SOUTHERN FOREST EXPERIMENT STATION

1966

U.S. FOREST SERVICE RESEARCH NOTE

SO-34

Forest Service, U. S. Dept. of Agriculture

T-10210 FEDERAL BLDG. 701 LOYOLA AVENUE NEW ORLEANS, LA. 70113

# FIVE YEARS OF NITROGEN FERTILIZATION IN A SWEETGUM-OAK STAND

W. M. Broadfoot [1]
SOUTHERN FOREST EXPERIMENT STATION

*Diameter and height growth were significantly increased in a 20-year-old sweetgum-oak stand by annual surface application of ammonium nitrate and of complete N-P-K fertilizer. Nitrogen fertilization significantly increased the nitrogen content of foliage. With increasing nitrate application, exchangeable potassium in the soil 1 year after treatment decreased.*

Responses to surface application of fertilizer were measured in a natural sweetgum-oak stand on Sharkey clay near Tallulah, Louisiana.[2] The soil is alluvial and relatively fertile, receiving nutrients from uplands. Plots were fertilized primarily with nitrogen, the element often lacking in southern soils.

Annually for 5 years, 1/10-acre plots in a well-stocked 20-year-old stand of sweetgum *(Liquidambar styraciflua* L.), water oak *(Quercus nigra* L.), and willow oak *(Quercus phellos* L.) were top-dressed with one of five amounts of fertilizer. Rates applied per acre were (1) zero (control), (2) 75 pounds of nitrogen, (3) 150 pounds of nitrogen, (4) 300 pounds of nitrogen, and (5) 150 pounds of nitrogen plus 35 pounds of phosphorus and 66 pounds of potassium. Treatments were replicated four times. The source of nitrogen was ammonium nitrate, and the phosphorus and potassium were from a 0-20-20 mixed fertilizer.

Five dominant and codominant trees of sweetgum and five of oak were randomly selected on each plot. Because willow and water oak resembled each other in form and growth, oaks were combined and treated as one in this test.

D.b.h. was measured at the beginning and end of the study to the nearest tenth of an inch at a marked position on each sample tree. Heights were measured to the nearest foot with a Haga altimeter placed at a staked position out from each tree. At the beginning of the study, oak sample trees averaged 5.9 inches in diameter and 45 feet in height, and sweetgum trees averaged 4.6 inches in diameter and 37 feet in height.

[1] Stationed at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Miss., in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group.

[2] The study was on land owned by Chicago Mill and Lumber Company.

A year after the last fertilizer application, tree foliage and soil samples were analyzed for N-P-K. Sample leaves were picked at random from the middle of the crown of each tree, composited by species, plot, and treatment, dried at 60° C., ground in a Wiley mill, and stored in ½-pint jars. For each treatment, representative samples of the upper 4 feet of soil were taken, air-dried, sieved, and stored in 1-pint ice cream cartons.

Nitrogen content of leaves and soil was determined by the standard Kjeldahl procedure; phosphorus in leaves, by the chlorostannous-reduced molybdophosphoric blue color method in a hydrochloric acid system with a spectrophotometer; phosphorus in soil, by the ammonium molybdate-sulphuric acid method with a spectrophotometer; potassium in leaves, by the flame method with a Beckman DU spectrophotometer; and exchangeable potassium in soil, by extraction with slightly acid ammonium acetate and flame spectrophotometer.

Statistical tests of differences between species and treatments were made at the 0.05 level of confidence.

## RESULTS AND DISCUSSION

*Growth response.*—All fertilizer treatments increased diameter and height growth of both sweetgum and oaks (table 1). The best diameter growth for the 5 years was 1.99 inches in sweetgum fertilized with 300 N, and the best height growth was 12 feet in sweetgum fertilized with N-P-K. Responses of the oaks, though smaller, were similar to those of sweetgum. For oak and sweetgum combined, 300 N produced a 65-percent increase in diameter growth, and N-P-K produced a 44-percent increase in height.

Table 1.—*Five-year growth by species and treatment* [1]

| Treatment (pounds per acre) | Sweetgum | | Oak | |
|---|---|---|---|---|
| | D.b.h. | Height | D.b.h. | Height |
| | *Inches* | *Feet* | *Inches* | *Feet* |
| 0 | 1.07 | 6.9 | 1.64 | 8.8 |
| 75 N | 1.50 | 9.8 | 1.96 | 8.9 |
| 150 N | 1.59 | 10.0 | 2.62 | 9.1 |
| 300 N | 1.99 | 11.4 | 2.51 | 8.9 |
| 150 N, 35 P, 66 K | 1.80 | 12.0 | 2.31 | 10.5 |

[1] Each value in the table is the average for 20 sample trees.

For diameter growth, 75 N was significantly better than none. There was no difference between N-P-K and 150 N, but each was better than 75 N. And 300 N was better than any other treatment (table 2). For height growth, all nitrogen applications were better than none, but there was no difference between rates of application; N-P-K was better than 75 N and 150 N, but not 300 N.

Table 2.—*Growth responses to fertilizing by all species combined*

| Five-year growth | Treatment | | | | |
|---|---|---|---|---|---|
| | Control | 75 N | N-P-K | 150 N | 300 N |
| | *Inches* | | | | |
| Diameter [1] | 1.36 | 1.73 | 2.05 | 2.10 | 2.25 |
| | Control | 75 N | 150 N | 300 N | N-P-K |
| | *Feet* | | | | |
| Height | 7.8 | 9.4 | 9.5 | 10.2 | 11.2 |

[1] Horizontal lines connect values not significantly different at the 0.05 level when analyzed by Duncan's multiple range test.

*Foliage analysis.*—Leaves from trees fertilized with 150 N, N-P-K, and 300 N contained more nitrogen than leaves from unfertilized trees (table 3). The nitrogen content of leaves

Table 3.—*Nutrient content of foliage*

| Treatment (pounds per acre) | Sweetgum | | | Red oak | | |
|---|---|---|---|---|---|---|
| | N | P | K | N | P | K |
| | *Percent by weight* | | | | | |
| 0 | 1.507 | 0.186 | 0.59 | 1.564 | 0.089 | 0.71 |
| 75 N | 1.449 | .160 | .52 | 1.521 | .096 | .62 |
| 150 N | 1.687 | .170 | .62 | 1.670 | .096 | .58 |
| 300 N | 1.868 | .122 | .68 | 2.149 | .131 | .63 |
| 150 N, 35 P, 66 K | 1.620 | .170 | .69 | 1.640 | .115 | .60 |

from trees fertilized with 300 N was greater than that of other leaves.

Phosphorus content of foliage was not significantly affected by fertilizing. However, in terms of foliar phosphorus, sweetgum and oak responded significantly differently to fertilization. Apparently, there was a slight decrease in phosphorus content of sweetgum as nitrogen was increased, whereas the reverse appeared to be true for oak.

The potassium content of leaves was not affected by fertilizer treatment.

*Soil analysis.*—A year after the last fertilizer application, there were no differences, by treatment, in nitrogen and phosphorus content of the soil (table 4). With increasing nitrogen application, however, the potassium content of soil decreased (fig. 1). The reason for this decrease is not known. An imbalance created by heavy N applications seems unlikely, since Sharkey clay soils usually have much exchangeable potassium and little nitrogen. Probably, the trees grew faster when fertilized and used more exchangeable potassium as a result.

Table 4.—*Average nitrogen and phosphorus in upper 4 feet of soil 1 year after last fertilizer application*

| Treatment (pounds per acre) | Nitrogen | Phosphorus |
|---|---|---|
| | *Pounds per acre-foot* | |
| 0 | [1] 2,952 | 83 |
| 75 N | 2,880 | 86 |
| 150 N | 3,168 | 88 |
| 300 N | 2,952 | 92 |
| 150 N, 35 P, 66 K | 2,808 | 95 |

[1] Each value in the table is the average of four plots.

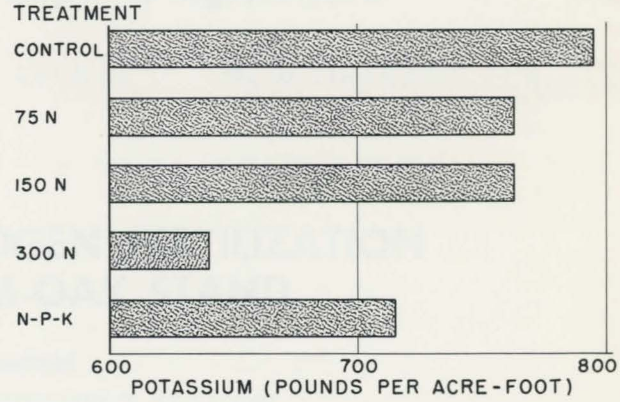


Figure 1.—*Exchangeable potassium in upper 4 feet of soil 1 year after treatment.*