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STANDARDIZATION OF FOUR FLAP (BANANA GRAFT) PROPAGATION TECHNIQUE IN PECAN NUT (*CARIYA ILLINOINENSIS* W.)

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ABSTRACT

Pecan nut (*Carya illinoinensis* W.) is one of the most difficult nut fruit species to propagate. Long juvenile stage, hard shelled nature of seed and poor success rate has been the major concerns in pecan nut production in the world. The aim of this experiment was to standardize the pecan nut propagation technique for production of elite planting material in summer season to overcome the problems of success rate and to lessen the long juvenile period of 10-12 years. The study was conducted to determine the effect of four flap or banana grafting technique in conjugation with different grating time, *viz*., 2nd week of May, 3rd week of May, 4th week of May and 1st week of June. The highest graft success (86.33%), survival per cent (94.66 %) and marketable plant percentage (100.00 %) were recorded in the treatment T_3: FFG + 4th week of May. While, the growth parameters *viz*., shoot length, shoot girth, number of leaves and leaf area recorded were 88.20 cm, 3.83, 12.13mm, 21.66 and 287.48 cm^2 respectively, also in the same treatment T_3: FFG + 4th week of May.

Key words : Pecan nut, Four flap (banana graft), Time, Propagation.

Introduction

The production and consumption of nuts are increasing in the world due to strong economic returns and the nutritional value of their products (Vahdati *et al*., 2021). Pecan [*Carya illinoinensis* (Wangenh.) K. Koch], is an economically important nut crop native to North America, which is now cultivated widely in the world (Janick and Paul, 2008). The Carya genus has approximately 25 species, in which Carya illinoinensis represents the most economically viable nut crop (Casals *et al*., 2018). It is considered as the "Queen of Nuts" because of its value both as wild and cultivated nut (Woodroof, 1979). Other major producers of pecans include Mexico, Australia, South Africa, Asia, Brazil, Peru, Argentina, Israel, and Egypt (Janick and Paul, 2008). The crop has wider geographic and climatic adaptability. In India, pecan nut is grown throughout the Himalayas up to Assam and Meghalaya at an altitude of 1500 to 2500 m amsl (Ravindran *et al.*, 2008). Jammu and Kashmir is currently the largest pecan producer in India (Anonymous, 2022). Pecan requires 240 to 280 days growing under warm climate with a mean temperature of above 26.70 C (Naira *et al*., 2013) and chilling about 600 hrs (Lagarda, 1987). The majority of the trees being grown at present are of seedling origin, which has a long pre-bearing age, highly variable nut size and quality (Jhoolka *et al*., 2001), as a result, at present, the pecan nuts are growing mostly as scattered trees rather than planned regular plantations. Grafting success is affected by choice of cultivar and selection, rootstock quality (Mitrovic *et al*., 2008), time of scion wood collection (Mitrovic, 1995) and date and method of grafting (Wani *et al*., 2017). The primary requisite necessary for profitable and commercial cultivation of pecan seems to be the production of elite

plant material of improved varieties through vegetative propagation. In Pecan propagation there has been important improvements over the years using tissue culture and cuttings (Vahdati *et al*., 2020). However, the commercial Pecan industry is still dependent on vegetative propagation by grafting and budding. Pecan nut is one of the most difficult nut fruit species to propagate (Casales *et al*., 2018). Long juvenile stage, hard shelled nature of seed and poor success rate has been the major concerns in pecan nut production (Thompson and Grauke, 2003). In addition, the seedling tree accounts for much of the variation in tree performance, as each seed from an individual tree is not identical to the parent and considerable amount of variation in rootstock, even from seed arising from the same parent tree (Wells, 2014). Pecan is a highly heterozygous out-crossing species, which shows wide variation in nut and tree quality when propagated from seed (Sparks, 2005).

Open-pollinated half-sib populations existed until clonal propagation of superior genotypes led to the widespread use of true cultivars through the improvement of budding and grafting techniques. The propagation techniques mostly used to produce elite quality plant material are: rooting of cuttings, micro-propagation, layering, grafting and budding methods etc. Improved pecan cultivars are propagated by grafting or budding onto a rootstock (Grauke and Starr, 2014). Grafting and budding provide a success rate of more than 75% (Nesbitt *et al*., 2002 and Mir *et al.*, 2022). However, different reasons that may have an influence on graft success: inherent system of cellular incompatibility, formation of plasmodesmata, vascular tissue connections, and the presence of growth regulators and peroxidases (Pinna and Errea, 2005). As with many practices related to pecan production, timing is important for successful propagation (Wells, 2014). Four flap or banana grafting technique provides an opportunity to exploit the spring season in between the dormant and summer. The four flap or banana graft is the easiest graft to perform with a high success rate because it allows more cambium contact than other grafts (Wells, 2014). To cultivate pecan at a large scale, the immediate priority is to standardize the easy methods of reproduction of plants to produce the elite planting material of improved pecan cultivars for enhance the quality yield of pecan nut in a Western Himalayas of India. The main goal of this experiment was to standardize the pecan nut propagation technique in summer season to overcome the problems of success rate.

Materials and Methods

Experimental site

The experiment was conducted in the field of Fruit Plant Research Station Poonch, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Jammu & Kashmir, India, over a period of two consecutive years during 2022 and 2023. The experimental site is located in the highlands of the Southern Himalayas of Pir-Panchal region of Jammu & Kashmir state, within the line of latitude (33.766987) and the longitude (74.092468), while the altitude ranges from 1850 m amsl. The soil reaction of the steady area was slightly acidic (pH value: 6.65) with a sandy loam texture. High summer and low winter temperatures are characteristic and the mean annual cloudiness is about 8 (octa). Since temperature and relative humidity have crucial effects on the healing process, they were recorded during the experiment (Fig. 3). Pir-Panchal region has a continental rainfall regime 1200-1400 mm with 56-73 average rainy days and the vegetation period is characterized by dry and rainy periods of different durations and intensity, with more rain in May-July and then slightly less in August. In the warm part of the year, there is plenty of summer rain, and occasionally hail, but the snow cover in winter is not thick, and often in winter there is no snow.

Experimental details

Collection and storage of scion wood

Stored graft-wood is pre-required for several grafting methods, unless the wood is collected and stored properly, the grafting endeavor is destined for failure (Wells, 2014). Scion wood used for four flap (banana) grafting technique was collected during the dormant stage from the pecan nut trees of varieties (Mahan and Nelish) from mother block in Fruit Plant Nursery, Poonch, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, (J&K), India. It is important to collect scion wood stock to match during the grafting, because it is especially important when using the four-flap grafting technique. By mid-January, vigorous one-year (current season) graft-wood ranged from 1/4 to 1/2 inches in diameter, healthy grayish green in color with plump, prominent, well developed buds from the desired variety was collected. To keep alive and healthy, scion wood was packed in one gallon zipper top air tight polythene bags with cut ends painted with chaubatia paste to avoid desiccation. The graft-wood was moist during collection and was not required additional moisture in the airtight bag, as the dry wood is the chief cause of propagation failure. Scion wood was normally cut into 12-18 inches, labeled carefully to

avoid errors in identification.

Scion wood collected was stored in an ordinary house hold refrigerator with the temperature of 30 F to 38 F, until they were used in grafting. Graft-wood was placed in a small ice chest during grafting and put back in storage when finished for the day. Entire experiment comprised of four flap grafting method was considered as the first factor and four contrasting grafting time: 2nd, 3rd, 4th week of May and 1st week of June, was chosen as the next factor in the research. The experiment was structured completely randomized block design (RCBD), constituted four treatments which are mentioned in Table 1. The treatment combinations used in the study were, T_1: FFG + 2nd week of May; T_2: FFG + 3rd week of May; T_3: FFG + 4th week of May and T_4: FFG + 1st week of June. Results were calculated and expressed in percentage basis. Percentage of successful grafts of individual treatment was calculated by using the following formula.

$$\text{Per cent success} = \frac{\text{Number of plants sprouted}}{\text{Number of plants propagated}} \times 100$$

The number of survival grafts in each treatment was recorded at the end of growing season. Results were calculated and expressed in percentage basis. Percentage of successful survival grafts of individual treatment was calculated by using the following formula.

$$\text{Per cent survival} = \frac{\text{Number of plants survived}}{\text{Number of plants propagated}} \times 100$$

Statistical analysis

Statistical analyses between groups were made by One-way ANOVA followed by Least-significant difference (*LSD*) using SPSS version 13.0 program for Windows (*SPSS*, Chicago, IL, USA). The significance of the difference between the means of the examined characteristics was tested using the Duncan test for significance at $P < 0.05$

Grafting procedure

Four flap grafting was done by the procedure given by Carroll (2017). The rootstocks used were healthy two years old seedling. All lateral growth on the stock to about 6 inches was removed and the rootstocks were cut straight across with sharp pruning shears. Flat cuts were made through the bark on four sides of the scion, beginning 1 to 2 inches from the bottom end. Small light weight rubber band was put around the stock 3 to 4 inches below to maintain moderate pressure on the stock. The grafting was done at a height of 45 to 60 cm from the ground, on a selected point of the rootstock without damage and no bud scars. Grafting was conducted in spring season when the bark separates (slips) freely from the rootstock. Grafts were tied with electrical tape followed by aluminum foil. The whole scion wood was covered by polythene bag to maintain the humid environment for bud forcing.

Results and Discussion

Table 1 : Treatment details of the standardization of four flap (banana graft) propagation technique in pecan nut (*Cariya illinoinensis* L).

Grafting method	Time of grafting
T_1: Four flap grafting (FFG)	2nd week of May
T_2: Four flap grafting (FFG)	3rd week of May
T_3: Four flap grafting (FFG)	4th week of May
T_4: Four flap grafting (FFG)	1st week of June

Days to bud burst

The statistical analysis of data showed a significant variation of various active factors for days taken to sprouting (Table 2). The minimum number of days (22.33) taken to bud burst were recorded with treatment T_3: FFG + 4th week of May, followed by T_2: FFG + 3rd week of May. While, the maximum number of days (35.10) taken to bud burst were recorded under treatment T_1: T_1: FFG + 2nd week of May. The earlier bud bursting might be due to regenerating ability of plant which is found higher in younger scion wood combined with translocation continuity of water and nutrients and this could be due to higher meristimatic activity of cells in younger scion and stock resulting in faster callus formation and quick healing of graft union that enhance bud bursting. These results are in agreement with (Mir and Kumar, 2011 and Bhat *et al*., 2021) in walnut.

Callus quality

Callus formation was significantly influenced during the different grafting timings (Table 2 and Fig. 1). Higher callus formation was observed under the treatment T_3: FFG + 4th week of May, followed by T_2: FFG + 3rd week of May. However, the lower callus formation was recorded in the treatment T_1: T_1: FFG + 2nd week of May. It might be due to temperature and humidity had a pronounced effect on the production of callus tissue, which is essential for good graft union formation (Hartmann *et al*., 2001; Karadeniz, 2005; Vahdati and Zareie, 2006). These results are in conformity with Erdogan (2006), who reported that ideal temperature for callus formation is 26^0 C resulted in higher graft success.

Graft success

From the perusal of data (Table 1 and Fig. 3), significant difference was observed for graft success performed by four flap of grafting in conjugation with different time of grafting. Maximum grafting success

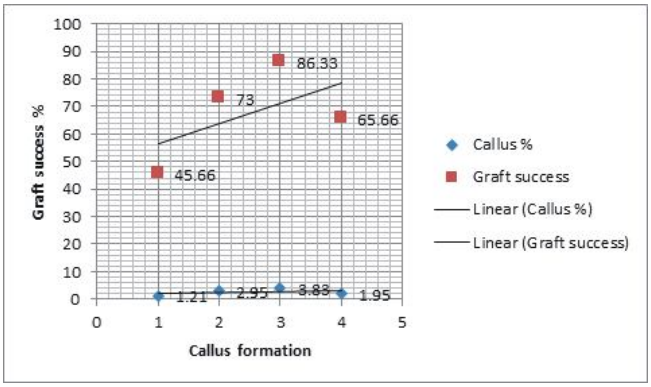

Fig. 1 : Correlation between callus formation v/s graft success in pecan nut.

Fig. 2 : Four flap grafting success of pecan nut.

(86.33%) was recorded in the treatment T_3: FFG + 4th week of May, followed by T_2: FFG + 3rd week of May. However, minimum success (45.66%) was recorded in the treatment T_1: FFG + 2nd week of May. The high degree of success with the four flap graft can be attributed to the large amount of contact between the cambium of the rootstock and scion (Well, 2014). This cambium contact is necessary for callus formation and subsequent successful graft union (Carroll, 2017). Whereas most grafting techniques only allow for the cambiums to connect at two locations, the four flap allows eight opportunities for cambium contact with each graft. Therefore, a precise cut and fit is less critical with the four flap graft. These results are in agreement with those of Stafne (1914) and Carroll (2017), who reported that the maximum graft success during the month of May and due to heat, grafting season usually ends by early June. Similar results were reported by Hartman *et al*. (2001), who reported that the high degree of success with the four flap graft can be attributed to the large amount of contact between the cambium of the rootstock and scion, as the four-flap allows eight opportunities for cambium contact with each graft.

Table 2 : Effect of four flap (banana) grafting method and time of grating on growth, callus quality, graft success and marketable plants in pecan nut.

Treatments	Days to bud burst	Shoot length (cm)	Callus quality*	Shoot girth (mm)	No of leaves	Leaf area (cm^2)	Graft success (%)	Survival (%)	Marketable plants (%)
T_1	35.10^b	55.33^b	1.21^c	8.21^b	14.10^b	210.23^b	45.66^b	82.20^b	80.30^c
T_2	26.36^c	66.20^c	2.95^b	10.40^c	19.35^b	256.73^b	73.00^b	88.25^b	90.24^b
T_3	22.33^a	88.20^a	3.83^a	12.30^a	21.66^a	287.48^a	86.33^a	94.66^a	100.00^a
T_4	28.15^b	62.00^c	1.95^c	9.33^b	17.42^b	232.25^b	65.66^c	73.10^c	82.33^c

1. *Values are means of callus scoring ratings from 1 (low callus) to 4 (very good callus).
2. Means with different letters in each column are significantly different at $P \leq 0.05$.

Growth parameters

The results showed that the four flap grafting method in conjugation with different grafting time had significantly different effects on growth parameters like shoot length, shoot girth, number of leaves and leaf area (Table 2 and Fig. 2). The highest shoot length, shoot girth, number of leaves and leaf area recorded were 88.20 cm, 3.83, 12.13mm, 21.66 and 287.48 cm^2, respectively, in the treatment T_3: FFG + 4th week of May. Highest shoot length might be due to early bud burst and rapid uptake

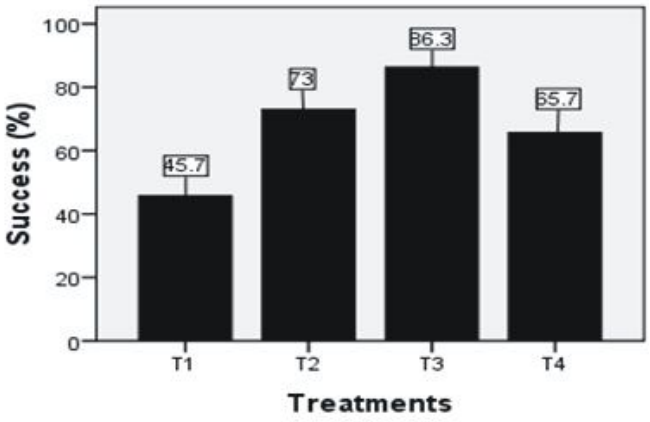

Fig. 3 : Effect of Four flap (banana) grafting technique and time of grafting on graft success in pecan nut.

plants grafted in 2nd week of May might be due to low sap flow, low temperature and humidity. These results are in agreement with those of Joolka *et al*. (2001).

Marketable plants

Results showed in Table 2, revealed that the marketable plants was significantly affected by four flap grafting method in conjugation with different grafting time. Maximum marketable plants (100.00%) were recorded in treatment T_3: FFG + 4th week of May, followed by T_2: FFG + 3rd week of May (90.24%). However, the minimum marketable plants (80.30%) were recorded in treatment T_1: FFG + 2nd week of May. The higher marketable plants might be due to early bud burst and higher shoot length of plants by vigorous rootstock. These results are in close

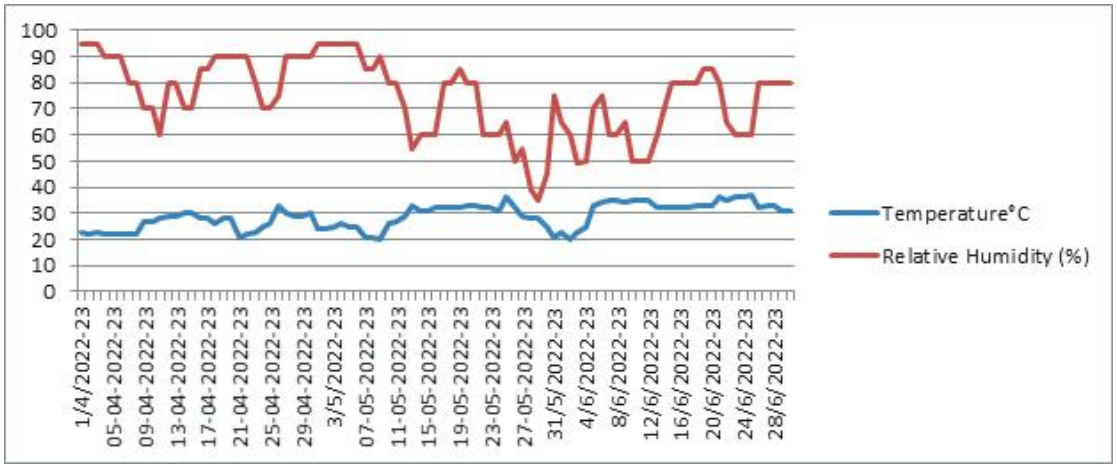

Fig. 4 : Daily average temperature and relative humidity at experimental site.

of food and nutrients (Chiranjivi *et al.*, 2022). Our result is also compatible with the result of Chandel and Ananda (2002), where they recorded maximum linear and radial growth of pecan nut performed on 30th May. The better growth attained by grafted plants may be attributed to the better graft union due to more contact of the cambial layers of stock and scion, early bud sprouting and early initiation of subsequent scion growth (Bharadwaj *et al.*, 1983 and Mir *et al*., 2022).

Survival percentage

After the end of growing season highest per cent survival (94.66%) was recorded under four flap grafting when performed during 4th week of May followed by the same method percent survival (88.25%) when performed during 3rd week of May. Higher rate of survival might be due to the large amount of contact between the cambium of the rootstock and scion, as the four-flap allows eight opportunities for cambium contact with each graft (Hartman *et al*., 2001 and Wells, 2014). The minimum survival (45.66%) was recorded when four flap grafting was performed during 2nd week of May. Poor survival of line with Grauke and Pratt (1992), they reported that three pecan cultivars (Cape Fear, Stuart and Candy) on seven open-pollinated seed-stocks including Curtis, Burkett, Elliott, Moore, Riverside, Apache and Sioux have a diverse effect on scion growth.

Conclusion

It can be concluded from the present investigation that the four flap (banana) grafting performed during 4th week of May gave highest graft success (86.33%) as compared to rest of the grafting time. The survival percentage was also highest in T_3: FFG + 4th week of May, followed by T_2: FFG + 3rd week of May. Hence, it is recommended that the best method during spring season is four flap or banana grafting performed 4th week of May for higher success and survival of pecan plants.

Conflict of interest : The authors declare no conflict of interest.

References

Anonymous (2022). Department of Horticulture, planning and marketing, Jammu and Kashmir-India.

Bhardwaj, K.N. (1983). Standardization of vegetative propagation techniques in pecan nut (*Carya illionensis*). *Thesis Abstracts, Haryana Agricultural University*, **9**, 65

Bhat, R., Simnani S.A. and Hassan I. (2021). Exploring Combinations of Rootstock Planting Time, Scion type and time of Grafting on Grafting Success of Walnut Plants. *Biolog. Forum – An Int. J.*, **13(1)**, 106-115

Carroll, B. (1983). *Four-Flap Grafting of Pecans*. Published Feb. 2017|Id: HLA-6230.

Casales, F.G., Watt E.V. and Coetzer G.M. (2018). Propagation of Pecan (Carya illinoensis): A review. *Afr. J. Biotechnol*., **17(18)**, 586-605.

Chandel, J.S. and Ananda S.A. (2002). Comparative performance of budding methods in pecan nut propagation. *J. Appl. Horticult.*, **4(1)**, 45-46.

Chiranjivi, S., Thapa R., Thapaliya K.P., Ghimire M.S. and Adhikari H. (2022). Exploring combinations of grafting time and scion cultivar in walnut grafting success under open field condition. *Heliyon*, **8(12)**, 485-492.

Erdogan, V. (2006). Effect of hot callusing cable on graft success in walnut (*Juglans regia*) propagation. *Indian J. Agricult. Sci*., **76(9)**, 544–6.

Grauke, L.J. and Pratt J.W. (1992). Pecan bud growth and freeze damage are influenced by rootstock. *J. Am. Soc. Hortic. Sci*., **117**, 404–406.

Grauke, L.J. and Starr J.L. (2014). Phenotypic screening of pecan seedling rootstocks in search of nematode resistance. *Trees* (Berl), **28(5)**, 1333–1341.

Hartmann, H.T., Kester D.E., Davies F.T. and Geneve R.L. (2001). *Plant Propagation: Principles and Practices*. 7th edition. Prentice Hall International, Inc. NJ.

Janick, J. and Paul R.E. (2008). *The Encyclopedia of Fruits and Nuts*. Cambridge University Press, Cambridge, UK.

Joolka, N.K., Rindhe A.B. and Sharma M.K. (2001). Standardization of method and time of grafting in pecan. *Indian J. Horticult*., **58(3)**, 212–4.

Karadeniz, T. (2005). Relationships between graft success and climatic values in walnut (*Juglans regia* L.). *J. Central European Agr*., **6**, 631-634.

Lagarda, A. (1987). The effects of chemical treatments to supplement chilling on bud burst of pecan (*Carya illinoensis* Koch) at la Comarca lagunera, Mexico. *Acta Hort*., **199**, 145-150.

Mir, M. and Kumar A. (2011). Effect of different methods, time and environmental conditions on grafting in walnut. *Int. J. Farm Sci*., **1(2)**, 17-22.

Mir, M., Gupta A., Pandith B.A., Jamwal S.S. and Guroo M. (2022). Standardization of Methods and Timing of Budding on Pecan Nut (*Carya illinoinensis* W.) under Intermediate Agro-Climatic Conditions. *J. Community Mobilization and Sustainable Development*, **1**, 116-118

Misic, P.D. (1983). Nursery production. *Doctoral dissertation*, Faculty of Agriculture, University of Novi Sad, Lead pads, Nolit, Belgrade.

Mitrovic, M. (1995). The influence of the time of removal of the walnut branch graft on reception and callus formation. *Yugoslav Leadership*, **29**, 59-63.

Mitrovic, M., Miletic R., Lukic M., Blagojevic M. and Rakicevic M. (2008). The influence of the substrate on the formation of callus during room grafting of walnut. *Vocarstvo*, **42**, 43-47.

Naira, A., Moieza A. and Tomar C.S. (2013). Effect of foliar application of nutrients and bio-stimulant on growth, phenology and yield attributes of pecan nut cv. "Western schley". *J. Food, Agricult. Environ*., **11(3&4)**, 1222-1226.

Nesbitt, M.L., Goff W.D. and Stein L.A. (2002). Effect of Scion wood Packing Moisture and Cut-end Sealing on Pecan Graft Success. *Hort Technology*, **12(2)**, 257-260.

Pinna, A. and Errea P. (2005). A review of new advances in mechanism of graft compatibility–incompatibility. *Scientia Horticult*., **106(1)**, 1-11.

Ravindran, C., Sharma M. and Kher R. (2008). Present status and problems of pecan nut (*Carya illinoinensis* (wang.) K. Koch) cultivation in Jammu and Kashmir. *Acta Horticulturae*, **772(2)**, 179-182.

Sparks, D. (2005). Adaptability of pecan as species. *HortScience*, **40(5)**, 1175-1189

Stafne, E.T. (1914). Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30

Thompson, T.E. and Grauke L.J. (2003). Pecan Tree Growth and Precocity. *J. Amer. Soc. Hort Sci*., **128**(1), 63–66.

Vahadhati, K., Ajamgard F., Rahemi M. and Driver J. (2020). Advances in micropropagation in commercial pecan cultivars. *Int. J. Fruit Sci*., **20(4)**, 1-12.

Vahdati, K. and Zareie N. (2006). Evaluation of side-stub and hypocotyle grafting efficiency for walnut propagation in Iran. *Acta Horticulturae*, **705**, 347-350

Vahdati, K., Sarikhani S., Mehdi M.A. and Leslie C.A. (2021). Advances in Rootstock Breeding of Nut Trees: Objectives and Strategies. *Plants*, **10(11)**, 2234.

Wani, R.A., Baba J.A., Gul Zaffer and Hakeem S.A. (2017). Grafting take success in walnut under different environment conditions. *Int. J. Curr. Microbiol. Appl. Sci*., **6(7)**, 2195-2201.

Wells, L. (2014). *Budding and Grafting of Pecan*. University of Georgia, Cooperative Extension Bulletin 1376:1-8

Woodroof, J.G. (1979). *Tree Nuts*. AVI Publishing Corporation and Incorporation Westport Connecticut.