

STUDIES ON GROWTH, FLOWERING AND FRUITING OF SOME IMPORTED PECAN VARIETIES UNDER EGYPTIAN ENVIRONMENTAL CONDITIONS

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ABSTRACT

The present investigation was carried out in both 2001 & 2002 seasons to study the growth, flowering and fruiting characteristics of ten new pecan varieties were imported from Georgia, U.S.A. namely: Apache, Caddo, Cape Fear, Cheyenne, Choctaw, Farley, Mohawk, Sioux, Stuart and Sumner under the Egyptian conditions in Kalubia Governorate at El-Gabal El-Asfar region. This study clearly showed a wide significant variety differences in all vegetative growth characteristics of the studied trees. As for number of staminate, pistillate and total buds / twig, the highest averages were observed in Apache, Mohawk, Stuart and Sumner varieties. However, the highest average number of vegetative buds / twig was observed in Apache in both seasons. The variety differences were also clear in number of flowers per pistillate inflorescence. Choctaw and Stuart recorded the highest values in this concern, while Caddo variety was the lowest. Considering the pollination combination with stigmatic receptivity phenomenon in the studied varieties, data clearly showed that pollen shedding period before pistils are receptive (Protandry Type I) as shown in Caddo, Cape Fear and Cheyenne varieties. Whereas pistils receptive before pollen is shed (Protogyny Type II) as shown in most of the studied varieties. As for fruit set date, Mohawk variety was the earliest one in this regard. With regard to fruit yield (Kg)/tree and quality especially hull, nut, kernel and shell weight, it can be seen that Mohawk was the promising variety for obtaining the best results in this concern. Furthermore, the highest percentage of kernel to whole nut was observed in Sioux followed by Choctaw compared to other varieties. Cape Fear followed by Mohawk and Caddo varieties were the earliest in hull cracking, while, Sioux was the latest. Similar results were recorded for harvesting date. Moreover, Farley and Sioux trees were the earliest in leaf abscission date compared to other varieties.

INTRODUCTION

The pecan (*Carja illinoensis*) belongs to family *Juglandaceae* that is native to the warm southern states of the U.S.A. In Egypt the environmental conditions are suitable for the pecan tree growth and production, compared to Persian walnuts and other nut trees. Most of the current production is derived from Moneymaker, Curtis and Mahan cultivars; there is likely much untapped potential existing among the 1000+ existing scion cultivars (Thompson and Yang, 1985). Many investigators evaluated some pecan varieties under ARE conditions, they found that vegetative growth, flowering & fruiting varied from one cultivar to the other in different year. This may be genetically related characters, environmental condition and production zone. (Bakr, 1965); (Hamoda, 1973 and 1982); (Sari El-Deen, 1993) and (Awad, 2002). Pecan orchards are long lasting and expensive investment. Careful variety selection is one of the most important decision of a grower has to be make. Some

factors that have to be taken into consideration when selecting a variety are regular production capacity, tree strength, branching properties, nut size and quality, kernel percentage, maturity and pollination characteristics (Herrera, 1985). William (1989) demonstrated that, dichogamy refers to the characteristic of pecan cultivars to mature both male and female flower at different times on the same tree. This prevents self-fertilization, which generally impose nut growth and development. Pollen shed occurs before the female flowers are respective in Type I (protandrous) cultivars, and the reverse occurs with Type II (ptotogynous) cultivars. For this reason, both types of trees must be planted in an orchard for optimum pollination (Mullenax & Young, 1973 and Wolstenholm, 1972). Old pecan varieties characteristics by poor nut quality and low nutritive values as compared with the introduced new ones.

Recently, the Ministry of Agriculture imported in 1992 some other new pecan varieties from Georgia, U.S.A., which are characterized by low chilling requirements and early cropping. Thus, the present investigation was carried out to study the growth, flowering and fruiting characteristics of ten of the most promising new pecan varieties namely: Apach, Caddo, Cape Fear, Cheyenne, Choctaw, Farley, Mohawk, Sioux, Stuart and Sumner under the Egyptian conditions in kalubia Governorate at El-Gabal El-Asfar region. Such studies are very essential to recommend the best of these varieties to be grown with regard to cropping and fruit characteristics.

MATERIALS AND METHODS

This investigation was carried out in both 2001 and 2002 seasons, on ten new pecan varieties were imported by the Ministry of Agriculture from Byron, Georgia, U.S.A., namely: Apache, Caddo, Cape Fear, Cheyenne, Choctaw, Farley, Mohawk, Sioux, Stuart and Sumner. Trees were about 8 years old, grown in sandy soil at El-Gabal El-Asfar orchard, Kalubia Governorate. Six trees from each variety planted at 8x10 meters apart were used in this work. The trees were of the same age and grown under the same environmental and cultural practices. The following characters were investigated for each individual tree:

I. Morphological characters:

Tree dimensions: Tree height, top and trunk diameter were measured. Tree head shape was classified from rounded to pointed.

Shoot growth and leaf characteristics: 30 shoots/ replicate tree from fully developed spring growth were measured for: length and diameter (cm), No. of internodes, leaves and leaflets/ leaf and leaflet area (cm)² using area meter CI-203.

II. Tree blooming: On mid-March in 2001 and 2002 seasons, 30 twigs (one-year old)/ tree replicate tree were tagged at random. At the time of growth, number of dormant and vegetative buds per twig were recorded. The average number of staminate and pistillate inflorescences on flowering twigs was estimated. Lengths of laterals and middle panicles/ staminate inflorescence were measured in cm and average length of the three panicles was calculated. Number of flowers / pistillate inflorescence (female clusters) was

also counted. Dates of different stages of flower growth (blooming, shedding of pollens and stigma receptivity) were recorded. Beginning of fruit set was also determined at the end of blooming period.

III. Harvesting and yield:

Dates of hull cracking, harvesting and leaf abscission were recorded. The average weight of the total yield (kg) per each tree and number of nuts /kg were determined at harvest.

Nut physical characteristics: A sample of 100 nuts was taken from each tree and cured by storage under temperature of about 20-30°C for about 40-50 days, to determine nut characteristics as follows: the averages of nut and shell weight in grams, nut dimensions (polar & equatorial diameters / length & width in cm.), and nut shape index was calculated by dividing polar diameter by equatorial one. Kernel percentage was also calculated according to the following equation:

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

In addition, percentage of kernel's oil content was determined by extracting the oil from the dried kernel samples by means of Soxhlet fat extraction using petroleum ether as a solvent at 60-80°C boiling point (A.O.A.C. 1975).

The experimental treatments were arranged in a Randomized Complete Block Design. Data recorded in both seasons were subjected to analysis of variance according to Snedecor and Cochran (1980) and means were differentiated using Duncan's multiple range test (Duncan, 1955).

RESULTS and DISCUSSION

Tree dimensions and vegetative growth

Data dealing with tree dimensions and vegetative growth of the studied pecan varieties are presented in Tables (1 & 2) and Figure (1). It can be clearly noticed that, there is a wide significant variety differences in all studied tree dimensions Table (1), specially tree height, top and trunk diameter. Tree height varied from 6.84 m. in Caddo variety to reach 11.01 & 10.67 m. in Apache and Mohawk varieties, respectively in the 2nd season and this was clearly related to top and trunk diameter. As for head shape it can be seen that, Apache, Cape Fear, Cheyenne, Sioux and Sumner varieties are pointed while the others are rounded. In general, the shape and confirmation characteristics of the tree can identify most varieties. Angeles at which limbs branch from the trunk or other limbs, affect confirmation, and indirectly the strength of the framework of a variety (Harnoda, 1982). In this respect, Birson, (1974) demonstrated that, growth habit of pecan tree is mainly characterized by apical dominance of the initial shoot, that arises from the plumule which tends to produce a central leader that shapes the branches, which forms the general framework of the tree.

In regard to the variations of vegetative growth, it may be interested to note (Table, 2) that Farley variety was higher in shoot length and diameter compared with other varieties, and lower in number of internodes/ shoot in both 2001 & 2002 seasons.

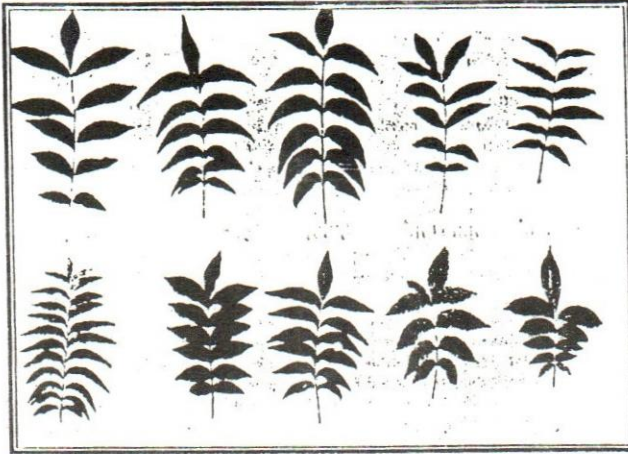


Fig. (1) : Leaves of the studied pecan varieties .

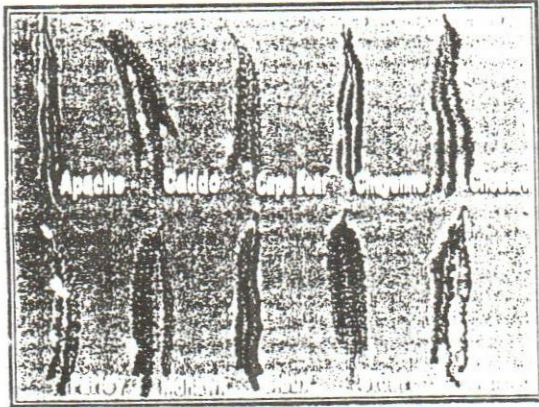


Fig. (2) : Staminate (male) flowers of the studied pecan varieties .



Fig. (3) : Pistillate (female) flowers of the studied pecan varieties .

The obtained data also reveal that number of leaves/ shoot was higher in Stuart trees as compared with other varieties. The same observation was found in number of leaflets/ leaf especially in 1st season and Cape fear & Stuart in 2nd season. With regard to leaf area, marked differences between Caddo and Cape Fear varieties were noticed which ranged from 28.64 & 28.87 to 19.35 & 18.99 (cm)³, in both seasons, respectively.

Variation in different varieties concerning tree dimensions and vegetative growth in pecan are in line with those of Haulik & Holtzhausen (1988); Miller *et al*, (1995) and Muhammad (1999) who reported that, the different vigour may be due to the differences in some genetically related characters which result from hybridization action.

Table (1): Tree dimensions of the studied pecan varieties during 2001 and 2002 seasons.*

Varieties	Tree height (m)		Top diameter (m)		Trunk diameter (cm)		Head shape
	2001	2002	2001	2002	2001	2002	
Apache	9.66 A	11.01 A	14.74 A	15.38 A	99.67 A	101.7 A	Pointed
Caddo	5.60 E	6.84 E	6.99 E	7.85 F	63.00 E	64.33 E	Rounded
Cape Fear	8.15 C	9.74 BC	7.58 E	8.12 F	74.33 D	76.00 D	Pointed
Cheyenne	6.18 D	7.07 E	8.04 E	10.11 E	94.67 B	97.33 B	Pointed
Chocataw	7.80 C	9.04 D	12.78 BC	13.13 C	73.33 D	74.33 D	Rounded
Farley	8.03 C	9.39 CD	14.42 A	15.17 A	75.67 D	77.67 CD	Rounded
Mohawk	9.43 A	10.67 A	13.80 AB	14.17 B	80.33 C	81.00 C	Rounded
Sioux	7.80 C	9.04 D	11.56 D	12.06 D	64.67 E	66.33 E	Pointed
Stuart	8.84 B	9.62 BC	12.51 C	12.83 C	91.67 B	93.67 B	Rounded
Sumner	8.89 B	10.08 B	13.36 BC	12.91 C	93.00 B	94.00 B	Pointed

* Means not followed by a common letter are statistically different at 5% using Duncan's Multiple Range Test. **Bud growth**

The average numbers of different developmental stages of bud growth are presented in Table (3). The highest average number of staminate, pistillate and total buds / twig was observed in Apache, Mohawk, Stuart and Sumner. Referring variation in average number of dormant buds / twig, it is quit evident that Stuart, Mohawk and Apache recorded the highest numbers in this respect. However, the highest average number of vegetative buds / twig was observed in Apache in both seasons, while the lowest values was recorded in Sioux in 2001 and Mohawk in 2002. Varietal differences with regard to bud growth are nearly similar to those obtained by Bakr (1965); Hamoda (1978&1982) and Awad, (2002) under Egyptian conditions.

Morphological characteristics of staminate and pistillate inflorescences

Table (2): Growth characteristics of the studied pecan varieties during 2001 and 2002 seasons.*

Varieties	Shoot length (cm)		Shoot diameter (cm)		No. of internodes/shoot		No. of leaves/shoot		No. of leaflets/ leaf		Leaf Area (cm) ²	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Apache	22.72 BC	21.03 B	0.46 D	0.57 BC	9.67 A	10.67 CD	7.33 DE	9.33 BC	13.00 C	15.00 AB	23.03 CD	22.89 CD
Caddo	22.33 BC	20.05 B	0.50 CD	0.50 CD	9.67 A	8.67 E-G	8.00 CD	9.00 BC	11.00 DE	12.00 CD	28.64 A	28.87 A
Cape Fear	22.72 BC	20.03 B	0.60 B	0.53 B-D	9.67 A	10.67 CD	8.67 B-D	8.33 B-D	13.00 C	15.33 A	19.35 E	18.99 E
Cheyenne	22.44 BC	22.44 B	0.57 BC	0.50 CD	10.67 A	12.67 B	10.00 BC	10.33 BC	12.00 CD	12.67 C	23.86 BC	23.86 C
Choctaw	20.55 C	20.93 B	0.53 B-D	0.70 A	10.00 A	16.67 A	9.33 BC	10.67 B	14.33 B	14.33 B	21.36 DE	21.78 D
Farley	27.78 A	25.55 A	0.77 A	0.73 A	5.67 B	7.00 G	7.50 DE	8.00 CD	9.67 F	10.67 E	23.49 CD	23.76 C
Mohawk	20.97 C	20.78 B	0.47 D	0.40 E	9.33 A	9.00 EF	7.33 DE	6.37 D	10.67 EF	11.67 C-E	25.90 B	25.75 B
Sioux	20.13 C	15.85 C	0.57 B-D	0.47 DE	8.67 A	10.33 C-E	3.00 D	9.33 BC	11.67 DE	11.00 DE	23.39 CD	23.52 CD
Stuart	20.55 C	21.42 B	0.60 B	0.60 B	9.00 A	7.67 FG	12.67 A	14.00 A	15.67 A	15.76 AB	28.37 A	26.89 B
Sumner	24.43 B	25.92 A	0.53 B-D	0.60 B	9.33 A	11.67 BC	6.33 E	8.00 CD	9.67 F	11.67 C-E	24.65 BC	26.08 B

*Means not followed by a common letter are statistically different at 5% using Duncan's Multiple Range Test.

Table (3): Eud growth parameters of the studied pecan varieties during 2001 and 2002 seasons.*

Varieties	Av. no. of dormant buds/twig		Av. no. of vegetative buds/twig		Av. no. of staminate inflorescences/twig		Av. no. of pistillate inflorescences/twig		Av. no. of total buds/twig	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Apache	2.10 A	2.77 A	6.03 A	3.27 A	2.90 CD	4.43 A	4.03 A	3.67 AB	15.06 A	14.14 A
Caddo	0.73 C	1.73 CD	4.17 B	2.73 AB	1.53 EF	2.37 C	3.10 B	2.87 CD	9.54 BC	9.70 BC
Cape Fear	0.87 BC	1.43 DE	2.70 C	1.70 CD	1.87 EF	2.90 BC	2.27 C	3.43 BC	7.70 CD	9.37 BC
Cheyenne	1.10 BC	1.77 B-D	2.77 C	2.23 BC	2.47 DE	2.60 BC	2.30 C	3.17 B-D	8.64 C	9.78 BC
Choctaw	1.20 BC	2.03 BC	1.43 DE	2.37 BC	1.40 F	1.43 D	1.53 D	3.00 CD	5.60 D	8.83 CD
Farley	1.33 BC	1.37 E	1.47 DE	2.23 BC	1.57 EF	3.17 B	1.73 CD	2.00 E	6.15 CD	8.77 D
Mohawk	2.47 A	2.73 A	2.53 CD	1.47 D	4.33 AB	4.30 A	3.93 A	4.10 A	13.27 AB	12.62 AB
Sioux	1.20 BC	2.10 B	1.20 E	2.33 BC	1.93 EF	3.03 BC	1.53 D	2.60 D	5.00 D	10.06 B
Stuart	2.50 A	2.83 A	2.57 CD	2.03 B-D	3.70 BC	4.07 A	4.43 A	3.20 B-D	13.20 AB	12.13 AB
Sumner	1.50 B	1.73 CD	2.00 C-E	2.40 BC	5.20 A	4.07 A	4.43 A	4.07 A	15.15 AB	12.27 AB

*Means not followed by a common letter are statistically different at 5% using Duncan's Multiple Range Test.

It could be clearly noticed that, in all varieties under study, the staminate inflorescence contained only three panicles (Table 4) and Figures (2&3). In addition, panicle length also varied significantly between different varieties and between panicles in the same inflorescence. Moreover, it is noticed that, both lateral panicles were shorter in length than the middle ones. Furthermore, the average length of 1st, 2nd and middle panicles was the tallest in Apache variety, while the shortest was recorded in Cape fear variety compared with the other ones. The same observation was found in the average length of the three panicles. This is true in both tested seasons. Such findings are supported by Bakr, (1985) and Hamoda (1978&1982) who observed that average length of the three panicles of staminate inflorescences was linearly related with average number of flowers. This may indicate that the average length of the three panicles with respect to varietal difference mainly affects the average number of flowers.

Table (4): Morphological characteristics of staminate and pistillate inflorescences of some pecan varieties during 2001 and 2002 seasons.*

Varieties	Staminate inflorescence								Pistillate inflorescence	
	Av. panicle length (cm)						Av. length of the three panicles (cm)		Av. no. of flowers/ inflorescence	
	1 st lateral		2 nd lateral		Middle					
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Apache	12.91 A	13.40 A	13.06 A	13.67 A	14.39 A	15.42 A	13.45 A	14.16 A	3.66 C	3.00 CD
Caddo	6.33 E	8.29 H	6.47 G	7.62 H	8.35 F	9.53 H	7.05 F	8.48 G	2.33 F	2.00 E
Cape Fear	6.45 E	6.63 J	8.29 F	7.57 I	5.99 G	5.86 J	6.91 F	6.68 I	3.00 DE	3.00 CD
Cheyenne	8.27 D	7.52 I	8.40 EF	7.35 J	9.68 E	8.69 I	8.78 E	7.85 H	3.00 DE	2.66 D
Choctaw	11.66 B	13.28 B	11.56 B	12.42 B	13.74 B	13.71 B	12.32 B	13.13 B	5.00 A	5.33 A
Farley	9.54 CD	9.47 E	8.60 D-F	8.67 G	9.93 E	10.71 E	9.36 DE	9.64 E	3.00 DE	3.33 C
Mohawk	11.95 AB	8.80 G	11.58 B	8.78 F	13.47 B	9.88 G	12.33 B	9.16 F	3.33 CD	4.00 B
Sio'x	8.80 D	9.10 F	9.02 DE	9.31 E	9.40 E	10.53 F	9.07 E	9.65 E	2.66 EF	3.00 CD
Stuart	8.55 D	9.65 D	9.13 D	10.82 C	11.30 D	13.63 C	9.66 D	11.37 C	4.33 B	5.00 A
Sumner	10.11 C	10.73 C	10.62 C	10.23 D	12.14 C	12.35 D	10.97 C	11.10 D	2.33 F	2.66 D

*Means not followed by a common letter are statistically different at 5% using Duncan's Multiple Range Test.

The varietal differences was also clear in number of flowers per pistillate inflorescence, Choctaw and Stuart recorded the highest values in this concern, while Caddo variety was the lowest. Such findings are supported by Bakr (1985); Miller *et al.*, (1995) and Muhammad (1999).

Flowering characteristics and fruit-set

From the obtained data in Table (5) and Figure (4), it can be safely said that, there was a significant varietal difference in flowering date of the trees as well as fruit set. In most varieties, the period of pollen shed did not fully coincide with period when the most pistillate flower receptive. Moreover, data also indicated that, the pollen-shedding period differed widely between varieties, A similar relationship was obtained for the period of pistillate receptivity, but only slight differences were recorded between the two seasons. In addition, it could be noticed that the number of days in which pollen shedding coincided with receptivity of pistillate flowers varied between varieties, there was more consistent period of overlap in Cheyenne, Stuart and Sumner. When we consider the pollination combination with stigmatic receptivity phenomenon in the studied varieties, data clearly showed that pollen shedding period before pistils are receptive (Protandry Type I) as shown in Caddo, Cape Fear and Cheyenne varieties. Whereas pistils receptive before pollen is shed (Protogyny Type II) as shown in most of the studied varieties as Apache, Choctaw, Farley, Mohawk, Sioux, Stuart and Sumner. The obtained information may be very important to illustrate the final choice for orchard plantation. In this respect we may use a wide range of pollinators such as Cape Fear followed by Caddo, Mohawk and Sioux, respectively, with any other commercial variety. As for fruit set date, the obtained data declare that Mohawk variety was the earliest one in this regard, while the latest ones were Cheyenne & Choctaw followed by Apache in 1st season and Apache & Sioux followed by Cape Fear & Choctaw in 2nd season. These results are partially in harmony with those obtained by Aleta & Ninet (1993); Sparks & Jancudi (2000) and Awad (2002)) on some pecan varieties. Brison (1974) reported that pecan tends strongly to be dichogamy. He also added that variations in physiological and environmental conditions have different influence on the timing of pollen shedding and pistil respectively. Higher temperature and lower relative humidity caused a prolonged overlapping in stigmatic receptivity and pollen shedding periods (Hamoda, 1982). In addition, blooming dates are evidently due to variations in the genetically background in such varieties (Hamoda, 1978).

Table (5): Flowering characteristics of the studied pecan varieties during 2001 and 2002 seasons.

Varieties	Beginning of blooming		Staminate flower				Pistillate flower				Beginning of fruit set		Type
			Shedding of pollens				Receptively of pollens						
			Beginning		End		Beginning		End				
2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002		
Apache	24/4*	20/4	8/5	10/5	18/5	19/5	27/4	28/4	2/5	6/5	1/5	4/5	11
Caddo	26/3	24/3	5/4	4/4	16/4	19/4	18/4	16/4	26/4	26/4	23/4	22/4	1
Cape Fear	1/4	7/4	8/4	13/4	22/4	27/4	22/4	26/4	29/4	7/5	7/5	1/5	1
Cheyenne	10/4	12/4	20/4	17/4	30/4	27/4	27/4	20/4	2/5	29/4	1/5	25/4	1
Choctaw	14/4	13/4	6/5	1/5	15/5	10/5	27/4	25/4	4/5	3/5	3/5	1/5	11
Farley	1/4	5/4	17/4	20/4	25/4	29/4	9/4	15/4	16/4	22/4	20/4	21/4	11
Mohawk	28/3	30/3	6/4	8/4	17/4	20/4	2/4	1/4	8/4	7/4	16/4	5/4	11
Sioux	18/4	22/4	30/4	5/5	11/5	17/5	22/4	1/5	30/4	8/5	29/4	7/5	11
Stuart	5/4	1/4	15/4	13/4	26/4	23/4	10/4	8/4	20/4	17/4	15/4	12/4	11
Sumner	1/4	5/4	15/4	17/4	25/4	25/4	9/4	13/4	19/4	21/4	14/4	16/4	11

*Day/ Month **Type 1= Protandrous (pollen shedding before pistils are receptive)

***Type 2= Protogynous (pistils receptive before pollen is shed)

Yield and fruit characteristics:

Data concerning fruit yield and quality of the studied pecan varieties is shown in Table (6) & Figure (5). There was a noticeable significant varietal difference in fruit yield (kg.), which varied from 4.49 & 4.69 kg/tree in Choctaw variety up to 12.23 & 14.03 kg/tree in Mohawk in both seasons, respectively. In addition, fruit yield in 2002 was somewhat higher than 2001 season in most varieties. In this respect, Worley *et al.*, (1972) found that pecan yield was negatively correlated with yield of the previous year, but was positively correlated with accumulated yield over several years. With regard to fruit quality specially hull, nut, kernel and shell weight, it can be seen that Mohawk was the promising variety for obtaining the best results in this concern. It is also interesting to mention that varieties with higher nut weight had lower number of nuts / kg. Thus, Mohawk followed by Stuart which produced the heaviest nut weight, require less nuts / kg. Moreover, the data reported that, pecan differed in their dimensions and shape index according to the variety. In this respect, although Mohawk was superior in nut width, it recorded the lowest nut length and shape index. Furthermore, the percentage of kernel to whole nut varied greatly between varieties. The highest percentage was observed in Sioux variety followed by Choctaw compared to other varieties. This is evidently related to the lowest shell weight in both varieties. While the lowest kernel % was recorded in Stuart (in both seasons) and Apache (in 2nd season) only. Nut filling is considered to be one of the most characteristics of pecan fruit evaluation. It gives an idea of the edible part of the fruit, and an indication of the nutritional status of the tree. High nitrogen fertilization in the stage of fruit filling may lead to poor filling due to competition between vegetative growth and embryo (kernel) growth. High temperature may also cause poor nut filling (Brison, 1974; Hamoda, 1982; Miller *et al.*, 1995 and Muhammad, 1999). As for kernel oil content, Choctaw kernel was the richest in oil content followed by Cheyenne and Stuart, respectively. Whereas, Mohawk variety was the lowest, the other varieties were in between in both 2001 and 2002 seasons. Oil content reported to vary in pecan according to region, tree load, variety and the geographic area. Our results on yield and fruit quality variations of the studied pecan varieties are partially in harmony with those recorded by Bakr, (1965); Hamoda, (1978&1982); Costhuizen, (1992); Aleta and Ninot, (1993); Kaplankiron and Faraclar, (1993); Khan and Misra, (1996) and Awad, (2002).

Hull cracking, harvesting and leaf abscission dates

Data dealing with hull cracking, harvesting and leaf abscission dates are presented in Table (7). Hull cracking is known to be closely related to harvest time. The duration between the beginning and end of hull cracking and harvesting date varied between all studied varieties and also between the two seasons due to environmental conditions. In this respect, this duration was observed to be longer in Stuart and Sumner, but in Sioux variety it was the shortest. It is also noted that, Cape Fear followed by Mohawk and Caddo varieties were the earliest in hull cracking, while, Sioux was the latest. Similar results were recorded for harvesting date. Leaf abscission date was also variable in most varieties in both seasons.

Table (6): Yield (kg/tree) & fruit characteristics of the studied pecan varieties during 2001 and 2002 seasons.

Varieties	Av. yield/tree (kg)		Nut				Kernel														
	Hull weight (gm)		No./ kg	Shell weight (gm)		Av. length (cm)	Av. width (cm)		Shape index (cm)		Av. weight (gm)		Av. weight (gm)		% of total nut		% of oil				
	2001	2002		2001	2002		2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002			
Apache	4.53 H	8.57 D	15.0 C	13.2 D	147.3 D	2.92 F	2.79 D	3.54 D	3.33 CD	1.72 F	1.70 F	2.06 A	1.95 AB	6.70 F	6.43 G	3.78 E	3.63 D	53.23 D	43.76 E	69 F	40 D
Caddo	8.98 D	8.40 B	18.1 B	18.1 B	170.3 A	3.21 C	3.19 DE	3.99 A	2.90 EF	2.54 AB	2.50 AB	1.57 D	1.16 E	7.48 DE	7.42 EF	4.26 CD	4.23 C	57.02 BC	57.03 C	69 F	70 D
Cape fear	6.38 F	8.50 D	9.0 G	10.1 F	125.0 F	3.89 B	3.99 C	3.13 E	3.58 C	2.10 D	2.17 D	1.49 D	1.66 C	8.12 C	8.14 D	4.22 CD	4.32 C	52.01 D	51.99 D	70 E	69 E
Cheyenne	8.31 E	15.8 C	14.5 C	15.8 C	122.0 G	3.26 C	3.00 D	3.86 C	4.03 B	2.23 C	2.10 D	1.73 C	1.92 B	7.87 CD	7.38 EF	4.61 B	4.37 C	58.66 A	59.27 BC	73 B	72 B
Choctaw	4.49 H	4.69 G	13.9 D	14.9 CD	150.0 D	2.74 DE	2.70 EF	4.43 B	4.41 A	2.10 D	2.13 D	2.11 A	2.07 A	6.86 F	6.76 E	4.11 DE	4.05 CD	59.94 AB	60.01 AB	76 A	73 A
Farley	5.73 G	7.31 E	10.6 F	11.7 F	135.0 E	3.13 D	3.24 D	4.73 A	4.00 B	2.47 AB	2.49 B	1.92 B	1.87 B	6.94 EF	7.55 DE	3.80 E	4.30 C	55.09 CD	57.02 C	71 D	70 D
Mohawk	12.23 A	14.03 A	19.5 A	20.1 A	108.0 H	9.94 H	5.24 A	2.50 G	2.70 F	2.53 A	2.56 A	0.98 F	1.05 E	11.73 A	12.43 A	6.82 A	7.24 BC	57.97 BC	57.98 BC	67 H	65 G
Sioux	4.51 H	6.16 F	13.9 D	14.0 E	153.3 B	2.42 E	2.51 F	2.80 F	3.13 DE	1.87 E	2.03 E	1.50 D	1.54 C	6.38 F	6.61 FG	3.95 DE	4.09 CD	61.96 A	62.01 A	68 G	66 F
Stuart	9.68 C	9.25 D	13.1 D	11.2 DE	108.0 H	4.91 A	5.19 AB	3.23 C	3.20 C-E	2.50 AB	2.36 C	1.29 E	1.35 D	8.94 B	9.44 C	4.02 C	4.24 DE	45.38 E	44.96 E	72 C	71 C
Sumner	10.70 B	11.03 B	17.9 B	18.3 B	121.0 G	3.97 B	4.73 B	4.60 A	4.60 A	2.43 B	2.45 B	1.89 B	1.90 B	8.45 BC	10.27 B	4.47 BC	5.51 B	53.02 D	53.73 D	71 D	70 D

Means not followed by a common letter are statistically different at % using Duncan's Multiple Range Test

Table (7): Hull cracking, harvesting and leaf abscission dates of some pecan varieties during 2001 and 2002 seasons.

Varieties	Hull cracking date				Harvesting date				Leaf abscission date			
	Beginning		End		Beginning		End		Beginning		Majority	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Apache	10/10*	12/10	20/10	23/10	15/10	18/10	25/10	25/10	14/11	20/11	10/12	18/12
Caddo	23/9	25/9	5/10	10/10	25/9	28/9	10/10	15/10	15/12	10/12	25/12	20/12
Cape Fear	20/9	18/9	5/10	1/10	22/9	22/9	15/10	10/10	5/12	15/12	11/12	25/12
Cheyenne	17/10	15/10	29/10	1/11	19/10	17/10	30/10	5/11	15/11	20/11	15/12	22/12
Choctaw	15/10	15/10	25/10	23/10	20/10	25/10	5/11	5/11	29/11	2/12	5/12	15/12
Farley	25/9	27/9	10/10	15/10	28/9	30/9	15/10	18/10	10/11	20/11	25/11	3/12
McHawk	20/9	22/9	5/10	10/10	25/9	28/9	15/10	23/10	5/12	15/12	15/12	20/12
Sioux	10/11	15/11	18/11	20/11	15/11	18/11	20/11	22/11	10/11	15/11	2/12	10/12
Stuart	5/10	10/10	30/10	2/11	15/10	18/10	10/11	10/11	28/11	25/11	10/12	8/12
Sumner	25/9	22/9	15/10	10/10	28/9	25/9	25/10	20/10	15/11	25/11	5/12	13/12

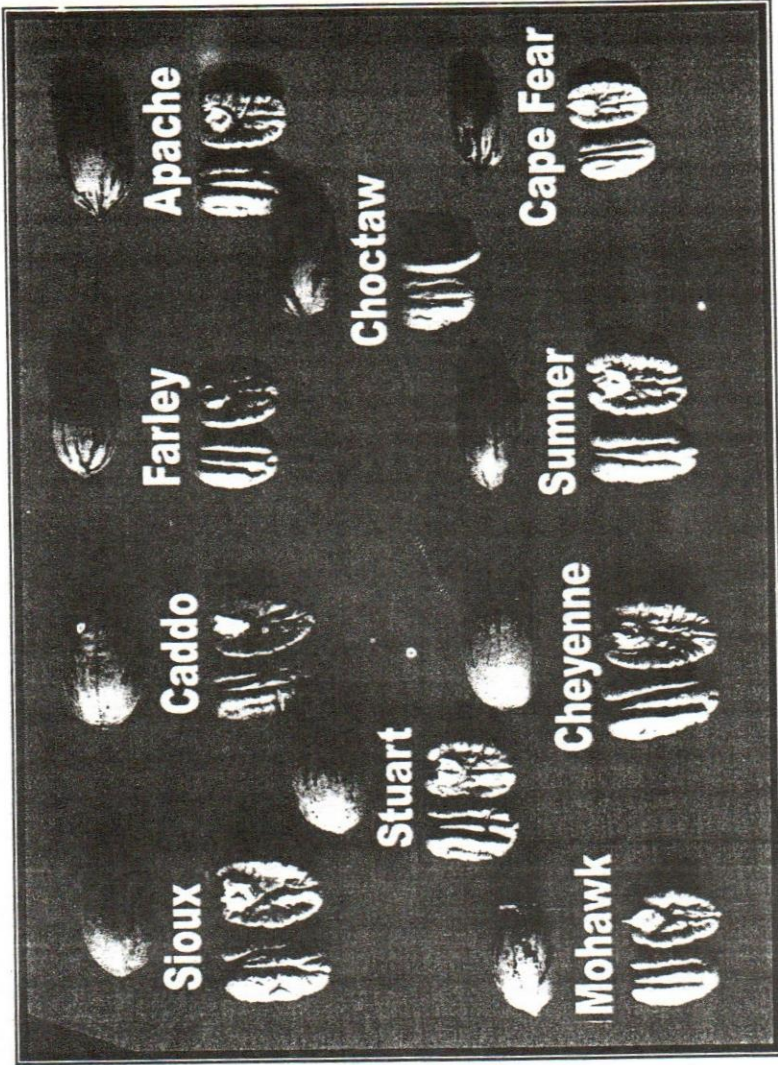


Fig. (5) : Nuts and kernels of the studied pecan varieties .

In this regard, Farley and Sioux trees were the earliest compared to other tree varieties. These results are in agreement with those of Miller *et al.*, (1995); Silva *et al.*, (1995) and Muhammad (1999).

From the above mentioned results we may conclude that, most of the studied varieties are commercially feasible to grow in Egypt. Some varieties such as Caddo, Cape Fear and Cheyenne had smaller tree size. This leads to increase yield by increasing the number of trees/ feddan. Other varieties start bearing and harvesting earlier than the others such as Caddo and Mohawk. Others can be good pollinators (long period shedding) as Cape Fear followed by Caddo, Mohawk and Sioux. While others characterized by their higher percentage of kernel to the whole nut such as Sioux, Choctaw, Cheyenne and Mohawk. Generally, Mohawk is a recommended variety for its high fruit quality and yield and Choctaw kernel was the richest in oil content.

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دراسات على النمو والتزهير والأثمار لبعض أصناف البيكان المستوردة تحت الظروف البيئية لجمهورية مصر العربية صفية عبد المنعم أبو طالب، نبيل فهمي يوسف، فرجينى فارس نعمان، فاطمة أمين خليل معهد بحوث البساتين - مركز البحوث الزراعية - الجيزة - مصر

تختلف أصناف البيكان فى النمو الخضري و الزهري و الثمرى لأصناف البيكان عند زراعتها فى المناطق المختلفة، ولهذا فقد أجرى هذا البحث على عشرة أصناف من البيكان هى Choctaw Cheyenne, Cape Fear, Caddo, Apache Farley, Mchawk, Sioux, Stuart and Sumner الزراعة فى عام ١٩٩٢ من ولاية جورجيا بالولايات المتحدة الأمريكية بهدف دراسة النمو والأزهار والأثمار تحت ظروف مصر فى محافظة القليوبية. وقد أوضحت الدراسة أن هناك اختلافات معنوية واضحة بين الأصناف تحت الدراسة من حيث طبيعة النمو الخضري. كذلك أظهرت أصناف Mohawk, Apache, Stuart, Sumner أعلى نسبة من البراعم المذكرة والمؤنثة والكلية/الفرخ. أما صنف Apache فقد أعطى أعلى نسبة من البراعم الخضرية/الفرخ. كذلك كانت هناك اختلافات بين الأصناف فى عدد الأزهار/النورة المؤنثة حيث سجلت أصناف Choctaw, Stuart أعلى القيم وكان صنف Caddo على العكس من ذلك. أما عن التلقيح الخلطي ومدى التوافق بين فترات استعداد المياسم للتلقيح وبين انتشار حبوب اللقاح، فقد كانت هناك اختلافات واضحة بين الأصناف تحت الدراسة، حيث أوضحت النتائج أن أصناف Caddo, Cape Fear, Cheyenne تنتمى إلى مجموعة مبكرة الطلع (انتثار حبوب اللقاح قبل نضج مياسم الأزهار المؤنثة) أما باقى الأصناف فقد انتمت إلى مجموعة مبكرة المتأخر (نضج مياسم الأزهار المؤنثة قبل انتشار حبوب اللقاح). كذلك اتضح من النتائج أن صنف Mohawk قد تفوق على الأصناف الأخرى من حيث المحصول (كجم/الشجرة) ومعظم صفات الجودة فى الثمار. كذلك فقد تميزت صنف Choctaw يليه Sioux باحتواء ثمارها على أعلى نسبة من اللب. كذلك أبرزت النتائج أن أصناف Cape Fear, Mohawk, Caddo كانت الأكبر من حيث ميعاد انفصال الغلاف الخارجى (hull) عن الثمرة، على الترتيب، وعلى العكس من ذلك كان صنف Sioux. وقد تم الحصول على نفس النتائج بالنسبة لميعاد الحصاد. كذلك كانت هناك اختلافات واضحة بين الأصناف من حيث ميعاد تساقط الأوراق فقد بكر صنفى Sioux, Farley عن الأصناف الأخرى.