25 m height (T_2), which was statistically at par with tongue grafting (35.67) at 1 m height (T_1), tongue grafting (36.65) at 1.5 m height (T_3), T-budding (33.87) at 1 m height (T10) and chip budding (37.30) at 1 m height (T_{11}). While, the least leaf chlorophyll value was reported in bark grafting (24.13) at 1.25 m height (T_8). Carmen *et al.*, (2009) [9] observed that grafting boosted net photosynthetic rate which resulted in assimilate accumulation and therefore, increased the growth capability in stems and leaves. He further observed that grafting also improved stomatal conductance and intercellular CO_2 concentration which strengthened the transfer capability of photosynthates and supply capability of photosynthetic materials to ensure increased photosynthetic efficiency and thus resulted in higher chlorophyll content in citrus.

Data presented in Table 2 depicted that the plants top worked with cleft grafting at 1 m height (T_4) recorded the maximum diameter of scion above graft/bud union (19.41 mm), which was statistically at par with cleft grafting (17.36 mm) at 1.25 m height (T_5). Whereas, T-budding at 1 m height observed the minimum scion diameter (*i.e.* 9.27 mm) (T_{10}) which was found to be at par with tongue grafting (11.75 mm) at 1.25 m height (T_2) and chip budding (10.17 mm) at 1 m height (T_{11}). The study found that cleft grafting produced thicker shoots, which may be due to the larger diameter and higher food reserves of the branches used in cleft grafting, both of which resulted in a larger scion diameter. These findings are in line with those of Singh and Sharma (1979) [26], who found that increasing stock diameter led to larger scion diameters in peaches.

From Table 2 it is shown that the maximum number of non-graftable shoots was achieved with bark grafting (244.00) at 1.25 m height (T_8), which was at par with cleft grafting (238.33) at 1 m height (T_4). Whereas, minimum number of non-graftable shoots (15.33) were reported in the plants top worked with T-budding at 1 m height (T_{10}), which was statistically at par with chip budding (20.33) at 1 m height (T_{11}). Maximum number of standard graftable shoots (4-8 mm) was obtained with tongue grafting (248.00) at 1.25 m height (T_2), which was found to be significantly greater than all other treatments. Whereas, minimum number of graftable shoots (14.00) were reported in the treatment T_{10} *i.e.* T-budding at 1 m height which was statistically at par with chip budding (18.33) at 1 m height (T_{11}). The highest pruning weight (2.89 kg/tree) was observed in treatment T_2 *i.e.* tongue grafting at 1.25 m height, whereas the lowest pruning weight was obtained with chip budding (0.19 kg/ tree) at 1 m height (T_{11}) which was statistically at par with T-budding at 1 m height (T_{10}) *i.e.* 0.50 kg/tree.

On the basis of the data obtained in the current research, it can be stated that various top working treatments had substantial influence on the quality bud wood formation in apple. Among the several treatments, top working performed using tongue grafting method at a height of 1.25 m offered the greatest results in regard of graft/bud-take success, internodal length, leaf chlorophyll content, number of graftable shoots and graftable scion wood. Whereas, cleft grafting conducted at a height of 1 m resulted in maximal diameter diameter of scion above graft/bud union.

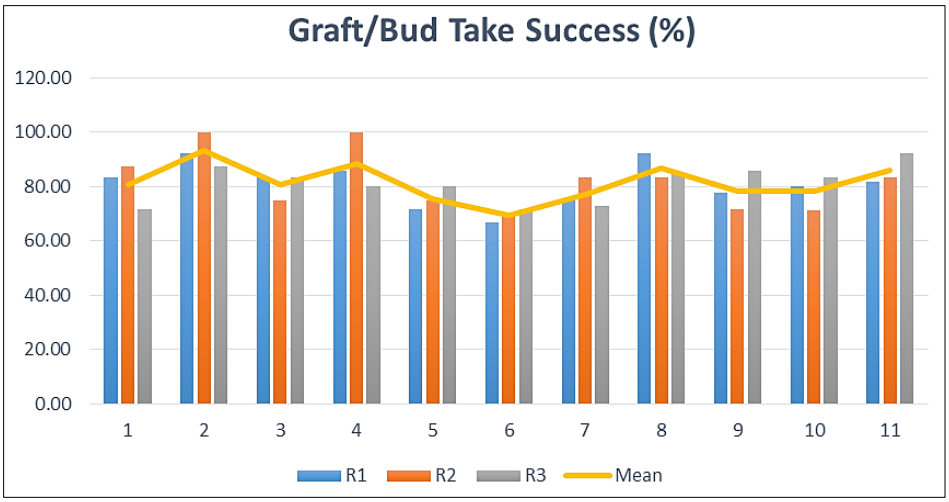

Fig 1: Effect of top working methods on graft/bud take success (%) in apple

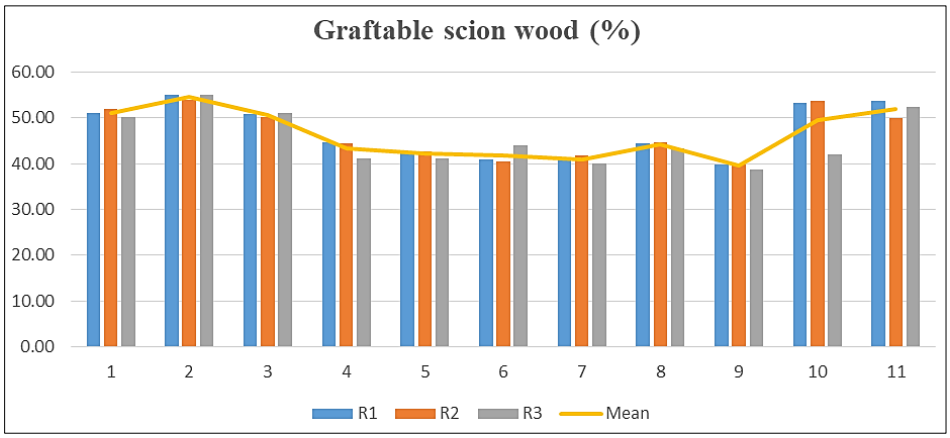

Fig 2: Effect of top working methods on graftable scion wood (%) in apple

Table 1: Effect of top working methods on time taken for initiation of sprouting, internodal length and total chlorophyll content in apple

Treatment	Tree part used	Time taken for initiation of sprouting (days)	Internodal length (cm)	Chlorophyll content (SPAD value)
T_1: Tongue grafting at 1 m	Shoots	43.10	2.50	35.67
T_2: Tongue grafting at 1.25 m	Shoots	40.67	2.55	38.92
T_3: Tongue grafting at 1.5 m	Shoots	42.33	2.43	36.65
T_4: Cleft grafting at 1 m	Trunk	48.33	2.44	28.67
T_5: Cleft grafting at 1.25 m	Trunk	44.67	2.42	28.44
T_6: Cleft grafting at 1.5 m	Trunk	51.33	2.40	26.81
T_7: Bark grafting at 1 m	Trunk	44.33	2.36	25.94
T_8: Bark grafting at 1.25 m	Trunk	48.67	2.49	29.48
T_9 (bark grafting at 1.5 m	Trunk	44.33	2.37	24.13
T_{10}: T-budding at 1 m	Scaffolds	32.67	2.03	33.87
T_{11}: Chip budding at 1 m	Scaffolds	30.00	2.09	37.30
$CD_{(0.05)}$		6.58	0.19	3.93

Table 2: Effect of top working methods on diameter of scion above graft/bud union, number of non-graftable shoots, number of graftable shoots pruning weight (kg/tree)

Treatment	Diameter of scion above graft/bud union (mm)	Number of non-graftable shoots	Number of graftable shoots	Pruning weight (kg/tree)
T_1: Tongue grafting at 1 m	14.34	204.00	213.67	2.56
T_2: Tongue grafting at 1.25 m	11.75	222.33	248.00	2.89
T_3: Tongue grafting at 1.5 m	12.48	180.00	182.67	2.24
T_4: Cleft grafting at 1 m	19.41	238.33	182.00	2.68
T_5: Cleft grafting at 1.25 m	17.36	214.67	155.33	2.31
T_6: Cleft grafting at 1.5 m	15.94	206.67	131.67	2.07
T_7: Bark grafting at 1 m	15.81	215.00	147.33	2.28
T_8: Bark grafting at 1.25 m	14.23	244.00	190.00	2.72
T_9 (bark grafting at 1.5 m	11.90	211.00	143.67	2.22
T_{10}: T-budding at 1 m	9.27	15.33	14.00	0.50
T_{11}: Chip budding at 1 m	10.17	20.33	18.33	0.19
$CD_{(0.05)}$	2.52	10.58	8.77	1.19

Acknowledgements

Authors are highly thankful to the facilities and funds provided by Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan 173 230 (H.P.) India.

References

1. Anonymous. Area and Production estimates for Horticulture Crops. National Horticulture Board, Gurgaon, 2020a. http://www.nhb.gov.in.
2. Anonymous. Horticultural Statistics at a Glance. State Department of Horticulture. Government of Himachal Pradesh, 2020b. http:/www./hpagrisnet.gov.in.
3. Bhardwaj KN. Standardization of vegetative propagation techniques in pecan nut (*Carya illionensis*). Thesis Abstracts, Haryana Agricultural University. 1983;9:65.
4. Carmen MG, Liosa MJ, Antonio Q. Rootstock effects on leaf photosynthesis in „Navelina‟ trees grown in calcareous soil. HortScience. 2009;44:280-283.
5. Chadha KL, Awasthi RP. Apple: Improvement, Production and Post-harvest management. Malhotra publishing house, New Delhi, 2005, 1p.
6. Chadha KL. Apple In: Handbook of Horticulture. Council of Agriculture Research, New Delhi, 2001, 119p.
7. Chauhan A, Dwivedi MP, Tomar CS. Effect of different methods and dates of grafting on per cent bud take and growth of apricot plant. Scientific Horticulture. 2000;9:73-77.
8. Dimri DC, Petwal A, Kamboj P. Determination of

optimum time for chip budding in apple cv. Red Fuji. Acta Horticulturae. 2005;696:173-176.
9. Dwivedi SK, Singh B, Paljor E. Studies on vegetative propagation of apricot (*Prunus armeniaca* L.) through grafting in Ladakh. Indian Journal of Horticulture. 2000;57:39-41.
10. Gautam DR, Banyal A. Studies on top working techniques in walnut (*Juglans regia* L.) trees. M.Sc. Thesis. Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan, 2003, 45p.
11. Godeanu I, Cosmulescu S, Baciu A. Research concerning the influence of pruning applied to mature walnut trees for obtaining quality scion wood. Acta Horticulturae. 2001;544:495-502.
12. Gomez KA, Gomez AA. Statistical procedures for agricultural research. John Wiley and Sons Inc, New York, 1984, 680p.
13. Hartmann HT, Kester DE, Davies FT, Geneve RL. Plant Propagation: Principles and Practices. 6th ed. Prentice Hall of India Pvt. Ltd., New Delhi, 1997, 532p.
14. Hartmann HT, Kester DE, Davies FT, Geneve RL. Plant Propagation: Principles and Practices. 7th ed. Prentice Hall of India Pvt. Ltd., New Delhi, 2007, pp. 199-248.
15. Howard BH, Skene DS, Coles JS. The effect of different grafting methods upon the development of one-year old nursery apple trees. Journal of Horticultural Science and Biotechnology. 1974;49:287-295.
16. Janick J. The apple in Java. HortScience. 1974;9:13-15.
17. Jindal KK, Kakara BK, Sharma VK, Uppal DK. Apples. In: Emerging trends in temperate fruits production in India (Chadda KC, Uppal DK, Pal RN, Awasthi RP and Ananda SA eds). NHB Ted Communication, Gurgaon, India, 1992, pp. 39-94.
18. Li ZQ, Sun GM, Zhang GS, Yang SW, Lu YX. Study on the top working techniques for apple trees. China Fruits. 1995;4:8-11.
19. Marquard RD, Tipton JL. Relationship between extractable chlorophyll and an *in situ* method to estimate leaf greenness. HortScience. 1987;22:327-346.
20. Mehta G, Kumar D, Bakshi P, Wali B, Jasrotia A, Bushan J, *et al*. Standardization of method and time of grafting on pecan (*Carya illinoensis*) under intermediate agro-climatic conditions. Indian Journal of Agricultural Sciences. 2018;88:104-107.
21. Mng‟omba SA, Akinnifesi FK, Sileshi G, Ajayi OC. Rootstock growth and development for increased graft success of mango (*Mangifera indica*) in the nursery. African Journal of Biotechnology. 2010;9:1317-1324.
22. Mukred A, Hrotkó K. A szemzési mód hatása az oltványnevelés kihozatali arányaira és az oltványok minóségére. Kertgazdaság. 1989;2:13-19.
23. Rafikul I. Effect of scion diameter on grafting success, survivability and growth of different mango varieties. Mymensingh: Bangladesh Agricultural University, 2013.
24. Rezaee R, Vahdati K. Introducing a simple and effective procedure for top working Persian walnut tree. Journal American Pomological Society. 2008;62:21-26.
25. Rongting X, Pinghai D. A study on the uniting process of walnut grafting and the factors affecting. Acta Horticulturae. 1993;311:160-170.
26. Sharma HC, Singh R. Vegetative propagation of peach under subtropical conditions. Punjab Horticultural Journal. 1979;19:53-55.
27. Sharma RC, Dhillon BS. Grafting peach in October. Indian Horticulture. 1981; 26:26-27.
28. Singh PN, Sharma R. Relative performance of chip and T-budding over tongue grafting in peach (*Prunus persica* (L.) Batsch) cv. Shan-e-Punjab. M.Sc. Thesis. G.B. Pant University of Agriculture and Technology, Pantnagar - 263145 (Uttarakhand) India. 2017.
29. Srivastava KK, Sharma AK, Sharma MK, Khalil A. Standardization of budding time and methods in pecan. Haryana Journal of Horticultural Sciences. 2007;36:55-56.
30. Vahdati K. Walnut situation in Iran. Nusis Newsletter. 2000;9:32-33.
31. Zenginbal H, Ozcan M, Demir T. An investigation on the propagation of kiwifruit (*Actinidia deliciosa* A. Chev.) by grafting under Turkey ecological conditions. International Journal of Agricultural Research. 2006;1:597-6.
32. Zenginbal H, Dolgun O. Determining of suitable graft method for apple propagation in cool climate and high altitude conditions. International Journal of Agriculture, Forestry and Fisheries. 2014;2:53-59.