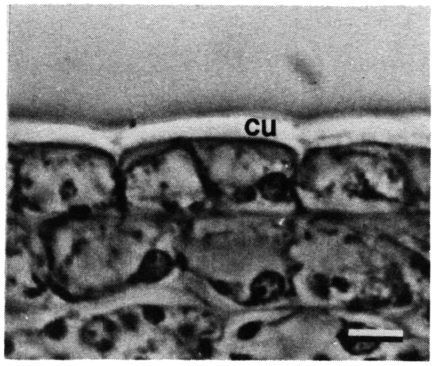

Fig. 6. Healthy fruit tissue from a papaya fruit after 21 days of incubation at 15 mm Hg and 10°C. (Bar represents 10 μm).

viously described for *C. gloeosporioides* on papaya fruit incubated in 24° air (2, 3, 7).

Less disease occurred on inoculated fruit stored at LP than on those stored in air (Table 2). On the first day after removal from storage, 88% of fruit stored at LP were marketable. After ripening for 5 days in air, 26% and 6% of the fruit stored at LP and 10° air, respectively, were marketable. No damage to papaya fruit tissue was observed after 21 days of storage at LP with gradual equilibration of pressure (Fig. 6), but softening occurred with rapid pressure changes (data not shown).

This study substantiates previous evidence (1, 6) that LP storage reduces losses due to anthracnose. However, since growth of the pathogen and disease development are merely retarded, LP storage only will be effective in reducing decay if disease control programs (1, 4) are used to reduce infection of fruit prior to LP storage.

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Genetic Variability in Pecan Fruit Development

Tommy E. Thompson[1]
W.R. Poage Pecan Field Station, Agricultural Research Service, U.S. Department of Agriculture, Brownwood, TX 76801

Additional index words. *Carya illinoensis*, breeding

Abstract. **Fresh and dry weights of fruit (nut and shuck) samples of 39 clones of pecan [*Carya illinoensis* (Wang) K. Koch] were determined weekly from July 23 until harvest. One early maturing clone had accumulated 24% of its final fruit dry weight by July 23, when the average for all clones was 11%. Total fruit dry matter decreased during October for some late-maturing clones. These decreases, which were the most obvious in 'Mahan' and its progeny clones, were not as common in early maturing clones.**

Pecan is a lower-yielding nut crop than Persian walnut (*Juglans regia* L.). One reason for this may be late nut development. Nut filling in pecan occurs mainly during September (1, 3, 6, 7, 8), when the days are shorter, leaves are often unhealthy, and when moisture and soil nutrients have often been depleted by 6 months of active growth. Trees also replenish root carbohydrate reserves for the winter during this period which may compete with other sinks for photosynthates.

Productivity of young walnut orchards has been increased by the development of new precocious cultivars (2, 4). This was accomplished by selecting clones which produced more pistillate flowers, especially on lateral branches. Pecan, in contrast, is incapable of filling more nuts, possibly due to its late nut-filling period (5). Clones which produce more nuts than they can fill are often useless because of poor nut quality and low percentage of kernel.

Clones which fill earlier and have a longer filling period may be needed to increase yields. This study was undertaken to determine genetic variability among clones for fruit developing periods.

Three- and 4-year-old, open-pollinated 'Riverside' seedling rootstocks were planted in deep, loamy Frio soil formed in calcareous alluvium with 0–1% slopes in a square design (7.5 × 7.5 m) in March 1967 at Brownwood, Texas. Thirty-nine clones representing a wide range in nut maturity periods (Table 1) were budded on these stocks in May 1971. Two tree plots of each clone were randomized within each of 3 replications. Rainfall and irrigation water received by the plots in 1980 totaled 94.1 cm. Trees were maintained by a normal spray and fertilizer program.

A 10-fruit (nut and shuck) sample was collected from each plot on July 23, 1980. Fruits were removed uniformly from the tree canopies. This sampling was repeated every 4–20 days, as weather permitted, through November 4. The earliest clones matured October 6, and the latest clones were harvested on November 4. All fruit samples were weighed, dried at 50°C to a constant weight, and reweighed. Fruit weights were expressed as percentages of mature fruit weights to correct for characteristic clonal fruit sizes.

There were pronounced differences in cross-sectional areas of fruits of selected clones on July 24 (Fig. 1). The earliest clone (48-15-3) was over twice as large as the latest one ('Mahan') on that date. 'Mahan' at maturity was 1.9 times as large (by volume) and weighed 1.7 times as much as 48-15-3.

Differences among clones for fruit dry-matter accumulations for all dates through October 14 were significant at the 0.1% level, but differences on October 21, 28, and November 4 were nonsignificant (Table 1). Percentages which decreased from the previous sampling dates are underlined. Twenty-four of the 39 clones decreased on at least one sampling date.

A typical clonal response for fruit dry-matter accumulation for each of the 5 maturity dates is shown in Fig. 2. The earliest maturing clones (e.g., 48-15-3) had the highest percentages of dry-matter accumulation when sampling began July 23. It maintained almost a linear accumulation rate until about September 1, then leveled off and matured during the first part of October. A typical clonal response for an October 14 maturity date is shown by 40-9-266. Accumulation initially was slow, then increased and sometimes exceeded 100% of final dry weight before receeding slightly at maturity. 'Cheyenne' had a more uniform accumulation and exceeded 100% on one date. 'Wichita' was variable for dry-matter percentage, increasing and decreasing for about a month before maturity. One late-maturing clone (i.e., 40-9-277) exceeded 100% of final dry weight on more

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[1]Research Geneticist.

Table 1. Total dry weight (expressed as a percentage of final dry weight) of fruits from 39 pecan clones on different harvest dates at Brownwood, Texas in 1980.

Clone[z]	July 23	Aug 8	Aug 19	Aug 26	Sept 2	Sept 12	Sept 16	Oct 6	Oct 14	Oct 21	Oct 28	Nov 4
48-15-3	24 a[y]	43 a	61 a	68 a	87 a	93 a	99 a	100 a–f				
44-15-51	14 c–f	27 b–f	40 c–f	46 b–j	56 b–f	81 a–b	91 a–b	100 a–f				
49-15-22	11 d–l	23 d–k	37 c–i	49 b–g	58 b–e	78 a–c	83 a–d	100 a–f				
Chickasaw	13 c–h	25 b–i	37 c–i	47 b–i	56 b–g	77 a–d	81 a–e	100 a–f				
Shoshoni	20 a–b	33 b	46 b–c	50 b–f	66 b–c	76 a–d	77 a–g	100 a–f				
53-11-139	14 c–f	28 b–e	38 c–g	52 b–c	58 b–e	73 a–f	75 b–h	100 a–f				
44-4-135	21 a	30 b–d	46 b–c	51 b–e	59 b–e	74 a–f	80 a–e	100 a–f				
40-10-1	11 d–l	21 d–m	36 d–k	48 b–i	57 b–f	73 a–g	80 a–e	95 b–f	88[x] c–e	97	92	100
40-9-266	15 c–d	26 b–i	41 b–e	52 b–d	57 b–f	75 a–e	77 a–g	111 a–d	100 c–e			
49-1-478	20 a–b	33 b–c	50 b	55 b	62 b–d	78 a–c	87 a–c	99 a–f	100 c–e			
61-6-67	17 b–c	30 b–d	44 b–d	55 b	59 b–e	78 a–c	78 a–f	107 a–e	100 c–e			
Cherokee	14 c–e	21 e–n	32 e–m	38 e–l	49 d–j	62 b–k	61 d–i	90 c–f	86 d–e	100		
Mohawk	12 d–j	27 b–g	36 c–j	48 b–h	56 b–g	67 b–i	80 a–e	100 a–f				
Wichita	14 c–e	25 c–j	38 c–g	52 b–e	60 b–e	71 b–h	79 a–f	114 a–c	98 c–e	108	100	
Tejas	12 c–i	23 d–k	35 d–l	43 b–k	52 c–i	65 b–j	68 c–i	97 a–f	99 c–e	100		
Shawnee	8 i–l	15 k–n	25 l–n	32 k–l	41 g–l	51 g–k	61 d–i	90 c–f	89 c–e	100		
Cowley	10 g–l	18 h–n	33 e–m	38 d–l	48 d–k	63 b–k	63 d–i	87 c–f	86 d–e	94	82	100
40-9-277	11 d–k	23 d–l	40 c–f	55 b	67 b	78 a–c	91 a–b	124 a	139 a	130	122	100
45-3-3	9 h–l	18 g–n	33 e–m	42 b–k	53 b–h	61 b–k	68 c–i	111 a–d	113 b–c	123	100	
Sioux	9 g–l	16 j–n	28 h–n	34 i–l	39 h–l	50 h–k	61 d–i	84 d–f	89 c–e	100		
Caddo	7 k–l	16 j–n	27 i–n	34 h–l	40 h–l	51 h–k	53 h–i	79 f	99 c–e	100		
GraBohls	9 g–l	15 k–n	26 k–n	33 j–l	37 i–l	49 h–k	55 g–i	80 e–f	96 c–e	101	100	
Cheyenne	11 d–k	21 e–n	30 f–n	40 c–l	47 e–l	55 d–k	65 c–i	97 a–f	103 c–e	100		
Western	10 e–l	18 h–n	33 e–m	41 b–l	48 d–k	58 c–k	64 d–i	100 a–f	103 c–e	88	105	100
Riverside	13 c–g	26 b–h	38 c–h	49 b–g	54 b–h	68 b–i	76 b–g	109 a–d	102 c–e	100		
Cape Fear	6 l	12 n	21 n	27 l	35 j–l	45 j–k	49 i	79 e–f	89 c–e	90	109	100
41-19-20	10 f–l	18 g–n	31 e–n	34 i–l	43 f–l	55 e–k	59 e–i	87 c–f	96 c–e	90	98	100
56-7-14	7 k–l	14 l–n	28 g–n	36 g–l	37 i–l	53 f–k	60 e–i	102 a–f	97 c–e	105	100	
Apache	11 e–l	21 e–n	30 f–n	42 b–k	52 c–i	74 a–f	80 a–e	119 a–b	134 a–b	109	126	100
49-20-112	8 i–l	16 j–n	27 j–n	35 g–l	40 h–l	56 c–k	67 c–i	94 b–f	105 c–e	100		
Sumner	7 k–l	15 k–n	22 n	30 k–l	32 l	43 k	53 h–i	81 e–f	89 c–e	99	135	100
Choctaw	7 k–l	15 k–n	22 n	30 k–l	37 i–l	48 i–k	55 g–i	76 f	88 c–e	92	88	100
53-3-36	8 j–l	13 m–n	23 m–n	28 l	34 k–l	48 i–k	49 i	78 f	86 d–e	100	100	
Kiowa	7 k–l	16 j–n	24 m–n	29 k–l	41 h–l	51 h–k	57 f–i	88 c–f	91 c–e	97	99	100
53-9-1	7 k–l	14 m–n	23 m–n	32 j–l	46 e–l	53 f–k	59 e–i	79 f	86 d–e	94	92	100
53-9-340	9 g–l	17 i–n	28 h–n	37 f–l	43 f–l	54 f–k	59 e–i	89 c–f	103 c–e	100		
45-10-38	9 g–l	14 m–n	24 m–n	31 k–l	34 k–l	43 k	52 i	79 f	82 e	110	107	100
33-1-5	9 g–l	19 f–n	29 g–n	39 c–l	47 e–l	58 c–k	65 c–i	93 b–f	98 c–e	94	100	
Mahan	11 d–l	19 f–n	33 e–m	41 b–l	46 e–l	59 c–k	59 e–i	92 b–f	109 c–d	116	117	100
Avg	11	21	33	41	49	62	68	95	98	101	103	100

[z]Clones are arranged in order of nut maturity (earliest to latest) based on 10 years of data recorded at Brownwood, Texas.
[y]Mean separation within columns by Duncan's multiple range test, 5% level.
[x]Values which decrease from previous harvest dates are underlined.

than one sampling date, and receeded sharply just prior to maturity. Other clones had similar dry-matter decreases (Table 1). The reason for these decreases is not known. Further research is needed to determine which fruit part(s) are most affected.

Genetic variability for time of fruit development is common among pecan clones. Nut maturity variation among sibs is common in most pecan progenies, with transgressive segregants being somewhat common. Three of the clones in Fig. 2 ('Wichita', 40-9-266, 40-9-277) are sibs, and each has a different relative nut maturity. These different clonal responses are important since they concern yield directly. I believe that selection for an early-filling pecan may be the way to obtain high yields.

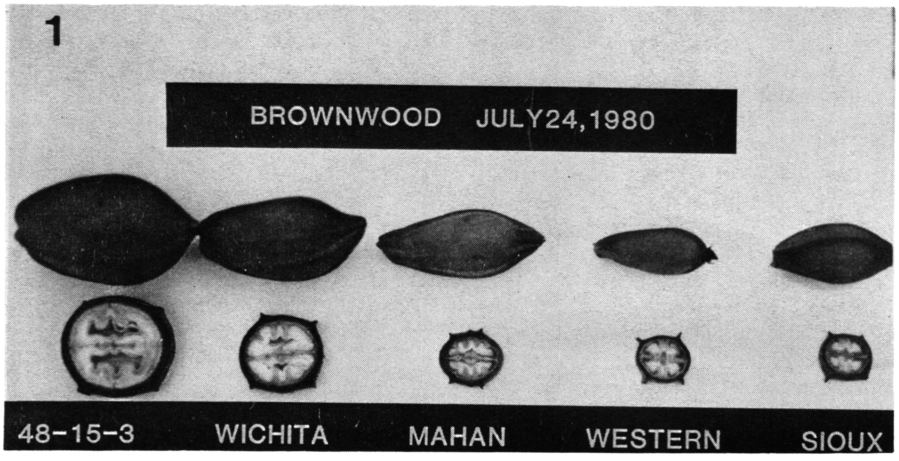

Fig. 1. Relative differences in cross-sectional area of fruits of 5 pecan clones on July 24, 1980.

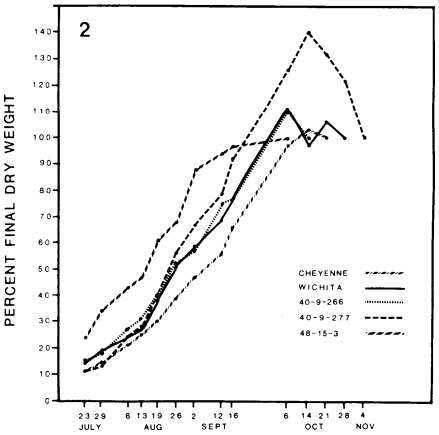

Fig. 2. Fruit dry-matter accumulation curves for pecan clones at Brownwood, Texas, 1980.

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Quality and Decay of Mango Fruit Wrapped in Heat-shrinkable Film

W.R. Miller and P.W. Hale
Agricultural Research Service, U.S. Department of Agriculture, 2120 Camden Road, Orlando, FL 32803

D.H. Spalding
Agricultural Research Service, U.S. Department of Agriculture, 13601 Old Cutler Road, Miami, FL 33158

P. Davis
Agricultural Research Service, U.S. Department of Agriculture, 2120 Camden Road, Orlando, FL 32803

Additional index words. *Mangifera indica*, anthracnose, stem-end rot, postharvest storage

Abstract. **Fruit of mango (*Mangifera indica* L.) were individually sealed in heat-shrinkable plastic films, stored for 2 weeks at 12°C, and then ripened at 21°. Weight loss of film-sealed fruit was significantly less than that of nonsealed fruit. There were no significant differences in firmness, color development of the skin, decay development, or time to ripen to the soft-ripe stage between film-sealed and nonsealed fruit.**

For many years, wholesalers and retailers have film-packaged fresh produce to prolong a fresh appearance during merchandising. Interest in film-wrapping of individual fruit at the source of supply is a relatively new phenomenon. Three major factors contribute to this increased interest: 1) recent studies show that certain fresh fruits and vegetables benefit from sealing in plastic films—moisture loss in particular is reduced (1, 4, 5, 6); 2) recent improvements in the film-manufacturing processes provide a wide selection of films with differing properties; and 3) equipment is available now for high-speed handling and wrapping of fresh fruits and vegetables.

Mangos are particularly susceptible to decay during postharvest ripening and much research has been conducted to seek treatments and techniques to maintain an extended postharvest shelf-life (3, 7, 8). The objective of this study was to determine the effect of individual film-sealing on storage and ripening quality of mango fruit; 3 different biaxially oriented, heat-shrinkable films were used.

'Tommy Atkins' mango fruit obtained from a single Dade County grower were randomly sorted into treatment lots of 16 fruit in each of 5 tests (replications) during June and July, 1982. Fruit were mature-green, uniform in size (about 400 g each), and were washed with fresh water of ambient temperature but not treated with fungicide. Fruit were divided into 4 treatments of 16 fruit each in each test: 1) control (nonsealed); 2) sealed in Clysar EH-60 (Du Pont) polyethylene film of 0.01 mm (0.6 mil) nominal thickness; 3) sealed in Clysar EHC-50 copolymer film of 0.013 mm (0.5 mil) nominal thickness; and 4) sealed in Clysar EHC-100 copolymer film of 0.025 mm (1.0 mil) nominal thickness. Refer to Hale et al. (4) for properties of each film used. The plastic film was applied using a Weldotron sealer (model 6001), and it was shrunk tightly around the fruit using a Weldotron heat tunnel (model 7001). Though tightly sealed, the film did have some small holes (pin holes) and no attempt was made to make all sealing airtight. Following sealing, fruit were placed in storage for 14 days at 12°C with relative humidity 88–95%. After storage, the film on 8 fruit from each film-sealed treatment was removed and fruit from all treatments were placed at 21° until soft-ripe. All fruit were evaluated for weight loss, firmness, color, decay, and sugars following storage at 12° and again at the soft-ripe stage.

Weight loss was determined by weighing (accuracy ± 0.1%) each fruit before and after storage and upon reaching soft-ripe stage. Firmness was subjectively measured by finger pressure and scored on a scale of 1 through 5 [5 = hard; 4 = fairly hard; 3 = fairly soft; 2 = soft-ripe (consumer eating stage); and 1 = overripe]. Yellow-red color development in the skin was rated on a scale of 1 through 5 (1 = 0% green; 2 = 1–25%; 3 = 26–50%; 4 = 51–75%, and 5 = 76–100% nongreen surface area), and ripening time was determined following storage by evaluating fruit firmness each day until fruit were soft-ripe.

Decay was rated by the percentage of surface area affected for anthracnose (*Colletotrichum gloeosporioides*) and for stem-end rot (*Diplodia natalensis*). Scoring for decay was as follows:

Rating	*Anthracnose* (%)	*Stem-end rot* (mm)
1	≤ 2 (trace)	≤ 3 (trace)
2	3–10 (slight)	4–13 (slight)
3	11–20 (moderate)	14–25 (moderate)
4	> 20 (severe)	> 25 (severe)

Sugars were analyzed before storage and at soft-ripe. Pulp (50 g) from each of 3 fruit were combined and blended with 200 ml of water for at least 1 minute. The homogenate was filtered through cheesecloth and then centrifuged. An aliquot of the supernatant was filtered through a 1- to 3-μm prefilter then through a 0.2- to 0.8-μm prefilter, and a 0.45-μm final filter. Ten μl of juice were analyzed with a Waters 202/401 liquid chromatograph equipped with a refractive index detector and a Waters carbohydrate column, 4 mm × 30 cm. The solvent was acetonitrile/water (85/15) at a flow rate of 1 ml/min; analysis time was about 12 min.

There was no significant difference in weight loss among the film-sealed treatments, but weight loss of nonsealed fruit was significantly greater than that of sealed fruit (Table 1). Fruit kept sealed until soft-ripe lost about 1.0% weight. Fruit unwrapped following storage lost about 4.0%, and nonsealed control fruit decreased 6.7% in weight at the

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