Hamlin L. Williston, *Forester,*
Southeastern Area, State & Private Forestry
USDA Forest Service

Foresters Can Lengthen Tree Growing Season Through Silvicultural Practices

The length of the loblolly pine growing season is affected by many factors such as amount and availability of soil moisture, length of day, night and day air temperatures, and soil temperatures. The forester can do little to alter some of the factors involved, but certain studies have shown that he definitely can influence tree growth by two means: Reducing competition for moisture and selecting the proper stock for planting.

Heavy thinnings, for example, along with removal of cull trees and undesirable brush conserve the water supply and thus prolong the growth of the pine crop trees. Intensive culture can lengthen the growing season by as much as three months.

The Study

In 1954 the author established the "accelerated sawlog" study near Crossett, Ark., in which a 9-yearold loblolly pine plantation was thinned back to 100 crop trees per acre in one treatment and all crop trees were released from competition in another treatment for comparison with the growth of an unthinned plot nearby. Zahner and Whitmore reported (14) that diameter growth began each year in early March on all treatments in this study. (Last killing frost in spring, March 29; first in fall, November 11.) Trees in the untreated control usually ceased growth by late June or July, whereas those in the other treatments grew well into the fall. On the sawlogs-only plots, growth extended into early November most years. The fastest growth rates for all treatments occurred during April each year. Thinning intensity did not affect height growth.

Soil on the control plots dried very rapidly, nearing the wilting point by July. Soil moisture in the other two treatments did not reach low levels until much later. In 1956, diameter growth on the control plots stopped when about half of the available water had been depleted. This moisture level represented a soil-moisture tension of about three atmospheres. At the periphery of the roots in the sawlogs-only treatment, where diameter growth continued until November, the soil to a depth of 3 feet was near field capacity throughout the entire growing season.

Discussion

The initiation of diameter growth probably depends upon a supply of auxin and perhaps gibberellic acid from the growing stem tips (10). Diameter growth also probably depends upon the products of current photosynthesis (9) and therefore is quite sensitive to variations in water supply during the growing season. Regardless of. the amount of moisture available during the summer to sawtimber stands of loblolly pine in northeastern Louisiana, Moehring and Ralston *(11)* found that diameter growth was curtailed when soil moisture loss was rapid.

Height growth generally begins earlier in the season and ends sooner than diameter growth. The first flush of height growth is usually not dependent upon current sources of photosynthesis. Drought conditions will reduce the number of seasonal growth flushes in loblolly pine (13). (It is natural for seedlings to cease growth one or more times during the growing season without becoming dormant.)

All too often, loblolly pine is faced with serious competition from hardwood brush. Loblolly pine has shorter roots and less absorbing root surface than do the competing hardwood species (8). This places loblolly at a distinct disadvantage when competing with oak, for example, in times of soil moisture stress. With a larger root system, such as would be produced by growth in an optimum light intensity, pine seedlings can survive greater drought. Chapman (3) has confirmed that loblolly pine seedlings growing in full sunlight were found to be much more resistant to drought than those growing in shade.

Of course, soil moisture is not such a critical factor in the winter time because of the usually low winter transpiration rate of conifers. This is due partly to atmospheric factors and to low soil temperatures decreasing absorption (7). A decreased soil temperature decreases the rate of movement of water from the soil to the absorbing surfaces. The viscosity of water increases as temperature decreases and is twice as high at 32° F. as at 77° F. This results in a decreased rate of water movement from soil to roots and through the root cells during cold weather.

Loblolly and slash pine can absorb only 40 percent as much water at 50° F. as at 77° F., while red and white pine absorb 60 percent as much at 50° F. as at 77° F. 45). The differences between species presumably result chiefly from differences with respect to changes in viscosity and permeability of the protoplasm of the roots caused by low temperature. Much winter injury in loblolly pine is really injury from desiccation brought about by sun and wind causing excessive transpiration at times when the soil is frozen or so cold that absorption is too slow to replace the water lost in transpiration.

Kramer (6) explored the effect of various combinations of day and night temperatures on the height growth of loblolly pine seedlings in a phytotron. He found that growth increased with increasing day temperature and decreased with increasing night temperature. A day temperature of 63° F. was too cool for good growth and a day temperature of 86° F. (highest tested) was not above optimum. The best height growth occurred with night temperatures 19 to 21* F. lower than (lay temperatures and the poorest growth occurred in seedlings kept at 63 or 73° F. (lay and night.

According to Barney (l) the roots of loblolly pine seedlings grow most rapidly at 68° to 86° F. and the rate of elongation at 41' F. and 96° F. is less than 10 percent of the maximum rate. If soil temperature alone were the limiting factor, loblolly would continue to grow in diameter and height throughout the winter in such places as northern Florida. There, length of day appears to be limiting.

Selection of seed from the proper geographic source is also important to tree growth, chiefly because the various provenances of loblolly pine respond differently to day length and temperature. Downs and Piringer (4) found that plants from a North Carolina seed lot made more growth on photoperiods of 16 hours or more than those from a Delaware seed lot. Perry (12) found in a study with two provenances of loblolly pine (Tennessee and Texas) that there was geographic variation in the day temperatures required for optimum growth. Incidentally, Boyer (2) has reported that the threshold temperature for loblolly pine shoot growth was about 40° F. at night and averaged 50° F. (luring the day.

Conclusions

No longer can we equate growing season with the length of the frostfree period. Studies cited here demonstrate that the length of the growing season depends upon a complex interaction of a number of factors. Aware of this, the forester can exert some degree of control over loblolly tree growth through his selection of seed and thinning practices.

Literature Cited

1. Barney, C. W.
   1951. Effects of soil temperature and light intensity on root growth of loblolly pine seedlings. Plant Physiol. 26: 146-163.
2. Boyer, W. D.
   1970. Shoot growth patterns of young loblolly pine. Forest Sci. 16 (4) : 472-482.
3. Chapman, H. H.
   194[5], The effect of overhead shade on the survival of loblolly pine seedlings. Ecology 26: 274-282.
4. Downs, R. J. and Piringer, **A. A.**
   Effects of photoperiod and kind of supplemental light on vegetative growth of pines. Forest Sci. 4(3): 185-195.
5. Kramer, P. J.
   1942. Species differences with respect to water absorption at low soil temperatures. Amer. Jour. Bot. 29: 828832.
6. _____
   1957. Sonic effects of various combinations of day and night temperatures and photoperiod on the height erowth of loblolly pine seedlings. Forest Sci. 3(l): 45-55.
7. Kozlowski, T. T.
   1913. Transpiration rates of some forest tree species during the dormant season. Plant Phvsiol. 18: 252-260.
8. _____
   1919. Light and water in relation to growth and competition of Piedmont forest tree species. Ecol. Monog. 19: 207-231.
9. _____
   1958. Water relations and growth of trees. Jour. Forestry 56: 498-502.
10. _____
    1971. Growth and development of trees. Vol. II, Academic Press, 514 pp., illus.
11. Moehring, D. M. and Ralston, C. W.
    1967. Diameter growth of loblolly pine related to available soil moisture and rate of soil moisture loss. Soil Sci. Soc. Amer. Proc. 31: 560-562, illus.

12. Perry, T. O.
1962. Racial variations in the day and night temperature requirements of red maple and loblolly pine. Forest Sci. 8 (4) : 336-344.

13. Zahner, Robert

1962. Terminal growth and wood formation by juvenile loblolly pine under two soil moisture regimes. Forest Sci. 8 (4) : 345-352.

14. Zahner, Robert and Whitmore, F. W.
1960. Early growth of radically thinned loblolly pine. Jour. Forestry 58: 628634, illus.