Southern Pine Overstories

Influence Herbage Quality

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Highlight: A cover of young longleaf or slash pines increased protein and phosphorus and decreased nitrogen-free extract in herbage on pine-bluestem range. Under protection from grazing, the proportion of big bluestem in the herbage stand increased more on forested than cutover land. Herbage decreased about 15 lb/acre for every 1 ft² increase in pine basal area.

On southern pine-bluestem range it has been shown that herbage production decreases as density of the pine stand increases, and regressions have been computed (Gaines et al., 1954; Halls, 1955, 1957; Halls and Schuster, 1965). Overstory effects on composition of bluestem range herbage, however, are not well documented. This paper reports changes in botanical composition and chemical content of herbage as young pine plantations develop.

Experimental Procedure

The study area, on the Palustris Experimental Forest in central Louisiana, contained 32 0.4-acre plots, 16 planted to longleaf pine (*Pinus palustris*) and 16 to slash pine (*P. elliottii*). The study was begun in 1960, 9 years after the longleaf and 5 years after the slash pines were planted. Four randomly selected plots in each plantation were designated as controls, and the pines on them were cut during June 1960. The longleaf plantation was burned by headfire in January 1955 to control brown spot needle blight. Both plantations were burned by controlled backfires in March, 1960, and every third year thereafter.

The area was typical cutover longleaf pine land prior to reforestation and supported dense bluestem grass and a few widely scattered second-growth longleaf pines. Pinehill bluestem (*Andropogon divergens*) and slender bluestem (*A. tener*) were the dominant grass species, but other bluestems as well as several panicums (*Panicum* spp.) and paspalums (*Paspalum* spp.) contributed significant quantities of herbage (Duvall, 1962). The area was moderately grazed yearlong by one brood cow/20 acres until fenced in 1960 to exclude cattle.

Soils were classed as Bowie and Beauregard. They are moderately well drained with slow to medium runoff. Permeability is moderate to slow. The ground is nearly level with a few slopes of up to 10%. The A horizons are dark grayish brown fine sandy loam to dark gray silt loam. B horizons range from yellowish brown sandy clay loam in upper B horizons to yellowish brown silt loam and mottled in the lower B horizons.

Annual precipitation averages about 57 inches, with over 3 inches each month except October.

Herbage and timber were measured initially in 1960 and at 3-year intervals through 1969. Herbage production and botanical composition of yield were determined in November by clipping eight randomly located 1.55- x 1.55-ft quadrats on each plot. As the herbage was clipped it was separated by species or species group, bagged, oven-dried at 75°C for 48

hours, and weighed to the nearest 0.1 g. Values were converted to lb/acre.

A composite sample of all herbage was collected from each plot during the first 2 weeks in June and September. Samples were oven-dried, ground, and analyzed by E. A. Epps, Jr., at the Feed and Fertilizer Laboratory, Louisiana Agricultural Experiment Station, Baton Rouge.

All 4.5-ft or taller pines were inventoried on each plot. Diameters were measured to the nearest 0.1 inch at 4.5 ft above the soil surface, and basal area in ft²/acre was calculated from diameter measurements.

The experimental design was a complete randomized block with species of planted pine blocked four times. Data were tested by analysis of variance and regression analysis; mean differences were compared by Tukey's Test (Steel and Torrie, 1960).

Results and Discussion

Production

Longleaf basal area averaged 13.5 and slash pine 6.9 ft²/acre in 1960 (Table 1). From 1960 to 1969, the slash pine plantation increased in basal area about 12 ft²/acre/year, whereas the longleaf pine plantation increased only about 7 ft²/year. Delayed height growth of many longleaf pine seedlings and about 25% fewer trees/acre than on the slash pine plantation were the principal factors contributing to slower longleaf basal area growth/acre.

Herbage production on cutover range averaged about 2,000 lb/acre in 1960 and 1963, but it increased to over 2,400 in 1966 and over 2,600 in 1969 (Table 2). The increase in production probably resulted from the combined effects of physical treatment and moisture conditions. Excluding cattle, even though the range had been grazed only moderately, and cutting the young pines in 1960 probably stimulated herbage production. The delayed response to pine cutting was apparently associated with low growing-season precipitation during 1960 and 1963. Rainfall values during 1966 and 1969 growing seasons were approximately 50% greater than during 1960 and 1963.

Herbage production on reforested range was similar to that on cutover range in 1960, but during successive years timber growth significantly depressed herbage production. Similar findings were indicated earlier by Duvall and Hilmon (1965). Even though it was planted 4 years after the longleaf pine,

Table 1. Pine basal area (ft²/acre) on longleaf and slash pine range.

Year	Longleaf pine			Slash pine		
	Average	Minimum	Maximum	Average	Minimum	Maximum
1960	13.5	8.1	16.3	6.9	4.4	9.2
1963	30.6	17.2	39.0	40.7	18.5	49.2
1966	51.7	38.9	60.6	78.5	45.2	93.4
1969	76.9	53.5	89.7	115.2	75.4	131.9

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Fig. 1. Herbage production averaged over 2,000 lb/acre on cutover range (above), about 1,000 lb/acre under 75 ft² of slash pine basal area (above right), and less than 300 lb/acre under 120 ft² of slash pine basal area (lower right).

slash pine reduced herbage yields much earlier than longleaf pine.

The reductions in herbage production were closely associated with basal area of the pine growing stock. The regression equation $P = 2048.9 - 14.7BA$ explained 87% of the variation in P , where P is herbage production in lb/acre and BA is basal area of slash pine in ft²/acre. The regression equation $P = 2250.7 - 15.0BA$ accounted for 52% of the variation in herbage production in the longleaf pine plantation. Thus, herbage production diminished about 15 lb/acre for every ft² increase in pine basal area, regardless of species or plantation age (Fig. 1). The more rapid crown closure and larger array of basal areas of slash pine probably explain the larger proportion of herbage production accounted for by slash pine basal area. Variation in herbage production decreased in both plantations as pine basal area increased. Similar herbage responses to pine basal area have been reported before (Halls, 1955; Halls et al., 1956; Gaines et al., 1954).

Botanical Composition

Pinehill and slender bluestem were the principal and about equal producers in 1960; each accounted for about 25% of the total herbage (Table 3). The proportion of pinehill bluestem increased, while that of slender bluestem decreased on both cutover and forested range. Apparently, protection from grazing favors pinehill bluestem. The reduction in slender bluestem may be due either to the lack of a stimulus produced through grazing or to an inability to compete with pinehill

bluestem on ungrazed range. A similar response to protection from grazing was reported by Wahlenberg et al. (1939) and Duvall and Linnartz (1967). Grelen and Duvall (1966) reported that an accumulation of old herbaceous material interferes with slender bluestem growth, thereby reducing herbage production.

Yields of both slender and pinehill bluestem were significantly and inversely related to basal area of slash pine in 1966 and basal area of longleaf in 1969. In 1969 the simple linear regressions explained 90% of the variation in both pinehill and slender herbage production on slash pine range. The equations were: $PB = 1445.68 - 11.02BA$ and $SB = 166.44 - 1.31BA$, where PB is pinehill bluestem production and SB is slender bluestem production in lb/acre and BA is slash pine basal area in ft²/acre. Longleaf pine basal area explained less variation in species production than slash pine basal area for reasons already discussed. Production of other species and species groups was not significantly associated with pine basal area.

Big bluestem (*A. gerardi*), a preferred tall grass, was sparse in 1960, but it increased in proportion under protection from use. Big bluestem is one of the first species to decrease under grazing and is expected to increase after use ceases. Its rapid increase on forested range indicates that a young plantation produces an environment more beneficial to growth of big bluestem than does treeless cutover range. Even on forested

Table 2. Herbage production (lb/acre) on cutover and forested longleaf and slash pine range.

Year	Cutover range	Forested range	
		Longleaf pine	Slash pine
1960	1995 a ¹	1955 a	1948 a
1963	1997 a	1784 ab	1419 b
1966	2415 a	1746 b	879 c
1969	2623 a	1011 b	412 b

¹ Means within years followed by the same letter are not significantly different at the 0.05 level.

Table 3. Proportion (%) of total herbage production on cutover and reforested longleaf and slash pine range.

Species	1960			1963			1966			1969		
	Cut-over	Reforested		Cut-over	Reforested		Cut-over	Reforested		Cut-over	Reforested	
		Longleaf	Slash		Longleaf	Slash		Longleaf	Slash		Longleaf	Slash
Pinehill bluestem	26.3	25.6	28.2	46.6	53.4	55.6	48.0	64.4	57.6	48.5	49.9	47.9
Slender bluestem	24.6	32.0	23.9	20.3	13.2	8.0	16.0	10.9	6.5	12.1	8.0	3.7
Big bluestem	0.0	0.0	0.9	0.3	3.1	4.9	2.0	1.0	4.1	1.7	11.9	6.9
Other bluestems	8.1	8.0	5.1	10.5	2.9	2.4	11.1	1.2	3.3	7.4	T	5.5
Panicums	13.2	12.4	12.4	8.0	12.1	13.3	8.2	7.4	11.0	9.7	13.0	14.8
Other grasses	23.4	15.8	26.7	10.6	12.9	12.4	9.2	10.5	11.0	10.6	10.3	8.7
Forbs	4.4	6.2	2.8	3.7	2.4	3.4	5.5	4.6	6.5	10.0	6.9	12.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

range, however, big bluestem generally produced less than 100 lb/acre.

Other bluestems, primarily Elliott (*A. elliotii*), fineleaf (*A. subtenius*), paintbrush (*A. ternarius*), and broomsedge (*A. virginicus*), produced about 10% of the herbage on cutover range. The proportion of other bluestems generally diminished under forest cover.

The proportion of panicums remained fairly uniform from 1960 to 1969 on both cutover and forested range. Other grasses yielded about 1/4 of the total herbage in 1960; production was measured late in the fall and most of this herbage group consisted of unidentified species. After 1960, the proportion of other grasses diminished to about 10% on both cutover and forested range.

Forbs, largely swamp sunflower (*Helianthus angustifolius*) and grassleaf goldaster (*Chrysopsis graminifolia*), increased in proportion on cutover and slash pine range in 1969; otherwise, little change was noted.

Chemical Composition

As in earlier studies on similar range (Campbell et al., 1954; Campbell and Cassady, 1951), nutritive values of the herbage were low: phosphorus content was inadequate yearlong, and protein met animal requirements only during a short period in early spring. It is significant, however, that tree cover enhanced protein and phosphorus contents (Table 4). Chemical contents of herbage were similar on cutover and forested range in 1960, but during succeeding years herbage protein

and phosphorus contents were consistently higher under pine plantations than on cutover land. The differences grew larger as the plantations developed. Except for the 1963 June herbage under longleaf pine, protein contents of June and September herbage were significantly associated with pine basal area in all years after 1960. For example, the 1969 slash pine basal area explained 84% of the variation in protein content of September herbage. The equation describing total protein content was: $N = 4.427 + 0.0268BA$ where N is percent total herbage protein content and BA is slash pine basal area in $ft^2/acre$.

Phosphorus content of herbage was similarly associated with tree cover. September values were significantly correlated with slash pine basal area during 1963, 1966, and 1969, and with longleaf pine in 1969. Forested range produced a similar reaction in Kentucky bluegrass (McEwen and Dietz, 1965).

A reduction in crude protein and phosphorus contents with advancing maturity of southern range grasses was earlier reported by Campbell and Cassady (1951) and Campbell et al. (1954). Present findings suggest that chemical composition was influenced by stage of plant maturity, although other factors may be involved.

The proportion of nitrogen-free extract (NFE) decreased as tree cover increased. Herbage NFE content in June and September was significantly and inversely related to pine basal area during later years. In September, 1969, the regression with slash pine basal area explained about 70% of the variation in herbage NFE content. The equation was: $NFE = 51.872 - 0.0437BA$ where NFE is percent herbage NFE content and

Table 4. Chemical analysis (%) of herbage from cutover and reforested longleaf and slash pine range.

Month and chemical components	1960			1963			1966			1969		
	Cut-over	Reforested		Cut-over	Reforested		Cut-over	Reforested		Cut-over	Reforested	
		Longleaf	Slash		Longleaf	Slash		Longleaf	Slash		Longleaf	Slash
June												
Protein	7.8	7.4	8.2	5.2	5.4	6.7	5.2	6.6	7.3	6.2	9.2	9.2
Fat	2.4	2.3	2.3	2.9	2.7	3.2	2.1	2.5	1.9	2.7	2.4	3.4
Fiber	28.4	30.4	29.4	30.8	32.0	30.7	35.4	37.1	36.9	33.5	36.9	33.3
Ash	10.0	9.4	8.3	7.3	6.0	6.1	8.4	7.8	7.7	7.9	6.9	7.5
Calcium	.51	.47	.46	.29	.31	.38	.34	.38	.39	.45	.37	.48
Phosphorus	.08	.08	.08	.09	.09	.12	.10	.11	.12	.06	.10	.09
N. F. E.	51.4	50.5	51.8	53.8	53.9	53.3	48.9	46.0	46.2	49.7	44.6	46.6
September												
Protein	4.5	4.6	4.9	4.7	5.1	5.9	3.9	4.9	5.5	4.5	6.2	7.6
Fat	2.3	2.3	1.9	3.1	2.9	2.5	2.1	1.8	1.9	2.7	2.6	3.2
Fiber	32.9	33.4	33.5	31.1	32.6	33.1	36.4	38.2	38.8	33.8	36.8	35.6
Ash	8.8	8.6	7.6	9.0	6.8	7.4	8.5	7.0	7.2	8.0	6.7	6.8
Calcium	.38	.37	.33	.27	.33	.36	.30	.34	.36	.44	.38	.57
Phosphorus	.05	.04	.05	.10	.10	.11	.09	.11	.10	.06	.07	.08
N. F. E.	51.5	51.1	52.1	52.1	52.6	51.1	49.1	48.1	46.6	51.0	47.7	46.8

BA is slash pine basal area in ft²/acre. The trends were similar but weaker on longleaf pine plots.

Fat content of herbage varied during the study, but did not appear to be affected by overstory condition. There were indications that fiber and calcium contents of herbage increased with forestation.

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