CHARACTERISTICS OF GIRDLING ROOTS ON URBAN NORWAY MAPLES

by Robert L. Tate

Abstract. Girdling roots were examined on 336 street-side mature Norway maple trees (*Acer platanoides*) in Ann Arbor, Michigan. Most of the girdled trees were girdled by multiple, shallow, subsurface roots. There was no association between girdled trees and narrow tree lawns. Most of the trees were not girdled severely. There did not appear to be any significant effects on crown characteristics attributable to root girdling.

Trees may be girdled to some degree by their roots. Although the magnitude, causes, effects and treatment of girdling roots on street and landscape trees have received little attention, they may be serious problems (Tate 1980). Root girdling is presumed to reduce the translocation of water, nutrients, and photosynthates by crushing vascular tissues at the base of the trunk. Trees may be weakened and killed by girdling roots alone or in conjunction with environmental stresses or attacks by pests.

Since little is known about girdling roots, and treatment for root-girdled trees by excavation and cutting girdling roots is time consuming and expensive (Tate 1980), a better understanding of girdling root characteristics is needed.

Materials and Methods

Between August 1977 and August 1979, the root system of 410 54 to 57-year-old Norway maples (*Acer platanoides*) in Ann Arbor, Michigan were observed for incidence and severity of girdling roots. The trees were 2 in. caliper balled and burlapped when planted by city crews over a four-year period between 1925 and 1928. A root was arbitrarily defined as a girdling root if it encircled at least 12 percent of the truck's circumference and at least 10 percent of its diameter was overgrown by the trunk. Girdling roots were divided into two classes, surface and subsurface. Soil at the base of each tree was excavated to a depth of 46 cm (18 in.) and the following observations were noted: root diameter at origin and girdling point, distance between origin and first contact with bole, amount and direction of encirclement, depth, amount of overgrowth and girdling root type. Tree crown characteristics of leaf color, leaf size and general foliage dieback were measured to determine the effects of root girdling. Also measurements of tree lawn widths were taken to determine if girdled trees were associated with narrow tree lawns.

Results and Discussion

Of the 410 trees examined, 336 had one or more girdling roots. Thirty-five percent of the girdled trees were girdled by only one root, 46 percent by 2 or 3 roots, and 19 percent by 4 to 9 roots (Table 1).

Table 1. Number of girdling roots

Girdling roots/tree	*No. of trees*
1	117
2	94
3	61
4	30
5	24
6-9	10

Surface and subsurface roots up to 22.9 cm (9 in.) and 20 cm (8 in.) in diameter, respectively, were found, but 75 percent of all girdling roots were 7.5 cm or less in diameter (Table 2). The mean diameter of all surface and subsurface girdling roots was 6.4 cm (standard deviation 3.8 cm).

Table 2. Diameter of surface and subsurface girdling roots

Diameter	*Surface*	*Subsurface*	*Total*
cm	*No. of roots*	*No. of roots*	*No. of roots*
0.3-3.7	37	219	268
3.8-6.2	31	148	180
6.3-8.7	42	125	162
8.8-11.2	44	59	97
11.3-13.7	26	18	41
13.8-16.2	18	0	16
16.3-18.7	4	6	0
18.8-22.9	2	0	16
—[a]	15	18	32

[a]Diameter measurements could not be taken because of bole overgrowth or other factors.

Comparisons of the diameters of surface and

subsurface girdling roots show that 83 and 50 percent of the subsurface and surface roots, respectively, were 7.5 cm or smaller in diameter (Table 2). The percentage of subsurface roots up to 3.7 cm in diameter was more than twice that of surface roots (37 vs. 17 percent, respectively). Surface roots had a larger mean diameter than subsurface roots (8.6 vs. 5.6 cm, respectively) and the difference was highly significant (0.001).

On the average, 2.4 girdling roots were found on each girdled tree (812 roots on 336 trees). Of the 812 girdling roots, 27 percent (219) were surface roots and 73 percent (593) were subsurface roots. The depths of 546 of these subsurface roots were measured as follows:

Root depth (cm)	No. of roots
2.5	131
5.0	192
7.5	109
10.0	71
12.5	22
15.0	11
17.5	5
20-25	5

Seventy-nine percent of subsurface roots were found within 8.7 cm of the ground surface; the mean depth was 6.4 cm (standard deviation 3.6 cm).

The degree to which each girdling root was overgrown by the main trunk was measured as a percentage of the root diameter.

Overgrowth as % of root diameter	No. of trees
0-10	3
11-20	205
21-40	74
41-60	37
> 60	17

Only 5 percent of the trees had roots that were overgrown by more than 0.6 of their diameters, and 62 percent had roots overgrown by less than 0.2 of their diameters. Since the mean diameter of all girdling roots was 6.4 cm, the extent to which roots had been overgrown was not great.

The degree of encirclement by girdling roots was measured on each tree at eight points, each point representing 12.5 percent of the circumference of the bole:

% of encirclement	No. of trees
12.5	37
25.0	141
37.5	108
50.0	34
62.5	10
75.0	3
87.5	0
100.0	3

Only 5 percent had more than one-half of the bole encircled by roots, and 53 percent had no more than 25 percent of the bole encircled.

Clearly most of the girdled trees did not appear to be severely girdled. This was further substantiated by evaluating and measuring crown symptoms commonly attributed to the effects of root girdling (abnormal leaf color, smaller than normal leaf size and amount of dead wood). Moreover, there was no correlation in the magnitude of these characteristics as the extent of encirclement, depth of girdling and diameter of girdling roots increased. However, the magnitude of abnormal crown characteristics and amount of dead wood was greater, though not significant, on girdled trees than on non-girdled trees (Tate 1980).

To test the belief that girdling roots are most often associated with narrow lawn extensions, extension width and distances between the bole and the sidewalk and bole and the curb were measured. The proportions of normal and girdled trees were about the same in all extensions encountered, most of which ranged 1.2 to 2.4 m wide.

Extension width *m*	Normal[z] %	Girdled[y]
0.6-1.2	1	1
1.3-1.8	61	62
1.9-2.4	33	36
2.5-3.0	5	1

[z]74 trees

[y]336 trees

Also measured were the distances between 1) the curb and the edge of the trunk facing the curb, and 2) the sidewalk and the edge of the trunk facing the sidewalk. These measurements were taken because street trees are not always planted in the center of tree lawns. Nevertheless, the proportions of normal and girdled trees were approximately the same even when the trees had been planted off-center:

Distance	Normal[z]	Girdled[y]
m	%	
Curb to trunk		
0.3-0.6	24	20
0.7-1.2	46	55
1.3-2.4	30	25
Sidewalk to trunk		
0.3-0.6	4	74
0.7-1.2	26	25
1.3-2.4	0	1

[z]74 trees

[y]336 trees

Hence, these data do not support the general assumption that trees with girdling roots are more frequently associated with narrow tree lawns or confined areas where trees have been planted close to the edge of a curb or sidewalk.

Summary and Conclusions

This study showed that thirty-five percent of the girdled trees were girdled by one root, 46 percent by 2 or 3 roots and 19 percent by 4 to 9 roots. The mean diameter of all girdling roots was 6.4 cm. Surface girdling roots had significantly larger mean diameters than subsurface girdling roots. On the average, 2.4 girdling roots were found on each girdled tree. Most of the girdling roots were subsurface, most of these were within 7.5 cm of the ground surface and did not appear to be severely girdling the trees or otherwise affecting their crown characteristics of leaf color, leaf size and foliage dieback. Moreover, there did not appear to be an association between tree lawn width and girdled trees.

Since only one tree species at one general location was examined in this study, general conclusions about girdled street and landscape trees would be premature. But arborists and especially urban tree managers who are responsible for large populations of older Norway maples should be aware of the results of this study. It may indicate that Norway maples could have a high incidence of subsurface girdling necessitating soil excavation before accurate diagnosis and subsequent treatment can be made. However, since most of the subsurface girdling roots in this study were found just below the soil surface, excavation may need only to be a depth of a few centimeters. Since most of the girdled trees were girdled by more than one root, careful examination around the entire trunk circumference may be necessary in searching for subsurface girdling roots.

Since there seems to be no association between girdled Norway maples and narrow tree lawns, other factors such as improper tree planting techniques and poor nursery practices may play important roles in causing girdling roots. The costs of excavating and treating girdling roots make careful inspection of nursery stock, proper training of employees, and supervision of tree planting activities imperative.

Literature Cited

Tate, Robert L. 1980. Detection, description and treatment of girdling roots on urban Norway maple trees. Ph.D. diss., The Univer. of Mich., Ann Arbor, Mich. 93p.

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