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Forage Production in PECAN ORCHARDS

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Contents

Summary

The production of Coastal and NK-37 bermudagrass and hybrid sudangrass was evaluated in irrigated and dryland pecan orchards of varying ages.

Young pecan trees, even if closely spaced, shade a relatively small percentage of the ground, especially during the critical midday period. Producing trees spaced 50 x 50 feet shaded 36 percent of the total area during a midday period between 10:00 a.m. and 2:30 p.m.

Light is reduced under full grown trees as much as 90 percent, which essentially eliminates grass growth. Light reduction under young trees is less than under mature trees apparently because of greater light reflectance through and around the smaller canopy.

Coastal and NK-37 bermudagrass in a young irrigated pecan orchard produced yields in excess of 5 tons per acre at Brownwood and Mineral Wells.

Coastal bermudagrass and hybrid sudangrass produced yields of 2 to 3 tons of dry forage per acre in a dryland orchard of 12- to 16-year-old trees in the Brazos River bottom near College Station. In general, 200 pounds of nitrogen per acre gave maximum forage production. Coastal and NK-37 survived in an orchard of mature trees in areas not shaded between 10:00 a.m. and 3:00 p.m., but production was very limited.

As trees increase in size, both the extent and intensity of shade increases, and grass production decreases. The major effect is in midday, and not all the area is shaded at this time. Tree spacing is a major determining factor on the length of time forage production is practical in a pecan orchard since this determines the percentage of the total area shaded by trees at any stage of development. Pasture shade trees would likely have similar effects on grass growth as pecan trees, the amount of reduction in grass growth being dependent on tree size and spacing.

Forage Production in PECAN ORCHARDS

Ethan C. Holt*

FOR SEVERAL YEARS FOLLOWING ESTABLISHMENT of pecan trees, no economic returns are realized from nut production. This is overcome to some extent by closer tree spacing initially, but other practices such as hay production may provide an alternative source of income during this period. However, information is needed on the effects of understory crop competition on tree growth and development and nut production. Also, trees as they develop compete with interplanted crops both directly and indirectly. The tree roots compete for nutrients and moisture, while the overstory competes for light and carbon dioxide.

This publication, based on research concerned with tree effects on forage production, provides information on production levels at various stages of tree development. Tree shade patterns, light reduction under trees and subsequent grass production and survival were evaluated.

Shade Patterns

Grass requires light for growth, and plants compete for available light. Light intercepted by the leaves of one plant is not available for use by another plant. In competition for light between pecan trees and interplanted grass, the tree has the advantage since the canopy of the tree is always above that of the grass. Not all light is intercepted since the tree cover is usually not complete, and the canopy may be open enough to permit some light penetration to the ground level.

Both tree size and tree spacing influence the proportion of light intercepted for a fixed area. When the trees are small, a relatively small percentage of the total light is intercepted, and interplanted grass would be affected little. Also, there are no areas continuously or completely shaded when trees are small. As the trees increase in size, the potential for grass production is dependent on tree spacing. The area directly under the tree canopy may be continuously shaded which limits grass growth; thus production is restricted to the area between canopies.

Shade patterns were plotted for 6-year-old trees spaced 35 x 35 feet at Brownwood (Figure 1). The observations were made in August at intervals during the day. The area shaded during the midpart of the day represented no more than 10 percent of the total area. Thus, even if grass growth is affected by shade in young orchards, the total effect would be small since, at most, grass growth is reduced but not stopped by partial shade.

Shade patterns in July were plotted for 12-year-old trees spaced 50 x 50 feet at College Station (Figure 2). The trees averaged 28 feet tall with a canopy spread of 21 feet. The total shaded area represented approximately 36 percent of the area assigned to each tree. The severest effect of shade appeared to be during midday or from about 10:00 a.m. to 2:30 p.m. The midday shaded area was considerably less than the total shaded area. Obviously tree spacing would have a major effect on the proportion

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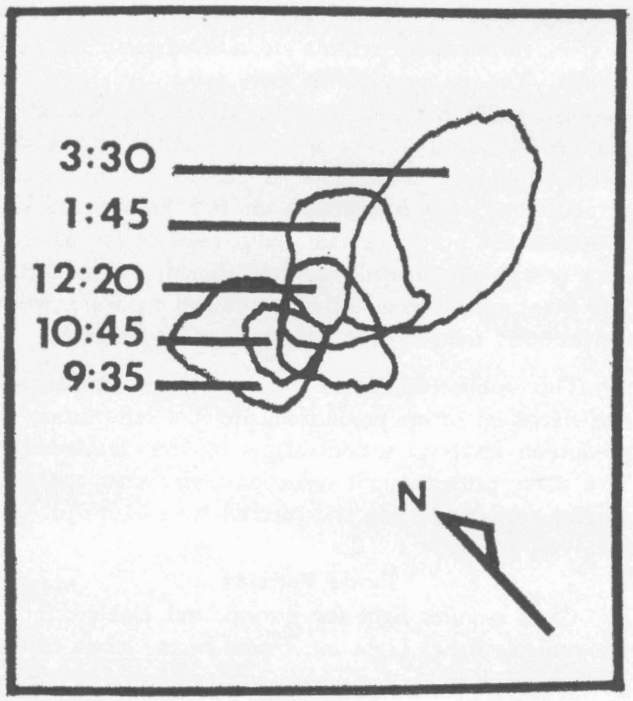

Figure 1. Shade patterns of 6-year-old pecan tree from 9:30 a.m. to 3:30 p.m.

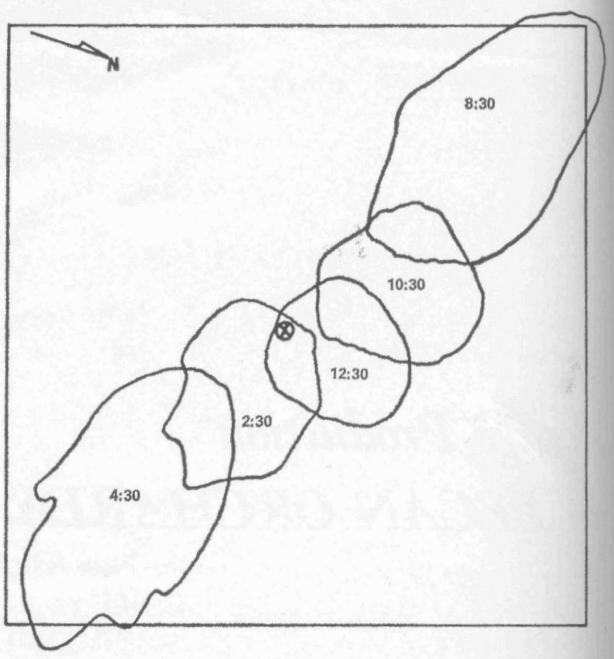

Figure 2. Shade pattern of 12-year-old pecan tree spaced 50 feet x 50 feet, 8:30 a.m. to 4:30 p.m.

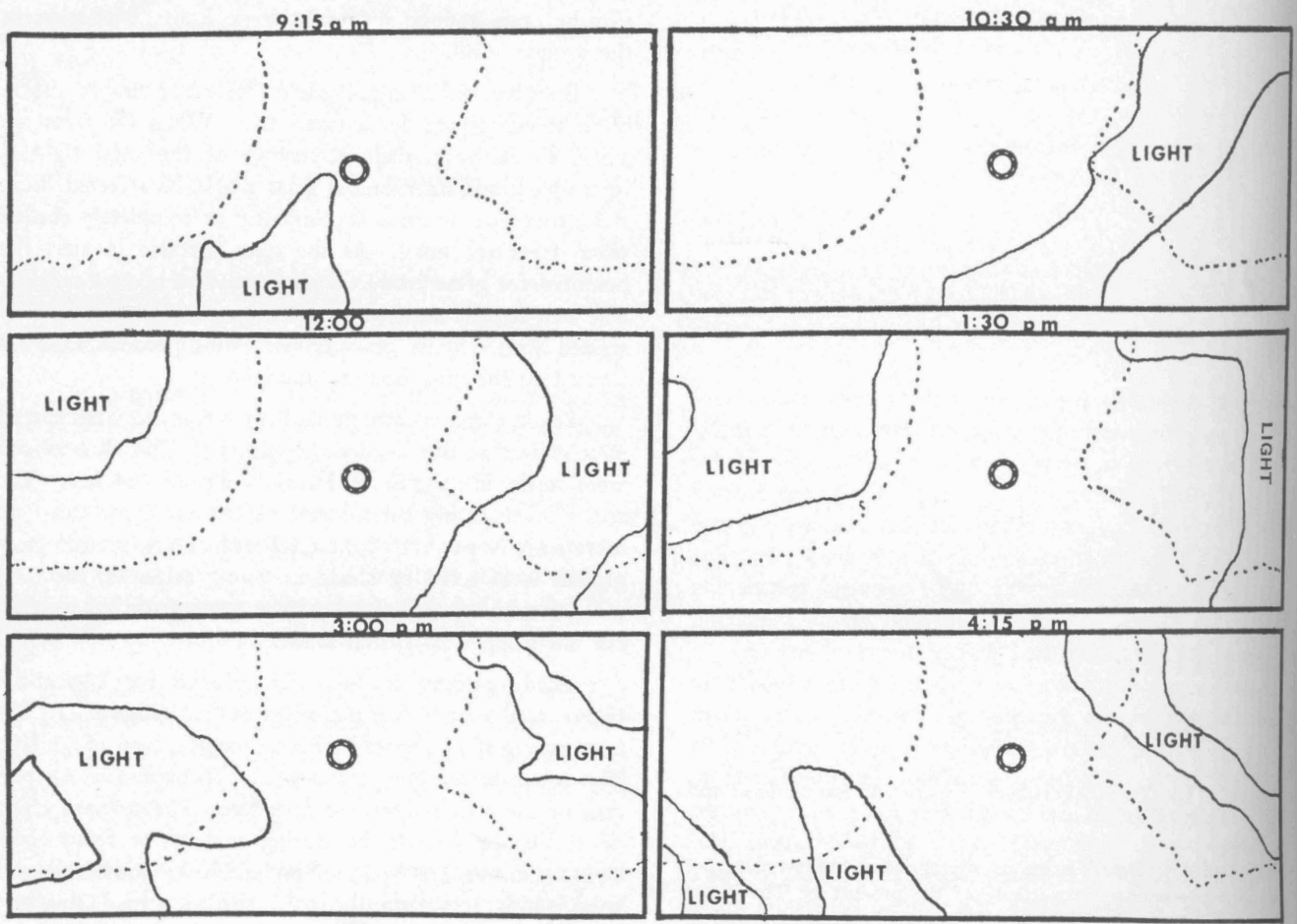

Figure 3. Shade pattern of 33-year-old pecan trees spaced 25 feet x 70 feet (area inside dotted line occupied by light grass cover).

of the area receiving shade. If the trees had been spaced 35 x 35 feet, the shaded area would have represented 75 to 80 percent of the total area. Even closer spacing would have resulted in more complete shade. Thus, not only tree size but also tree spacing determines light interception and the period of time during which grass production may be at an acceptable level.

Shade patterns for mature pecan trees (33 years old) at Brownwood are shown in Figures 3 and 4. The trees were established originally on 35-foot centers, but alternate trees were removed later to provide a 35 x 70-foot spacing. Tree removal was staggered in alternate rows which provided a 35 x 70-foot spacing in perpendicular directions and more uniform distribution of the trees over the area. No direct sunlight reached the ground level under the tree canopy between approximately 10:00 a.m. and 3:00 p.m. The percentage of the area shaded between 10:00 a.m. and 3:00 p.m. was not determined, but it would appear to be approximately 50 percent, even with this tree spacing. Further, the length of time any area received direct light seems to be no more than 2 to 3 hours.

Light Reduction and Quality

The amount and quality of light reaching the ground level under the canopy of both mature and young pecan trees were measured and related to full sunlight measurements in the same area. Photosynthetically active light is generally considered as that with wave length between 400 and 700 millimicrons (mμ). Light was measured using a spectroradiometer at 50 mμ intervals between 380 and 700 mμ and at 100 mμ intervals between 750 and 1050 mμ, the latter being in the far-red and infrared range and having no direct effect on photosynthesis. The results of light measurements under mature trees are given in Table 1 as percentage reduction from full light. Little photosynthetically active light is transmitted through the canopy of mature trees, and, therefore, little or no grass growth could be expected under such trees. Generally, it is found that a greater proportion of green light (500-560 mμ) as well as the far-red and infrared light is transmitted through trees; however, in this case, the only change in proportion of wave lengths was in the far-red and infrared range which was transmitted to a greater extent than the other wave lengths. Thus, light quality is changed to some extent under tree cover, and light intensity is drastically reduced. The degree of reduction is apparently related to canopy spread and density. Light under small trees (6 years old) was reduced only about 45 percent as contrasted to 90 percent under the mature trees — evidently because of light reflectance through and around the smaller canopy. Shade effects of small trees are limited, then, because the total shaded area is restricted, the length of time any area is shaded is limited and light reduction in the shade is less than with larger trees.

TABLE 1. LIGHT QUALITY UNDER MATURE PECAN TREES, U.S. PECAN FIELD STATION, BROWNWOOD

Wave length (mμ)	Percent of full sunlight[1]		
	8:30 a.m.	11:30 a.m.	2:30 p.m.
380	13.7	5.1	7.8
400	20.6	5.7	9.5
450	16.6	4.5	7.1
500	15.0	3.8	6.9
550	16.1	4.7	9.9
600	11.2	3.2	8.8
650	9.3	2.6	8.1
700	13.4	3.9	7.7
Average (400-700)	14.6	4.1	8.3
750	25.2	9.9	15.4
850	27.7	10.9	18.5
950	25.0	10.1	17.9
1050	24.4	11.0	22.2
Average (750-1050)	25.6	10.5	18.5

[1]Readings were made for each wave length in full light and under the tree canopy and the readings under the canopy expressed as percent of full light.

Forage Production

Grass Varieties and Species

Crops may be interplanted in pecan orchards to provide income during the establishment and early production years, to reduce weed competition and the necessity of cultivation, to provide improved footing for harvesting equipment and to prevent erosion. The grass should enhance harvesting and nut recovery.

Annual grasses such as sudangrass have been used successfully in pecan orchards — they may be planted in the spring, harvested two or three times for hay and the soil completely tilled and leveled prior to nut harvest. Thus, these crops provide income and reduce the need for weed control during the summer but do not provide for soil stabilization during harvest or the ensuing winter period. The finer-stemmed and shorter grass-type or sudan hybrids would seem to be more suitable for use in orchards than the robust types. The shorter stems would make them less competitive with young trees, and the finer stems would not only make better hay, but the stubble would be easier to destroy before harvest.

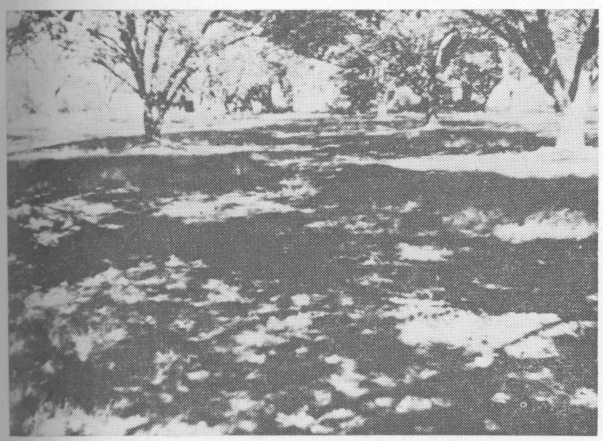

Figure 4. Shade in an orchard of mature pecan trees.

Bermudagrass is the most widely grown sod crop in pecan orchards, and any of several varieties is probably satisfactory. This research has been concerned largely with Coastal because of its superiority over common for hay and with NK-37 in the more northern and western locations because it can be established rapidly from seed. NK-37 is susceptible to leaf diseases and is less suitable for use in East and South Texas. The bermudagrasses produce a sod which can be mowed closely prior to harvest and which provides footing for harvesting equipment, thus enhancing harvest. Since they are perennials, they provide soil protection year round and reduce weed competition. Because the bermudagrasses are deep rooted, they compete with the tree crop for moisture and nutrients; both must be in adequate supply if good grass production is expected and if nut production is maintained. It seems unlikely that a noncompetitive yet productive grass will be found that would meet the other requirements for an interplanted crop.

Nonproducing Orchards

Coastal and NK-37 bermudagrasses were established in a young breeding orchard at the U.S. Pecan Field Station at Brownwood in 1966. Each grass was fertilized at two nitrogen rates: 100 and 300 pounds nitrogen per acre. Each treatment was replicated four times. The main plots were 35 x 35 feet with the tree in the center. Yields were determined from four mower strips 3 x 10 feet in each main plot. Since the trees shaded no more than 10 percent of the plot area at the beginning of the experiment, tree competition for light was assumed to be a minor factor. NK-37 became established from seed rapidly, whereas Coastal required the entire growing season to produce a cover even with limited irrigation.

Hay yields of 5 to 7 tons per acre were obtained in 1968 (Table 2), depending on variety and nitrogen level. Yields have been somewhat less since 1968, but generally satisfactory. Yield is increased with added nitrogen, and nitrogen in excess of 100 pounds probably is needed to avoid undue effect on the trees. Coastal and NK-37 yields have varied but with no consistent difference between the two. NK-37 sod is more open than Coastal sod (Table 3), but its density should be adequate for soil protection and equipment footing.

TABLE 2. BERMUDAGRASS FORAGE YIELDS IN AN IRRIGATED PECAN ORCHARD (5-YEAR OLD TREES IN 1968) AT THE U.S. PECAN FIELD STATION, BROWNWOOD

Variety	Nitrogen (lb./acre)	Pounds of dry forage per acre[1]			
		1968	1969[2]	1970	1971
Coastal	100	10,060[b]	3,690[c]	8,590[b]	6,707[c]
	300	13,810[a]	4,512[b]	11,310[a]	7,065[c]
NK-37	100	7,290[c]	2,990[c]	6,720[c]	8,402[b]
	300	11,450[b]	5,320[a]	11,220[a]	10,629[a]

[1]Values in a column followed by the same letter are not significantly different.

[2]Yields are for two cuttings only which represent approximately 50% of the total production in 1969.

TABLE 3. COASTAL AND NK-37 BERMUDAGRASS STAND DENSITY IN AN IRRIGATED PECAN ORCHARD (5-YEAR OLD TREES IN 1968) AT THE U.S. PECAN FIELD STATION, BROWNWOOD

Grass variety	Nitrogen treatment (lb./acre)	Relative density rating[1]		
		1968	1969	1970
Coastal	100	1.75	1.00	1.25
	300	1.00	1.00	1.00
NK-37	100	2.50	2.50	2.50
	300	3.10	3.50	2.50

[1]Ground cover density was rated on a scale of 1 to 5 with 1 being dense and 5 being open sod.

Young pecan trees were established in a Coastal sod in the Brazos River bottom near Mineral Wells (H. L. Petty Farm) on 50 x 50 feet centers. Forage yields were determined from four mower strips per plot, each 3 x 10 feet. All treatments were replicated four times. Very high forage yields were obtained the first and fifth years (Table 4) and yields of approximately 5 tons in other years. Response to nitrogen was essentially maximum at 200 pounds of nitrogen per acre. However, it was not determined whether this was adequate for both the grass and the trees. This experiment included a treatment involving clean cultivation in the tree row to reduce effects of grass competition on the trees. Such a practice should favor the trees and reduce grass production proportionately. A 12-foot clean-tilled strip was maintained representing approximately 20 percent of the area; thus, production was reduced about 20 percent. In later years as the trees increase in size and shade effects become more severe, the influence of a clean-tilled strip on forage production would be decreased. Since the primary shade effects are in the area surrounding the tree, removal of grass in this area by cultivation would not reduce yields in proportion to the cultivated area.

Producing Orchards

A forage production study was started in 1966 in a 12-year-old dryland orchard in the Brazos River bottom near College Station. Coastal bermudagrass (Figure 5) was

TABLE 4. COASTAL BERMUDAGRASS PRODUCTION IN YOUNG PECAN ORCHARD IN BRAZOS RIVER BOTTOM NEAR MINERAL WELLS[1]

Nitrogen (lb./acre)	Pounds dry forage per acre[2]				
	1967	1968[3]	1969[4]	1970	1971
200	18,960[b]	9,283[b]	3,636[c]	11,000[a]	19,660[a]
400	20,640[a]	9,613[a]	4,343[b]	10,750[a]	20,920[a]
600	20,720[a]	9,124[b]	4,808[a]	10,955[a]	17,840[b]

[1]Trees were planted in 1966.

[2]Values in a column followed by the same letter are not significantly different.

[3]One cutting was lost which would have increased production by at least 50%.

[4]One cutting on May 28, 1969.

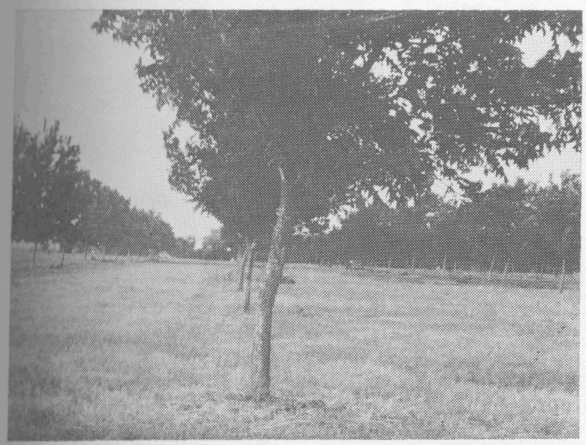

Figure 5. Coastal bermudagrass in a dryland pecan orchard in the Brazos River bottom near College Station, Texas.

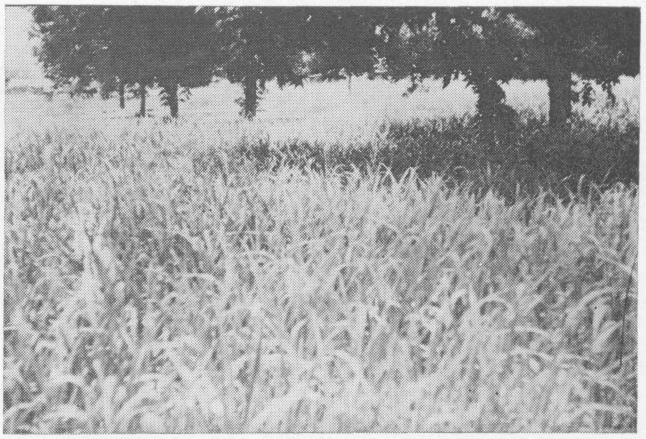

Figure 6. Sudangrass in a dryland orchard in the Brazos River bottom near College Station, Texas.

sprigged in 1966, hybrid sudangrass (Figure 6) was seeded each spring, and each was fertilized with 0, 100, 200 and 300 pounds of nitrogen per acre. Each main plot was 50 x 50 feet with the tree in the center, with four replications. Yields were determined from eight mower strips 3 x 10 feet in each plot, four strips being taken around the periphery of the plot and four underneath the tree. Sudangrass production (Table 5) was highest the first year, approximately 3½ tons per acre, and declined each year thereafter. Increasing tree size and shade effects no doubt contributed to the decline. Also, extended dry periods in the springs of 1970 and 1971 delayed planting and seedling emergence and further reduced or limited production. Production at the 1971 level is economically questionable, but this was due in part to late planting and not entirely to tree competition.

Coastal bermudagrass produced up to 2½ tons of hay annually in two or three cuttings and has declined to some extent with time (Table 5). However, Coastal production in 1971 exceeded 2 tons even with the dry spring and the increased shade effects.

Measurements and observations have indicated that grass growth is affected most by shade in the 4- to 5-hour

TABLE 5. FORAGE PRODUCTION IN DRYLAND PECAN ORCHARD, BRAZOS RIVER BOTTOM NEAR COLLEGE STATION (TREES ESTABLISHED IN 1954)[1]

	Pounds of dry forage per acre[2]					
	Sudangrass			Coastal bermudagrass		
Nitrogen (lb./acre)	Shaded area	Open area	Weighted total	Shaded area	Open area	Weighted total
			1967			
0	3160	4820	4300[b]		2160[c]	
100	3730	5150	4630[b]		5390[b]	
200	6360	7780	7280[a]		7540[a]	
300	5760	7140	6640[a]		6590[a]	
			1968			
0	3195	3270	3240[c]	2910	4170	3720[c]
100	4180	5340	4920[b]	4340	5720	5220[b]
200	5710	6295	6080[a]	4340	6540	5750[a]
300	5715	6840	6440[a]	4405	6145	5520[a]
			1969			
0	2368	3288	2957[c]	2042	3364	2888[c]
100	2087	5040	4337[b]	4148	5375	4933[b]
200	3778	5999	5199[a]	4670	6600	5905[a]
300	4432	5534	5137[a]	4600	5911	5438[ab]
			1970			
0	1754	2264	2080[b]	2372	3238	2926[c]
100	2181	2680	2500[b]	3724	4072	3947[b]
200	3034	3392	3263[a]	4142	5106	4758[a]
300	3113	4010	3687[a]	3418	5078	4480[ab]
			1971			
0	1378	2751	2664[a]	1764	3207	2485[c]
100	1459	2631	2045[a]	2752	4945	3848[b]
200	1816	3128	2472[a]	2967	6047	4507[a]
300	1792	3343	2567[a]	2302	5143	3722[b]

[1]Trees are spaced 50′ x 50′.

[2]Values within a column for any 1 year followed by the same letter are not significantly different.

midday period. In the College Station study, this shade area was estimated to represent 36 percent of the entire area, increasing to 48 percent in 1971. The weighted yields were calculated on the basis of production in the shaded and open areas and the proportion of the entire area represented by each.

The effect of tree shade on grass growth is shown in Tables 5 and 6. The reductions in growth under the tree canopy reported in Table 6 are based on growth in the most open areas within the orchard. These areas may have received some shade during early morning and late afternoon; therefore, the estimates of shade effects may be low. Estimates of reduction in growth have been somewhat erratic but are adequate to show that growth in areas receiving midday shade is definitely reduced. This has ranged from as low as 18 percent in sudangrass to as high as 48 percent in Coastal bermudagrass. There is not a definite pattern in growth reduction in the shade. Further, while the midday shaded area increased gradually, the calculated weighted effect was based on the same area until 1971 when the estimated area was increased because of increased canopy size. The increasing canopy size must have reduced light in the shade still further since production in the shade showed a drastic reduction in 1971.

The influence of duration of shade and, possibly, intensity of shade may be seen in the contrast between growth on the north and south sides of the trees, both from areas receiving midday shade. The north side of the tree would be shaded a longer period, and the shade intensity probably would be greater because of less opportunity for reflected light. The shade pattern in Figure 2 suggests these conclusions. Within a radius of 10 feet of the tree, production on the north side of the tree was 11, 11, 14, 21 and 40 percent less than on the south side in the years 1967 through 1971, respectively. If the north side is contrasted to unshaded area, the decrease was 60 percent in 1971. These data demonstrate the effect of increasing shade intensity as the canopy increases in size. Thus, production is restricted as orchards increase in age by both the total shaded area and the increased density of the shade (Figure 7).

TABLE 6. EFFECT OF TREE SHADE ON DRYLAND GRASS PRODUCTION (TREES ESTABLISHED IN 1954)

	Coastal bermudagrass		Hybrid sudangrass	
	% reduction in growth			
Year	Under canopy	Weighted effect on total production	Under canopy	Weighted effect on total production
1967			23.7	9.2
1968	29.2	12.0	13.5	5.5
1969	27.3	11.9	36.3	15.8
1970	21.9	10.1	18.3	8.4
1971	48.7	23.9	45.7	22.4

Figure 7. Coastal bermudagrass in an orchard of 20-year-old pecan trees.

Mature Orchards

Coastal and NK-37 bermudagrasses were sprigged and seeded, respectively, in an orchard of 33-year-old pecan trees spaced 35 x 70 feet at Brownwood. The grasses, planted in 1966, became established and survived only in areas that received direct sunlight during a part of the time between 10:30 a.m. and 2:30 p.m. According to the shade patterns shown in Figure 3, no area received direct light for more than 2 to 3 hours daily. Growth was attenuated with narrow leaves and showed no tendency to produce runners and rhizomes during the first year. Yields were not determined, but would have been nil, and approximately 50 percent of the area was completely bare. Both Coastal and NK-37 bermudagrasses survived in the more open areas and increased in density in 1967 and 1968. Growth approximately 10 inches high was present in August 1968 with an estimated production of 1,000 pounds per acre in the open areas. Since this represented total production for the growing season and no more than half the total area was covered, acre production would have been too low to be of value. Thus, forage production is not feasible with mature trees even spaced as widely as 35 x 70 feet.

Acknowledgments

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