RESEARCH NOTE NC-225

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

Folwell Avenue, St. Paul, Minnesota 55101

1977

ROOT-CROWN RELATIONS OF YOUNG SUGAR MAPLE AND YELLOW BIRCH

Carl H. Tubbs, *Principal Plant Physiologist*
Marquette, Michigan

ABSTRACT.—Young forest-grown sugar maple and yellow birch (1 to 6 inches d.b.h.) crowns were mapped and roots excavated. Crown dimensions were compared. Sugar maple roots usually terminated within a few feet of the crown perimeter. Yellow birch roots frequently terminated well outside crown perimeters and roots of birch were more irregularly distributed than those of maple.

OXFORD: 181.62:181.36.
KEY WORDS: sugar maple, yellow birch, root distribution, crown dimension.

The trend toward more intensive culture of northern hardwoods has made it desirable to know more about root distribution of individual trees. Knowledge of root distribution can be used both in fertilizer application and in thinning. Also crown perimeter frequently is used to gauge thinning intensity and area of fertilizer application. This investigation sought to find a relation between crown perimeter and root extent and to also describe horizontal root distribution.

METHODS

During the summer of 1975, the roots of 18 randomly chosen sugar maple and 18 yellow birch, ranging from 0.85 to 5.97 inches d.b.h. were excavated from a fully stocked stand that originated from a clear-cut in 1963. Soils were sandy loam podsols with a cemented layer at about 2 feet. Following the general method of Hannah (1972) all large lateral roots were excavated for their full length and diagrammed; crown perimeters were measured and diagrammed on the same map. Root length was considered to be the straight line distance from the end of the root to the tree stem. Average root length was calculated from the four longest roots. The average crown radius was calculated using the radii at cardinal points. Trees were cut and total heights measured.

RESULTS

Root-crown-stem Size Relations

Most tree characteristics were closely related (table 1). Diameter breast height was well related to total height, average crown radius, and average root length. In turn, these characteristics are well related to each other. Crown radius was only slightly better related to the logarithm of d.b.h. than to d.b.h.; average yellow birch root length was better related to the logarithm of crown width than with actual data.

Small increases in stem diameter of both species were associated with disproportionately greater root lengths (fig. 1) in the smallest size classes; also small changes in crown radius of yellow birch were related to disproportionately large changes in root lengths (fig. 2). Average sugar maple root lengths and average crown radius were surprisingly close to a one-to-one ratio regardless of tree size. Average root lengths tend to exceed average crown widths in the smallest size classes (0.5 to 1.5 d.b.h.). Trees larger than 1.5 d.b.h. tended to have roots less than the average crown width. In general, the longest sugar maple roots were a few feet outside the perimeter.

Table 1. – *Coefficients of correlations between various characteristics of sugar maple and yellow birch sapling and poles*

Characteristics	Sugar maple				Yellow birch			
	Total height	Average crown radius	Longest root	Average root	Total height	Average crown radius	Longest root	Average root
D.b.h.	0.91	0.91	0.38	0.71	0.94	0.90	0.67	0.67
Log d.b.h.	--	.93	--	.80	--	.89	--	.85
Total height	--	.83	.40	.68	--	.69	.48	.74
Average crown	--	--	.51	.84	--	--	.69	.69
Longest crown	--	--	.76	--	--	--	.55	--
Average crown	--	--	--	--	--	--	--	.74

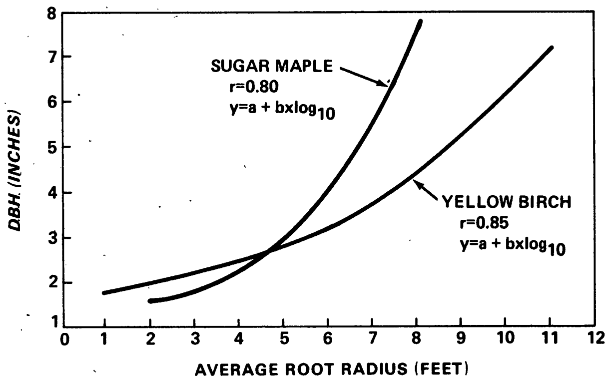

Figure 1. – *Average root length vs. diameter breast height for yellow birch and sugar maple.*

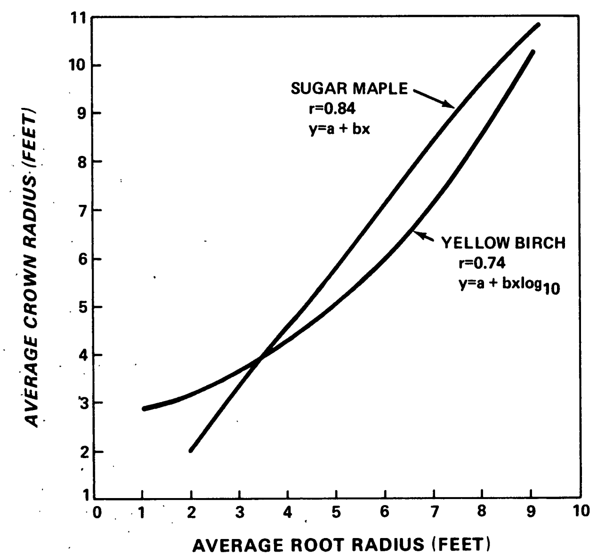

Figure 2. – *Yellow birch and sugar maple average root lengths vs. crown radius.*

For example, the data shows that the longest roots of trees with a 2.5- to 3-foot crown radius were about 4.5 feet in length.

The ratio of root length to crown radius in yellow birch was generally less than 1:1 in the smallest size classes (up to 2 inches d.b.h.), but about 1:1 in the larger size classes.

Root Distribution

Crown maps were divided into segments each equalling an 8th of a circle whose center was the tree stem. Boundaries of the segments were compass directions (N to NE, NE to E, etc.). The number of segments in which roots fell were counted to provide an estimate of distribution. Most yellow birch had short roots in all segments, but no tree had long roots (2 feet or longer) in all segments. Nine trees had roots in only 50 percent of the segments. There seemed to be no relation between root distribution and other tree characteristics.

Twelve of the 15 birch had roots extending beyond the actual crown perimeter. Of these, three trees had all examined roots terminating beyond the crown and nine trees had roots terminating both within and beyond the crown.

Fifteen of the 16 maple had one or more roots extending beyond the actual crown perimeter. In most cases these roots did not extend more than 2 or 3 feet beyond the crown (in contrast to the birch whose roots occasionally grew 8 or 10 feet beyond). Seven maples 1 inch in d.b.h. had 50 percent or fewer of the segments penetrated by roots. The larger trees had better distributed root systems.

The vertical distribution of roots was not measured but variations from the typical were noted. Several birch and maple had sinker roots which grew straight down for some distance. One maple originated from a root sucker.

The actual distribution of the root mass in relation to the crown mass appeared to be much more variable in birch than in maple, as the previous data suggest. Maple crowns seemed to be more regular and roots were fairly evenly distributed (fig. 3). In contrast, birch crowns seemed quite irregular in shape and roots frequently were mostly on one side or other of the tree (fig. 4). Inspection of the maps of both species suggested that if the crown mass was off center from the stem, then the roots tended to fill in that part of the circle not occupied by the crown. This tendency is accentuated in leaning trees. The roots of leaning trees of both species always grew away from the direction of lean (and crown mass) as if to offset the imbalance created by the stem and crown (fig. 5).

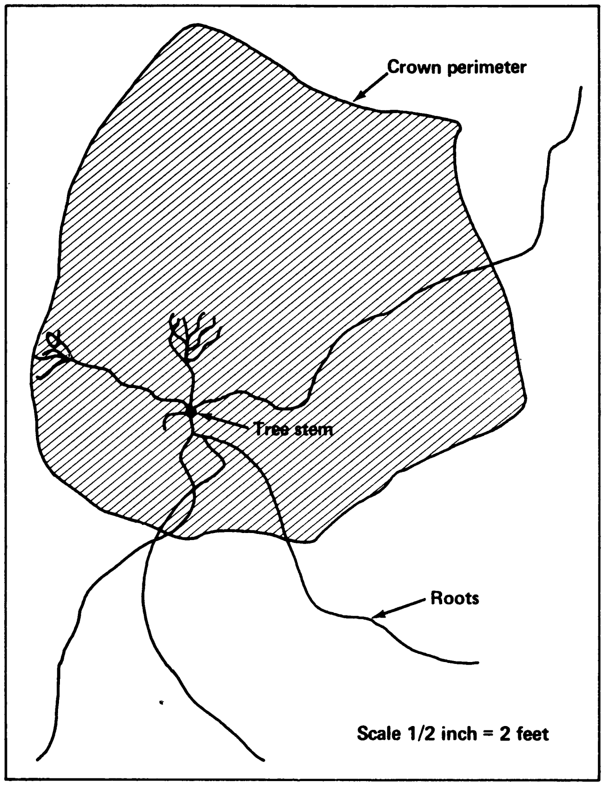

Figure 4. – *Yellow birch (5.3 inches d.b.h.) with irregular crown and root distribution.*

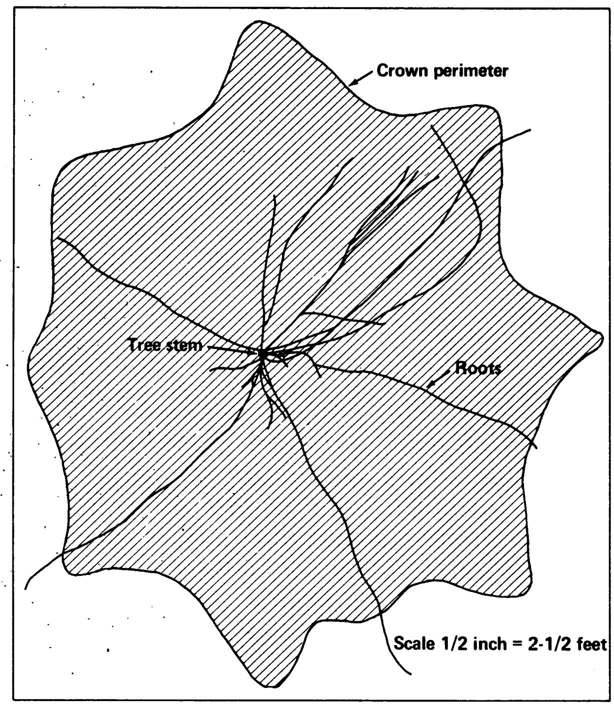

Figure 3. – *Sugar maple (4.3 inches d.b.h.) with regular crown shape and well-distributed root system.*

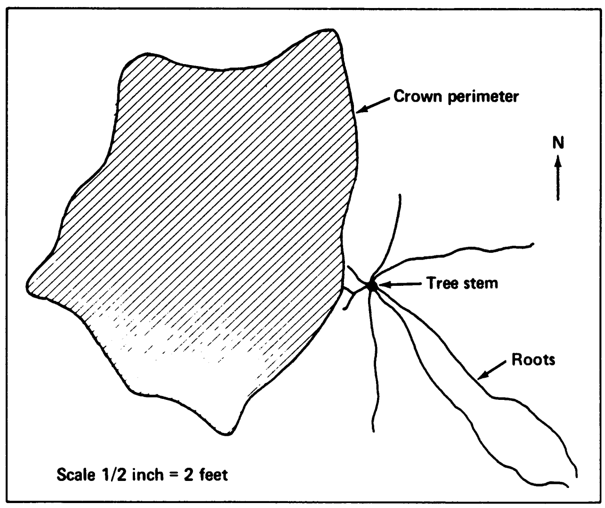

Figure 5. – *Yellow birch (1.4 inches d.b.h.) leaning toward west illustrating direction of root mass.*

DISCUSSION AND SUMMARY

Because these trees were growing in an unthinned stand and were chosen more or less randomly on the basis of diameter, most were probably suppressed to some degree. Generally, this reduction in photo-synthetic capability would result in relatively poor root growth; more open grown trees might not show the relations noted in this study. This possibility seems greatest with yellow birch; the smaller and more likely to be suppressed trees had roots which ended close to the crown perimeter, while trees more than 2 inches d.b.h. grew roots which on the average ended well beyond the crown perimeter.

Sugar maple roots in the seedling stage, on the other hand, do not respond to reduction in light (Logan 1965) and appeared to be less suppressed in this study than yellow birch. Maple roots seemed sparse under the smallest trees and this may be internally regulated or the result of some suppression.

In contrast to red pines (Day 1941, Stiehl 1970) whose roots are so widespread that individual tree thinning has little effect, forest grown yellow birch and sugar maple have fairly regular root distributions. Distribution is irregular enough however, that it is probably a significant cause of variation between trees in thinning studies, and warrants some caution in thinning and fertilization. Fertilizing done under the crown of a leaning tree may miss the roots entirely (fig. 5) and carefully weighed and evenly distributed fertilizer may be only partially effective because of irregular root distribution.

Measurements were not made of the influence of surrounding trees on root distribution. It seems noteworthy, however, that irregularities in crowns presumably caused by competitors were not necessarily copied by roots.

In summary, the average lengths of the main roots of yellow birch was greater than average crown length, especially in the smaller trees. The horizontal distribution of birch roots in relation to crowns was irregular and crowns were often irregularly shaped. Longest roots frequently were well outside crown perimeters.

Average sugar maple root area coincided closely to crown areas and longest roots frequently were within a few feet of the crown perimeter. The horizontal distribution of maple roots was fairly regular as were crowns.

Roots of both species were distributed away from the direction of lean of the tree.

LITERATURE CITED

Day, M. W. 1941. The root system of red pine saplings. J. For. 39:468-472.

Kramer, P. J., and T. T. Kozlowski. 1960. Physiology of trees. 534 p. McGraw-Hill Book Co., Inc., New York.

Logan, K. R. 1965. Growth of tree seedlings as affected by light intensity. I. White birch, yellow birch, sugar maple and silver maple. Can. Dep. For. Pub. 1,121, 16 p.

Stiehl, W. M. 1970. Some competitive relations in a red pine plantation. Dep. Fish. For., Can. For. Serv. Pub. 1,175, 9 p.

✩ U. S. GOVERNMENT PRINTING OFFICE: 1978-767819/69 REGION NO. 6