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Fertilizing Southern Hardwoods

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IF present trends continue, fertilizing may soon be economically feasible in southern hardwood stands. Demands for the wood are rising, and the acreage alloted for growing it is steadily shrinking. To supply anticipated requests for information, the U. S. Forest Service has established tree nutrition studies at the Southern Hardwoods Laboratory in Stoneville, Mississippi, and the Forestry Sciences Laboratory in Athens, Georgia.

Responses to fertilizer, of course, vary by tree species, soil conditions, and individual tree. So far, experiments have been made with eastern cottonwood, sweetgum, water and willow oak, yellow-poplar, and sycamore. The results of thes experiments will be discussed by species.

Cottonwood

Eastern cottonwood has been given the highest research priority at the Southern Hardwoods Laboratory because the paper industry is keenly interested in intensively managing the species. Responses to various concentrations of nutrients have been measured on seedlings grown in sand cultures and in four common alluvial soils of the Midsouth.

Seedlings were grown in sand cultures to determine the approximate amounts of nitrogen (N), phosphorus (P), and potassium (K) required for maximum growth. Seeds were planted in leached sand in 5-gallon crocks, and solutions were added to the crocks with one of seven concentrations of N, P, and K:

N—0, 10, 25, 50, 100, 200, and 300 parts per million (ppm).
P—0, 5, 10, 25, 50, 75, and 100 ppm.
K—0, 25, 50, 100, 200, 300, and 400 ppm.

In groups of crocks where one element was varied, the other two elements were supplied at constant rates of 100 ppm of N and K, and 50 ppm of P. Nutrient solutions were added every 90 seconds with an automatic irrigating device.

After 9 weeks, the experiment was terminated and seedlings were dried and weighed.

With the amounts of the other elements held constant, the concentrations of each element that resulted in the greatest average seedling weight were 100 ppm of N, 75 ppm of P, and 100 ppm of K. However, differences in growth at these levels and at concentrations of 50 ppm of N, 5 ppm of P, and 25 ppm of K were insignificant. Addition of 300 ppm of N resulted in less growth than addition of lesser amounts.

In another experiment, samples of four bottom-land soils common in the Midsouth—Sharkey clay, Adler silt loam, Commerce fine sandy loam, and Bibb sandy loam—were collected from the surface 9 inches in forested areas. The soils were placed in crocks, and cottonwood seeds were sown. After the seeds germinated, various amounts of fertilizer were added equivalent to: 0, 50, 100, or 150 pounds of N per acre, 0 or 50 pounds of P per acre, and 0 or 100 pounds of K. Because the Bibb soil was stronly acid, 2,000 and 4,000 pounds of lime per acre were added as an additional test. Each treatment was replicated in a randomized block design, and seedling responses were measured after 3 to 5 months.

On Sharkey clay and Adler silt loam, fertilizing did not stimulate growth, probably because sufficient concentrations of nutrients were present originally. Fertilizing Commerce fine sandy loam increased growth slightly. The best responses were from heavy N applications alone or in conjunction with K or P and K. Complete fertilizer and lime increased growth on Bibb sandy loam, but growth was poor even with them.

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FERTILIZING SOUTHERN HARDWOODS — Cont

Sweetgum and Oak

Responses of sweetgum and oak to surface application of fertilizer were measured in a natural stand on Sharkey clay near Tallulah, Louisiana. Annually for 5 years, 1/10 acre plots containing 20-year-old sweetgum, water oak, and willow oak were top-dressed with fertilizer applied at rates equivalent to: zero (control), 75 pounds of N, 150 pounds of N, 300 pounds of N, and 150 pounds of N plus 35 pounds of P and 66 pounds of K per acre. Treatments were replicated four times. The source of N was ammonium nitrate, and the P and K were from 0-20-20 fertilizer.

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.

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 150N, 35P, and 66K. Responses of the oaks, though smaller, were similar to those of sweetgum. For oak and sweetgum combined, 300N increased diameter growth by 65%, and 150N, 35P, and 66K increased height growth by 44%.

Yellow-Poplar

At Athens, yellow-poplar and sycamore have been studied because both species grow rapidly and make satisfactory paper pulp. Yellow-poplar is also highly valued as a furniture wood.

In one experiment with 1-year-old yellow-poplar seedlings, diammonium prosphate was broadcast in May at rates of 0, 250, 500, and 1,000 pounds per acre, which supplied 0, 50, 100, and 200 pounds of N and 0, 130, 260, and 520 pounds of P.

The two high rates of fertilizer application were more effective than the low rate in stimulating growth, and all treatments were better than none. Treatment-related differences in total height increased with time.

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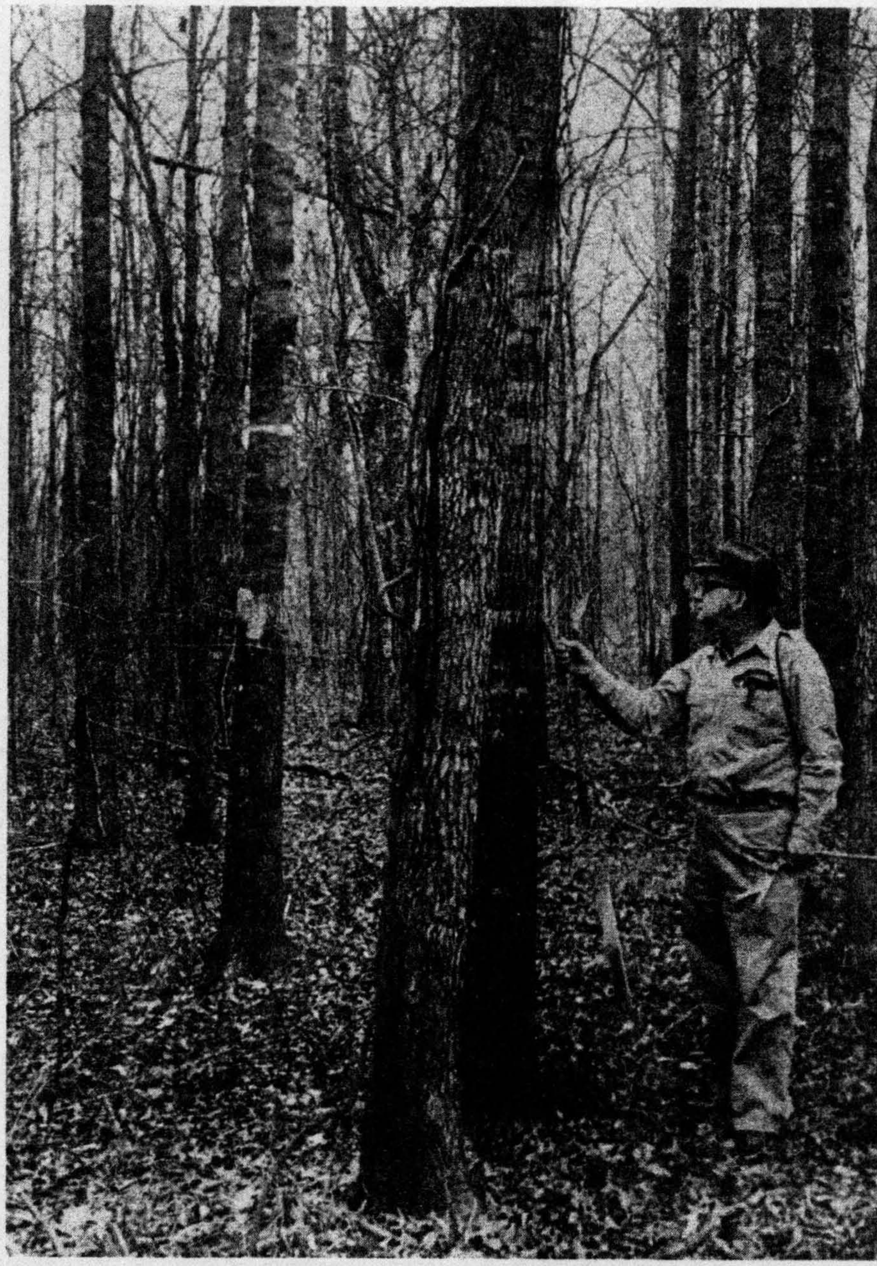

Annual application of 300 pounds of nitrogen per acre increased diameter growth by 65% in a sweetgum-oak stand.

Table 1. — **Average 5-year growth by species and treatment**

Treatment	Sweetgum		Oaks	
(pounds per acre)	D. b. h.	Height	D. b. h.	Height
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

At age 4, tree crowns on the most heavily fertilized plots were closing, thereby eliminating weed competition. Check plots and those that received only light fertilization were being invaded by volunteer sweetgum.

In a subsequent test, N proved to be the key element for increasing growth. Trees fertilized with N and P grew only slightly faster than trees fertilized with N alone.

These studies and several related greenhouse experiments indicate that yellow-poplar is more tolerant of heavy fertilizer application than are many hardwoods. A balanced nutrient supply seems to increase yellow-poplar's resistance to high fertilizer salt concentrations.

Sycamore

Fertilization also stimulated the growth of sycamore. Site preparation and cultivation increased the response, which was greater in seedlings than in cuttings.

An experiment of particular interest tested the effects of broadcasting N, P, and K on 1-year-old seedlings. The experiment site was a 7-acre overflow bottom-land pasture located on the Oconee River floodplain in northeastern Georgia. The alluvial soil was well drained but low in nutrients by agricultural standards. Texture varied from clay to silty clay loam.

Graded 1-0 seedlings were handplanted in December 1960 at an 8-by 8-foot spacing. Plots containing 16 trees were separated from each other by 2 isolation rows. Ammonium nitrate was broadcast at rates equivalent to 0, 150, and 300 pounds of N; triple superphosphate at 0, 44, and 87 pounds of P; and muriate of potash at 0, 83, and 166 pounds of K per acre.

Seedling growth was measured in September of the first year. Responses to N, P, and K were all statistically significant, but only that to N was silviculturally meaningful. An equation describing the response to N alone indicates that a maximum height growth of 6.2 feet would be associated with an N application of 225 pounds per acre. If the N application were cut in half, the equation indicaates that height growth would be 5.7 feet, a difference of only 6 inches. Unfertilized seedlings grew only 3.7 feet during the first year. The height growth pattern the second year after fertilizing indicated that the true optimum rate of N application was between 250 and 300 pounds per acre.

Conclusions drawn after the first year still apply after the sixth growing season: growth has been slowest on checq plots, only N has produced meaningful responses, and 300 N has been only slightly more effective than 150 N.

Conclusions

Forest Service research on fertilizing southern hardwoods is incomplete, but the preliminary results are promising. Under some conditions, nitrogen alone and in mixed fertilizers has meaningfully increased tree growth. To get full value from the fertilizer in young plantations, it appears to be necessary to control vegetation that will compete with the trees for the added nutrients. Indeed, control of competing vegetation, which is a standard forestry practice, is probably more important than fertilizing in many areas.

How can an owner decide whether to fertilize hardwoods? In the same way as he decides whether to fertilize field crops, but with one important difference. In either case, he must compare the cost of fertilizing with the value of the production increase. The difference is that with a field crop he need look only a few months into the future to estimate the value of the crop. With trees he must look much further ahead—10, 20 or 30 years, perhaps more.

At current prices, fertilizing southern hardwoods is seldom economically justified. But at the prices trees planted today will probably bring 20 or 30 years from now, cultivating and fertilizing may well be profitable. With southern hardwood acerage steadily dwindling, the productivity of these acres must be increased in some way to keep industry supplied.

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