RESULTS AND DISCUSSION

IV. RESULTS AND DISCUSSION

(1) Phynological phases and its extent

Concerning the phynological phases and its extent of some Pecan varieties data are presented in **(Tables 1, 2)**. The obtained results showed an obvious varietal difference of bud burst, Wichita variety was the earliest one in this respect while Mohawk variety ranked last as well as other varieties came in between. Moreover the difference between the earliest and latest ones reached about 9 and 7 days in 1998 and 1999 seasons respectively.

The beginning of flowering of pistillate flowers varied for different varieties and from year to year. In 1998 season the Sioux variety was the earliest April 19th while the Western Schelly variety was the latest one April 28th. Mean while Wichita and Cherokee varieties came in between in this respect. In 1999 season Wichita was earlier by 5 days only than the latest one (Sioux variety). Moreover beginning of flowering started early in 1999 season as compared to first season 1998.

The shortest period from bud burst to flowering was exhibited by Sioux variety (16 and 20 days in 1998 and 1999 seasons respectively), while Wichita variety had the longest duration in this respect (30 and 52 days in 1998 and 1999 seasons respectively), Western Schelly and Cherokee came in between in this respect.

Concerning date of fruit set, the obtained data showed that Cherokee variety was the earliest one in this respect (May 5th and May 4th during 1998 and 1999 seasons respectively). While the latest one

was Western Schelly May 18th during two seasons of study. Wichita and Sioux came in between **(Table 1).**

The average periods from beginning of flowering until fruit set ranged from 23 to 27 days **(Table 2)**

Data also indicated a varietal difference in harvesting date, Western Schelly had the earliest harvest date (October 3th and first October in 1998 and 1999 seasons respectively), and the latest one in this respect was Sioux variety 28 and 26th October during 1998 and 1999 seasons respectively. It means that Sioux was later than Western Schelly variety in maturity by 25 days as an average of two seasons was concerned.

Average period from fruit set to harvesting ranged from 145 days in Western Schelly to 171 days in Sioux varieties. While Wichita and Cherokee varieties came in between in this respect (165 and 159 days respectively). Moreover average period from bud burst to harvesting date was 189 days in Western Schelly, 197 in Cherokee, 205 in Sioux and 208 days in Wichita. While the growing season of studied varieties extended from 242 days in Mohawk to 273 days in Wichita variety. The other varieties ranged in between in this respect.

The previous results were in general agreement with the finding of Hamoda (1982) who reported that the number of days from starting growth to maturity was 188 days in Western Schelly,193 in Cherokee, 200 in Wichita and 224 in Sioux Pecan varieties.

Table (1) : Dates of phynological phases for some Pecan varieties during 1998 and 1999 seasons.

Varieties	Bud burst		Beginning of flowering*		Full bloom		Fruit set		Harvesting of yield		Leaf fall	
	98	99	98	99	98	99	98	99	98	99	98	99
Wichita	26/3	24/3	26/4	15/4	5/5	1/5	8/5	10/5	20/10	19/10	25/12	22/12
Western Schelly	29/3	25/3	28/4	17/4	6/5	1/5	18/5	18/5	3/10	1/10	1/12	3/12
Cherokee	3/4	29/3	22/4	18/4	30/4	29/4	5/5	4/5	17/10	15/10	15/12	12/12
Sioux	3/4	1/4	19/4	20/4	29/4	29/4	10/5	8/5	28/10	26/10	29/12	25/12
Mohawk	5/4	1/4	-----	-----	-----	-----	-----	-----	-----	-----	1/12	1/12

* For pistillate flower.

Table (2): Duration of phynological phases extent (estimated in days) for some Pecan varieties during 1998 and 1999 seasons.

Phynological Phases / Varieties	From bud burst to beginning of flowering			From beginning of flowering to fruit set			From fruit set to harvesting			From bud burst to harvesting			From bud burst to leaf fall		
	98	99	mean	98	99	mean	98	99	mean	98	99	mean	98	99	mean
Wichita	30	32	31	23	26	25	166	164	165	208	207	208	274	271	273
Western Schelly	29	22	25.5	26	28	27	146	144	145	188	190	189	247	251	249
Cherokee	19	20	20.5	21	25	23	160	157	159	193	201	197	252	256	254
Sioux	16	20	18	25	22	24	169	172	171	204	205	205	266	262	264
Mohawk	-----	-----	----	-----	-----	----	-----	-----	----	-----	-----	----	239	244	242

(2) Seasonal changes in leaf mineral content

(2-1) Nitrogen content

Seasonal changes in leaf nitrogen content are shown in (**Table3**). The percentage of leaf N content varied greatly from one variety to another, regardless of the date of collecting samples. Whereas the highest percentage was found in Western Schelly (2.35%) in 1998 followed in a descending order by Cherokee (2.27%), Mohawk (2.17%), and Sioux (2.03%) then Wichita variety which ranked last and showed the lowest level (1.77%).The difference between varieties was significant in this respect. However leaf N % did not follow the same trend previously found in 1999 season, whereas leaves of Cherokee variety were the richest in their N content (2.47 %) while the lowest leaf N percentage was detected in Wichita variety (1.50%). The other varieties came in between in this respect.

Referring variation in leaf N content in relation to specific effect of sampling date, it was quite evident to be noticed that leaf sampled at June was the richest in their N content (2.86) regardless of variety followed in a descending order by samples taken during May (2.66%), July (1.68%) and August (1.28%) in the first season as shown from data presented in (**Table 3**).

Meanwhile, in the second season leaf sampled in May had the greatest N level (2.62%) and was Statistically the richest in this respect followed in a descending order by they collected in June (2.36), July (1.88) and August (1.46). It could be safely concluded that leaf samples collected early in May and June were generally the richest in their N content comparing with those samples collected later, whereas the differences between N% of periodical samples were significant.

Table (3): Seasonal changes in leaf nitrogen content of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Nitrogen (%)									
	1998					1999				
	May	June	July	Aug.	Mean*	May	June	July	Aug.	Mean*
Wichita	2.20 e-h	2.00 g-j	1.50 i-k	1.40 jk	1.77 C	2.00 d-f	1.50 f-h	1.40 gh	1.10 h	1.50 D
Western Schelly	3.80 a	3.20 a-c	1.50 i-k	0.90 k	2.35 A	2.50 a-d	1.90 e-g	2.00 d-f	1.00 h	1.85 C
Cherokee	2.70 c-f	2.80 c-e	2.00 g-j	1.60 h-j	2.27 AB	3.00 ab	3.00 ab	1.90 e-g	2.00 d-f	2.47 A
Sioux	2.50 d-g	3.20 a-c	1.50 i-k	0.90 k	2.03 BC	2.50 a-d	2.60 a-c	2.10 c-e	1.40 gh	2.15BC
Mohawk	2.10 f-i	3.10 b-d	1.90 g-j	1.60 h-j	2.17 AB	3.10 a	2.80 ab	2.00 d-f	1.80 e-g	2.42AB
Mean**	2.66 B	2.86 A	1.68 C	1.28 D		2.62 A	2.36 A	1.88 B	1.46 C	

*, ** Refer to specific effect of variety and sampling date, respectively.

It means that the leaf nitrogen percentage generally decreased as the growing season advanced regardless of the variety. This was true during the two seasons of study.

Similar results were obtained by Guillen et al (1966), Ibrahim (1970) and Sharaf (1979) who found that N content of both leaf organs (blade and petiole) of grapes was decreased as the season was advanced. However the previous results obviously revealed that the leaf N content was less than such normal range suggested by Norman (1976) for normal producing of Pecan trees ranged from 2.3 to 2.9 % for the date representative samples on mid-July and August for the all studied varieties during two seasons of study.

(2-2) Phosphorus content

Data presented in **(Table 4)** displayed that Wichita Pecan variety had significantly the highest leaf Phosphorus content (0.34%) while the variation between other studied varieties was insignificant, regardless of the collecting date of sampling leaves in 1998 season.

Moreover in 1999 season Wichita and Cherokee varieties had the highest level in this respect (0.32 and 0.30 % respectively) followed in a descending order by Western Schelly (0.20%), Sioux (0.19 %) and Mohawk (0.16 %).

Referring variation in Phosphorus percentage in response to specific effect of sampling date, it was quite evident to be noticed that there was noticeable variation between sampling dates in this respect during the two seasons of study. However the previous results revealed that the leaf P % content was so sufficient to be adequate to that normal range suggested by Norman (1976) for

Table (4): Seasonal changes in leaf phosphorous content of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Phosphorous %									
	1998					1999				
	May	June	July	Aug.	Mean*	May	June	July	Aug.	Mean*
Wichlta	0.50 a	0.40 ab	0.19 d	0.26 cd	0.34 A	0.30 ac	0.30 ac	0.30 ac	0.40 ab	0.32 A
Western Schelly	0.30 bc	0.18 d	0.15 d	0.16 d	0.20 B	0.20 bc	0.10 c	0.30 ac	0.20 bc	0.20 B
Cherokee	0.20 cd	0.15 d	0.30 bc	0.30 bc	0.24 B	0.50 a	0.15 c	0.30 ac	0.24 bc	0.30 A
Sioux	0.10 d	0.41 ab	0.16 d	0.30 bc	0.24 B	0.20 bc	0.20 bc	0.16 c	0.18 bc	0.19 B
Mohawk	0.22 cd	0.20 cd	0.15 d	0.31 bc	0.22 B	0.20 bc	0.18 bc	0.14 c	0.13 c	0.16 B
Mean**	0.26 A	0.27 A	0.19 B	0.27 A		0.28 A	0.19 A	0.24 A	0.23 A	

*, ** Refer to specific effect of variety and sampling date, respectlvely.

optimum producing (0.11 to 0.30 %), in all studied varieties during two seasons of study.

(2-3) Potassium content

Seasonal changes in leaf Potassium content are tabulated in **(Table 5)** the obtained data showed a varietal difference in the two seasons of study, regardless of the collecting dates of leaf samples.

Wichita variety was the poorest one as its leaves had the lowest Potassium content (0.55%), while Cherokee in 1998 season and Mohawk in 1999 season were the richest and showed the highest level of K % (1.12 and 0.97 % respectively), the other varieties came in between in this respect. Moreover leaf sampling date did not specifically affect Potassium content **(Table 5)**. These data also indicated that the leaf K% was lower than that level adequate for producing good yield according to that reported by Norman (1976) (1.0 to 1.5 %), in all studied varieties except Mohawk variety which failed completely to produce flowers and consequently cropping under Egyptian conditions during two seasons of study.

(2-4) Calcium content

Concerning leaf Calcium percentage as affected by variety and sampling date, data from **(Table 6)** revealed that in 1998 season the leaves of Wichita variety had the highest level of Calcium content (0.90%), While the other studied varieties were not significantly differ in this respect. Moreover in 1999 leaves of Sioux and Mohawk were the superior in its Calcium content (1.0 and 1.1 % respectively) followed in a descending order by Cherokee (0.85 %), Wichita (0.82 %) and Western Schelly (0.68 %). The difference between varieties were significant in 1999 season in this respect.

Table (5): Seasonal changes in leaf potassium content of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Potassium %									
	1998					1999				
	May	June	July	Aug.	Mean*	May	June	July	Aug.	Mean*
Wichita	0.60 de	0.60 de	0.50 e	0.50 e	0.55 C	0.60 bc	0.60 bc	0.50 c	0.50 c	0.55 D
Western Schelly	0.70be	1.10 ab	0.90 bd	0.90 bd	0.90 B	0.90 a	0.90 a	0.90 a	0.80 ab	0.88 C
Cherokee	1.20 ab	1.40 a	1.00 bc	0.90 bd	1.12 A	0.90 a	0.90 a	0.90 a	0.80 ab	0.88 C
Sioux	1.20 ab	0.90bd	0.90 bd	0.90 bd	0.98 B	1.00 a	0.90 a	0.90 a	0.90 a	0.92B
Mohawk	1.00 bc	1.00 bc	1.00 bc	1.00 bc	1.00 B	0.90 a	1.00 a	1.00 a	1.00 a	0.97 A
Mean**	0.94 B	1.25 A	0.86 B	0.84 B		0.86 A	0.86 A	0.84 A	0.80 A	

*, ** Refer to specific effect of variety and sampling date, respectively.

Table (6): Seasonal changes in leaf calcium content of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Calcium %									
	1998					1999				
	May	June	July	Aug.	Mean*	May	June	July	Aug.	Mean*
Wichita	0.60 d	1.10 ab	1.00 ac	0.90 ad	0.90 A	0.70 cd	0.90 bc	0.90 bc	0.80 bd	0.82 B
Western Schelly	0.60 d	1.00 ac	1.00 ac	0.80 bd	0.85 A	0.50 d	0.80 bd	0.70 cd	0.70 cd	0.68 C
Cherokee	0.70 cd	1.20 a	0.80 bd	0.80 bd	0.87 A	0.80 bd	1.00 ac	0.90 bc	0.70 cd	0.85 B
Sioux	0.90 ad	0.90 ad	0.80 bd	0.80 bd	0.85 A	0.90 bc	1.10 ab	1.00 a-c	1.00 ac	1.00 A
Mohawk	0.60 d	1.00 ac	1.00 ac	0.90 ad	0.87 A	0.90 bc	1.30 a	1.10 ab	1.10 ab	1.10 A
Mean**	0.68 C	1.04 A	0.92 B	0.84 B		0.76 C	0.82 BC	0.92 A	0.86 AB	

*, ** Refer to specific effect of variety and sampling date, respectively.

Referring to the specific effect of sampling date on leaf Calcium content data in **(Table 6)** also showed that the leaf Calcium content was increased as the growing seasons advanced. The lowest percentage in this respect had the samples collected in May during the two seasons of study. While the highest was obtained from the samples collected in June and July.

These results are in agreement with that reported by Shoab (1990) and Fardassi et al (1993), who reported that the concentration of Ca increased as the growing season advanced. However present data showed that July and August sampled leaves for all studied varieties contained a desired Calcium level corresponding to that previously reported by Normen (1976) (0.7 - 1.5 %) for normal production.

(2-5) Magnesium content

Regarding leaf Magnesium percentage as affected by variety and sampling date during both 1998 and 1999 seasons, data are presented in **(Table 7)**. The obtained data showed clearly significant variation between studied varieties during two seasons of study. Nevertheless variation in leaf Magnesium content in response to sampling dates, revealed that the difference was so small to be significant during both seasons of study. Concerning the samples collected at July and August, our data showed that the leaf Magnesium content was at the desired Magnesium content as reported by Norman (1976)(0.3 - 0.6 %).

(2-6) Zinc content

Regarding leaf Zinc content of some Pecan varieties as influenced by sampling date and variety during 1998 and 1999 seasons, data are presented in **(Table 8).**

Table (7): Seasonal changes in leaf magnesium content of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Magnesium %									
	1998					1999				
	May	June	July	Aug.	Mean*	May	June	July	Aug.	Mean*
Wichita	0.30 a	0.50 a	0.50 a	0.40 a	0.42 C	0.30 a	0.30 a	0.30 a	0.30 a	0.30 C
Western Schelly	0.40 a	0.50 a	0.50 a	0.50 a	0.47 B	0.40 a	0.40 a	0.30 a	0.30 a	0.35 C
Cherokee	0.50 a	0.40 a	0.40 a	0.40 a	0.43 C	0.50 a	0.50 a	0.50 a	0.40 a	0.47 AB
Sioux	0.50 a	0.50 a	0.50 a	0.50 a	0.50 A	0.40 a	0.50 a	0.40 a	0.40 a	0.43 B
Mohawk	0.50 a	0.40 a	0.40 a	0.40 a	0.43 C	0.50 a	0.50 a	0.50 a	0.50 a	0.50 A
Mean**	0.44 A	0.46 A	0.46 A	0.44 A		0.42 AB	0.44 A	0.40 BC	0.38 C	

*, ** Refer to specific effect of variety and sampling date, respectively.

Table (8): Seasonal changes in leaf zinc content of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Zinc(ppm)									
	1998					1999				
	May	June	July	Aug.	Mean*	May	June	July	Aug.	Mean*
Wichita	49.00bc	49.00bc	48.00bc	49.00bc	48.75 C	50.00 bc	49.00 bc	48.00b-d	50.00 bc	49.25 C
Western Schelly	50.00bc	60.00 a	61.00 a	61.00 a	58.00 B	66.00 a	67.00 a	50.00 bc	51.00 bc	58.50 B
Cherokee	44.00cd	50.00bc	55.00ab	49.00bc	49.50 C	55.00 b	69.00 a	69.00 a	68.00 a	65.25 A
Sioux	61.00 a	61.00 a	62.00 a	59.00 a	60.75 A	48.00b-d	49.00 bc	51.00 bc	50.00 bc	49.50 C
Mohawk	40.00 d	38.00 d	39.00 d	39.00 d	39.00 D	35.00 d	44.00 cd	46.00b-d	44.00 cd	42.25 D
Mean**	48.80 C	51.60 B	53.00 A	51.40 B		50.80 B	55.60 A	52.80 B	52.60 B	

*, ** Refer to specific effect of variety and sampling date, respectively.

Data showed that the lowest leaf Zinc content as ppm was that of samples collected at May during the two seasons of study regardless of the studied variety, while the highest level in this respect was observed with samples collected at July in 1998 season and June in 1999 season. Samples of the other collecting dates came in between regarding their Zinc content. Moreover we can generally say that the leaf Zinc content as ppm significantly increased from May up to July and then decreased in samples collected at August.

Concerning leaf Zinc content as ppm as affected by variety the obtained data showed that Mohawk and Wichita varieties were the poorest in this respect while the highest levels was detected by Sioux 1998 and Cherokee 1999.

However the obtained results revealed that the leaf Zinc content was within the normal range as shown by Norman (1976) (50 to100 ppm) in all studied varieties except Mohawk variety.

(2-7) Iron content

Concerning leaf Iron content as ppm as affected by variety and sampling date during 1998 and 1999 seasons, data are presented in **(Table 9)** revealed that leaf Iron content varied greatly between varieties regardless of the date of collecting samples. The highest level had Wichita and Sioux. On the other hand the lowest level had Western Schelly and Cherokee.

Referring variation in Iron content in relation to specific effect of sampling dates, it was quite evident to be noticed that leaf Iron content as ppm was increased as the growing season advanced up to July then decreased in August sample.

Table (9): Seasonal changes in leaf iron content of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Iron (ppm)									
	1998					1999				
	May	June	July	Aug.	Mean*	May	June	July	Aug.	Mean*
Wichita	121.00bc	130.00ab	140.00 a	140.00 a	132.75A	99.00bc	100.00 b	100.00 b	101.00ab	100.00B
W. Schelly	49.00 g	48.00 g	50.00 g	52.00 g	49.75D	61.00de	71.00 de	72.00 de	70.00 de	68.50D
Cherokee	49.00 g	52.00 g	53.00 fg	53.00 fg	51.75D	71.00de	73.00 de	80.00 cd	80.00 cd	76.00C
Sioux	100.00 d	110.00cd	110.00cd	100.00 d	105.00B	120.00a	120.00 a	120.00 a	100.00 b	115.00A
Mohawk	71.00 e	71.00 e	69.00 e	68.00 ef	69.75C	71.00de	70.00 de	62.00 de	60.00 e	65.75D
Mean**	78.00 C	82.20 B	84.40 A	82.60 B		84.40 B	86.80 A	86.80 A	82.20 C	

*, ** Refer to specific effect of variety and sampling date, respectively.

This trend was true during the two seasons of study. Our results partial agreed with that reported by Sharaf (1979) who found that leaf blade Iron content of both fruitful and unfruitful vines was increased through the growing season. However present data showed that leaf Iron content in studied varieties were within the normal range as shown by Norman (1976) (50 to 300 ppm).

(3) Shoot growth and leaf characteristics

(3-1) Shoot growth

Data dealing with shoot growth and leaf characteristics are tabulated in **(Table 10)** and **(Fig.1 and 2)** the obtained data revealed that among the studied varieties, Wichita variety had statistically the longest shoot followed in a descending order by Western Schelly, Cherokee, Sioux and Mohawk. This trend was true in the two seasons of study. The differences between varieties was highly significant in this respect. This means that Wichita variety trees had the most vigorous vegetative growth while Sioux and Mohawk trees were the weakest ones in this respect. Furthermore the varietal differences in shoot length May be due to the different genetical character of the studied varieties. Similar results were obtained by Hamoda 1978 and 1982 under Egyptian conditions.

Also **(Table 10)** and **(Fig. 1 and 2)** shows obviously that the shoot growth rate was more in the first season during the period from April 15th up to May 1st in the first season while in the second season the shoot growth rate was increased more from May 1st up to May 30th then after this the growth rate was slower up to June 15th in which the growth was ceased or terminated. This was true in all studied varieties during the two seasons of study.

Table (10): Seasonal changes in shoot growth expressed as length in (cm) of some Pecan varieties during 1998 and 1999 seasons.

Varieties \ Date	15/4		1/5		17/5		30/5		15/6		29/6	
	98	99	98	99	98	99	98	99	98	99	98	99
Wichita	2.6	2.5	7.5	6.5	9.3	25.0	10.8	40.3	11.4	46.4	11.4	46.4
Western Schelly	1.9	2.0	6.0	5.3	8.7	13.7	10.2	20.8	10.6	22.7	10.6	22.7
Cherokee	2.0	2.0	6.8	5.3	8.4	10.7	10.0	17.2	10.5	19.1	10.5	19.1
Sioux	1.0	1.2	5.3	4.5	6.0	10.5	8.0	15.0	8.6	15.5	8.6	15.5
Mohawk	1.2	1.1	5.4	4.5	5.8	11.0	6.7	13.6	6.8	13.6	6.8	13.6
L.S.D 5%	0.60	0.12	0.35	0.15	0.48	0.50	2.48	0.72	0.85	0.56	0.85	0.56

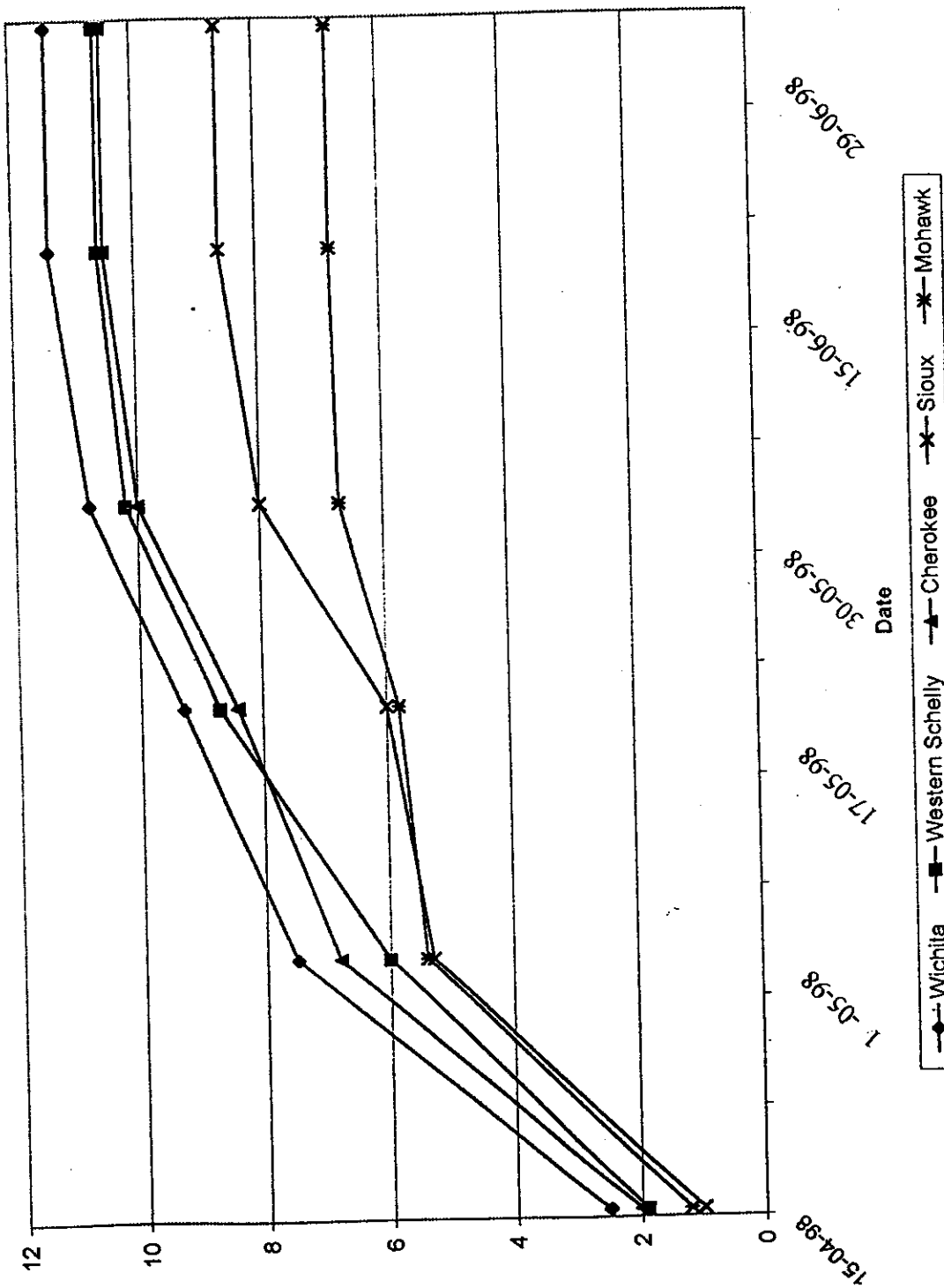

Fig.(1): Seasonal change in shoot growth (cm) of some Pecan varieties dates in 1998

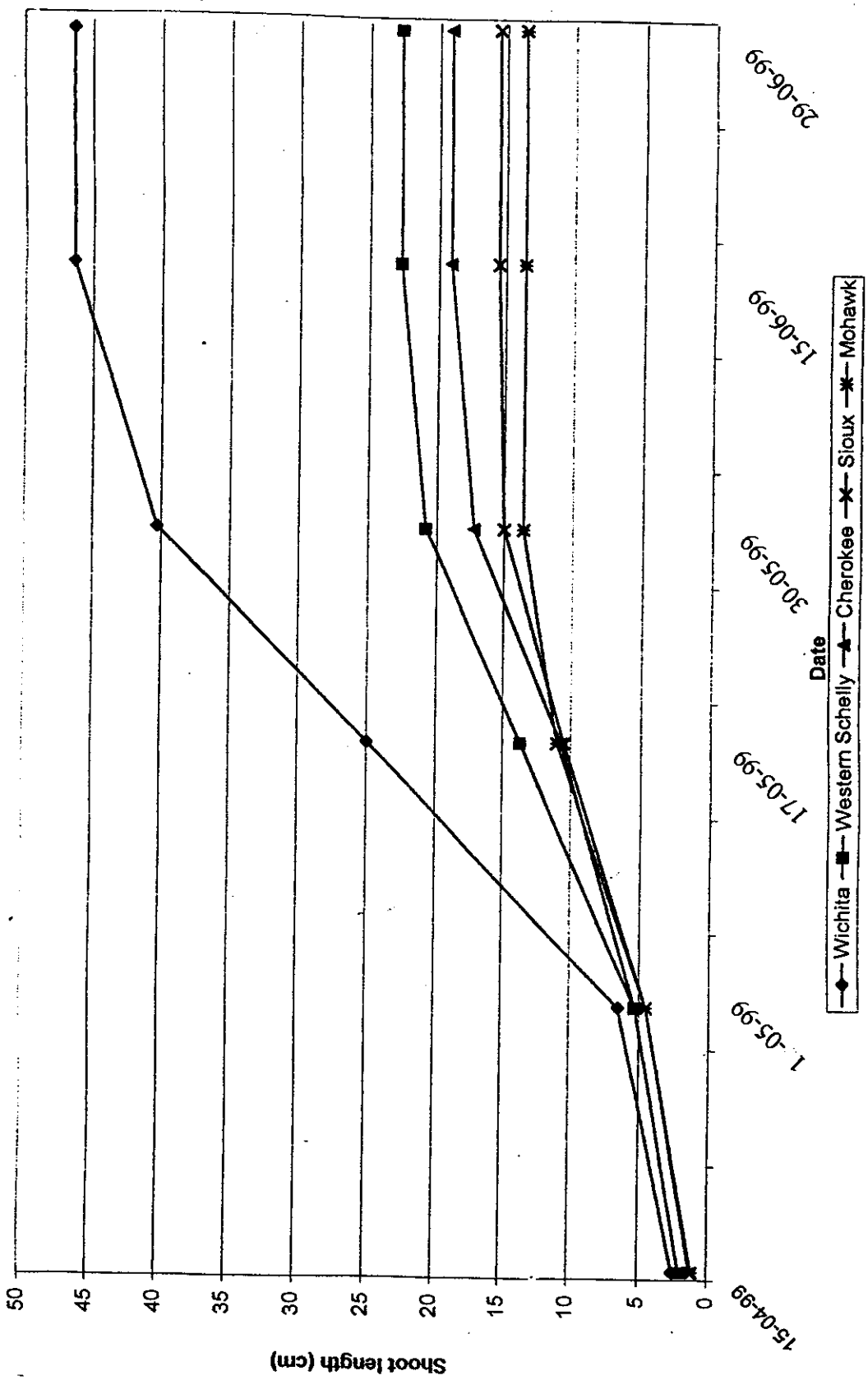

Fig.(2): Seasonal change in shoot growth (cm) of some Pecan varieties dates in 1999

(3-2) Leaf characteristics

Data dealing with leaf characteristics are tabulated in **(Table 11)** the obtained data clearly showed a highly significant differences between the studied varieties during the two season of study in petiole length, rachis length and number of leaflets of leaf. However length of petiole was longer in Sioux and Mohawk than the other studied varieties during the two seasons of study. While Mohawk had the longer rachises followed in a descending order by Wichita, Sioux, Cherokee and Western schelly.

The highest number of leaflets had Mohawk and Wichita varieties, while the other three studied varieties had the same number of leaflets and lower comparing with the two pervious varieties, this was true in the 1998 and 1999 seasons.

The previous results go in line with that mentioned by Awasthi and Singh (1973) and Hamoda (1978 and 1982) who revealed that there was a clear varietial differences in Pecan leaf Features, leaflets, rachis length and petiole length.

Data presented in **(Table 11)** revealed that the average area of leaf varied from one Pecan to another. Since, the greatest value was always in concomitant to both Wichita and Mohawk cultivars Whereas the increase was significant at 5% levels during both 1998 and 1999 seasons, respectively. Moreover, three other varieties were in between, however Cherokee leaf tended relatively to be more greater than those of rather ones, especially as an average of two seasons was concerned.

Table (11): Leaf characteristics of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Petiole length (cm)		Rachis length (cm)		Number of leaf-lets per leaf		Leaf area (cm^2)	
	98	99	98	99	98	99	98	99
Wichita	5.90	6.20	23.70	22.80	15	17	20.64	16.30
Western Schelly	5.67	5.50	17.43	15.50	13	13	15.20	19.20
Cherokee	5.70	4.90	19.90	19.21	15	13	18.12	22.30
Sioux	8.00	7.50	22.00	24.10	13	13	18.50	14.50
Mohawk]	7.00	7.50	23.70	23.00	17	17	20.80	30.10
L.S.D. 5%	0.06	0.27	0.21	0.88	0.59	0.60	2.27	2.61

4- Blooming characteristics of staminate and pistillate flowers

(Table 12) shows the different dates of pollen shedding, beginning of bloom and female flower receptivity days of different studied Pecan varieties. It is quite clear from obtained data that the variance in beginning date of pollen shedding between varieties under study was not so great throughout the same growing season. Hence difference was so limit and did not exceed 3 days or one week during first and second seasons respectively as the four studied Pecan varieties were compared during each individual season separately in this concern.

Contrary to that variation in number of days for pollen shedding detected during both successive season of study was too pronounced as compared to that due to varieties exhibited within the same season. This trend may be attributed to shift in the environmental condition prevailed in each season. On the other hand the present results are in conflicted with that finding of Hamoda (1978) who found that Pecan varieties greatly varied in this regard.

Data concerning the beginning of pistillate flower blooming show that Sioux was the earliest variety in this respect in 1998 season (April 19) while Wichita variety was the latest one (April 26). The opposite was detected in the second season (April 15 and April 20 for Wichita and Sioux varieties respectively). The other two varieties were in between **(Table12)**. The variation in the date of ending of receptivity to pollen for studied varieties in 1998 was more than 1999 season (7 days and 2 days respectively). Moreover the period of stigmatic receptivity to pollen ranged from 8 to 10 days in the first season and from 9 to 16 days in the second one.

Table (12): Blooming dates of staminate and pistillate flowers of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Pollen shedding of staminate flowers			Blooming and receptivity of pistillate flowers		
	Beginning	Ending	Number of days	Beginning of blooming	Ending of receptivity to pollen	Number of days
1998						
Wichita	24/4	1/5	7	26/4	5/5	9
Western Schelly	25/4	2/5	7	28/4	6/5	8
Cherokee	27/4	6/5	9	22/4	30/4	8
Sioux	24/4	5/5	11	19/4	29/4	10
1999						
Wichita	12/4	27/4	15	15/4	1/5	16
Western Schelly	15/4	2/5	17	17/4	1/5	13
Cherokee	20/4	5/5	15	18/4	29/4	11
Sioux	19/4	6/5	17	20/4	29/4	9

The obtained results revealed that there are a coincidence between pollen shedding and female flower receptivity in varieties under study during first and second season. It means that the studied varieties were monogamy in general especially in the second season.

(5) Pollen viability

Data in **(Table 13)** show that the average percentage of pollen viability was higher in Cherokee variety (55%) followed in a descending order by Sioux variety (52%), Wichita (51%) and Western schelly had the lowest percentage in this respect (46%). The difference between significant varieties was during the two seasons of study similar results was obtained by Hamoda (1978 and 1982).

(6) Fruit set and fruiting

(6-1) Fruit set

Data concerning fruit set and fruiting in four Pecan varieties during successive seasons of 1998 and 1999 are presented in **(Table14)** the obtained data clearly revealed that the initial percentage of fruit set in 1998 season was the highest in Western schelly Pecan variety (95.71%) followed in a descending order by Sioux (93.75%), Cherokee (90.0%) and Wichita (85%). While in 1999 season Cherokee had the highest initial fruit set % at May 18 (97.14%) followed by Western schelly (93.33%), Sioux (92.5%) and Wichita (90%). Generally we can say that the four studied varieties had a high initial fruit set percentage during the two seasons of study.

As for the fruit retention and fruit drop percentage of the four Pecan cultivars under study, data obtained during both 1998 and 1999 seasons are presented in **(Tables 14 and 15)**. It is quite clear that both

Table (13): Percentage of pollen viability of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Total No. of stinabilty pollen grains		No. of viability pollen grains			Viability % of pollen grains		
	98	99	98	99	mean	98	99	mean
Wichita	50	50	24	27	25.51	48	54	51
Western Schelly	50	50	23	23	23.00	46	46	46
Cherokee	50	50	25	30	27.50	50	60	55
Sioux	50	50	24	28	26.00	48	56	52
L.S.D. 5%	N.S	N.S	0.56	0.92	0.52	1.56	1.72	1.10

Table (14): Fruit set and fruit retention (%) of some Pecan varieties during 1998 and 1999 seasons.

Date / Varieties	Fruit set%		Fruit retention %											
	18/5		25/5		1/6		8/6		15/6		22/6		29/6	
	98	99	98	99	98	99	98	99	98	99	98	99	98	99
Wichita	85.00	90.00	75.00	88.57	58.33	78.57	50.00	71.43	48.33	64.29	46.67	60.00	46.67	60.00
W. Schelly	95.71	93.33	92.86	93.33	88.60	82.67	77.14	81.33	52.86	74.67	52.86	66.67	52.86	66.67
Cherokee	90.00	97.14	78.57	87.14	67.14	78.57	58.57	71.44	50.00	65.71	48.57	51.44	48.57	51.44
Sioux	93.75	92.50	83.75	82.50	80.00	82.50	61.25	62.50	52.50	45.50	50.00	42.50	50.00	42.50
L.S.D 5%	2.05	2.51	2.11	2.64	3.11	3.10	2.99	1.83	1.68	2.83	1.66	1.58	1.66	1.58

Table (15): Fruit drop (%) of some Pecan varieties during 1998 and 1999 seasons.

Date / Varieties	18/5		25/5		1/6		8/6		15/6		22/6		29/6	
	98	99	98	99	98	99	98	99	98	99	98	99	98	99
Wichita	15.00	10.00	25.00	11.43	41.67	21.43	50.00	28.57	51.67	35.71	53.33	40.00	53.33	40.00
W. Schelly	4.92	6.67	7.14	6.67	11.43	17.33	22.86	18.67	47.14	25.33	47.14	33.33	47.14	33.33
Cherokee	10.00	2.86	12.43	2.86	32.86	21.43	41.43	28.56	50.00	34.29	51.43	48.56	51.43	48.56
Sioux	6.25	7.50	16.25	17.50	20.00	17.50	38.75	37.50	47.50	55.00	50.00	57.50	50.00	57.50
L.S.D. 5%	1.13	0.99	2.12	1.03	1.41	1.37	0.85	0.56	0.71	0.99	1.02	2.21	1.30	2.21

fruiting measurements varied from one cultivar to another. Moreover, the retained fruits were continuously decreased from the initial counting i.e May 18th till the late of June, whereas the retained number of fruits was constant. The rate of reduction was more pronounced as it took place severely from early May till early June or mid June for Wichita and 3 other varieties, respectively. There after the rate of fruit drop % became genteelly till the late of June whereas drop was generally ceased at late of July, this was true for all studied varieties during the two seasons of study. These results go in line with that reported by Hamoda (1978) who found that the percentage of fruit set per three Pecan varieties were constant from July 15 up to September 15. In addition highest percentage of mature fruits per total number of openly pollinated had Western Schelly variety (52.86 and 66.67% during 1998 and 1999 seasons respectively) followed in a descending order by Wichita (46.67 and 60.0%), Cherokee (48.57 and 51.44%) and Sioux (50.0 and 42.50%) for 1998 and 1999 seasons respectively. Analogous results were obtained by Bakr (1965) who found that the percentage of mature Pecan fruits were 59.7 and 48.0% for Mohan and Success Pecan varieties respectively.

The obtained results are in line with those of Bakr (1965) who found that the percentage of mature fruits of some Pecan varieties openly pollinated were 59.7 and 48.0 for Mohan and Success varieties respectively.

(6-2) Fruit drop

Data in **(Table 15)** show that the great amount of fruit drop was occur in the period from May 25th up to June 15th this is known as June drop; increasing fruit drop in this period May be due to the high temperature. This May affect water balance in the trees.

Sioux variety had the highest dropping percentage followed in a descending order by Cherokee, Wichita and Western Schelly varieties during the two seasons of study such results are in general agreement with earlier findings by Hamoda (1978 and 1982) and Sparks (1994).

(7) Fruit growth and development

After fruit setting, the fruits usually grow to maturity. The growth in this period is usually in weight, volume and dimensions. Changes in equatorial diameter during 1998 and 1999 seasons for varieties under study are presented in **(Table 16)** and illustrated in **(figures 3, 4, 5 and 6)**. Data, revealed that growth of both equatorial and polar diameters was continuously and gradually throughout duration from June 30th upto September 30th. Whereas both dimensions reached their maximum value. On the other hand, the increase in both polar and equatorial diameters gained through the period extended from August 30th till September 30th represented about 50% of the total dimensions of mature fruits. Moreover, after September 30th the dimensions remained constant with no detected increase. Such trend was true for changes in both polar and equatorial diameters during both 1998 and 1999 seasons. Moreover varietal and seasonal variation in polar and equatorial diameters were moderate.

In general our findings go in line with that mentioned by Hamoda (1978 and 1982).

Table (16): Fruit growth of some Pecan varieties during 1998 and 1999 seasons.

Date / Varieties	1998										1999									
	30/6		30/7		30/8		30/9		30/10		30/6		30/7		30/8		30/9		30/10	
	L*	D**	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
Wichita	0.2	0.1	0.6	0.3	1.4	0.6	3.5	1.6	3.5	1.6	0.2	0.1	0.7	0.3	1.5	0.7	3.0	1.5	3.0	1.5
W. Schelly	0.3	0.1	0.8	0.4	1.5	0.8	3.0	1.5	3.0	1.5	0.2	0.1	0.8	0.5	1.6	0.5	2.5	1.4	2.5	1.4
Cherokee	0.3	0.2	0.9	0.3	1.5	0.8	2.9	1.4	2.9	1.4	0.4	0.2	0.8	0.4	1.6	0.5	2.6	1.6	2.6	1.6
Sioux	0.2	0.1	0.7	0.2	1.3	0.7	2.8	1.3	2.8	1.3	0.3	0.1	0.8	0.3	1.5	0.4	2.8	1.3	2.8	1.3
L.S.D 5%	0.19	0.08	0.07	0.02	0.01	0.05	0.06	0.04	0.06	0.04	0.18	0.08	0.06	0.02	0.02	0.08	0.08	0.05	0.08	0.05

* L. = Polar diameter

** D. = Equatorial diameters

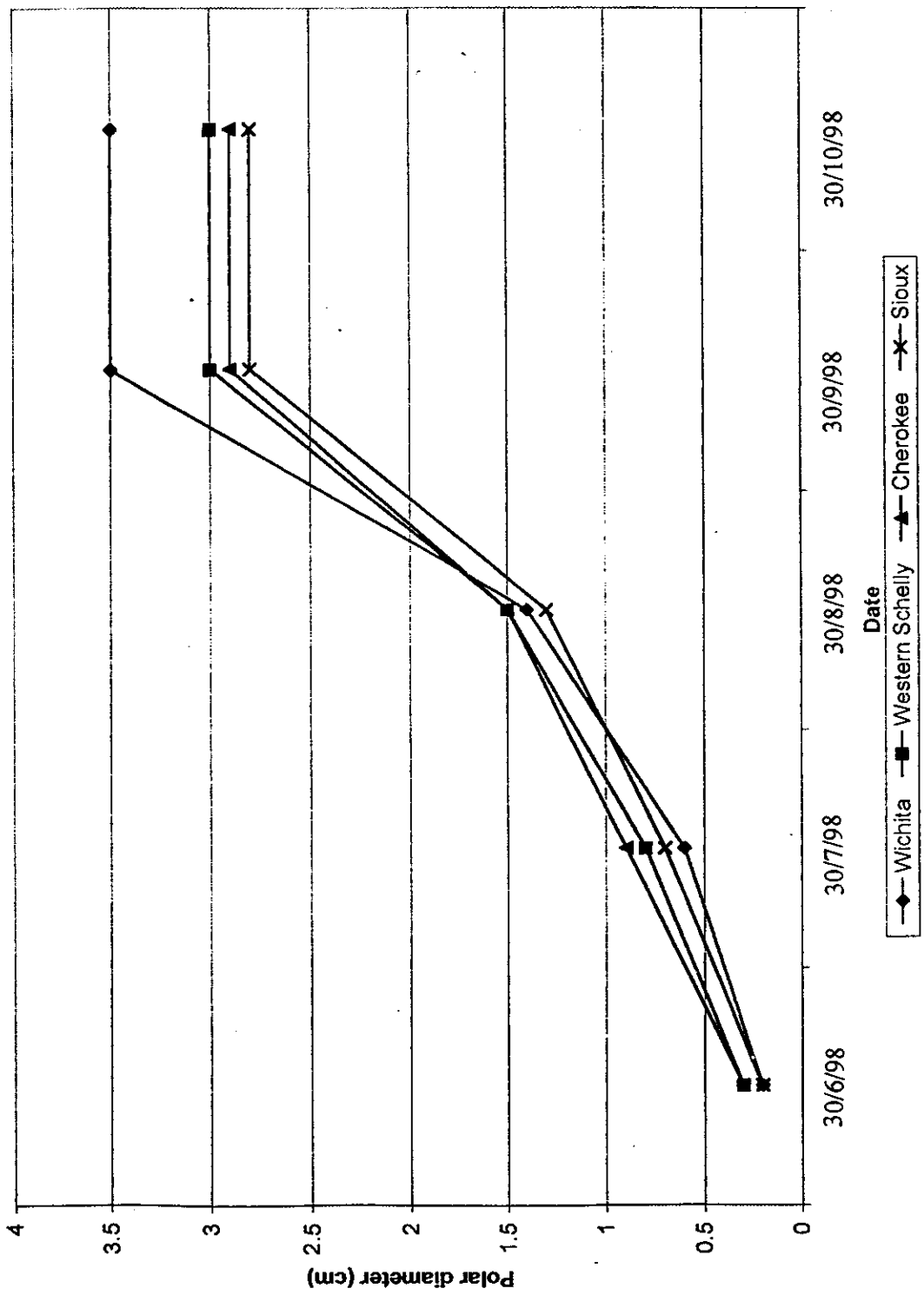

Fig.(4): Polar diameters (cm) of fruits at different growth dates in 1998

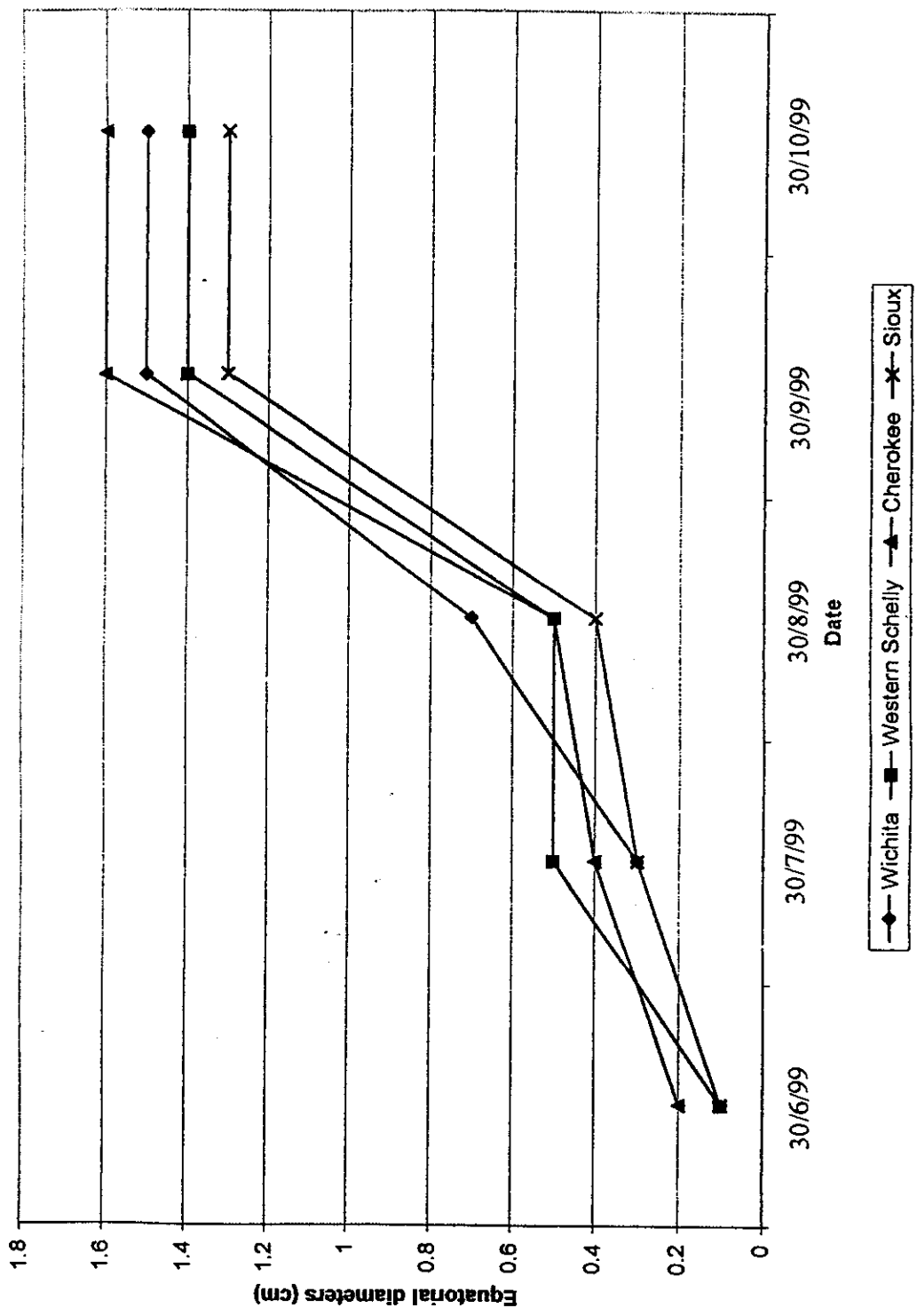

Fig.(5): Equatorial diameters (cm) of fruits at different growth dates in 1999

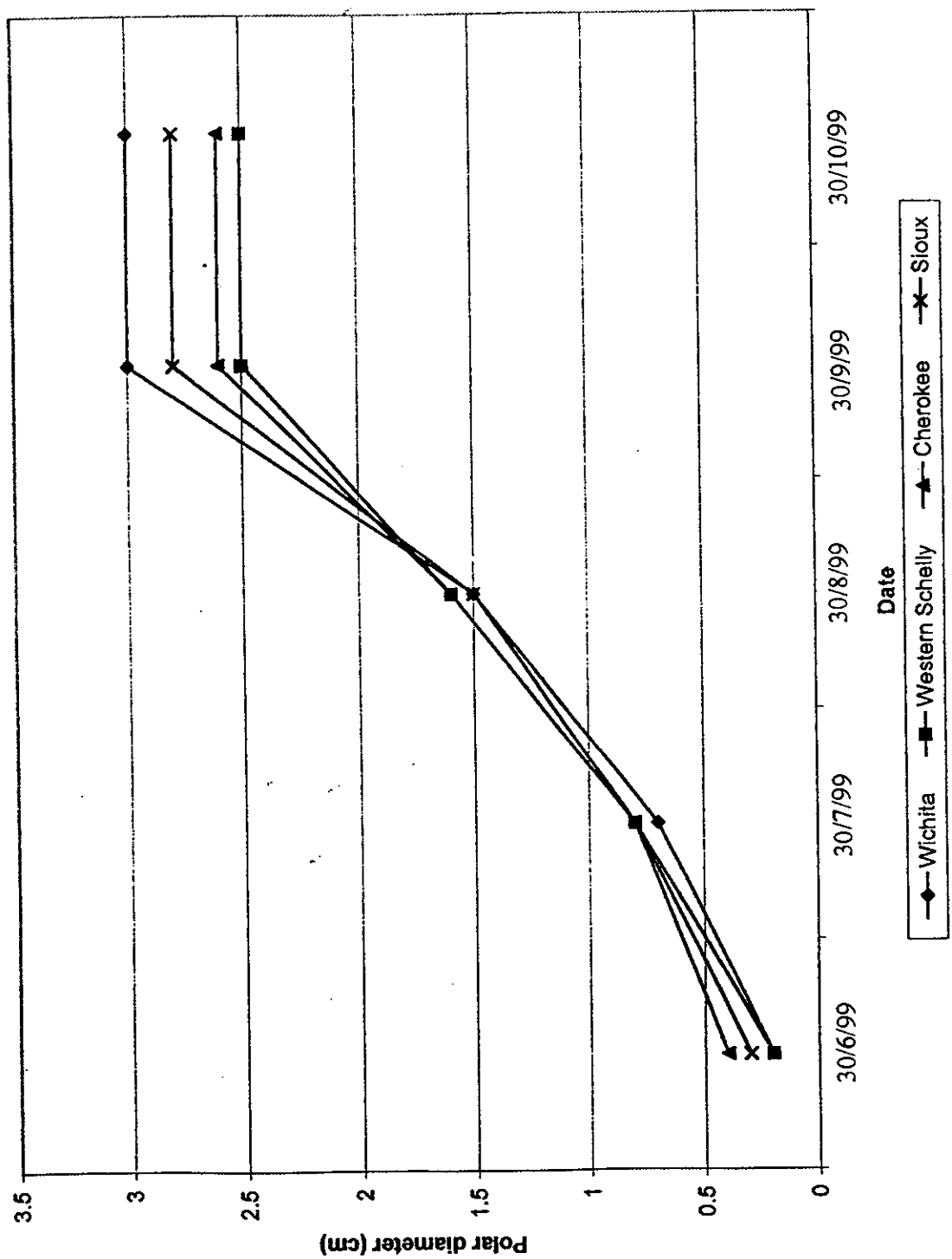

Fig.(6): Polar diameters (cm) of fruits at different growth dates in 1999

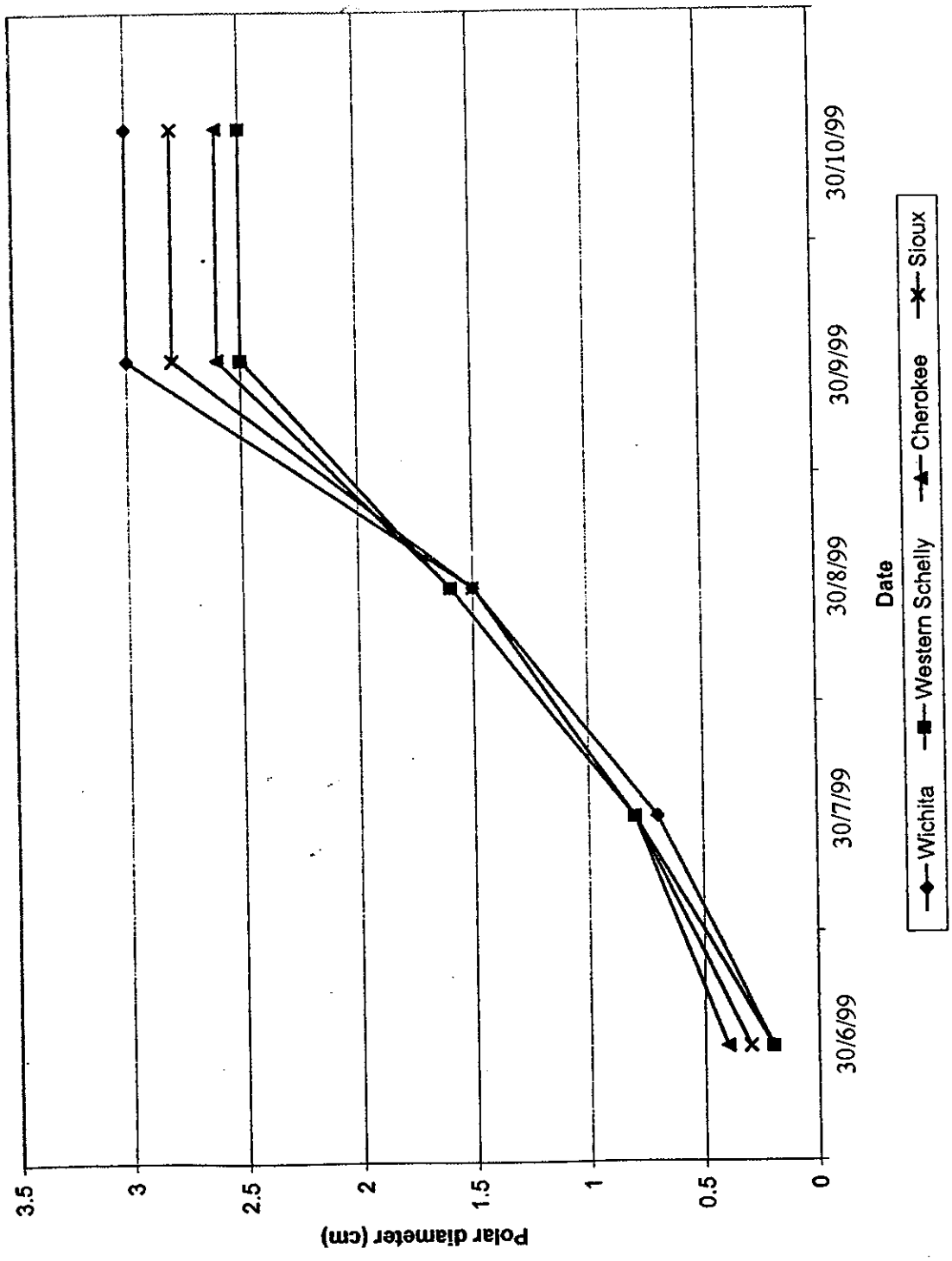

Fig.(6): Polar diameters (cm) of fruits at different growth dates in 1999

(8) Fruit yield

From data obtained during two seasons as shown from **(Table17)** and **(figures 7, 8, 9 and 10)**. **(Table 17)** it is quite clear to be observed that fruit yield in 1998 season was to somewhat higher than 1999 season in all studied varieties, moreover we must tell about that variety Mohawk till now did not induce any flowers and consequentially fruits this may be due to the environmental condition. The obtained data also declared that average nut yield of Cherokee variety was the highest as kg per tree or kg per feddan (10.8 kg / tree and 1814.40 kg/feddan) followed in a descending order by Western Schelly (9.70 kg/tree and 1629.60 kg / feddan), Wichita (7.45 kg/tree and 633.25 kg / feddan) and the lowest one in this respect had Sioux variety (9.7 kg / tree and 407.40 kg/feddan). The differences between varieties were significant.

The findings of Hamoda (1982) indicated that Western schelly variety gave the highest yield 1016.4 kg / feddan followed by Cherokee (929.04 kg / feddan), Wichita (376.98 kg / feddan) and Sioux (7.98 kg / feddan). This mean that the yield was increased by the development age of trees of studied varieties.

Moreover with comparing the yield as shell nut; Antalya-Turkya (1993) we can concluded that Cherokee, Western schelly and Wichita varieties produce high yield (above 2.5 ton from hectar) while Sioux variety gave medium yield (from 1 to 1.5 ton / hectar).

Table (17): Fruit shell and nut yield of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Shell nut						Nut					
	Kg / tree			Kg / feddan			Kg / tree			Kg / feddan		
	98	99	mean	98	99	mean	98	99	mean	98	99	mean
Wichita	17.0	10.5	13.8	1445	892.5	1168.8	9.6	5.3	7.5	816	450.5	633.3
W. Schelly	16.5	14.0	15.3	2772	2352	2562	10.9	8.5	9.7	1831.2	1428	1629.6
Cherokee	18.0	14.5	16.3	3024	2436	2730	12.6	9.0	10.8	2116.8	1512	1814.4
Sioux	17.5	13.0	15.3	735	546	640.5	12.5	6.9	9.7	525	289.8	407.4
L.S.D. 5%	1.30	0.98	0.91	102.11	62.54	100.14	1.04	0.80	0.81	83.87	72.99	71.92

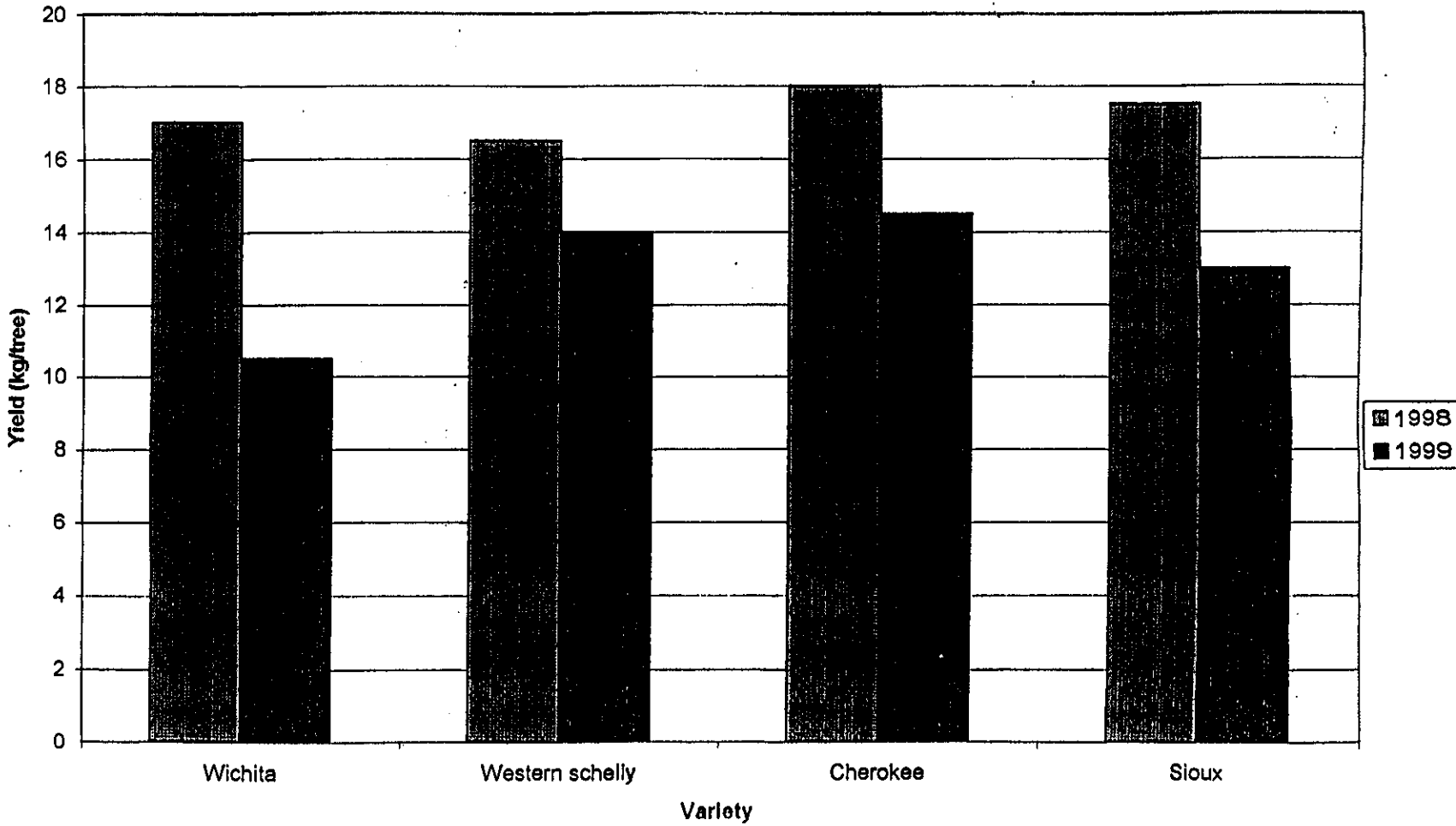

Fig.(7): Fruit shell nut yield as Kg/tree of some Pecan varieties during 1998 and 1999 seasons.

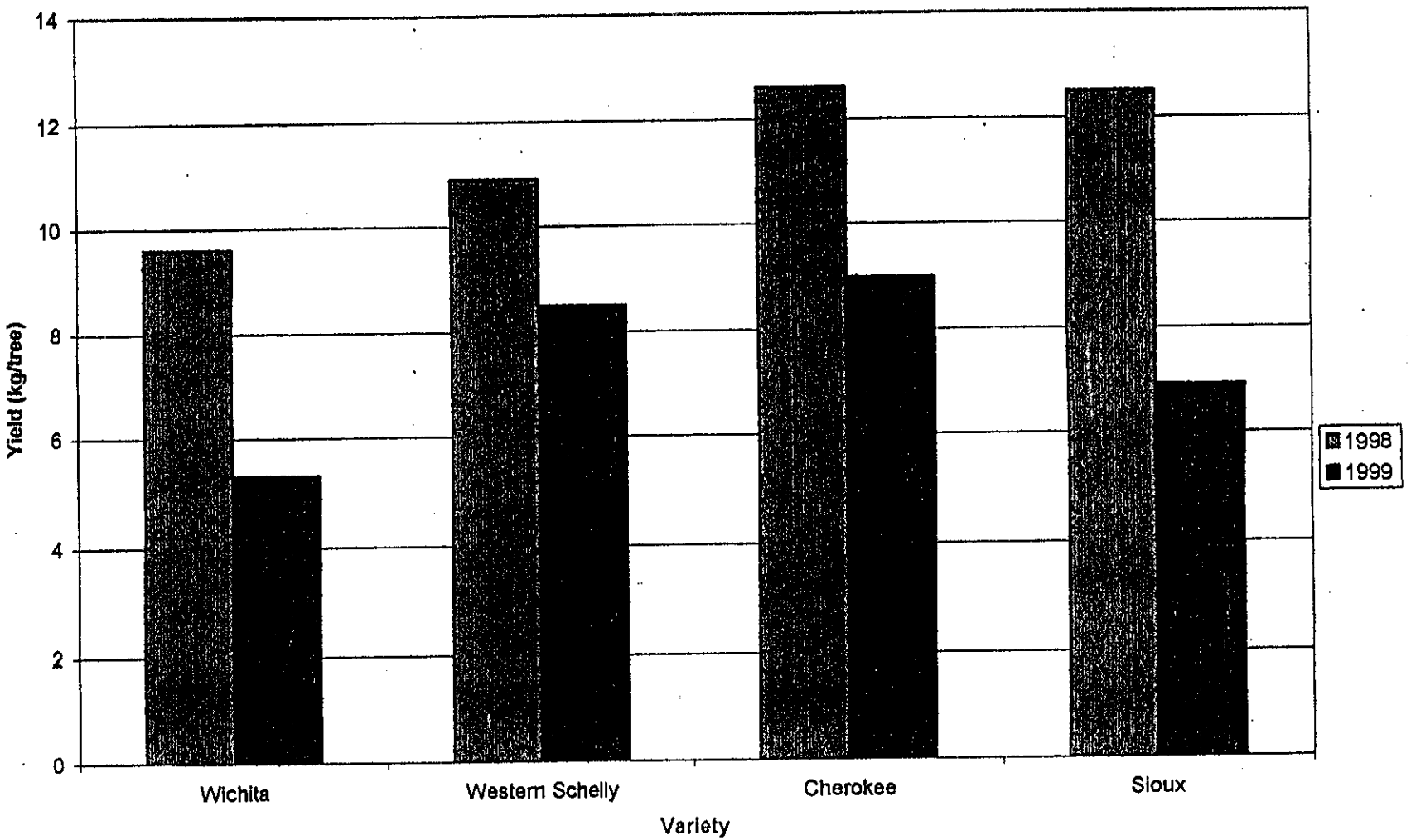

Fig.(8): Fruit nut yield as Kg/tree of some Pecan varieties during 1998 and 1999 seasons.

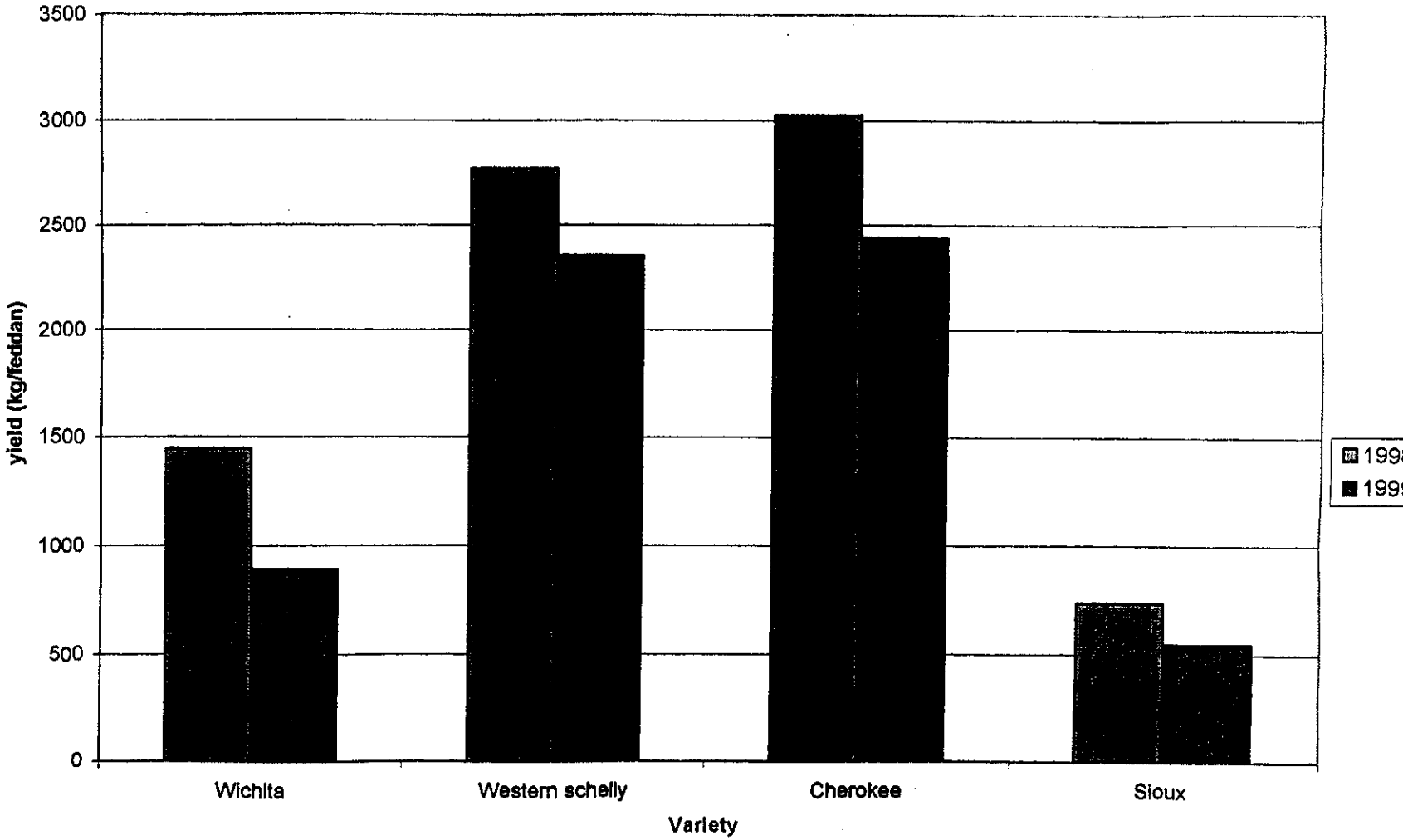

Fig.(9): Fruit shell nut yield as Kg/feddan of some Pecan varieties during 1998 and 1999 seasons.

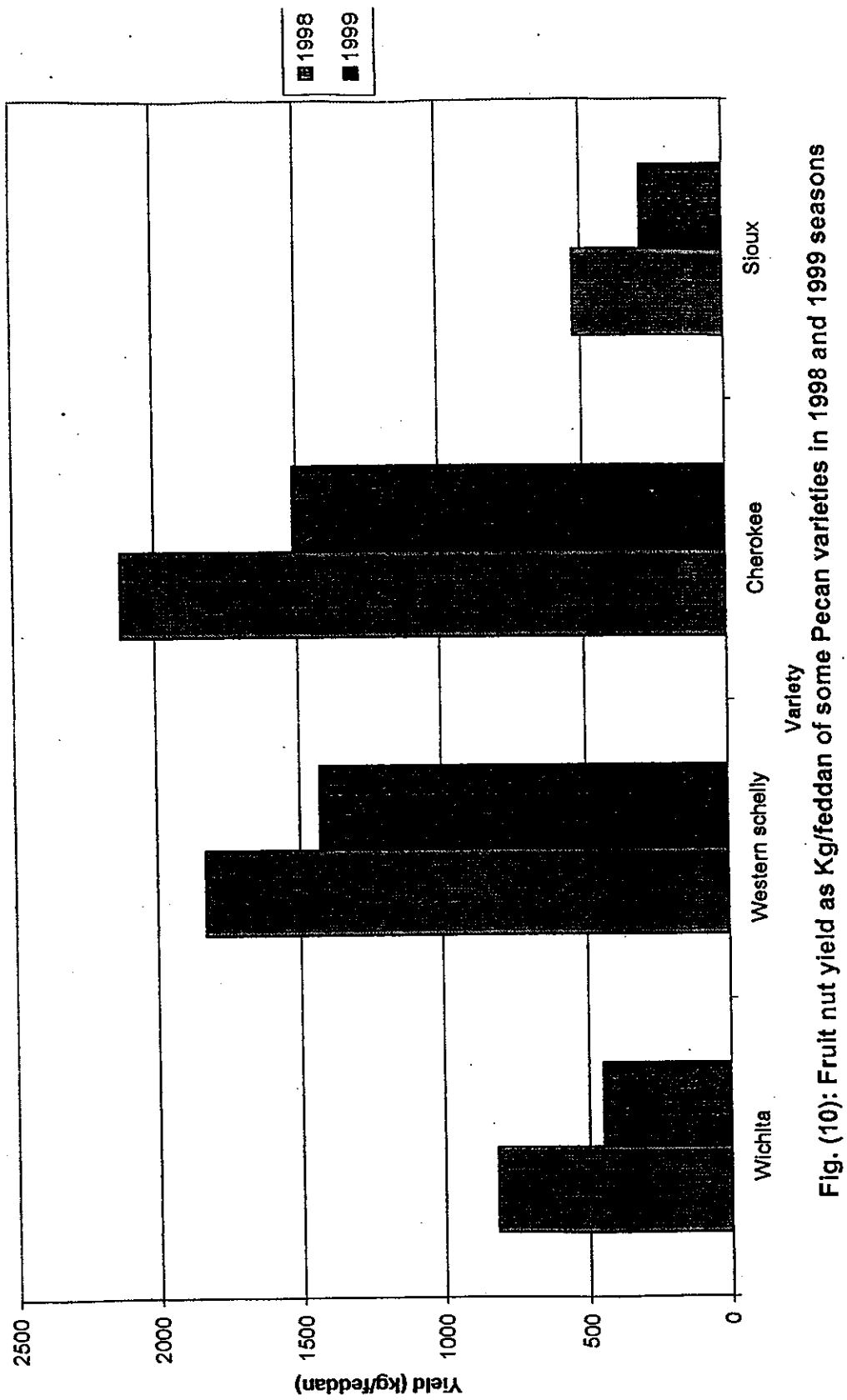

Fig. (10): Fruit nut yield as Kg/feddan of some Pecan varieties in 1998 and 1999 seasons

(9) Physical fruit characteristics

(9-1) Nut size

As for nut size which was estimated by measuring nut polar diameter and equatorial nut diameter of Pecan varieties under study it is shown in **(Table 18)** that Wichita was superior in its dimensions (polar diameter was 3.5 and 3.0 cm and equatorial was 1.6 and 1.5 cm during 1998 and 1999 seasons respectively) followed in a descending order by Cherokee , Sioux and Western Schelly during the two seasons of study. The differences between varieties in this respect were significant.

(9-2) Nut weight and number per Kg

(Table18) shows significant varietal difference in nut weight. The heaviest fruits were obtained from Wichita (7.7 and 7.4 gm) and Cherokee (6.7 and 7.2 gm) during 1998 and 1999 seasons respectively, while the lightest fruits were obtained from Sioux (5.9 and 6.0 gm) and Western Schelly (5.9 and 5.7 gm) in 1998 and 1999 seasons respectively. The difference between Wichita and other varieties was significantly while the differences between Sioux and Western Schelly was not significant in this respect during 1998 and 1999 seasons of study. These results agreed with that of Kaplankiran and Faraclar (1993) who found that nut weight varied between Pecan varieties.

As for number of nuts per Kilogram it was clear from **(Table18)** that varieties with heaviest nut weight had the lower number of nuts per kilogram. Also the results revealed that Pecan nuts of different varieties differ considerably in its number per kilogram.

Table (18): Nut physical characteristics and yield of some Pecan varieties during 1998 and 1999 seasons.

Varieties	No. of nut / Kg		Average nut weight (gm)		Polar nut diameter (H)		Equatorial nut diameter (D)		Nut shape (H/D)	
	98	99	98	99	98	99	98	99	98	99
Wichita	130	136	7.7	7.4	3.5	3.0	1.6	1.5	2.2	2.0
Western Schelly	170	175	5.9	5.7	3.0	2.5	1.5	1.4	2.0	1.8
Cherokee	150	139	6.7	7.2	3.2	2.5	1.5	1.5	2.1	1.7
Sioux	170	168	5.9	6.0	2.8	2.8	1.3	1.6	2.2	1.8
L.S.D 5%	5.58	7.50	0.16	0.16	0.04	0.16	0.10	0.01	0.06	0.06

The highest number of nuts per kilogram had Western Schelly variety (170 and 175 nuts/kg in 1998 and 1999 season respectively) followed in a descending order by Sioux (170 and 168 nuts/kg) Cherokee (150 and 139 nuts/kg) and Wichita (130 and 136 nuts/ kg) during 1998 and 1999 seasons respectively.

The obtained results go in line with findings of Awasthi and Singh (1973) and Hamoda (1978 and 1982) who found that the Number of nuts per kilogram significantly varied between different Pecan varieties.

(10) Kernel chemical contents

Data in **(Table 19)** show kernel contents of Protein, Oil, Carbohydrates and some mineral contents the obtained data revealed that a significant varietal differences were shown in the studied characteristics. Also it is quite obvious from **(Table 19)** that Sioux kernel was the highest in its protein content (9.6 and 9.01 % in 1998 and 1999 seasons respectively) followed in a descending order by Cherokee, Wichita and Western Schelly during the two season of study.

The differences between Pecan varieties in their kernel protein content was previously reported by Hamoda (1978).

Concerning oil content in different studied varieties, it is clear from **(Table 19)** that a considerable varietal and seasonal variation are evident in this respect. In the first season kernel of Cherokee variety had the highest oil percentage (77.21%) contrary to that Wichita variety had the lowest oil content in this respect had (66.50 %), meanwhile the Western Schelly and Sioux varieties were in between

Table (19): Kernel percentage of Protein, Oil and Carbohydrate of some Pecan varieties during 1998 and 1999 seasons.

Varieties	Protein %			Oil %			Carbohydrate %		
	98	99	mean	98	99	mean	98	99	mean
Wichita	7.41	7.06	7.24	66.50	70.49	68.50	18.60	17.15	17.88
Western Schelly	6.68	7.52	7.10	75.90	76.10	75.00	15.50	14.60	15.05
Cherokee	8.00	8.01	8.00	77.21	74.19	75.70	13.12	14.28	13.70
Sioux	9.60	9.01	9.31	72.11	75.21	73.66	12.99	14.15	13.57
L.S.D 5%	0.58	0.81	0.66	6.66	5.68	2.45	0.99	0.83	0.95

(75.90 % and 72.11 % respectively). While in second season Western Schelly had the highest content (76.10 %) and the lowest oil percentage was coupled with Wichita variety (70.49%). Moreover the differences between Cherokee and Western Schelly was not significant in the two seasons of study. Such results are in general agreement with earlier findings of Brison (1974), Merdrtial (1976) who stated that Pecan kernel oil content varied from 61 to 75 % in its selected varieties grown in Florida.

Regarding charbohydrate contents in kernel of studied varieties, it is quite evident that the richest variety in this regard was Wichita (17.88%) followed in a descending order by Western Schelly (15.05%), Cherokee (13.70%) and Sioux (13.57 %). The differences between varieties were significant. This were true during two seasons of study **(Table 19).**

With respect to phosphorous kernel content, data obtained during both 1998 and 1999 seasons, reveled that the highest variety in this regard was Sioux (0.62 and 0.52 % in the first and second season respectively) on the other hand Cherokee variety was the lowest in this respect (0.31 and 0.29 % in the first and second season respectively). While Wichita and Western Schelly varieties were in between. The differences between varieties were significant in both 1998 and 1999 seasons.

With regard to the kernel potassium percentage data in **(Table20)** declared that Wichita had significantly the highest K% level during both 1998 and 1999 seasons. On contrary Western Schelly had the lowest kernel K% content. While Sioux and Cherokee were in between in this respect.

Table (20) : Kernel percentage of Phosphorous, Potassium, Calcium and Magnesium of some Pecan varieties during 1998 and 1999 seasons .

Varieties	Phosphorus (%)			Potassium (%)			Calcium (%)			Magnesium (%)		
	98	99	mean	98	99	mean	98	99	mean	98	99	mean
Wichita	0.51	0.52	0.51	0.66	0.61	0.64	1.00	0.90	0.95	0.63	0.60	0.61
W. Schelly	0.42	0.42	0.42	0.45	0.39	0.42	0.98	1.10	1.04	0.71	0.82	0.77
Cherokee	0.31	0.29	0.30	0.42	0.46	0.44	1.20	1.00	1.10	0.85	0.83	0.84
Sioux	0.62	0.52	0.57	0.53	0.61	0.57	0.90	1.10	1.00	0.82	0.88	0.85
L.S.D 5%	0.11	0.11	0.07	0.09	0.22	0.07	0.04	0.12	0.05	0.06	0.09	0.06

Concerning calcium percentage of Pecan kernel, data in **(Table20)** shows that in 1998 season Cherokee variety had the highest Ca % level (1.20%) followed in descending order by Wichita (1.00%), Western Schelly (0.98%) and Sioux (0.90%). The differences between varieties were significantly. In the second season 1999 Western Schelly and Sioux had the highest calcium percentage (1.10%), followed by Cherokee (1.0%) and the lowest variety in this respect Wichita (0.90%).

Regarding magnesium kernel percentage of the studied Pecan varieties, the obtained data revealed that Sioux and Cherokee varieties had the highest level of magnesium content, (0.82 and 0.88% in Sioux and 0.85 and 0.83 % in Cherokee in 1998 and 1999 seasons respectively) on the contrary Wichita variety had the lowest level in this respect (0.63 and 0.60 % in 1998 and 1999 seasons respectively). While Western Schelly was in between. This was true during the two seasons of study **(Table 20)**.

Different varieties had varied also with regard to its kernel iron content as ppm. **(Table 21)** shows that Sioux had the highest iron content in both seasons of study (280 and 283 ppm in 1998 and 1999 respectively), followed by Cherokee variety (272 and 273 ppm), Wichita (251 and 248 ppm). And the lowest one in this respect was Western Schelly (240 and 249 ppm in the first and second seasons respectively. Moreover the difference between varieties were significant varied.

Data in **(Table21)** revealed that zinc of Pecan kernel as ppm varied From 69.5 up to 83.2 ppm. The highest content of zinc ppm had Cherokee variety (80.0 and 83.2 in the first and second

Table (21) : Kernel Iron and Zinc contents as (ppm) of some Pecan varieties during 1998 and 1999 seasons .

Varieties	Iron (ppm)			Zinc (ppm)		
	98	99	Mean	98	99	mean
Wichita	251	248	249.5	69.5	73.0	71.2
Western Schelly	240	249	244.5	71.3	72.1	71.7
Cherokee	272	263	272.5	80.0	83.2	81.6
Sioux	280	283	281.5	75.5	79.1	77.3
L.S.D .5%	6.90	5.45	5.14	2.57	1.98	3.87