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EVALUATION OF SOME IMPORTED PECAN VARIETIES UNDER GIZA GOVERNORATE ENVIRONMENTAL CONDITIONS

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ABSTRACT

This study was carried out during two successive seasons of 2007 & 2008 to examine the performance of six new pecan varieties imported from Georgia, U.S.A. namely: Burkett, Desirable, Pawnee, Success, Western Schley, and Wichita. The experimental trees were grown at the Horticulture Research Institute, Giza, Egypt. This evaluation included morphological, flowering, yield and fruit quality, physical characteristics as well as kernel oil fatty acids composition and the ability to vegetative propagation by grafting. The Effect of environmental conditions on dichogamy phenomenon was also studied. It can be clearly noticed that, there is a positive relation between shoot length & diameter, av. No. of leaves per shoot and internodes length, where Burkett variety was the superior in this concern, while, Pawnee variety exceeded the others in twig length and No. of shoots/twig. Desirable var. recorded the highest No. / of leaflets/leave and leaflet area. Western Schley had smaller tree size. There was an obvious varietals difference in pecan bud developmental stages (dormant, vegetative and starting buds for staminate or pistillate inflorescences). The highest No. of the abovementioned buds as well as total No. of such buds and No. of fruits/shoot was observed in Western Schley variety except for No. of vegetative buds. Fruit set (%) averaged between 66.04 & 66.04 in Wichita to reach 85.60 & 82.57 in Desirable. Number of days in which pollen shed coincides with stigma receptivity varied between the studied varieties, where there was more consistent period of overlap in Pawnee, Success & Western Schley varieties. The previously mentioned varieties can be classified as protandrous (type, 1), whereas, Burkett, Desirable & Wichita varieties as protogynous (2). Moreover, Wichita can be considered a good pollinator for most other studied varieties. Pollen shedding period in Wichita extended with the increase of relative humidity and lower temperature. Burkett followed by Success varieties started and ended to crack shuck and harvesting earlier than other varieties. Western Schley, Desirable & Burkett varieties had an excellent kernel ercentage, respectively, whereas, Pawnee variety was the poorest. Varieties with high nut weight had lower No. of nuts /kg. Desirable followed by Burkett produced the highest yield, while, Success was the lowest. In regard to kernel oil content (%), Desirable followed by Western Schley kernels were the richest. The main compositional characteristic of pecan kernel was the high concentration of oleic acid and very low content of Linolinec acid. It is also interesting to note that, successful grafts (%) varied between varieties from 33.33 % in Western Schley to reach 93.33 & 91.66 % in Desirable & Success, respectively.

As a conclusion under the same conditions of the present study Burkett & Success may be recommended as early cropping varieties; Wichita as a good pollinator; Western Schley as a small size tree which can be helpful in increasing number of trees / Fed. which in turn increases yield/Fed. as well as may facilitate the trees cultural practices. The primary pecan varieties Desirable & Burkett performed superior to other varieties in terms of yield; Western Schley and Desirable as varieties that have higher percentages of kernel and oil content and Desirable & Success are characterized by their easy to vegetative propagation. Moreover, all of these varieties

were likely to complete their developmental growth cycle, which indicates low chilling requirements character and can be grown commercially in Egypt.
Keywords*:* Pecan - Evaluation – Morphological - Flowering - Dichogamy - Yield - Fruit quality - Kernel oil content - Fatty acids - vegetative propagation.

INTODUCTION

Pecan *(Carya illinoensis)* belongs to the walnut family (*Juglanadaceae*). It is native to the warm southern states of the U.S.A. and accordingly has low chilling requirements (Pena, 1995). Pecan also is commercially grown in Australia, South Africa, Israel, Argentina, Chile and Brazil; therefore, it may be highly productive under Egypt environmental conditions compared to Persian walnuts and other nut trees (Wood, 1994).

All nuts including pecan are good protein sources, containing few saturated fats, cholesterol free and high in unsaturated fats (Silva *et al.,* 1995). The unsaturated fats in pecan are protected against oxidation by the high concentration of y- tocophenol and polymeric flavones (Haddad *et al.,* 2006 and Attia & Wafaa, 2007). Moreover, pecan can be considered an important dietary source of antioxidants (Villarreal-Lo Zoya *et al.*, 2007 and Lombardini *et al.,* 2009) and lowered total cholesterol and LDL cholesterol (Sabate, 2003). In Egypt, pecan was known in the last 20^{th} century where it concentrated in Kaliobia Governorate (El Jabal El- Assfer zone and El Kanater El-Khairia) and in some other scattered areas (Okasha *et al.,* 1994). The small acreage of this crop is mostly due to scant knowledge of varieties, cultivation and growth habit of pecan tree (Hamoda, 1982 and Andersen, 1995). As mentioned above, pecan cultivation has to increase in Egypt to satisfy Egyptian markets needs. This increase will save money paid to import other kind of nuts; also, Egyptian pecan price is cheaper than other available nuts.

Pecan is considered among very high cash crops which are beneficial for both the grower and the national economy if right varieties are chosen when establishing a pecan orchard (Hamoda, 1978). Some factors that have to be taken into consideration when selecting a variety are regular production capacity, tree growth, branching properties, nut size and quality, kernel percentage, maturity and pollination characteristics (Herrera, 1985; Yao *et al.,* 2004 and Thompson, 2005). Moreover, understanding the flowering system in pecan trees is necessary for choosing appropriate cultivars in the design of productive orchards. It is also necessary for monitoring bloom in orchards as an aid to diagnosing problems and routine management (Grauke & Thompson, 2007). A pecan tree has dichogamous flowering (dicho='two part'; gamy='sexual union'), since male and female flowers on a tree mature at different times. If male flowers dehisce pollen before pistillate flowers are receptive, the tree is protandrous (protos=first; andro=male) and is classified as type (I). If female flowers are receptive before pollen is shed from catkins, the tree is protogynous (protos=first; gyne=female), and is classified as type II (Thompson & Romberg, 1985 and Sudheer *et al.,* 2005). Properties in pecan oils were similar or superior to extra-virgin olive oil and unrefined sesame oil. Although all native pecan oils studied showed a significant concentration of

oleic acid composition with the nutritional appeal that consumers demand (Lara *et al.,* 2001; Raja ram 2001; Attia & Wafaa, 2007 and Malik *et al.,* 2009). The principle fatty acids which form the triglycerides of pecan oil are oleic and linoleic acid, usually comprising about 95% or more of total oil. Both the percent of oil and degree of saturation vary with geographical locations. Linoleic acid is the primary chemical component responsible for oxidation and rancidity in pecan kernels. Linoleic acid varies widely in different varieties of well matured and plump kernels, and it also varies from year to year in the same variety (Herrera, 2005).

The success or failure of grafting may depends on the quality of scion wood of the desired cultivar (Solis, 1982).Some Egyptian experiences and researches on pecan are already available (Hamoda, 1978 & 1982; Sari El Deen, 1993; Awad, 2002; Abu - Taleb *et al.,* 2004 and Attia & Wafaa, 2007)which gave support to the idea of growing pecan commercially in Egypt. Old pecan varieties in Egypt are characterized by late bearing habit, low productivity, poor nut quality and low nutritive value. For those reasons, the Ministry of Agriculture imported new pecan varieties in 1992 from U.S.A . characterized by low chilling requirements and early bearing. Therefore, this study was designed to evaluate the growth, flowering, fruiting and kernel oil chemical contents of six newly imported pecan varieties namely: Burkett, Desirable, Pawnee, Success, Western Schley, and Wichita under Giza governorate, Egypt conditions. Also, the ability of such varieties to propagate vegetively by grafting was studied. This evaluation may be essential to recommend varieties that are early, high cropping with best fruit quality and easy to propagate vegetively.

MATERIALS AND METHODS

This study was carried out during two successive seasons of 2008 & 2009 to study the performance of six new pecan varieties imported by the Ministry of Agriculture from Georgia, U.S.A. namely: Burkett, Desirable, Pawnee, Success, Western Schley, and Wichita. The experimental trees were grown at the Horticulture Research Institute, Giza, Egypt, and planted at 5x5 meters apart. The trees were of the same age (15 years), uniform in vigor and planted in alluvial clay soil under flood irrigation system. The trees were grown under the same environmental conditions and cultural practices.

Table (1): **Chemical analyses of the soil**

pH	EC (Mill mhos/Cm.)	SP	Anions (Mill equivalent/Liter)				Cations (Mill equivalent/Liter)			
			$SO_4^{=}$	Cr	HCO_3^{-}	$CO_3^{=}$	K^{+}	Na^{+}	Mg^{++}	Ca^{++}
7.6	9.55	50	31.21	98.0	3.57	-	1.14	99.84	13.62	18.18

Table (2): **Mechanical analyses of the soil**

Particles size distribution (%)				Texture
Clay	Silt	Fine sand	Coarse sand	
32.4	34.8	27.6	5.2	Alluvial clay

The Average monthly temperature (c°) and relative humidity (%) at Giza Governorate, Egypt are presented in Figures (1, 2 & 3): Figures (1&2): Average monthly temperature (c°) at Giza Governorate, Egypt during 2008 & 2009 seasons.

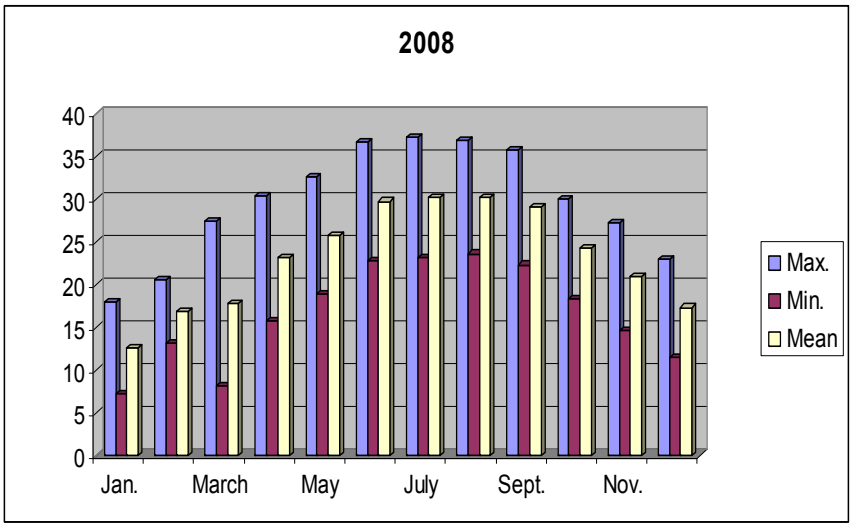

Figure (1): Average monthly temperature (C°) at Giza Governorate, Egypt during 2008 season.

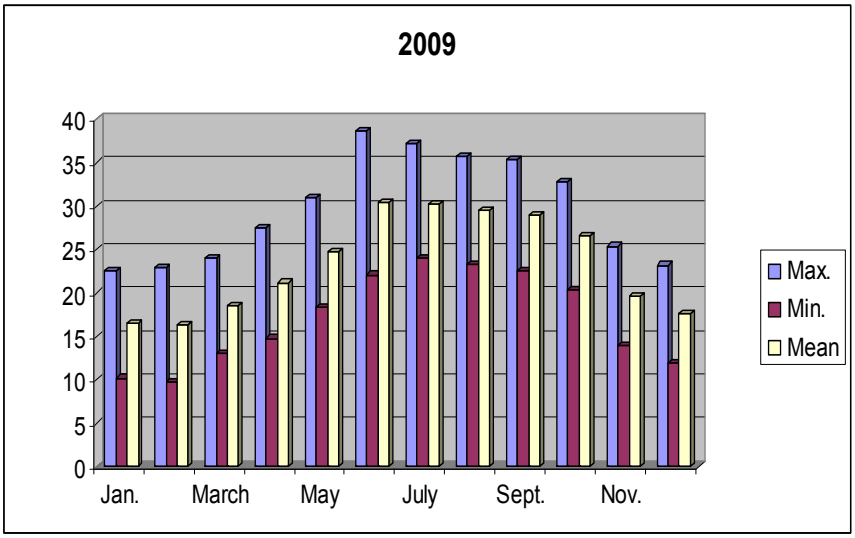

Figure (2): Average monthly temperature (C°) at Giza Governorate, Egypt during 2009 season.

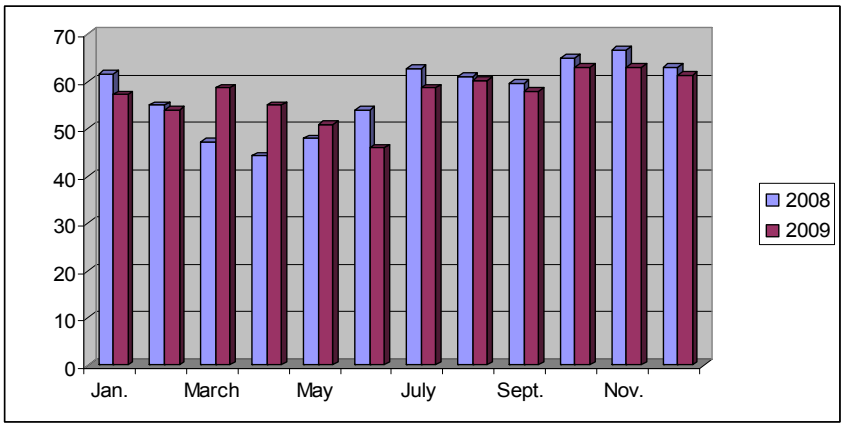

Figure (3): Average monthly relative humidity (%) at Giza Governorate, Egypt during 2008 & 2009 seasons.

The studied varieties were investigated for the following characters by represented 3 trees / each variety:

I. Morphological characters:

- **Shoot growth parameters:** In each season of study, 40 twigs of each replicate tree (10/each direction) were selected at random and tagged for measuring twig length (cm.), No. of fully developed shoots / twig, shoot length & diameter (cm.), leaves / shoot, leaflets / leave, internodes / shoot, internodes' length (cm.) as well as leaflet area $(cm.)^3$ using area meter CI-203. Leaf color: rates on 1-10 from dark green to brown, based on Munsell Color Chart for Plant Tissue.
- **Tree form:** Tree trunk diameter was measured at uniform height (1 m.) using calibrated circumference tape during dormant season. Tree height/canopy width was also recorded in dormant season with clinometers and canopy width measured across widest point in axis of row. In addition, tree canopy shape was classified from rounded to pointed.

II. Flowering characteristics:

At the time of growth (mid-March), the previously selected twigs were measured for the followings:

- **Bud developmental stages and fruit set (%):**

Number of buds was classified as: dormant – vegetative - staminate inflorescence (male), pistillate inflorescence (female) – and total No. of buds was calculated. No. of fruits/shoot was counted and fruit set (%) was calculated according to the following equation:

Number of pistilate flowers = No. of pistillate inflorescence x No. of flowers/ pistilate inflorescence

$$\text{Fruit set (\%)} = \frac{\text{Number of pistilate flowers} \times 100}{\text{Total No. of buds}}$$

- **Morphological characteristics of flowering inflorescences:**

The number of flowers / pistillate inflorescence was recorded. Average lengths of middle & the two lateral panicles / staminate flower and

length (cm.) of pistillate inflorescence were measured and the av. of total length of the three panicles was calculated. Number of flowers/ pistilate inflorescence was counted

- **Dichogamy**: First and last dates of pollen shed and pistil receptivity were recorded to be classified to either protandrous (type 1) or protogynous (type 2). In protogynous types, stigmas become receptive prior to pollen shed and in protandrous types; pollen begins to shed before the stigmas are receptive.
- **Effect of environmental conditions on dichogamy phenomenon:** The relation between average temperature (c^o) and relative humidity (%) at pollen shedding and stigma receptivity periods of the studied varieties was studied.
- **Dates of fruit set**: At the end of blooming period, the date of beginning and end of fruit set was determined.

III. Yield and fruit quality characteristics:

Pecan fruits were harvested from Sept. – Oct. (depending on variety) as soon as the outer inedible hull (also called a shuck, husk or bur) has split and the shells are brown and once the hull can be removed easily from the nuts. The outer hull was removed promptly by hands so the nuts can dry properly, then weight of hull (gm.) was determined.

- **Dates of shuck dehiscence, harvesting and leaf abscission:**

After harvesting and hulling the nuts were dried properly to reduce kernel moisture, prevent molds developing and a disagreeable flavor (rancidity) and prolonged nut storage life. Nuts were dried under room temperature of about 20-30 C^o for about 3-4 weeks by spreading in a single layer on a tray or screen to allow good air circulation and often stirred.

- **Yield:** The average number of nuts /kg. and weight (kg.) of total yield / each replicate tree were determined at harvest after hulling.

A random sample of 50 nuts/ each replicate tree was tested for nut physical properties as follows:

- **Nut shape:** Nut length, width (measured in the plane of the suture at the widest point) and height (measured perpendicular to the plane of the suture at the widest point). Nut shape based on nut length to height ratios as classified by Grauke & Thompson (2007) as follows: Orbicular (1 to 1.39); Ovate (1.40 to 1.59); Obviate (1.40 to 1.59); Oval elliptic (1.40 to 1.59); Elliptic (1.60 to 1.79) Oblong elliptic (1.80 to 1.99) and Oblong greater than 2.00. Apex & base shape (acute, acuminate or obtuse) and cross section form is described as laterally compressed, round or flattened. Dorsal grooves and Kernel color was also described.
- **Nut weight in grams:** Was determined by weighting 50 nuts/ tree and av. nut weight in grams was calculated. Kernel weight was determined after the nuts were cracked using hand-held pecan cracker and then nut shell weight (gm.) was calculated by difference. Kernel percentage was calculated according to the following equation:

$$\text{Percentage of kernel} = \frac{\text{Av. weight of kernel} \times 100}{\text{Av. weight of nut}}$$

- **Nut volume:** Determined as described by Dodge (1944).

- **Nut shell touch:** Nut shell was classified as rough or smooth**.**
- **Nut shell hardness:** A radial cut at tip, middle and base of nut, perpendicular to suture, and hardening is recorded as 0 =no hardening, 1= hardened at apex, 2 = hardened to middle, 3 = hardened to base of nut (Kaniewski, 1965).
- **Percentage of kernel oil content:** Samples were kept in sealed freezer bags at -18 C^o until analyzed. Before oil extracting pecan kernels were cracked using hand-held pecan cracker. Oil content was determined by extracting the oil from the dried kernel samples by means of Soxhelt Fat Extraction using petroleum ether as a solvent at 60-80 C^o boiling points (A.O.A.C., 1975).
- **Kernel oil fatty acids composition:**

Agilent 6890 series GC apparatus provided with a DB-23 column (60m x 0.32mm x 0.25µm) was used. Fatty acids methyl esters (FAME) were directly injected into the GC. Carrier gas was N2 with flow rate of 2.2 m1/min, splitting ratio of 1:50. The injector temperature was 250 C^o and that of FID detector was 270 C^o. The temperature setting were as follows:150 C^o to 225 C^o at 5 /min, and then held at 255C ^{o} for 20 min. Fatty acids were identified by comparing the retention time of the standard sample with that of the unknown sample (A.O.A.C., 1990).

IV. Ability to vegetative propagation: The ability of varieties under this study to vegetative propagation by grafting was investigated. Cleft grafting technique was carried out using the dormant scions cut during winter (last week of Feb.). Two years old pecan seedlings grown from a collection of pecan seeds were selected as rootstocks for grafting, uniform in growth and thickness of about 20 cm in height. The selected seedlings were grown in black plastic bags 22x45cm (1 seedling / bag) in a mixture of peat and sand (1:2). After grafting the containers were well watered and placed under shaded polyethylene tunnel. After one month of grafting, the plastic tunnels were removed gradually, then eradicating lateral branches under the graft union. Two months later, % of union success, length of grafts, number of sprouted shoots/ graft; number of leaves / sprouted shoots and number of leaflets/ leave were recorded.

Statistical analysis:

The Complete Randomized Block Design was followed in this study . The obtained data in both seasons was subjected to analysis of variance according to Snedecor & Cochran (1980). Differences between treatments were compared using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

I. Morphological characters

Shoot growth parameters

Table (3) & Figure (4) reveal significant differences between the studied varieties with respect to their shoot growth parameters. A positive relation between shoot length & diameter, av. No. of leaves per shoot and internodes length were noticed. Burkett variety was superior in this concern. With regard to the variations in twig length and No. of shoots/twig, it may be

interested to note that, Pawnee variety exceeded the others as it recorded 45.39 & 51.66 cm. for twig length and 8.33 & 7.66 for No. of shoots/twig, in both seasons, respectively. In addition, Desirable var. recorded the highest No./of leaflets/leave (17.00 & 16.33) and leaflet area (34.49 & 28.74 cm^3), however, it had the lowest twig length (especially in 1st season), No. of shoots/twig, shoot length (both seasons) and No. of internodes/shoot (1st season). Moreover, No. of internodes/shoot was the highest in Western Schley variety. In general, most varieties can be identified by leaf color characteristic, where it ranged from dark green (Wichita var.) to yellow green (Desirable & Pawnee). This wide variability that exists in shoot growth parameters in different varieties of pecan may be attributed to the differences in some genetically related characters which resulted from hybridization action. These results are in line with those of Awad (2002) and Abu - Taleb *et al.* (2004).

Table (3): Shoot growth parameters of the studied pecan varieties during 2008 & 2009 seasons.

Variety	Twig length (cm.)		No. of shoots/ twig		Shoot length (cm.)		Shoot diameter (cm.)		No. of leaves/ shoot	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Burkett	26.97 c	26.58 e	7.00 b	6.00 bc	28.33 a	28.70 a	0.58 a	0.66 a	10.50 a	13.33 a
Desirable	20.33 d	27.58 d	5.66 c	5.00 c	11.72 c	12.10 c	0.55 a	0.58 c	9.44 b	10.35 c
Pawnee	45.39 a	51.66 a	8.33 a	7.66 a	11.83 c	12.30 c	0.55 a	0.57 c	9.55 b	10.07 cd
Success	35.77 b	22.11 f	7..66 ab	7.33 a	14.00 bc	14.67 b	0.56 a	0.67 a	10.50 a	11.03 b
Western Schley	46.03 a	40.61 b	6.66 bc	6.00 bc	14.61 b	15.03 b	0.47 b	0.53 d	9.55 b	9.66 d
Wichita	34.67 b	33.34 c	7.33 ab	7.00 ab	16.33 b	14.45 b	0.55 a	0.62 b	7.44 c	8.61 e

Table (3): Cont

Variety	No. of leaflets/ leave		Internodes length (cm.)		No. of internodes/ shoot		Leaflet area $(cm.)^3$		*Leaf color
	2008	2009	2008	2009	2008	2009	2008	2009	
Burkett	13.00 cd	12.33 c	5.83 a	6.06 a	9.00 ab	10.0 a	16.61 d	21.32 c	**2**
Desirable	17.00 a	16.33 a	2.33 cd	2.52 c	8.00 b	8.33 bc	34.49 a	28.74 a	**3**
Pawnee	15.00 b	15.00 b	2.61 bc	2.86 b	9.33 ab	9.33 ab	25.95 b	20.23 d	**3**
Success	11.67 e	12.33 c	2.19 d	2.46 c	9.00 ab	10.0 a	21.53 c	24.75 b	**2**
Western Schley	13.67 c	14.33 b	2.16 d	2.34 c	10.0 a	10.3 a	21.62 c	22.09 c	**2**
Wichita	12.33 de	11.67 c	2.94 b	3.05 b	8.66 ab	8.00 c	25.89 b	18.52 e	**1**

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

***Alternatively, use 1-3 scale where 1=dark green; 2=medium green; 3=yellow green**

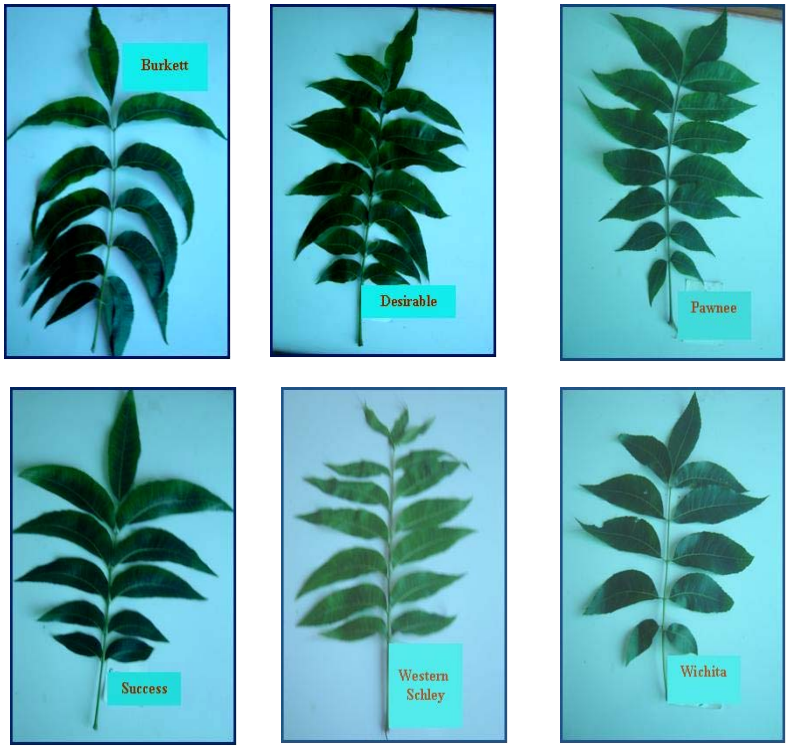

Figure (4): Leaf characteristics of the studied pecan varieties

Tree form:

It is noticed from Table (4) that, there are significant varietal differences in the studied tree dimensions among pecan varieties. In this respect, tree height, trunk diameter and canopy width varied from 4.50 & 4.63 m., 35.67 & 38.83 cm. and 4.50 & 4.73 m. in Western Schley var. to reach 11.00 & 11.13 m. in Pawnee var., 99.33 & 102.3 cm. in Wichita var. and 10.33 & 10.73 m. in Success var., respectively, in both seasons. As for canopy shape, it is observed that, Burkett, Pawnee and Success varieties have pointed shape while the others are rounded. In general we may note that, the difference in growth vigor may be due to the difference in growth habit. Common contrasting types are willowy and strong, spreading and upright, central leader and free branching. Angles at which limps branch from the trunk or other limps, affect confirmations and indirectly the strength of the frame work of a variety. These results were previously confirmed by ((Hamoda, 1982; Sari El Deen, 1993; Awad, 2002; Abu Taleb *et al.,* 2004; Thompson, 2005 and Attia & Wafaa, 2007).

Table (4): Tree dimensions of the studied pecan varieties during 2008 & 2009 seasons.

Variety	Tree height (m.)		Tree trunk diameter (cm.)		Canopy width (m.)		Head shape
	2008	2009	2008	2009	2008	2009	
Burkett	6.50 bc	6.63 d	50.33 c	52.50 c	6.50 b	6.70 b	Pointed
Desirable	7.00 bc	7.13 c	93.00 b	95.19 b	5.50 c	5.76 c	Rounded
Pawnee	11.00 a	11.13 a	51.67 c	51.80 c	7.00 b	7.30 b	Pointed
Success	6.00 c	6.01 e	40.67 d	47.87 d	10.33 a	10.73 a	Pointed
Western Schley	4.50 d	4.63 f	35.67 e	38.83 e	4.50 d	4.73 d	Rounded
Wichita	7.50 b	7.63 b	99.33 a	102.3 a	6.50 b	6.76 b	Rounded

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

II. Flowering characteristics:

Bud developmental stages and fruit set (%):

It is noticed in Table (5) that, there are obvious varietal differences in pecan bud developmental stages which had been previously identified as: dormant, vegetative and starting buds for staminate or pistillate inflorescences. In this respect, the highest No. of the abovementioned buds as well as the total No. of such buds was observed in Western Schley variety except for No. of vegetative buds observed in Pawnee variety. However, the opposite was true in Desirable variety (especially in 1st season). Moreover, Western Schley followed by Desirable produced higher No. of fruits/shoot in both seasons. As for fruit set (%), it averaged between 66.04 & 66.04 in Wichita var. to reach 85.60 & 82.57 in Desirable var. In this respect, Grauke & Thompson (1996 & 2007) proved that, mature pecan trees bear male and female flowers at different locations on the same tree. Pecan flowers develop from the compound buds, which are composed of two laterals floral, or catkin buds and a central mixed bud. As growth resumes in spring, the central mixed bud elongates to form the vegetative shoot, which may terminate in the female (pistillate) inflorescence. The two lateral floral buds each produce a three stalked catkin group, the male (staminate) inflorescence. It is also observed that, average No. of pistillate inflorescences was greatly lower than staminate ones, which is usually the case in dichogamus species to overcome the lack of the overlapping in reproductive organs maturity (Hamoda, 1982).

5

Morphological characteristics of flowering inflorescences:

It is interesting to note from Table (6) & Figure (5) that, the staminate inflorescence in all varieties under this study contained only three panicles (2 laterals & 1 middle). We also noticed that, there were three categories in pecan staminate inflorescence; one of them (middle) was usually recorded to be taller than the other two panicles (laterals). In this concern, the length and the av. length of the three panicles ranged between (10.30, 11.00, 9.83 & 31.13 cm.) in the 1st season and (11.00, 13.00, 11.00 & 35.80 cm.) in the 2nd season in Burkett vari. to reach (5.36, 6.70, 5.30 & 17.36 cm.) in Western Schley var. in 1st season and (5.83, 7.33, 5.16 & 18.32 cm.) in Pawnee var. in 2nd season. Moreover, there was a slight significant varietal difference in av. length of pistilate inflorescence between the investigated varieties, whereas, Western Schley var. had the highest records. The highest No. of flowers/ pistilate inflorescence was observed in Wichita (1st season) and Desirable (2nd season), while, Burkett took the other way around in both seasons of study. Such results are partially in harmony with those obtained by Sparks & Janoudi (2000); Awad, (2002) and Abu Taleb *et al.* (2004) on some pecan varieties.

Table (6): Morphological characteristics of flowering inflorescences of the studied pecan varieties during 2008 & 2009 seasons.

Variety	Staminate inflorescence								Pistilate inflorescence			
	Av. panicle length (cm.)								Av. length of pistilate inflor-escence (cm.)		No. of flowers/ pistilate inflor-escence	
	1st lateral		Middle		2nd lateral		Av. length of the three panicles (cm.)					
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Burkett	10.30 a	11.00 a	11.00 a	13.00 a	9.83 a	11.0 a	31.13 a	35.80 a	2.53 b	2.70 ab	3.27 d	3.72 c
Desirable	6.16 c	6.16 bc	8.16 b	8.83 b	5.83 c	6.00 d	20.15 bc	20.99 b	2.26 b	2.26 c	4.11 c	4.66 a
Pawnee	6.50 bc	5.83 c	8.16 b	7.33 c	6.23 c	5.16 e	20.89 bc	18.32 c	2.20 b	2.33 bc	4.16 c	4.00 bc
Success	6.16 c	6.83 b	7.66 b	8.66 b	5.83 c	7.00 bc	19.65 c	22.49 b	2.50 b	2.66 ab	4.65 b	4.00 bc
Western Schley	5.36 d	6.73 b	6.70 c	8.16 b	5.30 d	6.50 cd	17.36 d	21.39 b	2.98 a	2.83 a	4.11 c	3.99 bc
Wichita	6.83 b	6.83 b	7.50 b	8.16 b	7.50 b	7.33 b	21.83 b	22.32 b	2.50 b	2.66 ab	5.00 a	4.33 ab

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range test.

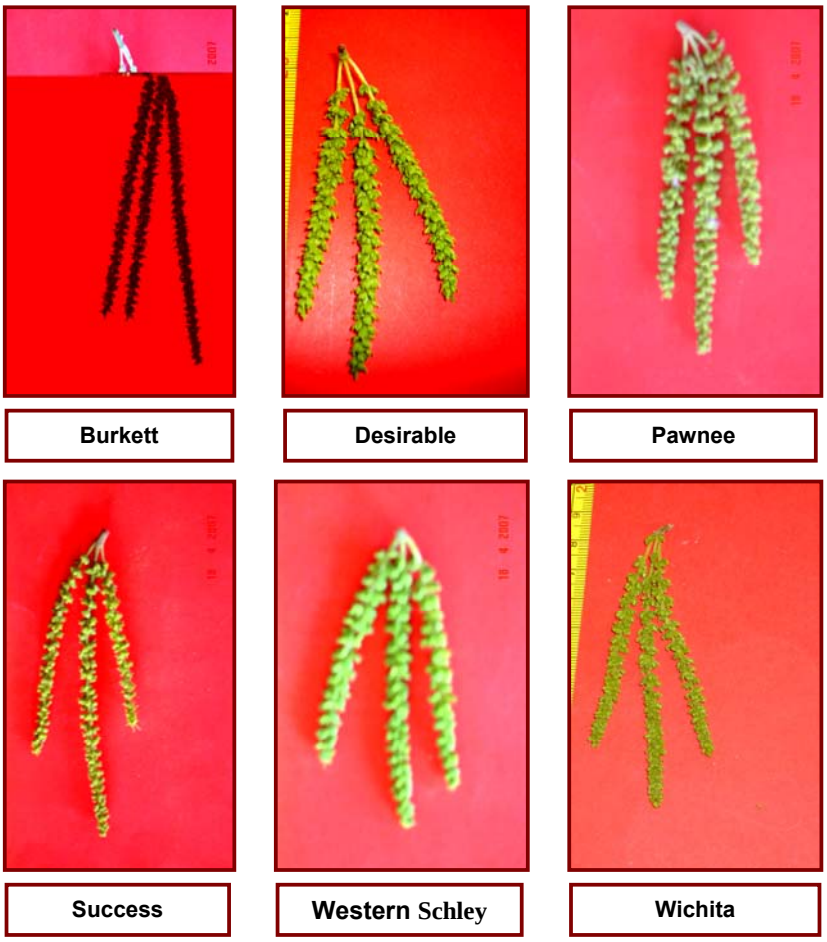

Figure (6): Staminate inflorescence characteristics of the studied pecan varieties.

Dichogamy and dates of fruit set:

The pattern of stigma receptivity and pollen shedding is very important consideration in selecting a pecan cultivar. Pollen must be shed at a time when stigma is receptive for pollination to occur. Since there is often little overlap in stigma receptivity and pollen shedding within a given variety, varieties with complimentary pollination characteristics should be planted together. The overlapping of pollen grain shedding and stigma receptivity is presented in (Table, 7 and Figures 6 & 7). We can clearly observe that, there was a noticeable difference in these combinations for each variety in both seasons under study. This may be due to environmental changes.

7 + Fig3-

Fig4

It is also noted that, number of days in which pollen shed coincide with stigma receptivity varied between the studied varieties, where there was more consistent period of overlap in Pawnee, success & Western Schley varieties. The previously mentioned varieties can be classified as protandrous (type, 1) where pollen begins to shed before the stigmas are receptive, whereas, Burkett, Desirable & Wichita varieties as protogynous (type, 2), where stigmas become receptive prior to pollen shed. Moreover، Wichita can be considered a good pollinator for most of commercial pecan varieties. With respect to dates of fruit set, Burkett & Wichita started to set fruit earlier, while, Desirable & Pawnee were the latest. However, Desirable ended fruit set later than the other varieties. These results are in line with other investigators on pecan (Hamoda, 1982; Awad, 2002; Abu Taleb *et al*., 2004; Sudheer *et al;* 2005 and Andersen, 2008). Timing of pollen shed and pistil receptivity may be affected by variations in physiological and environmental conditions (Brison, 1974). Moreover, Wolestenholm (1972) studying the phenomenon of dichogamy stated that, cool weather enhanced protogeny in invariable protogynous cultivars, whereas hot weather increased protandary in the regularly protandrous cultivars.

Effect of environmental conditions on dichogamy phenomenon: It is clearly obvious that the periods of polling shedding and stigma receptivity to pollens are greatly affected by temperature and relative humidity (Tables 8 & 9). There was a linear relationship between minimum temperature (both seasons) and relative humidity (2nd season) and pollen shedding period where it was extended with the increase of relative humidity and minimum temperature.

Table (8): Average temperature (c°) at pollen shedding and stigma receptivity periods of the studied pecan varieties under Giza Governorate conditions during 2008 & 2009 seasons.

Variety	Shedding of pollens						Stigma receptivity to pollens					
	2008			2009			2008			2009		
	No. of days for polling shedding	Av. Min. temp.	Av. Max. temp.	No. of days for polling shedding	Av. Min. temp.	Av. Max. temp.	No. of days for Stigma receptivity	Av. Min. temp.	Max. temp.	No. of days for Stigma receptivity	Min. temp.	Av. Max. temp.
Burkett	10	14.1	32.2	12	15.3	30.5	7	15.8	28.7	7	14.8	28.6
Desirable	10	16.8	33.9	10	15.4	29.7	7	17.1	30.6	9	15.3	30.6
Pawnee	12	15.8	34.4	10	15.3	31.1	5	16.9	30.9	6	15.1	29.4
Success	11	14.9	31.9	11	15.0	29.2	6	16.5	31.7	10	15.4	30.7
Western Schley	11	16.2	31.1	10	15.3	29.7	7	16.6	31.8	8	15.4	30.6
Wichita	16	16.9	31.2	15	16.3	29.6	5	14.9	27.9	5	16.2	25.1

- This was clear in Wichita variety which had the longest pollen shedding period. However, stigma receptivity to pollens took the opposite trend especially in the 1st season in the previously mentioned variety. The response was not clear in the other varieties. The dichogamy phenomenon may be strictly genetic in some pecan cultivars with no overlapping and may be environmentally influenced in other cultivars with different degrees of overlapping (Hamoda, 1982; and Abu - Taleb *et al*., 2004).

Table (9): Average relative humidity (%) at pollen shedding and stigma receptivity periods of the studied pecan varieties under Giza Governorate conditions during 2008& 2009 seasons.

Variety	Shuck dehiscence				Harvesting				Leaf abscission			
	2008		2009		2008		2009		2008		2009	
	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End
Burkett	3/9	2/10	25/9	20/10	25/9	11/10	12/10	27/10	6/11	2/12	20/11	12/12
Desirable	2/10	11/10	8/10	15/10	29/10	11/11	25/10	15/11	10/12	28/12	13/12	2/1
Pawnee	1/10	12/10	28/9	7/10	9/10	20/10	5/10	17/10	5/11	1/12	2/11	3/12
Success	28/9	8/10	25/9	5/10	2/10	12/10	30/9	11/10	29/10	25/11	27/10	21/11
Western Schley	4/10	24/10	10/10	27/10	12/10	28/10	15/10	3/11	10/11	10/12	13/11	15/12
Wichita	5/10	15/10	7/10	19/10	13/10	23/10	20/10	26/10	15/11	10/12	11/11	9/12

III. Yield and fruit quality characteristics:

Dates of shuck dehiscence, harvesting and leaf abscission:

Table (10) shows noticeable variations between varieties and even between two seasons in dates of shuck dehiscence, harvesting and leaf abscission, which may be due to changes in environmental conditions. In this concern, Burkett followed by Success varieties started and ended to crack shuck and harvesting earlier than other varieties, however, Western Schley was the latest in shuck dehiscence and Desirable in harvesting and leaf abscission dates. Moreover, Success var. was the earliest in leaf abscission. The duration between beginning & end of shuck dehiscence and harvesting seemed to be longer in Desirable and Burkett, while in Success var. was the shortest. These results are in general agreement with conclusions previously reported by Hamoda (1982) ; Thompson & Young (1985) and Abu - Taleb *et al.* (2004) they stated that, hull cracking is known to be closely related with harvesting time.

Table (10): Dates of fruit shuck dehiscence, harvesting and leaf abscission of the studied pecan varieties during 2008 & 2009 seasons.

Variety	Relative humidity (%) at shedding of pollens period		Relative humidity (%) at stigma receptivity to pollens	
	2008	2009	2008	2009
Burkett	45.0	54.9	44.9	44.9
Desirable	41.3	52.9	48.9	45.2
Pawnee	44.2	53.7	49.0	46.8
Success	45.5	51.8	46.8	46.8
Western Schley	45.3	52.0	46.0	45.6
Wichita	43.7	58.0	43.0	46.0

They also found that, there is also a relationship between date of the end of leaf abscission and kernel quality and yield in the next year, which may be due to the increase in carbohydrate storage in the prolonged period before leaf abscission.

Fruit quality characteristics:

Table (11) reveals significant differences between varieties with respect to their fruit quality characteristics expressed as weights of fresh fruits, hull, dry nut, shell and kernel. The records of these parameters ranged from 21.04 to 49.22 gm., 10.19 to 33.93 gm., 7.84 to 17.40 gm., 3.01 to 10.03 gm. and 4.83 to 9.10 gm, respectively in the second season. It is clear in some varieties that, the highest dry nut weight doesn't mean the highest kernel weight and percent of whole nut. From the economical point of view, Western Schley variety had an excellent kernel percentage (64.05 %) in the 1st season and Desirable in the 2nd one (63.25 %) followed by Burkett (62.40 & 61.61 %) in both seasons respectively. Only Pawnee variety represents poor kernel % especially in the 2nd season as it recorded (42.36 %) comparing to the other varieties. These results are in agreement with those obtained by (Herrera, 1985; Yao *et al.,* 2004; Thompson, 2005 and Maeda, 2006) they demonstrated that, some factors have to be taken into consideration when selecting a variety as regular production capacity, tree growth, branching properties, nut size and quality, kernel percentage, maturity and pollination characteristics. One of the most important characteristics of pecan fruit evaluation should be nut filling which give an idea of the edible part of the fruit and an indication for the nutritional status of the tree. Kernel (%) may be genetically a related character or high nitrogen fertilization in the stage of nut filling which leads to poor filling due to competitive between vegetative growth and kernel growth. High temperature may also cause poor nut filling (Brison, 1974).

Table (11): Fruit quality characteristics of the studied pecan varieties during 2008 & 2009 seasons.

Variety	Fruit weight (gm.)		Hull weight (gm.)		Dry nut weight (gm.)		shell weight (gm.)		Kernel weight (gm.)		% of kernel	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Burkett	27.72 c	24.64 d	18.89 d	19.40 d	7.74 f	7.84 e	2.91 c	3.01 d	4.83 de	4.83 d	62.40 b	61.61 b
Desirable	29.57 b	32.23 c	20.88 c	20.93 c	8.87 d	10.34 c	3.66 c	3.80 c	5.21 d	6.54 bc	58.74 c	63.25 a
Pawnee	35.34 a	35.18 b	23.61 b	23.80 b	16.36 a	17.40 a	7.36 a	10.03 a	9.00 a	7.37 b	55.01 e	42.36 e
Success	35.94 a	49.22 a	33.40 a	33.93 a	14.69 b	15.45 b	6.33 b	6.35 b	8.36 b	9.10 a	56.91 e	58.90 c
Western Schley	29.11 b	21.04 e	10.28 f	10.15 f	10.43 c	9.35 c	3.75 c	3.92 c	6.68 c	5.43 c	64.05 a	58.07 c
Wichita	26.67 c	21.34 e	12.93 e	12.01 e	7.95 e	8.50 d	3.47 c	3.58 c	4.48 e	4.92 d	56.35 d	57.88 d

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

Fruit dimensions and yield:

The results in Table (12) indicated that, pecan varieties differed in their dimensions and shape according to variety. The data declared that, nut length is longer than width in all varieties, whereas, Desirable nuts were the longest and superior in shape index. However, Burkett nuts recorded the lowest values of shape index, but, it had the highest values of nut height & volume. As for No. of nut /kg., it was clear that, varieties with high nut weight (as previously recorded in Table, 11) had lower No. of nuts /kg. In this respect, Pawnee & Success had the heaviest nuts (16.36, 14.39 & 17.40, 15.45 gm.) and the lowest No. of nuts /kg. (76.23 & 65.09, 86.36 & 62.25). On the other hand, Burkett & Wichita had the least nut weight (7.74 &7.95, 7.84 & 8.50 gm.) and the highest No. of nuts /kg. (134.9 & 158.6, 136.0 & 118.2), this was true in both seasons, respectively. Nut yield was also variable in both seasons, where, Desirable var. exceed other varieties as it yielded (12.50 & 10.20 kg), while, Success var. was the lowest in this concern (5.23 & 6.55 kg.) , during both seasons, respectively. In regard to kernel oil content (%), Desirable followed by Western Schley kernels were the richest. However, the differences were not significant between them. Whereas Burkett kernel was the poorest in oil content in both seasons under investigation. These results were previously confirmed by Awad, (2002) and Abu - Taleb *et al.* (2004), they demonstrated that, oil content vary in pecan according to tree load, variety, region and geographic area. Our data on nut dimensions and yield are partially supported by Hamoda (1982); Attia & Wafaa, (2007) and Grauke & Thompson (2007).

Nut physical characteristics:

Table (13) & Figure (8) shows some physical properties of the examined pecan varieties represent their external view and cross section form. The data declared that, for all varieties fruit length is longer than height & width. Therefore, Burkett, Pawnee & Western Schley have orbicular shape as their shape index (previously recorded in Table, 8) ranged between 1 to 1.39 cm. where Desirable & Wichita have oblong elliptic shape (1.80 to 1.99 cm.) and Success has Elliptic shape (1.60 to 1.79 cm.) . Variations between varieties with respect to their nut apex & base shape varied between acute, acuminate or obtuse. As for cross section form, Pawnee has laterally compressed form, while, the other varieties were rounded. Generally speaking, all varieties under study are attractive in kernel color. Shell surface was smooth in Burkett, Success & Western Schley and the others have rough touch. Moreover, the hardness of Desirable, Pawnee & Western Schley varieties shell was clear at nut apex where it hardened to base of nut in success variety. However, shell hardness didn't appear in Burkett variety. Such findings are supported by findings of Hamada (1982); Abu - Taleb *et al.* (2004); Attia & Wafaa, (2007) and Grauke & Thompson (2007).

12,13

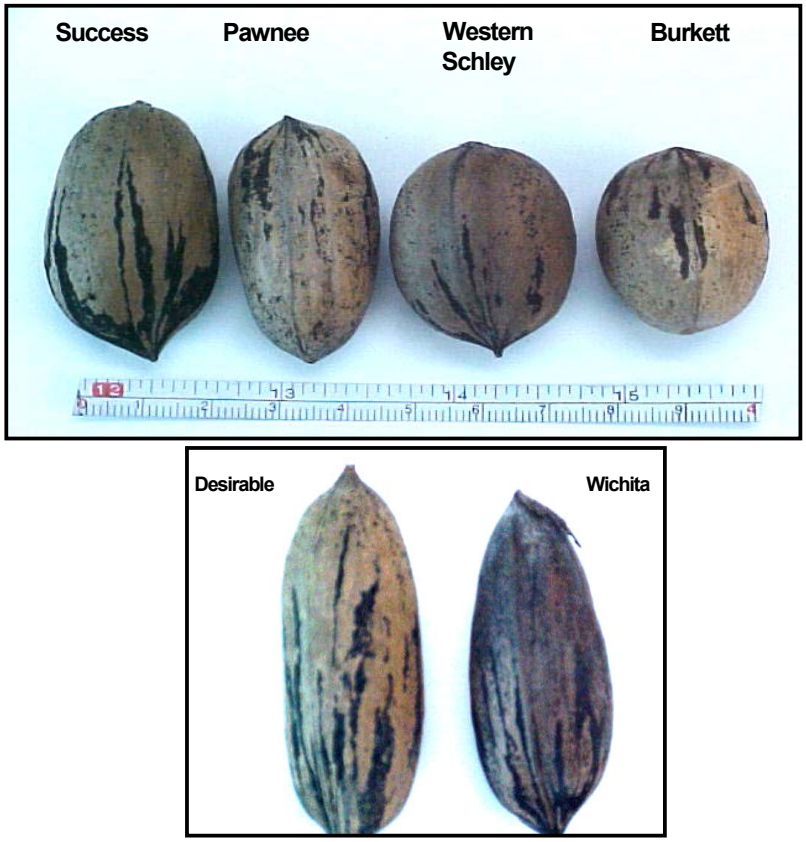

Figure (8): Nut shape of the studied pecan varieties.

Kernel oil fatty acids composition:

The fatty acids composition of the oil extracted from kernel of the studied pecan varieties are presented in Table (14). In general, the total unsaturated acids exceed the saturated ones. In this concern, the total unsaturated fatty acids ranged between 85.94 to 89.74 & 85.75 to 91.43 % w/w, where the total saturated fatty acids varied from 7.41 to 10.13 & 8.24 to 10.94 % w/w, in both seasons, respectively. The main compositional characteristic of the kernel was the high concentration of oleic acid (48.97 to 70.07 & 49.40 to 75.27 % w/w). The most abundant saturated fatty acid was Palmetic acid. It is worthy to mention that, one feature of pecan kernel oil is its very low content of Linolinec acid as in case of many other vegetables oils such as cottonseed, sunflower and maize oil (Lara *et al.,* 2001; Attia & Wafaa, 2007 and Malik *et al.,* 2009)). Linoleic acid is the primary chemical component responsible for oxidation and rancidity in pecan kernels. Linoleic acid varies widely in different varieties of well matured and plump kernels, and it also varies from year to year in the same variety (Herrera, 2005).The unsaturated fats in pecan are protected against oxidation by the high

concentration of y- tocophenol and polymeric flavones (Haddad *et al.,* 2006). The data also showed that, the ratio of unsaturated to saturated fatty acids ranged from 8.6 to 12.1 & 8.1 to 11.0 % w/w, in both seasons, respectively. The proportion of oleic, linoleic, and linolenic fatty acids determined the oxidative stability, viscosity, and melting/crystallization behavior of pecan oil. In general, these properties in pecan oils were similar or superior to extra-virgin olive oil and unrefined sesame oil (Toro-Vazquez *et al.,* 1999).

Table (14): Fatty acids composition (weight %) of pecan kernel of the studied pecan varieties during 2008 & 2009 seasons.

Variety	Fatty acids											
	Saturated Acids						Total Saturated		Unsaturated acids			
	Palmetic C16:0		Stearic C18:0		Arthodonic C20:0				Palmeionoleic C16:1		Oleic C18:1	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Burkett	5.46 cd	5.96 cd	2.03 d	2.30 cd	0.10 bc	0.10 b	7.59 e	8.37 e	0.04 ab	0.05 a	70.07 a	75.27 a
Desirable	7.36 ab	7.70 b	2.50 bc	2.70 b	0.15 a	0.22 a	10.01 c	10.63 b	0.08 a	0.08 a	57.80 d	55.73 c
Pawnee	7.03 b	7.53 b	3.03 a	3.33 a	0.07 c	0.08 b	10.13 a	10.94 a	0.04 b	0.01 b	48.97 f	49.40 d
Success	5.00 d	5.60 d	2.30 cd	2.53 bc	0.10 bc	0.10 b	7.41 f	8.24 f	0.06 ab	0.05 a	63.53 b	64.00 b
Western Schley	5.76 c	6.15 c	2.63 b	2.50 bc	0.13 ab	0.13 b	8.52 d	8.78 d	0.05 ab	0.06 a	61.87 c	62.10 b
Wichita	7.73 a	8.12 a	2.23 cd	2.16 d	0.11 ab	0.11 b	10.08 b	10.39 c	0.05 ab	0.06 a	54.80 e	55.37 c

Table (14) :Cont.

Variety	Unsaturated acids (cont.)						Total Un-Saturated		U/S ratio*	
	Linoleic C18:2		Linolinec C18:3		Gadoleic C20:1					
Burkett	15.47 f	15.77 f	0.04 ab	0.05 a	0.31 a-c	0.28 ab	85.94 e	91.43 a	11.4 b	10.9 b
Desirable	28.97 c	29.57 c	0.08 a	0.08 a	0.31 a-c	0.28 ab	87.25 d	85.75 f	8.7 d	8.1 d
Pawnee	38.20 a	38.77 a	0.04 b	0.01 b	0.24 c	0.22 b	87.50 c	88.42 d	8.6 d	8.1 d
Success	25.80 e	26.27 e	0.06 ab	0.05 a	0.28 bc	0.27 ab	89.74 a	90.65 b	12.1 a	11.0 a
Western Schley	27.27 d	27.63 d	0.05 ab	0.06 a	0.36 a	0.30 a	89.41 b	90.16 c	10.5 c	10.3 b
Wichita	32.00 b	32.27 b	0.05 ab	0.06 a	0.35 ab	0.31 a	87.26 d	88.08 e	8.7 d	8.5 c

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

IV. The ability to vegetative propagation by grafting:

The data on the percentage of successful grafts and their vegetative growth characteristics are presented in Table (15). It is interesting to note that, successful grafts (%) varied between varieties from 33.33 & 33.33 % in Western Schley to reach 93.33 & 91.66 % in Desirable & Success. However, the last mentioned variety recorded the lowest values of vegetative growth characteristics (except for No. of sprouted shoots/graft); whereas, Desirable exceed other varieties in average length of sprouted shoots and number of

leaflets/leave, this was true in both seasons of study. Moreover, Wichita produced the highest No. of sprouted shoots & leaves /graft. The success or failure of grafting may depends on the quality of scion wood of the desired cultivar (Solis, 1982; Fayek *et al.,* 1994 and El-Sayed *et al.,* 1992 *&* 2000).

Table (15): Vegetative propagation by whip grafting method of the studied pecan varieties during 2008 & 2009 seasons.

Variety	% of successful grafts		No. of sprouted shoots/graft		Av. Length of sprouted shoots		Av. No of leaves/graft		Av. No of leaflets/leave	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Burkett	58.33 c	53.33 d	1.44 d	1.66 b	17.72 b	27.67 b	11.95 ab	13.67 ab	7.21 c	6.33 c
Desirable	83.33 b	93.33 a	3.00 ab	3.33 a	20.43 a	29.33 a	10.99 bc	13.33 b	10.67 a	11.67 a
Pawnee	83.33 b	80.00 c	1.97 c	1.91 b	21.46 a	16.40 d	10.83 c	12.33 c	4.33 e	4.23 e
Success	91.66 a	86.66 b	1.83 cd	2.00 b	12.77 c	12.37 e	9.30 d	9.85 d	5.14 e	5.27 d
Western Schley	33.33 e	33.33 f	2.66 b	3.00 a	12.89 c	20.67 c	12.89 a	12.40 c	6.14 d	5.86 cd
Wichita	50.00 d	46.66 e	3.16 a	3.00 a	15.23 bc	20.67 c	12.75 a	14.33 a	8.81 b	10.33 b

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

It could be concluded from this study that, under the same conditions most of the studied varieties can be commercially grown under Giza governorate conditions, Egypt. Some varieties such as Burkett & Success started to crack shuck and harvesting earlier than the others as Desirable. Others have smaller tree size as Western Schley, which can be helpful in increasing number of trees / Fed. this in turn increases yield/Fed. as well as may facilitate cultural practices. Wichita had large pollen shedding period that overlapping with most other varieties stigma receptivity. Desirable & Burkett are considered productive varieties. Other varieties had higher percentages of kernel and oil content as Western Schley and Desirable. While others are characterized by their easy to vegetative propagation by using cleft grafting technique as Desirable & Success which can be helpful in expansion of pecan in Egypt.

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تقييم بعض أصناف البيكان المستوردة تحت الظرف البيئية لمحافظة الجيزة

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أجريت هذه الدراسة خلال موسمى الدراسة ٢٠٠٨ & ٢٠٠٩ لدراسة سلوك ستة أصناف من البيكان (بيركيت – ديزايرابل – باونى – ساكسيس – ويستيرن شلاى – ويشيتا) والتى تم استيرادها من ولاية جورجيا –الولايات المتحدة الأمريكية ، والنامية بمزرعة بحوث البساتين - الجيزة – مصر. شمل هذا التقييم الصفات المرفولوجية – التزهير – صفات جودة الثمار الفيزيائية – محتوى لب الثمرة من الزيت والأحماض الدهنية وكذلك مقدرتها على الإكثار الخضرى بالتطعيم بالقلم. اتضح أن هناك علاقة ايجابية بين طول وقطر الفرع ، عدد الأوراق/الفرع ، طول السلامية ، حيث أعطى صنف بيركيت أفضل النتائج بالنسبة لهذه الصفات، أما صنف باونى كان الأفضل بالنسبة لطول الفرخ الخضرى وعدد الأفرع الناتجة عليه ، وقد سجل صنف ديزايرابل أكبر عدد للوريقات/الورقة وكذلك مساحة الورقة. كان حجم شجرة ويسترن شلاى هو الأصغر. هناك اختلافات واضحة بين الأصناف فى مراحل نمو البراعم (ساكنة - خضرية – نورات مونثة- نورات مذكرة) حيث سجلت أعلى القيم لهذه البراعم (ماعدا البراعم الخضرية) والعدد الكلى لها وكذلك عدد الثمار/الفرع لصنف ويسترن شلاى. تراوحت النسبة المئوية للعقد مابين ٦٦.٠٤ % لصنف ويشيتا ، ٨٥.٦٠ & ٨٢.٥٧ % لصنف ديزايرابل. كان هناك اختلافات واضحة بين الأصناف من حيث التوافق بين فترات استعداد المياسم للتلقيح وبين انتثار حبوب اللقاح فقد تميزت أصناف باونى ، ساكسس ، ويسترن شلاى بطول فترة انتثار حبوب اللقاح كما أنها تنتمى الى مجموعة مبكرة الطلع (انتثار حبوب اللقاح قبل نضج المياسم المؤنثة) ، فى حين أن أصناف بيركيت ، ديزايرابل ، ويشيتا تنتمى الى مجموعة مبكرة المتاع (نضج مياسم الأزهار قبل انتثار حبوب اللقاح). كذلك يمكن اعتبار صنف ويشيتا كملقح جيد لبقية الأصناف تحت الدراسة حيث ساعد ارتفاع درجة الحرارة والرطوبة الى امتداد فترة انتثار حبوب اللقاح لصنف ويشيتا. كان صنف بيركيت يليه ساكسس الأبكر من حيث بداية ونهاية تشقق غلاف الثمرة وكذلك الحصاد. كما أحتوت أصناف ويستيرن ، ديزايرابل ، بيركيت ، على التوالى على أعلى نسبة للحم الثمار ، فى حين أن صنف باونى كان الأقل. اتضح أيضا من النتائج أن الأصناف التى تحتوى على أعلى وزن للثمار احتوت على أقل عدد للثمار/كجم. كذلك تفوق صنف ديزايرابل يليه بيركيت على الأصناف الأخرى من حيث المحصول (كجم/الشجرة)، ولكن صنف ساكسس كان الأقل فى هذا الصدد. كان أعلى محتوى للزيت فى لب ثمار صنف ديزايرابل يليه ويستيرن شلاى. كانت أهم الصفات المميزه للب ثمار البيكان هى زيادة محتواه من حمض الأوليك، وانخفاض حمض اللينولينيك.

تفاوتت نسبة نجاح التطعيم بين الأصناف حيث كانت ٣٣.٣٣ %لصنف ويستيرن شلاى لتصل إلى (٩١.٦٦ & ٩٣.٣٣ %) فى صنفى ديزايرابل وساكسس، على التوالى.

من هذه الدراسة يمكن أن نستخلص بأنه تحت نفس الظروف يمكن أن نوصى بالأصناف الأتية:

بيركيت وساكسس كأصناف مبكرة - ويشيتا كملقح جيد أما ويستيرن شلاى فيتميز بصغر حجم الشجرة مما يساعد على زيادة عدد الأشجار للفدان وبناء عليه زيادة الإنتاجية للفدان وكذلك تسهيل عمليات الخدمة للأشجار، كما تميز صنفى ديزايرابل و بيركيت بالإنتاجية العالية –أما ويستيرن شلاى وديزايرابل فقد تفوقت باحتواء ثمارهما على نسبة عالية من اللحم والزيت.وبالنسبة للمقدرة على الإكثار الخضرى فقد أظهر صنفى ديزايرابل وساكسس مقدرتهما على سهولة الإكثار خضريا بالتطعيم بالقلم. علاوة على ذلك فإن هذه الأصناف تمكنت من اكتمال دورة نموها ولذلك فهى تتميز بأنها تحتاج الى وحدات برودة قليلة ، ويمكن أن تنمو تجاريا فى مصر.

قام بتحكيم البحث

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Variety	No. of dormant buds/ twig		No. of vegetative buds/ twig		No. of staminate inflorescences/ twig		No. of pistilate inflorescences / twig		Av. No. of total buds / twig		No. of fruits/shoot		Fruit set (%)	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Burkett	6.77 B	6.22 ab	7.00 b	6.00 bc	4.55 c	6.38 c	3.00 a	2.66 b	21.32 c	21.26 b	7.66 ab	7.33 b	78.13 b	74.01 b
Desirable	5.41 C	5.55 b	5.66 c	5.00 c	4.00 d	5.50 d	2.66 ab	2.33 c	17.73 d	18.38 c	9.33 a	9.00 ab	85.60 a	82.57 a
Pawnee	8.83 A	6.77 a	8.33 a	7.66 a	7.16 b	10.80 b	2.33 bc	2.66 b	26.65 b	27.56 a	7.11 b	7.33 b	73.33 d	69.23 c
Success	6.27 Bc	4.33 c	7.66 ab	7.33 a	6.75 b	4.00 e	2.33 bc	2.66 b	23.01 c	18.32 c	7.00 b	7.33 b	64.80 e	69.20 c
Western Schley	8.44 A	6.62 a	6.66 bc	6.00 bc	14.90 a	13.33 a	3.00 a	3.33 a	33.00 a	29.28 a	9.33 a	9.66 a	75.67 c	72.57 b
Wichita	5.83 Bc	3.33 d	7.33 ab	7.00 ab	6.66 b	6.50 c	2.22 c	2.66 b	21.48 c	17.49 c	7.33 b	7.66 b	66.04 e	66.04 d

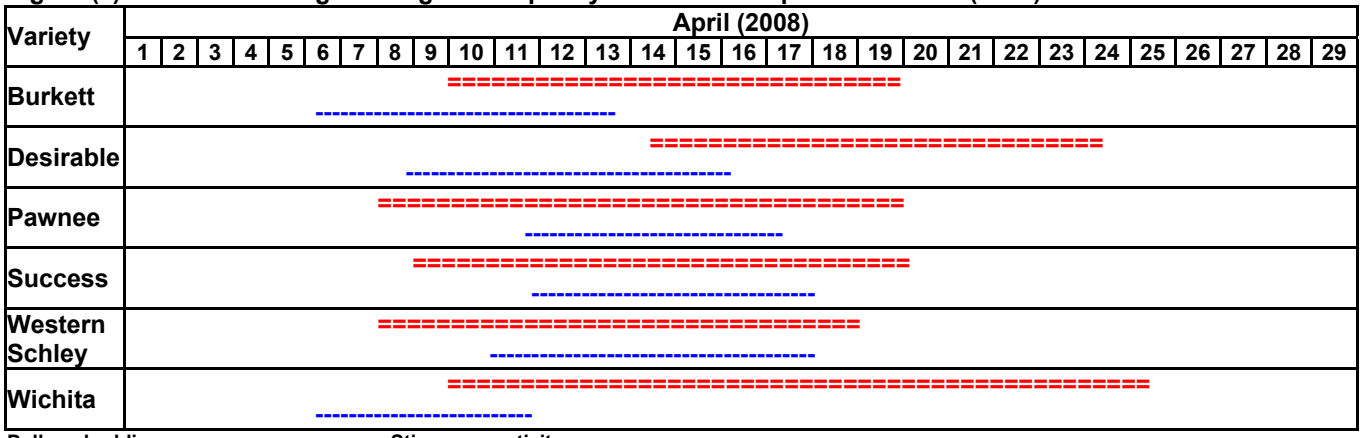
Table (5): Bud developmental stages characteristics and fruit set (%) of the studied pecan varieties during 2008 & 2009 seasons.

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

Table (7) : Dates of pollen shed, pistil receptivity and fruit set of the studied pecan varieties during 2008 & 2009 seasons.

Variety	Shedding of pollens				Stigma receptivity to pollens				Dichogamy	Type	Fruit set			
	2008		2009		2008		2009				2008		2009	
	Start	End	Start	End	Start	End	Start	End			Start	End	Start	End
Burkett	11/4	21/4	9/4	21/4	7/4	14/4	6/4	13/4	Protogynous	**II**	12/4	25/4	10/4	24/4
Desirable	16/4	26/4	18/4	28/4	10/4	17/4	12/4	21/4	Protogynous	**II**	16/4	28/4	18/4	29/4
Pawnee	9/4	21/4	11/4	21/4	13/4	18/4	13/4	19/4	Protandrous	**I**	16/4	22/4	17/4	24/4
Success	10/4	21/4	7/4	18/4	13/4	19/4	10/4	20/4	Protandrous	**I**	15/4	25/4	14/4	27/4
Western Schley	9/4	20/4	9/4	19/4	12/4	19/4	11/4	19/4	Protandrous	**I**	15/4	25/4	16/4	27/4
Wichita	11/4	27/4	13/4	28/4	7/4	12/4	6/4	11/4	Protogynous	**II**	13/4	22/4	11/4	23/4

Figure (3): Pollen shedding and stigma receptivity of the studied pecan varieties (2008).



Variety	April (2009)																												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Burkett										==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
										----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Desirable										==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
										----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Pawnee										==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
										----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Success										==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
										----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Western Schley										==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
										----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Wichita										==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
										----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------

Figure (4): Pollen shedding and stigma receptivity of the studied pecan varieties (2009).
Pollen shedding ========== Stigma receptivity ----------

Table (12): Nut dimensions and yield of the studied pecan varieties during 2008 & 2009 seasons.

Variety	Nut length (cm.)		Nut height (cm.)		Nut shape index		Nut width (cm.)		Nut volume (cm.)		No. nuts /kg.		Yield/tree (kg.)		Kernel oil content (%)	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Burkett	3.00 d	3.16 c	2.90a	2.76 a	1.03d	1.14e	2.46 b	2.50 b	10.33 a	10.67 a	134.9 b	136.0 a	10.03 b	8.51 bc	68.18 d	67.31 d
Desirable	4.50 a	4.46 a	2.36 c	2.33 de	1.91a	1.91a	2.18 c	2.13 d	8.67 b	9.33 b	118.6 c	103.1 c	12.50 a	10.20 a	79.62 a	80.20 a
Pawnee	3.00 d	2.96 d	2.26 c	2.16 e	1.33b	1.37d	2.46 b	2.38 c	9.33 ab	10.00 ab	76.23 e	86.36 e	7.14 e	8.38 c	78.75 a	78.86 ab
Success	4.35 a	4.18 b	2.36 c	2.60 ab	1.84ab	1.61c	2.73 a	2.76 a	8.67 b	8.00 c	65.09 f	62.25 f	5.23 f	6.55 e	74.75 b	75.13 b
Western Schley	3.16 c	3.10 cd	2.66 b	2.53 bc	1.19c	1.23d	2.66 a	2.81 a	9.93 a	9.83 ab	100.1 d	97.26 d	9.06 c	8.03 d	78.21 a	78.32 ab
Wichita	4.16 b	4.20 b	2.30 c	2.36 cd	1.81ab	1.78b	2.16 c	2.20 d	10.33 a	10.67 a	158.6 a	118.2 b	8.33 d	8.56 b	70.51 c	70.30 c

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

Table (13): Some Nut physical characteristics of the studied pecan varieties.

Variety	Nut shape	Apex shape	Base shape	Cross section form	Kernel color	dorsal grooves	Shell surface	*Shell hardness
Burkett	Orbicular	Obtuse apex	Round	Round	Golden to light brown	Prominent dark brown speckles	Smooth	0
Desirable	Oblong elliptic	Obtuse	Obtuse - round	Round	Golden	Wide	Rough	1
Pawnee	Orbicular	Obtuse	Round	laterally compressed	Golden	Wide	Rough	1
Success	Elliptic	Obtuse	Obtuse - round	Round	Golden to light brown	Wide, shallow	Smooth	3
Western Schley	Orbicular	Right angled	Acute	Round	Golden to light brown	Deep, tight	Smooth	1
Wichita	Oblong elliptic	Acute to acuminate	Rounded peculate	Round	Golden to light brown	Narrow	Rough	1