ROOT GROWTH OF TRANSPLANTED LOBLOLLY PINE (*PINUS TAEDA* L.) SEEDLINGS IN RELATION TO CHEMICAL ROOT RESERVES

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The ability of a seedling to produce new roots after being transplanted from the nursery affects the possibility of its survival. The general practice in nurseries growing loblolly pine seedlings is to run a lifting blade eight inches below the soil surface to remove the seedlings with the least amount of damage. Most of the fine rootlets and all roots more than eight inches below the soil surface are lost during this operation. This reduction in the amount of moisture absorbing surface as compared to the transpiring surface is critical and undoubtedly often determines if a seedling will survive.

Stone (1955) demonstrated that new root growth is necessary for survival of ponderosa pine and Douglas-fir when transplanted, but he did not determine which factors were associated with the production of new roots. Reed (1939) observed that root growth of field-planted pine seedlings in North Carolina is hindered by low soil moisture before the wilting point is reached. This means that a seedling transplanted into the field must produce new roots before soil moisture becomes low in early summer if the plant is to survive.

Many investigators have reported the presence of sugars, starches and other carbohydrate fractions in plants and plant parts, but the literature is nearly devoid of references to the role that carbohydrates play in the survival of transplanted seedlings. A high carbohydrate content in the roots of a seedling at the time of transplanting could indicate a high capacity to supply energy necessary for the production of new roots.

Wakeley (1954) reported that shading southern pine seedlings in nursery beds, reduced the survival of outplanted longleaf pine seedlings 26 per cent and slash pine seedlings 79 per cent. He attributed the high mortality to the failure of the shaded seedlings to develop new roots promptly after transplanting.

Wassink and Richardson (1951) reported that root growth of first year seedlings of sycamore maple was directly related to light intensity, while root growth of red oak seedlings of the same age appeared to depend on stored food rather than on products of current photosynthesis. In another study, Richardson (1953) reported that when photosynthesis was curtailed, root growth of silver maple proceeded at the expense of food stored in the roots. He also found that the leaves supply a stimulus essential to root formation and growth.

Reines (1957) in his comprehensive review of rooting southern pine states that many studies have been reported where the effects of carbohydrates on rooting of plant cuttings is mentioned.

Although little work has been done on root growth of transplanted pine seedlings, results from several studies indicate that root growth of seedlings might be dependent on the carbohydrates in the plant. In an early study using root growth chambers, the author found that a weak statistical relationship existed between the carbohydrates in the roots and root growth of transplanted loblolly pine seedlings; but, because of the wide variation in root growth, it was difficult to reach a positive conclusion regarding root growth and reserve root carbohydrates.

Carbohydrates are known to be translocated from the leaves through the stem phloem and into the roots. If this path of translocation could be blocked at the time of transplanting, carbohydrates would be prevented from entering the roots and a test could be made to determine the correlation between the carbohydrates in the roots at this time and during subsequent root growth. A scheme was devised that fulfills these requirements and enabled the investigator to test the results of the early study more thoroughly.

Methods

Twenty 1-year-old loblolly pine seedlings that were used in the exploratory phase of the experiment were girdled in the late spring of 1959. These seedlings and 20 control seedlings (not girdled) were planted in cans. All seedlings were removed after 30 days and the roots visually examined to determine whether or not root growth had begun.

Year-old seedlings used in the main part of the experiment were removed from the nursery bed each month from October, 1959 through April, 1960. Forty seedlings were girdled each month and then planted in root growth chambers. To serve as a control, each month 20 ungirdled seedlings were planted in gallon containers. All seedlings were observed over a 30-day period for root growth.

Results

During the exploratory phase of the experiment in the spring of 1959 a light pressure with the thumbnail was all that was required to remove the bark around the seedling stem. Both seedlings that were girdled and ungirdled developed new branch roots in addition to elongation of old roots after they were transplanted. Root growth was approximately four times greater on ungirdled seedlings than on girdled ones.

Seedlings removed from the nursery bed in October, 1959 and during the next 6 months, appeared to be in a dormant state. The bark adhered to the stem very tightly in all 7 groups of seedlings. To girdle a seedling it was necessary to double ring the stem with a razor blade and then scrape away the bark.

None of the seedlings girdled during the period from October, 1959 through April, 1960 showed any visible root growth after they were transplanted. In contrast, seedlings that were not girdled during this period developed new roots in addition to elongation of old roots.

Only a few of the girdled or ungirdled seedlings in the experiment died within 30 days after they were transplanted. A large percentage of seedlings girdled and transplanted in March and April of 1960 started height growth and the seedlings appeared to be healthy except for the girdle on the stem.

Discussion

The primary difference between seedlings transplanted in the late spring 1959 and those transplanted during the period from October, 1959 to April, 1960 must have been in their growing status. It is well known that easy mechanical removal of bark from trees occurs only when the cambium is physiologically active (Kramer and Kozlowski, 1960, p. 8). The fact that bark could be removed easily from the stems of seedlings girdled in the spring of 1959 but was difficult to remove during the other periods indicates that the former were physiologically active, whereas the other girdled groups of seedlings were in a dormant state.

Root growth of seedlings girdled in the spring of 1959, that were thought to be physiologically active at time of girdling, is not a significant event in itself. However, when compared with dormant girdled seedlings that produced no new roots after being transplanted, the results suggest that before a seedling can produce new roots, the roots must receive some stimulus from the leaves or buds.

The supposition that a root growth stimulus is translocated from the top of the seedlings to the roots is further substantiated by the two groups of seedlings tested in the spring of 1959. As previously stated, all seedlings in the spring of 1959 appeared to be in an active state of growth; seedlings from both groups developed new roots. If root growth did not depend upon a stimulus from the needles or buds, the total amount of root growth should be the same in both groups of seedlings. The fact that this did not result suggests that it is necessary to replenish some substance in the roots before root growth can proceed at the same rate as in ungirdled seedlings. This substance cannot be stored in roots, otherwise dormant girdled seedlings would produce new roots. This material probably is not one of the major carbohydrates (reducing sugars, sucrose, or starches) found in pine seedling roots, as loblolly pine roots contain relative large quantities of such carbohydrates during periods in which transplantings are made.

As previously stated, none of the girdled seedlings during the 7 month period produced either new roots or elongation of old roots. For this reason the carbohydrate content in the seedlings roots was not determined, as no correlation could possibly be established between root growth and food reserves of the roots.

Summary

No correlation was shown between root growth of transplanted seedlings and food reserves of roots. However, certain results indicate that before root growth can begin, the roots must receive a stimulus from the leaves or buds.

ACKNOWLEDGMENTS

The work reported here embodies a portion of a thesis submitted to the School of Forestry of Duke University in partial fulfillment of the requirements for the degree of Doctor of Forestry.

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Manuscript received December 31, 1961.