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RESEARCH ARTICLE

Multiplication of pecannut varieties at different times of grafting

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Abstract
Pecans are nuts producing tree plants which have high economic importance among horticulture crops. Plain and low hilly areas of Khyber Pakhtunkhwa have the highest future scope for Pecannuts cultivation. For the availability of good quality and maximum quantity of plants, the present study was carried out at Horticulture Research farm, Agricultural Research Institute, Tarnab, Peshawar during the year 2017.The study aimed to find the optimum time for the production of nursery plants of Pecannuts varieties through grafting. The experiment was laid out in randomized complete block design in split-plot arrangement with two factor and three replications. There were 30 plants per treatment. Pecannuts varieties Habib-96, Wichita, and Mohawk were grafted at different dates i.e. January 15, February 1st, February 15, and March 02. Findings of the study revealed that maximum graft sprouting and plant survival was recorded by grafting on January 15th. Grafting on first February had higher vegetative growth like stem diameter and number of leaves. Among the Pecan cultivars more sprouting percentage (47.1%), survival percentage (37.5), and stem diameter (1.27cm)were attained by Habib-96. As far as the interaction effects are concerned the maximum values were observed by grafting Habib-96 on February 15 for most of the parameters studied, in contrast to minimum values for all the parameters by grafting the varieties on 2nd March. Therefore, among the Pecan nut varieties, Habib-96 was best and the optimum time to graftismid-February.

Keywords: Carya illinoinensis; Scion; Grafting; Season; Propagation

Introduction

The pecan (*Caryaillinoinensis*) belongs to the Juglandaceae family. It is also called "Mississipi nut" or "illinoinensis nut". The pecan first appeared on the North American continent during the cretaceous period (Stuckey and Kyle, 1925). Those pecan cultivars named since 1920 comprise 28 southeastern, 64 western and 21 northern cultivars. Fifty one cultivars were named before 1900 (Miller, 1977). The native range of pecan is the flood plains along the Mississippi Lower Ohio, Lower Missouri, lower red rivers and their associated tributaries. The early French and Spanish explorers and settlers in this area found that native Indians using the nuts as food (Hartmann, 1981).Among the Horticulture crops, pecannuts are highly valuable due to excellent nuts production, good timber, and intercrops well with a variety of crops.

Trees are deciduous and can reach a height of 55 m or more, however the cultivated varieties attain their height upto 10-15 m and can spread upto 7-10m (Krochmal and Krochmal, 1982).
Pecans require a long, frost free growing season with hot days and warm nights to properly mature the nuts. Most commercial cultivars require from 180-210 days to mature their nuts, although some cultivars mature their nuts in 110-120 days. The tree requires some winter-chilling to overcome bud dormancy and permit proper vegetative growth in the spring. Pecan requires about 600 chilling hours (Lagarda, 1987).
The propagation through the sexual methods may result in the loss of desirable genetic traits, resulting in trees distinct from the mother tree. Therefore search for new and more desirable techniques for fruit propagation is necessary.
Pecans do not root easily from cuttings, so seedling pecans are used as rootstocks. Unlike many other fruit or nut crops, there is no specific rootstock but stronger growing wild pecan seedlings are preferred as rootstocks. The grafting success dependson the appropriate choice for scion/rootstock combinations, using of proper grafting method and grafts maintaining (El-Gazzaret al., 2016). According to Hussain et al, (2016) each variety has different graftage success when propagated in different time of grafting, therefore a proper time can be researched to find an appropriate time for the production of it,s nursery plants.
There are nine (9) varieties of pecan nutsat Agricultural Research Institute Tarnab, Peshawar. Which were planted around 25 years ago and now they are in full bearing. Two varieties i.e. Habib-96 and Wichita have been approved for commercial plantation. The farmers demand for nursery plants is day by day increasing due to its successful cultivation at the central zone of Khyber Pakhtunkhwa due to taste and other fruit qualities.
Keeping in view the importance of pecan nut vegetative propagation by grafting, this study was initiated. The project aimedto study the graft union and growth of three pecan nut cultivars at different grafting times.

Materials and methods

Experimental location

The experiment was conducted at Horticulture Research farm, Agricultural Research institute Tarnab Peshawar, Pakistan during year2017. The research Institute is located at 1178 ftfrom sea level.

Experimental detail

The research on grafting of pecan nut varieties Habib-96, Wichita, and Mohawk on different dates i.e., January 15, February 1st,February 15 and March 02 was carried out in the lathe house having 30% shade in randomized complete block design with two factorial arrangement. There were 30 plants per treatment. The wild pecan nuts seed were sown in plastic bags in January 2016 and were banana grafted when the seedlings were one year old. The Plants grafted were of pencil size, healthy and free of diseases. All the cultural practices were kept constant forall the treatment.

Measurements and observations

During the experiment the variables studied were; sprouting percentage (plants sprouted per treatment were counted and then percentage was calculated),days to sprouting (counting the days from date of grafting until it starts sprouting, plant survival percentage (total number of plants with successful scion and stock combination),

Number of shoots per plant, stem diameter, number of leaves by counting the leaves on each shoot and then average was calculated numbers of sprouts and leaflet area through leaf area meter.

Statistical analysis

The data in triplicate (10 plants per replication) were statistically analyzed by usingrandomized complete block design with 2 factors through observed that the effect of grafting timeSPSS program and the means were compared by using student's *t*-test (Jan, et al., 2009).

Results and Discussion

Graft sprouting percentage

The data pertaining to the graft sprouting percentage (Table 1) showed that different grafting dates had a significant effect on the graft sprouting percentage. Maximum sprouting percentage (53.8%) was recorded for the plants grafted on February 1st. Habib-96 was the variety with maximum sprouting percentage (47.1%).Generally, tongue grafting requires about a month after growth starts for the union to take place (Childers, 1983).The union between a rootstock and scion results from the interlocking of the cells from both parts. If this healing process of the graft wounds is not completed, then with the coming of spring, the rest period of the buds on the rootstock will be broken in response to adequate chilling, and the active growth of these buds will start, which will directly affect the sprouting and growth of grafted buds. Therefore, Hartmann etal.,(1981) suggested that for all types of grafting, the buds on the scion wood and bud wood must be dormant when the grafting.

Table 1: Graft sprouting and days to sprouting of different varieties of pecan nuts as affected by grafted dates.

Time of grafting (T)	Graftage sprouting Percentage				Days to sprouting			
	Variety (V)				Variety (V)			
	Habib-96	Wichita	Mohwk	Mean	Habib-96	Wichita	Mohawk	Mean
15th Jan	65.0	46.6	50.0	53.8a	66.6	64.6	65.0	65.4 a
1st Feb	58.3	45.0	41.6	48.3a	62.6	56.3	59.3	59.3 b
15th Feb	38.3	43.3	30.0	37.2b	57.3	51.0	52.3	53.5 c
2nd Mar	26.6	33.3	26.6	28.8b	50.4	46.3	44.3	47.0 d
Mean	47.1a	42.1ab	37.1b		59.2a	55.4 c	54.5 b	
LSD	T	V	T x V		T	V	T x V	
0.05	10.516	9.107	NS		2.7873	2.413	NS	

Means followed by same letter are not significantly different at 5% level of Significance.

Days to sprouting

Pecannuts varieties and their interaction had a significant effect on number of days to sprouting (Table 1). Maximum number of days to sprouting (65.4) was taken by the plants grafted on January 15th, whereas a minimum (47.0) days to sprouting were taken by the plants grafted on March 2nd.Mean value for different varieties showed that days taken to sprouting were maximum in Habib-96 (59.2 days), followed by Wichita (55.4

days). Minimum days to sprouting were taken by Mohawk (50.4 days). Grafting is practiced in the dormant season and buds start to grow actively in the spring. Therefore, those plants which are grafted early in the winter took more days to sprout as compared to others grafted late in the winter or early spring. These results are due to the varietal characteristics from cultivar to cultivar. The results are in line with Paunovic et al., (2011) early or late initiation of sprouting might have due to distinctive adaptability of each variety in that environment, genetic potential and ambient conditions favoring the sprouting phase by terminating its rest period.

Percent plant survival

Maximum plant survival (37.5%) was observed in Habib-96 and Wichita and Mohawk recorded a lower plant survival percentage. Various grafting dates had significant effect on the percent plant survival of various varieties. Maximum plant survival percentage 58.5% and 52.2% was recorded in plants grafted on 15th January and 1st February, respectively. In the previous paragraphs, the adverse affects on grafting in the spring are described. The findings are in line with an appropriate season to conduct grafting in many fruit trees, when plants have accumulated enough nutrients to allow the formation of new tissues, fundamental in the consolidation of the scion (Zanette, 2011, Hussain et al., 2016). Grafting late in the dormant season will contribute inadequate period for the healing process and, therefore, the absence of development of normal vascular tissue at the graft union will occur. This situation results in the premature failure of the grafts and poor plant survival percentage.

Number of Shoot

The data related to number of shoots per plant showed that different grafting dates and their interaction with variety had a significant effect on number of shoots per plant. Grafting on 15th February produced maximum number of shoots (2.2), while minimum number of shoots were found in all varieties plants grafted on March 2nd. The value of interaction between different grafting dates and varieties was also significant. Maximum number of shoots (3.0) were observed in Wichita grafted on 15th February, followed by Habib-96 (2.7) grafted on January 15th. Minimum number of shoots (1.0) were observed in all the varieties grafted on 2nd March.
It appears that number of shoots per plant are directly related to the graft sprouting percentage and percent plant survival in various varieties grafted at different timings. The high sprouting percentage and survival is due to the successful graft union and development of normal vascular tissue at the graft union. Therefore, the strong and functionally continuous system of vascular to the growing scion and thus enhance the number of shoots per plant. The same reasons are behind the significant value of interaction between grafting dates and varieties. Maximum and minimum values of each grafted variety are in accordance with the graft sprouting percentage and percent plant survival (Mohamed et al.,2014). Stem which contribute to the plant shoots emergence and growth is a genetic character and shows itself in the soil and climate most suited to the plants of the variety.

Stem diameter

The data related to stem diameter revealed that the plants grafted on different dates and interaction between grafting dates and varieties had significant effect on stem diameter (Table 3) The difference in stem diameter among the plants grafted on different dates is non significant, but is significant only in plants grafted on March 12, which showed the least stem diameter (1.08 cm). Maximum stem diameter was recorded in Habib-96 (1.7cm) grafted on 15th January, followed by Wichita (1.4cm) grafted 15th February. The findings are in line with Hussain

et al., (2016) that stem diameter is directly related to stem and number of leaves. Maximum number of leaves contribute to the preparation of additional photosynthate which enhances the growth and development of the stem. Minimum number of leaves result in less production of photosynthate and the stem thickness remain less (Lockhardand Schneider, 1981).

Table 2: Plant survival and Number of shoots of different varieties of pecan nuts as affected by grafted dates.

Time of grafting (T)	Plant survival percantage				Number of shoots			
	Variety (V)				Variety (V)			
	Habib-96	Wichita	Mohawk	Mean	Habib-96	Wichita	Mohawk	Mean
15th Jan	66.7	56.6	53.3	58.8A	2.7ab	1.0 e	2.0 cd	1.9 b
1st Feb	58.3	56.6	41.6	52.2A	2.0 cd	2.0 cd	2.3 bc	2.1 ab
15th Feb	40.0	48.3	31.6	40.0B	1.7 d	3.0 a	2.0 cd	2.2 a
2nd Mar	28.3	41.6	31.6	33.8B	1.0 e	1.0 e	1.0 e	1.0 c
Mean	37.5A	27.0B	25.0B		1.83	1.75	1.83	
LSD	T	V	T x V		T	V	T x V	
0.05	8.604	7.451	NS		0.302	NS	0.523	

Means followed by same letter are not significantly different at 5% level of Significance.

It is clear from the results that stronger graft union regulates the transport of water and nutrients and enhance the active growth of the scion with the start of spring season and end of the rest period. In this process, reduction in levels of growth inhibitors and magnification in the levels of growth promoters occur (Bekhradi et al., 2011).

Table 3: Stem diameter of different varieties of pecan nuts as affected by grafted dates.

Time of grafting (T)	stem diameter (cm)			
	Variety (V)			
	Habib-96	Wichita	Mohak	Mean
15th Jan	1.7[a]	0.9e	1.2d	1.27 a
1st Feb	1.2cd	1.3c	1.3c	1.28 a
15th Feb	1.2d	1.4b	1.2cd	1.27 a
2nd Mar	1.0e	1.2cd	1.01 e	1.08 b
Mean	1.27	1.23	1.18	
LSD	T	V	T x V	
0.05	0.062	NS	0.108	

Means followed by same letter are not significantly different at 5% level of Significance.

Number of leaves per plant

The data regarding number of leaves per plant Table 4 revealed that significant difference in number of leaves for time of grafting and also it,s interaction with variety. The value of interaction between grafting dates and varieties were highly significant. Maximum number of leaves (46) per plant were found in Habib-96 grafted on February 17, followed by Mohawk (40.3) grafted on March 04. Minimum number of leaves (16) were observed

in Habib-96 and Mohawk grafted on March 12, and Wichita grafted on February 17.Maximum number of leaves (46) ware found in Habib-96 grafted on 15th January followed by Mohawk (40.0) grafted on March 15th. Number of leaves have direct relation with number of branches and stem. The impact of leaves retention had positive impact on the rooting and also on the new sprouts emergence, which in turn caused higher percentage of success (Hussain et al, 2014). The plants having more branches produce more leaves. The variation in number of leaves may also be due to the genetic reason i.e. each cultivar has its own genetic background (El-Gazzar, et al., 2016).

Leaflet area

The data regarding average leaflet area (Table 4) showed that different grafting dates, varieties, and their interaction had significant effect on average leaflet area. Maximum leaflet area (20.55 cm²) was recorded in plants grafted on 15th January, whereas minimum leaflet area (14.8 cm²) was observed in plants grafted on 2nd March. The difference in leaflet area among Habib-96 and Mohawk is non significant, but is significant as compared to variety Wichita where leaflet was observed maximum (20.8cm²). The variations in leaflet area may be due to the number of leaves per plant and the result of genetic potential of the variety for better utilization of available nutrients. Moreover, the environmental factor may be responsible for the leaf expansion in comparison to other varieties which could not avail the prevailing conditions for leaf area development (Soumlidou et al., 1994).

Table 4. Number of leaves and leaf area of different varieties of pecan nuts as affected by grafted dates.

Time of grafting (T)	Number of leaves				Leaflet area (cm)²			
	Variety (V)				Variety (V)			
	Habib-96	Wichita	Mohak	Mean	Habib-96	Wichita	Mohawk	Mean
15th Jan	46a	16f	23cdef	28.3a	26.3a	18.1cd	17.3 cd	20.5a
1st Feb	24cde	28bc	31b	28.0a	16.3de	22.1b	19.1 c	19.1b
15th Feb	18ef	40a	27bcd	28.4a	14.3ef	23.7b	19.4c	19.2b
2nd Mar	16f	20def	16f	17.3b	11.8g	19.4c	13.2fg	14.8c
Mean	26.0	26.17	24.42		17.19 b	20.85 a	17.23 b	
LSD	T	V	T x V		T	V	T x V	
0.05	4.290	NS	7.430		1.359	1.239	2.354	

Means followed by same letter are not significantly different at 5% level of Significance.

Conclusions

It was concluded from the study that pecannuts variety Habib-96 was found the best among the tested Pecan cultivars with enhanced sprouting and survival percentage and stem diameter. Across varietis, grafting during January 15th were found better in term of plant survival and sprouting. The Grafting on first February was better for vigorous vegetative growth including stem diameter and number of leaves. The pecan variety Habib-96 when grafted during mid febrary were recommended for maximum survival and vegetative growth.

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