STUDIES ON THE VEGETATIVE PROPAGTION OF PECAN A. PECAN GRAFTING BY CLEFT GRAFTING METHOD UNDER OPEN FIELD CONDITIONS

BY

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ABSTRACT

This study was undertaken in the experimental farm of the Horticulture Research Station at Kaha, Kalubia Governorate, Egypt, during the two successive seasons (2007 and 2008). The main aim of the present study was to investigate some factors affecting vegetative propagation of pecan by cleft grafting method under open field conditions as date of grafting, graft wood storage, position of grafting zone and scion cultivar. It is quite evident from the presented vegetative growth data of the graft in this study that, grafting on 24th of February proved to be successful in increasing diameter of graft union zone and no. of sprouted shoots & leaves/ sprouted shoots more than date on 2nd of March. However, grafting on 2nd of March gave slightly longer grafts & sprouted shoots and increased % of successful grafts (6 months after grafting) as well as survival (a year after grafting). Also, when the graft union zone was kept under-ground proved to be a good agriculture practice and showed better results than grafting above-ground. Generally, it can be concluded that, when pecan seedling was grafted using Choctaw scions gave better growth results than Desirable scions. Better growth was also obtained when scions was directly grafted without storage. Moreover, the percentages of successful (after six months of grafting date) as well as survival of grafts (a year after grafting) reached (98.00 & 94.67 %) and (96.33& 92.00 %) when pecan grafting was done on 2nd March using un-stored Choctaw scions and the graft union zone was covered with soil, however, the least results were recorded (37.33 & 34.67 %) for success and (34.67& 33.00 %) for survival when the grafting was done on 24th Feb. using un-stored Choctaw scions and graft union zone was un-covered with soil, this was true during both seasons, respectively. Considering N. P. and K contents in leaves of sprouted shoots of the graft, it was indicated differences in nutrients uptake.

Key words: Pecan - Cleft grafting – Open field conditions - Date of grafting - Graft storage - Position of grafting zone - Scion cultivar - Vegetative growth – Mineral composition.

INTRODUCTION

Pecan [*Carya illinoensis (Wang. C. Koch)*] is a native North American tree-nut crop that is increasingly important throughout the world as a new horticultural crop **(Wood *et al.*, 1990** and **Wood & Payne, 1991).** As the economics of the developed and developing nations grow, the demand for high quality foods such as pecan will increase **(Abu-Taleb, 1992).**

It had been a general tendency to raise pecan by seed which causes a great variability, extends the juvenile period of plants and such trees occupy larger space and are often low in productivity with fruits of inferior quality **(Pathak & Srivastva, 1975** and **Dhuria *et al.*, 1982).** Due to the hard rooting of pecan cuttings, new techniques of vegetative propagation have been developed. In most cases, budding and grafting methods being the suitable techniques for asexual pecan trees **(Fayek *et al.*, 1994).**

The expansion of pecan cultivation is now limited by the difficult reproduction of budded seedlings of good and marketable varieties, since budding operations and results are tedious and yield a relatively low percentage of success **(Roghani *et al.*, 1977).** Hence, grafting is a type of asexual reproduction well adopted for the propagation of pecans. Through grafting, the exact genetic complex of a particular pecan selection or variety can be continued generation after generation, besides; it is an economical and easier technique of vegetative propagation **(Taylor, 1981 & 1982).** Several authors from other countries have been reported positive results with scion grafting **(Hegazy &Ashmawy, 1974; Bhardwaj, 1983; El-Sayed, 1992; El-Sayed *et al.*, 2000** and **El-Iraqi, 2006).** Propagation by grafting may be restricted by different factors. Scion variety has an effect on vigor of the rootstock combined with it **(Hartman *et al.*, 1990; Doaa, 2009** and **Tworkoski, 2006).).** Time of pecan grafting is considered a particular factor that affects graft union success. Cleft graft must be done in the spring just before growth starts **(Powell, 1998** and **William, 1998)**. The earlier the grafting operation the larger the growth of the grafts **(Jose, 1982).** In this respect, **Taylor (1982)** proved that, collecting propagation wood in February or early March while the tree is still dormant before the buds start to swell is considered the best time for pecan grafting. In addition, **Hegazy & Ashmawy (1974)** and **Bhardwaj (1983)** reported that, when pecan grafting was carried out on March it gave 80% of success. Moreover, successful pecan grafting is dependent on proper collection and storage of propagation wood. Cold storage of dormant scions during winter was one of the most important cultural techniques that greatly promote and enhance the percentage of grafting success. In addition, cover the graft with soil if it is below or at ground level may also affect percent of graft union success **(Taylor, 1982).**

It was, therefore, considered essential to carry out extensive studies to standardize factors affecting vegetative propagation of pecan by cleft grafting technique under open field conditions.

MATERIALS AND METHODS

This study was undertaken in the experimental farm of the Hort. Res. Instit. Station at Kaha, Kalubia Governorate, Egypt, during the two

successive seasons (2007 and 2008). The main aim of the present study was to investigate some factors affecting vegetative propagation of pecan by cleft grafting method under open field conditions.

Selection of rootstock: Two years old pecan seedlings uniform in growth and thickness, grown from a collection of pecan seeds, were selected as rootstocks for grafting. The selected seedlings were grown in the experimental orchard and planted in loamy clay soil at 1x1 meters apart.

Investigation of some factors affecting vegetative propagation of pecan by using cleft graft method:

1- Effect of scion wood cultivar: The scion wood of about one year age and 10cm. length and having the apical bud intact was collected from healthy mature pecan trees (Desirable and Choctaw cvs.) growing in the experimental area of this station.

2- Effect of grafting date: A preliminary study was conducted to determine the proper date for pecan grafting and the results showed the best success was obtained between the last week of Feb. to the 1st week of March. In this study, cleft grafting technique was carried out using the dormant scions cut during winter at two different dates (24th of Feb. and 2nd of March).

3- Effect of scion wood storage: Once the graft woods were selected they were either obtained directly from the tree at the time of grafting or they were stored under refrigeration at temperatures of 5c° for two weeks before grafting date. Before refrigeration, the stored graft wood were tied in bundles, dipped the ends in melted wax to prevent drying and wrapped in wet newspapers in plastic bags.

4- **Effect of position of grafting zone:** Cleft grafting was carried out in two different ways (above or under the ground). In the cleft graft under - ground, seedling was bare off by removing about 10-15cm. of soil from around its base so that the graft can be placed below the ground. The seedling trunk was cut off by making a cleft or split in the stock with a very sharp knife make a sloping cut about 1.5-2.5cm. long on each side of the scion, forming a wedge shape. One scion was inserted into the cleft on each side of the stock. The scion was pushed downward so that, the cambium or inner bark of the scion and stock must be in contact **(Powell, 1998)**, then, wrapped the graft tightly using grafting tape to exclude air and to keep the graft aligned **(Taylor, 1982)**. Then, the graft was covered with soil leaving at least two sets of uninjured buds exposed to air. In the cleft graft above – ground technique, grafting was done 15cm. above-ground and was wrapped more securely with grafting tape to keep it from drying out,

then, covered with plastic bags and tied at both ends using grafting tape. Every care was exercised to remove the weeds at proper intervals. The whole experimental area was provided with uniform cultural practices avoiding deep hoeing.

The tested treatments were arranged as follow:

1- Grafting on 24th of February above-ground using stored graft.
2- Grafting on 24th of February above-ground using un-stored graft.
3- Grafting on 24th of February under-ground using stored graft.
4- Grafting on 24th of February under-ground using un-stored graft.
5- Grafting on 2nd of March above-ground using stored graft.
6- Grafting on 2nd of March above-ground using un-stored graft.
7- Grafting on 2nd of March under-ground using stored graft.
8- Grafting on 2nd of March under-ground using un-stored graft.

The aforementioned treatments were applied using grafts from both Desirable & Choctaw pecan cultivars. Twenty-four pecan seedlings were selected per each treatment (3 replicates X 8 seedlings/replicate).

Measurements:

I. Vegetative growth:

After six months of grafting, diameter of graft union zone; length of grafts; diameter of sprouted shoots; length of sprouted shoots; number of leaves / sprouted shoots; number of leaflets/ leave; number of sprouted shoots/ graft; % of successful grafts (6 months after grafting date) and survival of grafts (a year after grafting) were recorded.

II- Leaf minerals content:

Leaf samples of twenty middle leaflets were taken from the middle leaves of terminal sprouted shoots then, washed, air dried at 70 C° till constant weight and grounded for the determination of N, P, & K as follows:

- Nitrogen was determined by MicroKjeldahl method **(Pregl, 1945).**
- Phosphorous was estimated by the method of **Murphy & Riley (1962).**
- Potassium was determined by flame-photometer according to **Brown & Lilleland (1946).**

Statistical analysis:

The obtained data in both seasons was subjected to Analysis of Variance according to **Snedecor and Cochran (1980).** Differences between treatments were compared using Duncan's Multiple Range Test **(Duncan, 1955).**

RESULTS AND DISCUSSION

Data presented in **Tables (1-8)** show the effect of some factors (scion wood cultivar; grafting date; scion wood storage and position of graft zone) on vegetative propagation of pecan by cleft grafting method under open field conditions during 2007 and 2008 seasons.

I- Vegetative growth parameters:

I. 1. Diameter of graft union zone:

The specific effect of tested treatments on diameter of graft union zone is shown in **Table (1).** It is quite evident that, in both seasons of study differences were so few to be significant between selected cvs. (both seasons) and stored or un-stored scions (especially in 2nd season). However, grafting in 24th of Feb. proved to be successful in increasing diameter of graft union zone (1.75 & 1.83 cm.) more than 2nd of March grafting (1.57 & 1.71 cm.) in both seasons, respectively. Also, grafting above-ground showed higher records. Meanwhile, the interaction between treatments under study was significantly affected diameter of graft union zone. In this respect, when pecan seedling was grafted on 24th of Feb. using un-stored Choctaw scions and grafted above-ground gave the maximum diameter of graft union zone (1.96 & 2.06 cm.) in both seasons respectively, while, the reverse was true when graft wood of Desirable cv. was grafted on 24th of Feb. under – ground using un-stored scions (1.46 & 1.48 cm.) during both seasons, respectively.

Table (1): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on diameter of graft union zone (cm.) of pecan under open field conditions during 2007 & 2008 seasons.

Seasons		2007						2008					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage
Desi.	+	1.96a	1.90b	1.46j	1.60h	1.48A	Stored	1.90d	2.03b	1.56i	1.80e	1.75A	Stored
	-	1.46j	1.80d	1.56hi	1.56hi		1.50A	1.48k	1.90d	1.66h	1.66h		1.75 A
Choct.	+	1.73e	1.83c	1.60h	1.66f	1.48A	Un-stored	1.86d	1.53j	1.70g	1.63h	1.79A	Un-stored
	-	1.40k	1.96a	1.53i	1.63g		1.42B	1.86d	2.06a	1.73f	1.93c		1.79A
Mea	Time	1.75 A		1.67 B				1.83 A		1.71 B			
	Graft positio n	Under-ground		Above-ground				Under-ground		Above-ground			
		1.59 B		1.74 A				1.72 B		1.82 A			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

I. 2. Length of grafts:

Results in **Table (2)** revealed that, cleft pecan grafting on 2nd of March gave slightly longer grafts (77.07 & 80.56 cm.) than 24th of Feb. grafting (72.65 & 72.03 cm.) in both seasons, respectively. Moreover, Choctaw cv. graft wood gave better results (85.62 & 85.44 cm.) than Desirable cv. (64.10 & 67.16 cm.) in both seasons, respectively. Nevertheless, when graft zone was covered with soil gave longer grafts, than un-covered ones; however, the differences were insignificant between stored or un-sorted scions in both seasons.

Referring the interaction between treatments, when grafting was done on 24th of Feb. using un-stored Choctaw scions and un-covered graft union zone with soil (1st season) and covered with soil (2nd season) gave the highest values (99.67 & 100.00 cm.), while, the trend took the other way around with Desirable graft wood under the aforesaid conditions (56.00 cm & 59.67 cm.) in both seasons, respectively.

Table (2): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on length of grafts (cm.) of pecan under open field conditions during 2007 & 2008 seasons.

Seasons		2007						2008					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage
Desi	+	65.80 k	57.00n	72.20l	68.57j	84.16 B	Stored	64.90j	59.80k	76.70g	72.00l	67.16B	Stored
	-	58.00m	56.00o	75.20h	60.00l		74.64A	58.10l	59.67k	80.80e	65.30j		75.95A
Choct	+	76.20g	85.33d	87.23c	82.80e	85.62 A	Un-stored	72.90h	92.30b	86.90d	80.10e	85.44A	Un-stored
	-	81.20f	99.87a	92.43b	78.10g		76.07A	78.80f	89.80c	100.0a	80.70e		76.65A
Me	Time	72.65 B		77.07 A				72.03 B		80.56 A			
	Gra positio	Under-ground		Above-ground				Under-ground		Above-ground			
		76.28 A		73.43 B				77.64 A		74.96 B			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

I. 3. Diameter of sprouted shoots:

Concerning the specific effect of each investigated factor on diameter of sprouted shoots **(Table, 3).** It is clear from the findings of both years of experimentation that, differences didn't reach level of significance (except for cultivar in 2nd season), where, Choctaw cv. produced wider sprouted shoots (85.44 cm.) than Desi. cv. (67.16 cm.). As for the interaction effect, it is quite clear that, the specific effect of each tested treatment was reflected on interaction effect of their combinations, whereas, the maximum diameter of sprouted shoots was achieved by using Choctaw scions and directly grafted on 24th of Feb., then grafted above-soil (1.60 &1.70 cm.) in both seasons, respectively. On the contrary, the least values were closely linked with grafting using stored Desi. scions and the graft zone was above-soil, this was true (o.96 & 1.03 cm.) during both seasons under study, respectively.

Table (3): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on diameter of sprouted shoots (cm.) of pecan under open field conditions during 2007 & 2008 seasons.

Seasons		2007						2008					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage
Desi.	+	1.46b	0.96h	1.10g	1.40c	1.21A	Stored	1.40d	1.03i	1.16g	1.50c	1.26B	Stored
	-	1.30d	1.16f	1.10g	1.20ef		1.25A	1.33e	1.16g	1.20fg	1.30e		1.35A
Choct.	+	1.23e	1.23e	1.30d	1.33d	1.28A	Un-stored	1.60b	1.46c	1.33e	1.30e	1.48A	Un-stored
	-	1.10g	1.60a	1.30d	1.16f		1.24A	1.10h	1.70a	1.46c	1.23f		1.31A
M	Time	1.25 A		1.23 A				1.35 A		1.31 A			
	Graft position	Under-ground		Above-ground				Under-ground		Above-ground			
		1.23 A		1.25 A				1.32 A		1.33 A			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

I. 4. Length of sprouted shoots:

Data presented in **Table (4)** indicate that, the time of grafting may be an important factor, where grafting done on March produced longer sprouted shoots than February grafting. Moreover, cleft pecan grafting using Choctaw scions gave better results (78.29 & 73.24cm.) than Desi. (55.87 & 58.76 cm.) in both seasons, respectively. Meanwhile, storing graft wood for 2 weeks before grafting time showed higher records in this respect (2^{nd} season only).

However, grafting under-ground showed longer sprouted shoots (68.40 & 72.17 cm.) than the above-ground grafts (65.76 & 59.83 cm.) in both studied seasons, respectively. Length of sprouted shoots was significantly affected with the interaction between tested treatments. In this regard, the longest shoots were obtained when grafting was done on March using un-stored Choctaw scions and the graft zone was under-ground (89.80 & 94.10 cm.). The reverse was true when un-stored Desirable scions were grafted on 24^{th} of Feb. under-ground (42.43 & 46.33 cm.) during both seasons under study.

Table (4): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on length of sprouted shoots (cm.) of pecan under open field conditions during 2007 & 2008 seasons.

Seasons		2007						2008					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage
Desi	+	54.77l	48.43m	66.67g	59.80k	55.67B	Stored	53.00l	47.67m	71.90g	61.70j	58.76B	Stored
	-	42.43o	47.23n	65.50l	60.13k		67.75A	46.33n	54.23k	69.80h	65.47i		61.00B
Choct.	+	63.80d	67.60c	75.20e	63.70j	76.29 A	Un-stored	88.20b	74.80f	82.03d	82.66d	73.24A	Un-stored
	-	67.00h	88.60b	89.80a	70.60f		66.41A	72.00g	84.80c	94.10a	81.30e		71.00A
M	Time	64.98 B		69.18 A				65.13 A		66.87 A			
	Graft position	Under-ground		Above-ground				Under-ground		Above-ground			
		68.40 A		65.76 B				72.17 A		59.83 B			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

I. 5. Number of leaves/ sprouted shoots:

A perusal of the results presented in **Table (5)** reveals undoubtedly that, scion wood of Desi. cv. produced significantly higher values. Moreover, grafting done in Feb. during the rest period was somewhat successful in increasing no. of leaves/ sprouted shoots. It was aiso observed that, grafting under-soil surface was statistically better (1st season), whereas the differences were so slight to be significant in the 2nd one.

As for the response of interaction, it was so clear that cleft pecan grafting using either Desi. or Choct. scions, directly grafted in Feb. without storage under-ground was the superior (1st season). In the 2nd season, the highest records were recorded in the case of grafts on 24th of Feb. with stored grafts of Desirable for 2 weeks before grafting time and graft zone was above-ground (26.23cm.), however, when it was done on March above-ground using stored Choctaw grafts took the other way around (13.77 & 14.00 cm.) in both seasons, respectively

Table (5): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on number of leaves/ sprouted shoots of pecan under open field conditions during 2007 & 2008 seasons.

Seasons		2007						2008					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage
Desi.	+	21.80d	26.97b	20.20f	21.90d	22.00A	Stored	19.43h	26.23a	18.77i	22.20de	21.60A	Stored
	-	27.80a	20.00fg	17.10i	20.23f		20.08A	25.43b	20.00g	19.00hi	21.77ef		19.20B
Choct.	+	25.80c	15.57j	14.67k	13.77l	19.42B	Un-stored	21.40f	15.23l	16.33k	14.00m	19.10B	Un-stored
	-	27.23b	17.80h	19.53g	21.00e		21.34A	23.87c	17.53j	22.47d	21.97de		21.60A
M	Time	22.87 A		18.55 B				21.14 A		19.56 B			
	Graft position	Under-ground		Above-ground				Under-ground		Above-ground			
		21.77 A		19.65 B				20.64 A		19.87 A			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

I. 6. Number of leaflets/ leave:

In this respect, the specific effects of grafting date, scion cv., storage and covering grafting zone with soil and their interactions are given in **Table (6).**

Referring the specific effects, the present parameter did not respond significantly to the factors under study in both investigating seasons (except for grafting time in 2nd season). Nevertheless the interaction shows that, when grafting was done in Feb. (1st season) and March (2nd season) using un-stored Choctaw scions and graft zone was under-ground induced the highest no. of leaflets/ leave as they recorded 16.00 & 18.77. The least values were linked with Feb. grafting using stored Desirable scions and graft union zone was above-ground (13.23 & 12.13) in both experimental seasons.

Table (6): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on number of leaflets/ leave of pecan under open field conditions during 2007 & 2008 seasons.

Seasons		2007						2008					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage
Desi.	+	14.43 c-e	13.23f	14.10de	13.90e	14.13 A	Stored	13.77gh	12.13i	14.53e	14.57e	14.14A	Stored
	-	15.33b	14.77c	13.90e	13.33f		14.11A	14.77de	14.03fg	14.43e f	14.87c-e		14.28A
Choct.	+	14.77c	13.97e	14.43c-e	13.97e	14.67 A	Un-stored	15.67b	13.80g h	15.13c d	14.67e	15.03A	Un-stored
	-	16.00a	14.23c-e	15.43b	14.53 cd		14.88A	13.43h	13.57h	16.77a	15.23c		14.89A
M	Time	14.60 A		14.19 A				13.90 B		16.27 A			
	Graft position	Under-ground		Above-ground				Under-ground		Above-ground			
		14.80 A		13.99 A				15.06 A		14.11 A			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

I. 7. Number of sprouted shoots/ graft:

It is clear from the findings of both years of experimentation **Table (7)** that, grafting on Feb. induced higher records (2.37) than March did (1.87) in the 1st season. Meanwhile, grafting under-ground (2.2 5 & 2.15) was better than above-ground (2.00 & 1.98) in both studied seasons.

As for interaction effects, Choctaw scions when used directly on Feb. the graft zone was under-ground seemed to be the best treatment (both seasons) as they recorded (3.33 & 2.53), while the reverse was true when Choctaw cv. was replaced by Desirable cv. as it recorded 1.56 in the 2nd season of study.

Generally, it can be concluded from the abovementioned data of vegetative growth parameters that, when pecan seedling was grafted using Choctaw scions gave better results than Desirable scions. The variation among plant species and in their grafting ability was probably related to their production of callus which is essential for a successful graft (**Hartman *et al.*, 1990; El- Sayed, *et al.*, 2000; Doaa, 2009** and **Tworkoski, 2006).** Rootstock is very important factor in determining

graft height and crown development **(Placidi, 1997).** However, **Tworkoski (2006)** reported that, scion had more influence than rootstock on monthly growth rate.

Also, the fore cited results cleared that, when the graft union zone was kept under-ground proved to be a good agriculture practice and showed better results when compared with those grafted above-ground. Our results are in agreement with those were reported by **Pathak** and **Srivatava (1975)** and **Taylor (1982)** who concluded that, when graft zone was covered with soil, the union could be saved from adverse weather conditions such as spraying frost or high temperature, this might be due to the protection of union from adverse weather condition and conservation of moisture due to proper humidity and congenial conditions for better union were created. Other finding of **Jose (1982)** stated that, environmental factors may affect the union of the scion and stock, high temperature and lake of water are unfavorable to callus formation. Considering the effect of grafting date, it appeared that grafting on 24th of February during the rest period was somewhat successful in enhancing most of vegetative growth parameters. These results are in accordance with **Hegazy** and **Ashmawy (1974)** who reported that, time of pecan grafting is considered a particular factor that affects graft union success. The earlier the grafting operation the larger the growth of the grafts **(Jose, 1982).** In this respect, **Taylor (1982)** proved that, collecting propagation wood in February or early March while the tree is still dormant before the buds start to swell is considered the best time for pecan grafting.

Moreover, successful pecan grafting is dependent on proper collection and storage of propagation wood. Cold storage of dormant scions during winter was one of the most important cultural techniques that greatly promote and enhance the percentage of grafting success. However, the present study showed opposite results, where better growth was obtained when scions was directly grafted without storage.

Table (7): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on number of sprouted shoots/ graft of pecan under open field conditions during 2007 & 2008 seasons.

Seasons		2007						2008					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	above-ground	Cv.	Graft stor
Desi.	+	2.10e	2.43b	1.80g	1.56i	2.01A	Stored	1.70j	1.90gh	2.03ef	1.80i	1.92B	Store
	-	2.13de	2.20cd	2.10e	1.80g		2.08A	1.56k	2.00f	2.33b	2.10de		2.02A
Choct.	+	2.46b	2.23c	2.10e	2.00f	2.23A	Un-stored	2.56a	1.86hi	2.20c	2.10de	2.21A	Un-stored
	-	3.33a	2.10e	2.00f	1.66h		2.16A	2.53a	1.96fg	2.33b	2.13cd		2.12A
Mea	Time	2.37 A		1.87 B				2.01 A		2.12 A			
	Graft position	Under-ground		Above-ground				Under-ground		Above-ground			
		2.25 A		2.00 B				2.15 A		1.98 A			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

I. 8. Percentages of successful and survival grafts:

It worthy to mention from the presented data in **Tables (8 & 9)** that, Choctaw cv. recorded relatively higher percentages of successful grafts (59.58 & 58.67 %) and survival (57.17 % & 56.50) than Desirable cv. as it recorded (52.50 & 50.50 %) for successful and (49.96 & 48.58%) for survival grafts in both 2007 - 2008 and 2008-2009 seasons, respectively. In addition, un-stored grafts recorded slightly better results. When grafting was done on March increased % of successful grafts (56.75 & 59.67 %) as well as survival (53.96 & 57.50 %) whereas Feb. grafting recorded (55.33 & 49.50 %) for successful grafts and (53.17 & 47.58 %) for survival, in both seasons, respectively. Grafting under-ground recorded higher successful (66.58 & 65.00 %) and survival grafts (64.25 & 62.92 %) values as compared with above-ground grafting as it recorded (45.50 & 44.17%) for success and (42.88 & 42.17 %) survival percentages, in both seasons, respectively. Regarding the interaction between tested factors, the percentages of successful and survival of grafts reached (98.00 & 94.67) and (96.33& 92.00 %) when pecan grafting was done on 2nd March using un-stored Choctaw scions and the graft union zone was

covered with soil, however, the least results were recorded (37.33 & 34.67 %) for success and (34.67& 33.00 %) for survival when the grafting was done on 24th Feb. using un-stored Choctaw scions and graft union zone was un-covered with soil, this was true during both 2007-2008 and 2008-2009 seasons, respectively.

These results in general are in agreement with those reported by **Hegazy &Ashmawy (1974), Roghani et al., (1977)** and **Bhardwaj (1983)** they reported that, when pecan grafting was carried out on March it gave higher percentage of success. At this point, this may be due to the low temperature in Feb. at the graft union when plants were in the nursery than in March, thus, limiting the degree of callus formation and graft success **(Avanzato, 1988).** The results in this study emphasize that grafting of pecan has been found out optimum time in Egypt where it ranged between the last week of Feb. to the 1st week of March.

Table (8): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on percentages of successful and survival grafts of pecan under open field conditions during 2007 - 2008 season.

Seasons		2007-2008											
		Successful grafts (%)						Survival of grafts (%)					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage
Desi.	+	60.00e	45.33j	41.33k	52.00h	52.50B	Stored	56.00e	42.67gh	40.00i	50.00f	49.96B	Stored
	-	74.67c	45.33j	54.67g	46.67i		56.00B	74.67c	41.33hi	51.00f	44.00 g		52.38B
Choct.	+	57.33f	61.33d	85.33b	37.33m	59.58A	Un-stored	55.33e	60.00d	80.00b	35.00j	57.17A	Un-stored
	-	61.33d	37.33m	98.00a	38.67l		57.08A	60.67d	34.67j	96.33a	35.33j		54.75A
Mean	Time	56.33 B		56.75 A				53.17A		53.96A			
	Graft position	Under-ground		Above-ground				Under-ground		Above-ground			
		66.58 A		45.50 B				64.25A		42.88B			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

Table (9): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on percentages of successful and survival grafts of pecan under open field conditions during 2008 - 2009 season.

Seasons		2008-2009											
		Union success (%)						Survival of grafts (%)					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage
Desi.	+	53.33g	38.67l	45.33j	53.33g	50.50 B	Stored	50.67e	36.33h	44.00f	51.33e	48.58B	Stored
	-	66.67c	38.67l	56.00e	52.00h		53.67B	64.67c	37.33h	54.33d	50.00e		51.71B
Choct.	+	62.67d	46.67i	86.67b	42.67k	58.67 A	Un-stored	62.00c	45.00f	84.00b	40.33g	56.50A	Un-stored
	-	54.67f	34.67m	94.67a	46.67i		55.50A	51.67h	33.00i	92.00a	44.00f		53.38A
Mean	Time	49.50 B		59.67 A				47.58B		57.50A			
	Graft position	Under-ground		Above-ground				Under-ground		Above-ground			
		65.00 A		44.17 B				62.92A		42.17B			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

II- Leaf minerals content:

II.1. Leaf nitrogen content:

Table (10) displays that, differences in leaf nitrogen content of both scion cultivars and storage factors didn't reach level of significance. As for the response to date of grafting, it was so clear that Feb. grafting proved to be effective for raising leaf N content in both seasons. Moreover, grafting above ground produced leaves richer in N content; however the differences were insignificant in the second season.

As for interaction effect, it is quite clear that when stored Desirable scions were grafted in Feb. and the graft union zone was under-ground was statistically the most simulative for N content (0.83 & 0.85 %). The reverse was true in most cases with March grafting under-ground using un-stored Desi. scions (0.33 & 0.40 %), during both seasons of study.

Table (10): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on leaf N content of pecan under open field conditions during 2007 & 2008 seasons.

Seasons		2007						2008					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage
Desi.	+	0.83a	0.66d	0.44g	0.55f	0.60 A	Stored	0.85a	0.71d	0.49j	0.65ef	0.64 A	Stored
	-	0.55f	0.67d	0.33h	0.77b		0.62A	0.62g	0.65f	0.40k	0.79b		0.63A
Choct.	+	0.60e	0.72c	0.60e	0.55f	0.59A	Un-stored	0.67e	0.78b	0.66ef	0.60gh	0.65 A	Un-stored
	-	0.66d	0.53f	0.44g	0.61e		0.57A	0.75c	0.59h	0.52i	0.67ef		0.62A
M	Time	0.65 A		0.53 B				0.70 A		0.60 B			
	Graft position	Under-ground		Above-ground				Under-ground		Above-ground			
		0.55 B		0.63 A				0.62 A		0.68 A			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

II.2. Leaf phosphorus content:

Table (11) shows that, storing graft wood 2 weeks before grafting time exerted statistically the richest leaves in P content in both seasons, while the differences were insignificant for the other tested factors (scion cv. and date & position of grafting) in both seasons. As for interaction effect, the highest values on leaf P content were in concomitant to grafting above-ground using stored Choctaw scions on March (0.75 & 0.82%). On the other hand, the aforementioned superior treatment resulted also in the poorest leaves P content when un-stored Choctaw scions were used (0.41 & 0.47 %); this was true in both working years.

Table (11): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on leaf P content of pecan under open field conditions during 2007 & 2008 Seasons.

Seasons		2007						2008					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage
Desi.	+	0.61bc	0.57d	0.59cd	0.59b-d	0.56A	Stored	0.68b	0.63c	0.61de	0.56g	0.60 A	Stored
	–	0.59cd	0.54e	0.61bc	0.41h		0.50A	0.60ef	0.58fg	0.67b	0.47j		0.62A
Choct.	+	0.75a	0.46g	0.50f	0.75a	0.56A	Un-stored	0.68	0.50i	0.52h	0.82a	0.68 A	Un-stored
	–	0.51f	0.62b	0.46g	0.42h		0.52B	0.52h	0.63cd	0.48ij	0.50i		0.55B
Mean	Time	0.58 A		0.54 A				0.60 A		0.58 A			
	Graft position	Under-ground		Above-ground				Under-ground		Above-ground			
		0.58 A		0.54 A				0.59 A		0.58 A			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

II.3. Leaf potassium content:

It is evident from **Table (12)** that, whip-grafting done on March when growth began raised K levels in the leaves of pecan. In addition, when graft-wood was collected and grafted directly was more effective in this respect. Grafting above-ground gave higher content of K than under-ground grafting, where, differences were significant during 2008

season only. Meanwhile, differences between both scion cvs. didn't reach level of significance during both seasons. In regard to interaction effect, when Desirable graft wood was collected and grafted directly above-ground at the 1st week of March exerted statistically the highest stimulate effect on leaves K content (1.42 & 1.60 %), however, the reverse was found with under-ground grafting (0.74 & 0.73 %), such trend was firm during both seasons.

Considering the results indicated above for N.P. and K contents in leaves of sprouted shoots of the graft, it was indicated differences in nutrients uptake and distribution according to the rootstock used and the kind of nutrient. Identification of rootstocks capable of improving the minerals uses efficiency of the scion. In that respect, it was cleared that the rootstock used had relatively the super absorption capability and translocation of N and P and K to scion leaves. This reflects the higher degree of graft compatibility between the rootstock and scion. Considering the mechanisms involved in graft compatibility, nutrient and water uptake, assimilation and translocation of solutes and the influence of the rootstock on the main physiological processes of the scion were previously reported by **Coldecarrera *et al.*, (1997)**; **Stefani *et al.*, (1997); Doaa, (2009); Colla *et al* ., (2010)** and **Martinez *et al.*, (2010)** . They all indicated that the positive or negative effect of the used rootstock was based on the capability of it to restrict or allow water flow from the root to the shoot or to remove or keep substances, particularly minerals.

Table (12): Effect of date of cleft grafting, graft storage, position of grafting zone and scion cultivar on leaf K content of pecan under open field conditions during 2007 & 2008 seasons.

Seasons		2007						2008					
Treatments		Feb.		March		Mean		Feb.		March		Mean	
		Graft position						Graft position					
Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft storage	Under-ground	Above-ground	Under-ground	Above-ground	Cv.	Graft stor
Desi.	+	1.13e	1.14e	0.99g	0.98gh	1.08A	Stored	1.15ef	1.14fg	0.98j	1.03i	1.12 A	Stored
	–	1.13e	1.15e	0.74j	1.42a		1.08A	1.12g	1.18e	0.73l	1.60a		1.09B
Choct.	+	1.30c	0.96h	0.99g	1.20d	1.09A	Un-stored	0.90k	1.07h	1.03i	1.45b	1.16 A	Un-stored
	–	0.85i	1.03f	1.34b	1.04f		1.08A	1.02l	1.16ef	1.38c	1.26d		1.18A
M	Time	1.08 A		1.08 A				1.09 B		1.18 A			
	Graft position	Under-ground		Above-ground				Under-ground		Above-ground			
		1.06 A		1.11 A				1.04 B		1.23 A			

Means of each factor and their combinations in each season having the same letter/s are not significantly different at 5% level.

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الملخص العربي

دراسات على الإكثار الخضرى للبيكان أ- تطعيم البيكان بطريقة التطعيم بالشق تحت ظروف الحقل المفتوح

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*قسم بحوث الزيتون وفاكهة المناطق شبه الجافة - معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة –مصر

أجريت هذه الدراسة فى المزرعة البحثية بمحطة قها – محافظة القليوبية – مصر، والتابعة لمعهد بحوث البساتين خلال موسمى الدراسة (٢٠٠٨ , ٢٠٠٧)، وذلك بهدف دراسة تأثير بعض العوامل التي تؤثر على الإكثار الخضرى للبيكان بطريقة التطعيم بالشق تحت ظروف الحقل المفتوح مثـل:ميعاد التطعيم – تخزين خشب الطعم – موضع مكان التطعيم – صنف الطعم). أظهرت البيانات المتحصل عليها و الخاصة بالنمو الخضرى للطعم الناتج أنه عند إجراء التطعيم فى ٢٤ من فبراير أدى إلى زيادة قطر منطقة التطعيم وكذلك كلا من عدد الأفرع الناتجة وكذلك عدد الأوراق/ الأفرع. أما عند إجراؤه فى ٢ مارس كان أفضل بالنسبة لأطوال الطعم وكذلك الأفرع الناتجة، كما أدى إلى زيادة النسبة المئوية لنجاح الطعم (بعد ستة أشهر من إجراء التطعيم) وكذلك نسبة البقاء (بعد عام). بالنسبة لتأثير موضع منطقة التطعيم وجد أن التطعيم تحت سطح التربة يعتبر أحد الممارسات الزراعية الجيدة والتى أعطت نتائج أفضل من التطعيم فوق سطح التربة.

عموما يمكن استنتاج أنه عند تطعيم شتلات البيكان باستخدام أقلام الطعم لصنف شيكتاوا أعطت نتائج أفضل للنمو الخضرى لنبات الطعم الناتج عنه فى حالة استخدام أقلام صنف ديزايرابل. كما تم الحصول على أفضل نتائج للنمو الخضرى عند التطعيم باستخدام أقلام الطعم مباشرة بدون تخزين. بالإشارة لتأثير العوامل تحت الدراسة على النسبة المئوية للنجاح (بعد ستة أشهر من ميعاد التطعيم) وكذلك البقاء (بعد عام) قد سجلت (٩٨,٠٠ & ٩٤,٦٧%) ، (٩٦,٣٣ &٩٢,٠٠%) عند إجراء التطعيم فى ٢ مارس بحيث تكون منطقة التطعيم مغطاة بالتربة باستخدام أقلام الطعم الغير مخزنة لصنف شيكتاوا، فى حين كانت الأقل (٣٧,٣٣% & ٣٤,٦٧%) ، (٣٤,٦٧% & ٣٣,٠٠%) عند إجراء التطعيم فى ٢٤ فبراير باستخدام أقلام الطعم الغير مخزنة لصنف شيكتاوا وكانت منطقة التطعيم فوق سطح التربة وذلك خلال موسمى الدراسة على التوالى. كما أظهرت النتائج اختلافات واضحة بالنسبة لمحتوى أوراق الأفرع الناتجة على الطعم من عناصر النيتروجين، الفوسفور ، البوتاسيوم.