

Research Note

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Herbage Yield Related To Basal Area and Rainfall In A Thinned Longleaf Plantation

HAROLD E. GRELEN AND RICHARD E. LOHREY

SUMMARY

Herbage yields averaged 1,295, 1,024, and 865 lb/acre/yr in longleaf pine stands thinned to 60, 80, and 100 ft² of basal area/acre. Yields were also related to May-September rainfall.

Additional keywords: *Pinus palustris* Mill.

Herbage Yield and Stand Density

Managers of grazed pine stands need to know how herbage yield is related to stand density. Previous research has shown that yields decrease when stand density increases (Gaines and others 1954; Halls and Schuster 1965; Jameson 1967). Little is known, however, of the fluctuations in herbage production resulting from frequent thinnings and variations in annual rainfall.

In this study, herbage production was measured annually from age 30 through 40 years in a longleaf pine (*Pinus palustris* Mill.) plantation near Alexandria, Louisiana. This paper reports the relationship of herbage yield to stand basal area, density, and rainfall for that 11-year period. Grelen and Enghardt (1973) reported early herbage production in this stand. Timber production was reported to age 30 years by Derr and Enghardt (1969) and to age 35 by Lohrey (1974).

THE PLANTATION

The 40-acre longleaf pine plantation was established in 1935 on a moderately well-drained silty loam soil with a site index of 78 for longleaf pine at age 50. The stand is part of a study to determine how pine growth is related to initial planting spacing (about 4, 5, 6, and 13 feet), stand density after thinning (60, 80, and 100 ft²/acre basal area), and height of pruning (17 feet, two-thirds tree height, total height, and none).

The plantation contains four square blocks with sixteen 0.62-acre plots each. Four randomly selected plots per block were planted at each spacing. In the three close spacings, stands were thinned to 60, 80, or 100 ft²/ac. Thinnings began at age 20 years and were repeated at 5-year intervals. Stands that had not reached their assigned density were not cut until the next scheduled thinning. Some of the 80- and 100-ft²/ac. plots did not reach their assigned densities until age 35. Only one plot had not reached its prescribed basal area by age 40.

The fourth thinning left a maximum of 100 crop trees per acre at age 20 years with no later cuttings. Some small trees later grew to merchantable size but were not cut. Crop trees had been pruned to 17 feet at age 16 years.

Plots in the wide 13-foot spacing treatment were not thinned because stand densities were low. In these wide spacings, four pruning treatments were compared. Crop trees were pruned at age 16 years to heights of 17 feet, two-thirds tree height, total height, or left unpruned. Many pruned trees in this wide spacing were heavily damaged by an ice storm shortly after the treatments were installed. Consequently, data for pruned plots in the wide spacing were not used in this study. Data for pruned plots in the three narrow spacings and unpruned plots in the 13-ft. spacing were used to provide data at densities below 60 ft²/ac.

The plantation was control burned every third year through age 15; since then prescribed fires have been applied at 5-year intervals, 1 year before thinnings. Cattle grazed the plantation until herbage measurements began in 1964.

Tree basal area and herbage yield were measured on all plots of the 4-, 5-, and 6-ft spacings and on the unpruned check plots in the 13-ft

spacing. Measurements were restricted to a 0.1-acre plot in the center of each 0.62-acre treatment plot. Beginning at age 20, all trees within this plot were measured, and basal area per acre was determined at 5-year intervals. Herbage production was measured annually from age 30 to 40 years on a grid of twelve 2.4-ft² quadrats within the measurement plot. Rainfall was measured by a recording gauge in an open area about 100 yards from the northeast corner of the plantation.

RESULTS

Heavy grazing of the plantation before the herbage study began apparently reduced herbage growth the first years of the study (fig. 1). For this reason, herbage yields for plantation ages 30 through 32 years were not included in stand density/herbage yield/rainfall correlations. Annual yields from ages 33 to 40 years averaged 1,295, 1,024, and 865 lb/acre for basal area treatments of 60, 80, and 100 ft²/acre.

Botanical composition was also apparently influenced by the heavy grazing. Pinehill blue-

stem (*Andropogon scoparius* var. *divergens* Anderss. ex Hack.), which generally makes up 50 to 60 percent of the herbage on longleaf-slash pine bluestem range, comprised only 29 percent by weight of the herbage at age 30. By age 35, pinehill bluestem made up 51 percent of the herbage, and at age 40, 52 percent. Slender bluestem (*A. tener* Nees, Kunth), which is usually the second most abundant grass and comprises about 30 percent of the herbage on cutover range, was reduced by shading or root competition to 3 percent of the herbage at age 35, and to 1 percent at age 40. Other major components of the herbage at age 40 were the panicum grasses (*Panicum* spp.) and forbs, averaging 16 percent and 14 percent, respectively, of the herbage weight. Other bluestem species averaged less than 5 percent.

Herbage yields among the three close spacings did not differ significantly at any time during the study. Stems per acre and height to live crown were related to herbage yield, but neither, alone or in combination with basal area, improved the equation enough to justify their

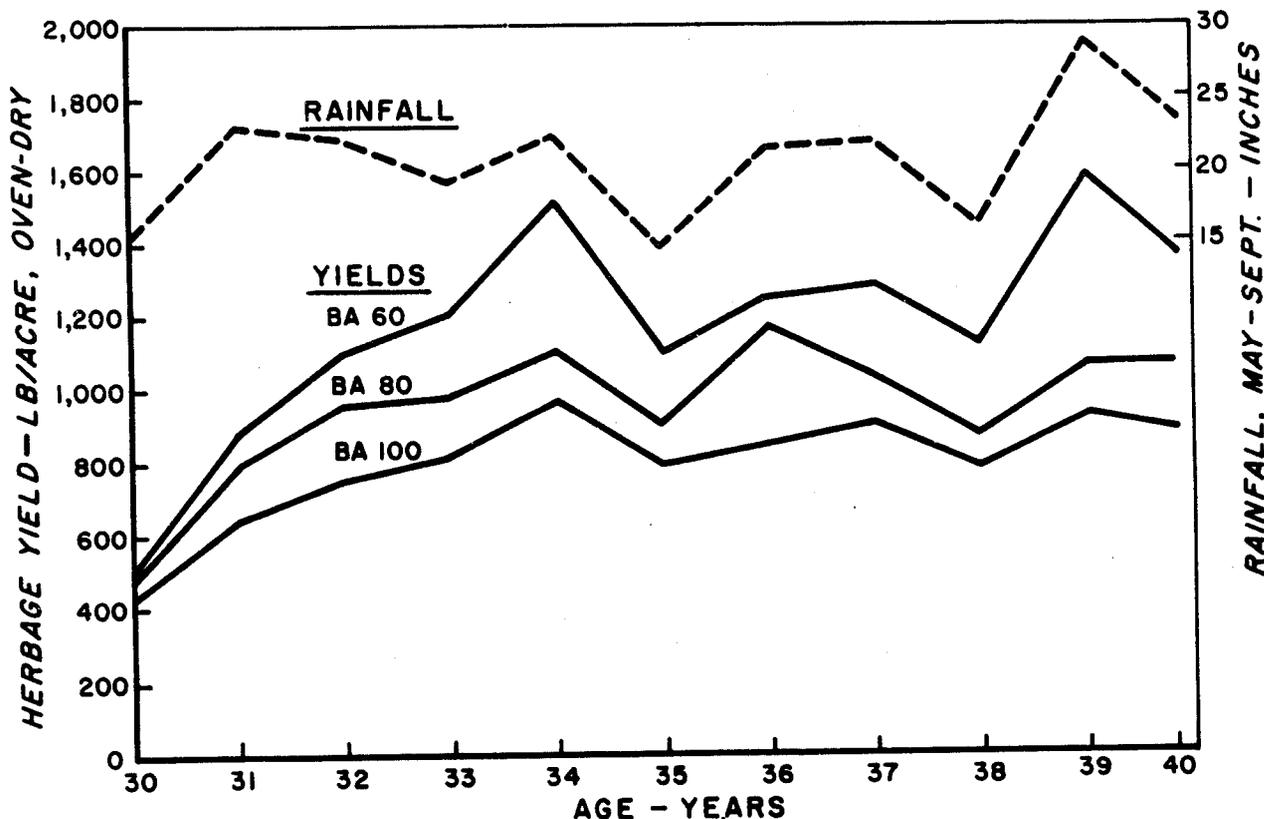


Figure 1.—Annual herbage yields and summer rainfall in a longleaf pine plantation.

Harold E. Grelen and Richard E. Lohrey are Principal Range Scientist and Silviculturist, Southern Forest Experiment Station, Forest Service—USDA, Alexandria, Louisiana.

use as predictors of herbage yield.

Linear regressions relating herbage yield to basal area per acre at ages 35 and 40 were not significantly different from each other in either slope or level. Data from 35 and 40 years were combined to calculate the following equation relating herbage yield to basal area:

$$Y = 1,670 - 6.80(X)$$

where Y = predicted oven-dry herbage yield (lbs./acre/year)

X = pine basal area stocking (ft²/acre)

This equation explained 20 percent of the total variation in herbage yield, and the standard error was 264 lbs/acre/year. It predicts yields of 1,262, 1,126, and 990 lbs/acre for basal areas of 60, 80, and 100 ft²/acre (fig. 2).

Because herbage yields varied markedly from year to year, we examined the correlation between average annual yield and rainfall. Rainfall during several periods, as well as total annual rainfall, was used in correlation tests, but only the periods below were significantly related to herbage yield:

Rainfall period	Correlation coefficient
May through September	0.89
April through September	.84
April through August	.72

Herbage yield predictions were much closer to observed yields when May to September rainfall was added as an independent variable. Herbage yield on plots with low basal area density responded more to differences in precipitation than did yield on plots with high densities.

Several linear and curvilinear models involving thinning treatment and May-September rainfall were screened to determine their relationships to herbage yield. Equations for all models were plotted. The most logical model, determined by visual inspection of the curves, resulted in the equation:

$$Y = 10(3.1865 - .00432753 (X_1) + .0084653 (X_2))$$

where:

Y = predicted oven-dry herbage yield (lbs/acre/yr)

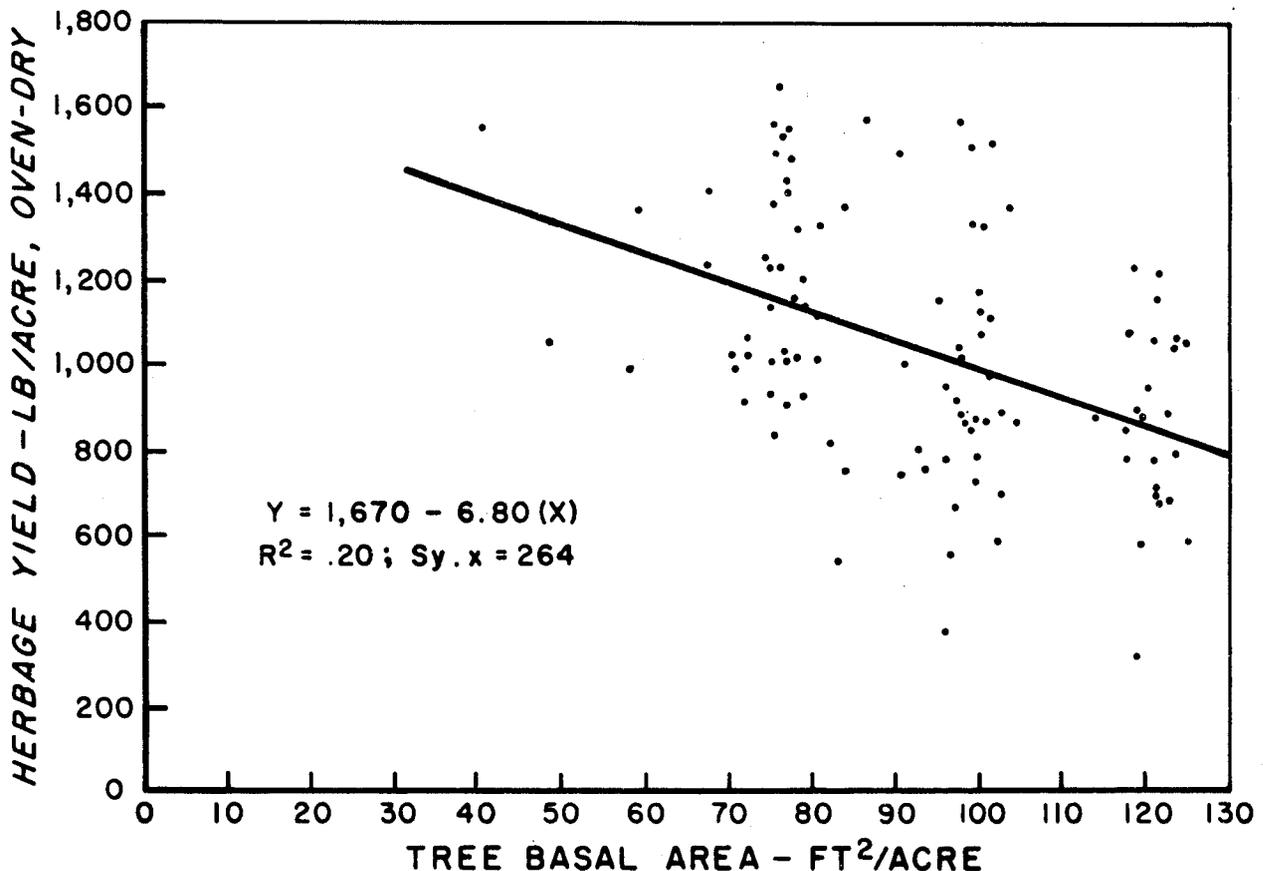


Figure 2.—Relationship of herbage yield (Y) to tree basal area (X) at ages 35 and 40 years in a longleaf pine plantation.

X_1 = pine basal area treatment (ft²/acre)
 X_2 = May-September rainfall (inches)

This equation gave estimates within 10 percent of the actual yield for all but two observations. The average deviation was less than 5 percent. Table 1 contains solutions for this equation for the three basal areas maintained by thinning in this study and the range of May-September rainfall that occurred during the 11 years reported here.

Table 1.—*Predicted herbage yields at selected levels of pine basal area and May-September rainfall, based on equation (2)*

Basal area	May-September rainfall (inches)			
	15	20	25	30
	----- Herbage yield (lb/acre) -----			
60	1132	1248	1376	1517
80	927	1022	1127	1243
100	772	837	923	1018

Pearson (1975) found that for moderately grazed range about 100 pounds of oven-dry herbage is required per cow-day to allow for consumption, trampling, weathering, wildlife use, and the ungrazed forage residue. Thus, based on the average annual yields from age 33 to age 40, grazing capacities would be about 28, 35, and 42 acres/cow/yr, for 60, 80, and 100 ba. On an animal-unit month basis, the conversion factors would be 2.3, 2.9, and 3.5 acres/aum, respectively.

The yield equations presented here should be useful to land managers planning multiple-use of similar longleaf pine forests in the South.

The accuracy of yield estimates will improve as more is learned about the complex relationships among yield, environment, and stand management.

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