CROWN DENSITY AND ITS CORRELATION TO GIRDLING ROOT SYNDROME[1]

by Robert P. d'Ambrosio

Abstract. In 1983, 832 roadside trees, 690 Norway maples *(Acer platanoides)* and 142 sugar maples *(A. saccharum)* approximately 30 years old were surveyed in Eastchester and New Rochelle, N.Y. using 42 different entries per tree. Forty eight percent of these trees (400) *did not* exhibit any of the presently believed causes of girdling root syndrome (GRS), namely; planted too deeply or on raised grades, container grown or in restricted growing spaces. These trees were classified as *atypical* and divided into two groups; *atypical with* GRS 86% (343) trees and *atypical without* GRS 14% (57 trees). The 57 trees that had *no* GRS had four times the number of old wound-closure scars on their trunks and higher crowns. The results of this study suggest that early and periodical pruning of lower branches should be considered as a cultural control of GRS.

Résumé. En 1983, 832 arbres de rues soit 690 érables de Norvège (*Acer platanoides*) et 142 érables à sucre (*A. saccharum*) âgés approximativement d'une trentaine d'années ont été inventoriés à Eastchester et New Rochelle, N. Y. en prenant 42 données différentes par arbre. 48% de ces arbres (400) ne montrait aucunes des causes du syndrôme des racines étouffantes (SRE) à savoir, plantation trop profonde ou surélevée, en bac ou en espace restreint. Ces arbres ont été classifiés comme atypiques et divisés en 2 groupes: atypiques avec SRE 86% (343) des arbres et atypiques sans SRE 14% (57 arbres). Les 57 arbres qui n'ont pas de SRE avaient 4 fois le nombre de cicatrices de blessures sur leurs troncs et dans leurs couronnes. Les résultats de cette étude suggèrent qu'un élagage tôt et périodique des branches basses devrait être considéré comme une méthode culturale de contrôle de SRE.

The normal pattern of tree roots is to grow horizontal to the ground surface and radially away from the trunk (5). The main framework of a tree's root system is known as its lateral roots. Roots at their early stages of growth, grow down prior to growing radially and horizontally away from their trunk. The pattern of girdling roots (GR), however, is to grow tangent to the trunk, and in many cases, upwardly, prior to their radial and lateral growth. This condition has been termed girdling root syndrome (GRS) by the author. There are two types of girdling roots; those which occur below the root collar (Fig. 1) and those which occur at or above the root collar (Fig. 2) with the latter being the

Fig. 1. GRS below the root collar of an atypical European beech.

Fig. 2. GRS above the root collar of a Norway maple whose grade was raised by 15" approximately 15 years ago.

[1]Presented at the annual conference of the International Society of Arboriculture in San Antonio, Texas in August of 1986.

most serious. It is the tangential aspect of this abnormal root growth that causes physiological stress on the expanding tissues of the trunk that can cause partial or complete death of a tree (3, 6, 9). When the expanding trunk is restricted by a girdling root it often causes *sarcody* (Figs. 2&3), an abnormal swelling of the trunk (7). Surgical removal of a girdling root (Fig. 4), prior to irreparable stem damage, will allow a tree to return to a normal healthy condition (Figs. 5&6).

Bark tissue that has been restricted by girdling roots can be 1/30 the thickness of normal, unaffected bark (3). Some of the symptoms of girdling root syndrome are premature fall leaf color and/or premature leaf drop in part or whole, reduced leaf size, leaf scorch in part or whole, upper crown dieback, heavy seed production, lack of root buttress flare in part or whole, swelling of the trunk, patches of dying bark, reduced twig growth in part

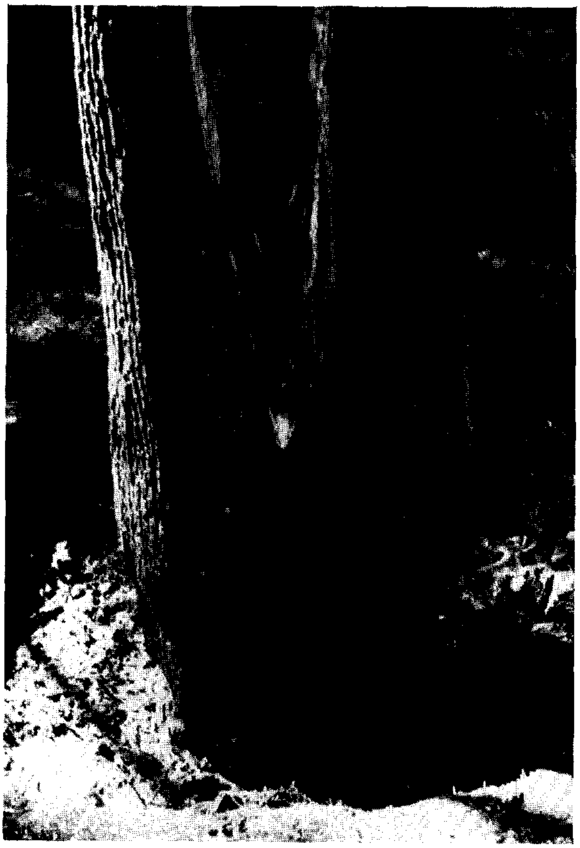

Fig. 3. Same tree as Fig. 2 after the girdling roots were removed to the depth of the *original* grade. Note the restricted stem and dying bark tissue. This tree died 5 years after surgery.

Fig. 4. Typical growth behavior of a girdling root of a sugar maple that was planted a little too deep. This tree responded favorably after the root was removed.

Fig. 5. Sugar maple exhibiting symptoms of a girdling root on its north side.

or whole and oozing areas on the trunk (6, 9).

Girdling roots have become more apparent in recent decades. One of the earliest records of girdling roots was reported in 1937 by Van Wormer (10). Girdling roots are found more often on plantation, nursery, park and lawn trees than on forest trees. Even self-seeded, open grown trees are more susceptible than forest trees. Transplanted maples, especially Norway maples, seem most prone to the problem. The history of GRS is unclear. We do not know if GRS has always been as serious a problem as it is today. Presently, there are three believed causes of GRS: 1) trees planted too deeply or on raised grade, 2) trees initially grown in containers, and 3) trees growing in very restricted growing spaces. These causes are considered *typical*. There are trees with GRS that did not originate from these 3 causes. These trees in this paper are called *atypical* and they became the target of this research.

Methods

In 1983, 832 roadside maples (690 Norway maples and 142 sugar maples) of approximately 30 years of age were surveyed in both the Huntley Farms area of Eastchester, N.Y. and the Wilmot Woods area of New Rochelle, N.Y. (Table 1). Both of these areas were post World War II housing developments.

Each tree was examined and the following data were collected: location (street address); species: girdling roots (yes or no); branch pattern (adaxial, abaxial or deliquescent); visual root buttress (yes or no); grade level (on or recessed); crown density (1, 2 or 3—3 being very dense); root restriction (0, 25, 50, 75 or 100%); nearest tree/feet (N, S, E, or W); height of trunk bifurcation (feet); sunlight on root flare (0, 25, 50, 75 or 100%); recent pruning scars (1—insignificant amount, 2—some, and 3—many and/or large); old pruning scars (1, 2 or 3—as above); planted too deeply (yes or no); percentage of root flare girdled; DBH; erosion (yes or no); crown height (low or high); and remarks.

Results and Discussion

There was no significant difference in the occurrence of GRS between Norway maples and sugar maples (Table 1). Restricted growing spaces were not associated with GRS. All of the *typical* GRS trees were associated with raised grades or were planted too deeply. Many of these trees had restricted growing spaces. Approximately 52% of the 832 trees had girdling roots of *typical* origin. Of the 400 *atypical* trees, 343 had girdling roots and 57 trees did not (Table 2).

There appeared to be differences (not statistically determined) between the two latter groups of atypical trees in crown height, trunk height, and branching pattern. All of these characteristics could be related to the presence of old pruning wounds on the lower portion of the trunk. The early removal of lower branches allowed sunlight and wind movement to dry the soil surface area at the base of the tree trunk. The data on percent sunlight on the basal portion of the trees were extrapolated and related to GRS in (Fig. 7). They lead to the conclusion that atypical

Table 1. Girdling root survey, 1983
Huntley Farms, Eastchester, N.Y.
Wilmot Woods, New Rochelle, N.Y.

Character	*Norway maples (690)*	*Sugar maples (142)*
Typical GR	370-54%	62-44%
Atypical GR	275-40%	68-48%
Atypical, no GR	45- 6%	12- 8%

Table 2. Results of girdling root survey.

Character	*Atypical No GRS (57 trees)*	*Atypical with GRS (343 trees)*
Crown Density		
sparse	0 %	0 %
moderate	19 %	5.5%
dense	81 %	94.5%
Crown Height		
low	4.5%	90 %
high	95.5%	10 %
Pruning scars		
recent	11 %	76 %
old	88 %	24 %
Trunk height		
0'- 6'	9 %	6 %
7'-14'	28 %	60 %
15'-30'	63 %	34 %
average dbh	16'6"	13'3"
Branching		
abaxial	18 %	64 %
deliquescent	82 %	36 %
Average dbh	12'8"	13'3"

Fig. 6. Same tree as Fig. 5 ten years after girdling root was removed.

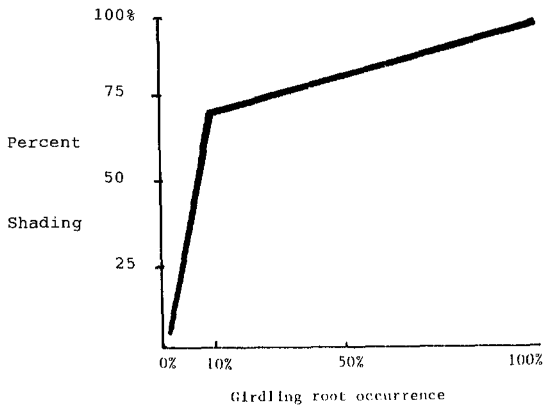

Fig. 7. Percentages of atypical maples expected to exhibit GRS under various levels of shading of their root collar zones. Estimated accuracy ±10%.

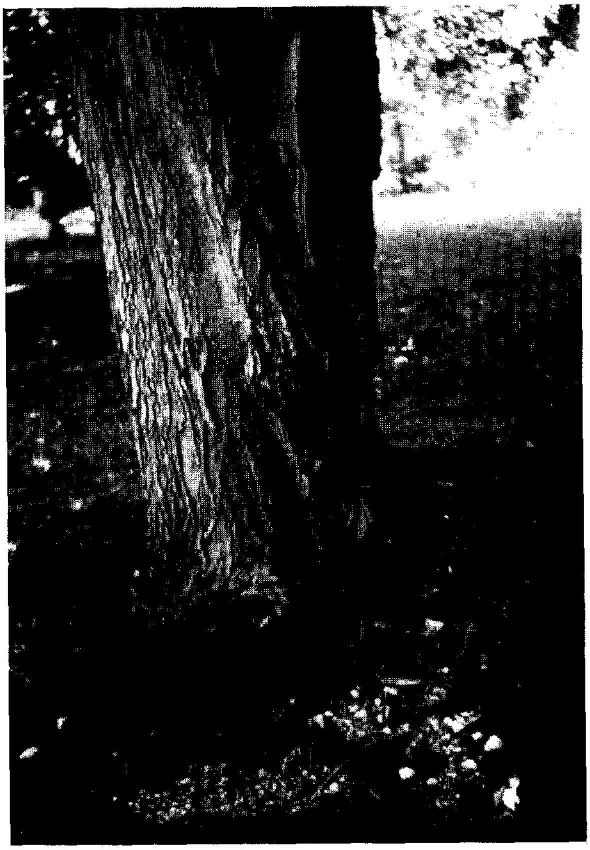

Fig. 8. The eroded soil was caused by a water trail which cascaded from a height of 15 feet. Note the girdling roots and their association with the water trail.

GRS was highest where soil conditions at the base of the tree remained cool and moist. Such conditions would favor the development of surface roots.

One other aspect of water or moisture concentration at the base of trees has seldom been considered. If we think of the tree trunk as a river and the branches as tributaries, it is obvious that during rainstorms there may be far more water running down the trunk than ever reaches the soil under the tree canopy 10 feet from the trunk. These "water trails" (Fig. 8) serve to keep the tree base cooler, moister, etc.

The hypothesis on the causal conditions of atypical girdling root syndrome deduced from this study needs further verification and experimentation, but, at the moment, appears to be worthy of consideration.

Acknowledgments. The author wishes to thank Penny Fineburg for her assistance in collecting field data and data extrapolations, along with Dr. John Skelly, Penn State University, for his enlightenment on the subject of water trails.

Literature Cited

1. Hartig, R. 1894. Textbook Of Diseased Trees. MacMillan & Co.
2. Holmes, Francis W. 1984. *Effects on maples of prolonged exposure by artifical girdling roots.* J. Arboric. 10:40-44.
3. Hudler, G.W. and M.A. Beale. 1981. *Anatomical features of girdling root injury.* J. Arboric. 7:29-32.
4. Lyer, J.G., R.B. Corey and S.A. Wilde 1980. *Mycohhrizae; facts and fallacies.* J. Arboric. 6:215-220.
5. Perry, Thomas O. 1982. *The ecology of tree roots and the practical significance thereof.* J. Arboric. 8:197-211.
6. Pirone, P.P. 1978. Tree Maintenance, pp. 219-222. Ed. 5. Oxford Univ. Press, N.Y.
7. Shaw, Kenneth. 1977. Girdling Roots. Arnoldia. 37:242-247.
8. Tate, Robert L. 1981. *Characteristics of girdling roots on urban Norway maples.* J. Arboric. 7:268-270.
9. Tattar, Terry A. 1978. Diseases of Shade Trees, pp. 233-235. Academic Press, New York, San Francisco and London.
10. Van Wormer, H.M. 1937. 13th Proceeding of the National Shade Tree Conference.
11. Wargo, Philip M. 1983. *Effects and consequences of stress on root physiology.* J. Arboric. 9:173-176.
12. Zimmerman, M.H. and Brown, C.L. 1971. Trees Structure and Form. Springer-Verlag, N.Y.

Landscape Consultant
Ambrose Laboratories Ltd.
235 Main St.
Eastchester, NY 10707

ABSTRACT

HERMS, DANIEL A. 1989. **Plants vs. herbivores: nature's arms race.** Am. Nurseryman 170(3):64-80.

There are more insect species than species of plants and all other animals combined. And about half of all insect species feed on plants. Despite these odds. An average of less than 10% of living plant tissue is consumed in natural systems by herbivores. The primary reason the world's flora can survive, even thrive, in the face of this numerical superior onslaught is that all plants are resistant to the vast majority of herbivores in their environment. A host plant's insect resistance is defined as "the relative amount of inheritable qualities possessed by the plant which influence the ultimate degree of damage done by the insect". Plants have always been subject to attack by pathogens, insects and other herbivores. In response, they have evolved many adaptations, including physical, nutritional and chemical defenses. Some have also developed relationships with other organisms that limit herbivore feeding. Many plants have developed simple physical defenses against many herbivores. Thorns and spines, foliar pubescence and tough cuticles are fine examples of physical barriers. Leaves can be protected by their pubescent trichomes. A leaf can increase in toughness throughout the course of the season. Plant tissues contain relatively low nutritional value. This is a major factor limiting the success of herbivores and an important reason why only nine of 29 orders of insects can live by feeding exclusively on higher plants. Many plants manufacture a vast array of secondary chemicals that protect them from insects, pathogens and the abiotic environment. Rather than relying on one line of defense, plants are almost always protected by a diverse combination of physical, nutritional and chemical defenses. While resistance is a combination of genetic traits, environmental factors, such as drought and soil fertility, can substantially affect the way these traits are expressed. With increasing restrictions on insecticide use, insect-resistant plants would seem to be the ideal pest-management tools.