THE EFFECT OF TRENCHING ON GROWTH AND PLANT HEALTH OF SELECTED SPECIES OF SHADE TREES

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Abstract. New telephone lines were installed in trenches throughout the campus of the University of Illinois at Urbana-Champaign in the spring of 1987. The trenches were in close proximity to tree trunks. Annual growth and mortality data were taken on *Celtis occidentalis, Liquidambar styraciflua, Acer saccharum* and *Gleditsia triacanthos* through 1991. Only 7 of 98 trees died during the trial period. Trenching distances of 0.5 to 3.3 m did not predispose the trees to readily evident disease or insect infestations. Only on *Celtis* was there statistically different growth between trenched and control trees for all growing seasons.

Shade trees contribute value and attractiveness to urban landscapes and city streets. However, disruptive activities such as street widening, trenching for utilities, grade changes or material storage (including soil) may occur resulting in damage to tree root systems. This activity may result in increased stress for trees. The majority of tree roots are concentrated in the top 1.0 meter (3 feet) of the soil and if growing in an open space, may spread at least as far as 2-3 times the height of the tree(3,6). Disturbing the soil around the tree may cause serious damage to the root system resulting in the possible decline or death of the tree.

Trenching around trees for the installation of utilities (e.g., telephone lines) can be very disruptive to root systems particularly when done within the dripline of the tree. Not only is the soil disturbed, but roots may be severed and exposed to the air resulting in possible additional injury of root tissues. Morell (4) found that trenching due to water main installation resulted in tree mortality rates of 25-44% with 100% mortality in certain cases approximately 12 years after the trenching activity had occurred. Current recommendations as proposed by BSI (2) and Watson (5) suggest a minimum distance for trenching along one side of the tree of 0.15 m (0.5 ft) for each 2.5 cm (1 in) dbh. Harris (3) and ASCA (1) recommend 0.3 m (1 ft) for each 2.5 cm (1 in) dbh. For augering along one side of a tree, Morrell (4) recommends approximately 0.3 m (1 ft) for each 2.5 cm (1 in) dbh.

In the spring 1987, fiber optic telephone lines were installed throughout the campus of the University of Illinois at Urbana-Champaign and,as a result, a number of trenches were excavated in close proximity to the trunks of various species of shade trees along the campus and city parkways. In order to examine the long term effect of trenching on certain shade tree species, a study was begun in the spring of 1987 with the following objectives: 1) to examine the long term effect of trenching on the growth and plant health of selected shade tree species particularly as it relates to the proximity of trenching to the trunk and annual incremental growth; 2) to monitor the long term effect of trenching on these shade trees and their predisposition to attack by insects and woody plant pathogens.

Materials and Methods

In the spring of 1987, prior to the initiation of plant growth, sites were selected on the University of Illinois at Urbana-Champaign campus that contained blocks of at least 9-10 trees of the same species in which trenching had occurred as a result of telephone line installation. The tree species selected for study included hackberry (*Celtis occidentalis*), sweetgum (*Liquidambar styraciflua*), sugar maple (*Acer saccharum*), and honeylocust (*Gleditsia triacanthos*). Non-trenched trees of the same species and a comparable size class, and located as near to the trenched trees as possible served as controls. During the 1987 growing season, the hackberry control trees experienced an unknown malady resulting in partial defoliation and chlorosis of the foliage. As a result, a new set of control trees within one block of the trenched trees was selected as a replacement. Therefore, there were no growth data for the hackberry control trees for the 1987 growing season. Trenches were 0.6 to 0.9 m (2-3 ft) deep and 25 to 30 cm (10-12 in) wide (Figure 1). Linear measurements were also taken from the trench to the trunk of the affected trees.

In order to evaluate the effect of trenching on these particular shade tree species, diameter at breast height (dbh) measurements (nearest 0.3 mm) were taken for both the trenched and control tree groups. A 5 cm (2 in) diameter dot of black spray paint was applied to the trunks of all trees to insure that dbh measurements from season to season were taken at a consistent height.The 1987 early spring measurements established baseline dbh values. Subsequent dbh measurements were taken each year in either the late winter or early spring following each growing season to determine annual incremental growth rate. The study was terminated following the 1991 growing season. Periodically, during each of the five growing seasons, observations were made as to insect or disease problems present and overall tree health.

Figure 1. Trenching alongside hackberry trees on the University of Illinois campus in 1987.

Weather records for the 1987-1991 growing seasons (March - October) were obtained from the Illinois State Water Survey Research Center, Champaign, Illinois. Data were analyzed using the Solo Statistical System, Version 2.0 (BMDP Statistical Software).

Results and Discussion

Overall growth effects. A summary of overall growth for trenched and control trees for the 1987-1991 growing seasons is presented in Table 1. Of the four tree species observed in this study, only hackberry showed a consistent statistically significant difference in growth between the trenched and control trees for all growing seasons (Table 1). Significant differences in growth between trenched and control trees were observed for sugar maple in1987, sweetgum in1991 and honeylocust (Site #2) in1988 and1990, but were not consistent throughout the five year study (Table 1).

Growth measurements taken in the fall of 1987, following the trenching activity in the spring revealed no significant difference in mean incremental growth rates between trenched and control trees except for sugar maple. Mean maximum temperatures were near normal for June-August and rainfall totalled 17.5 cm (6.9 in) above normal. The month of July was the sixth wettest ever recorded. During the 1988 growing season, trenched and control trees experienced reductions in growth of 44% and 50%, respectively (Table 1). The extensive drought that occurred throughout central Illinois and the north central United States may have been one of many factors responsible. The study area experienced rainfall levels 15 cm (5.9 in) below normal for March through August with June being the driest month ever recorded. In conjunction with the drought-like conditions, mean maximum temperatures were approximately 2.3 °C (5°F) above normal with June- August having the third highest recorded mean maximum temperature of 32°C, (90°F). More normal rainfall and temperature occurred during the 1989 and 1990 growing seasons. Trenched and control trees

Table 1: Mean incremental growth of four shade tree species on the campus of the University of Illinois at Urbana-Champaign, 1987-1991.

Tree species	Mean dbh[1] (cm)	Trench distance[2] (m)	Treatment	Mean incremental growth (cm)[4] 1987	1988	1989	1990	1991
Hackberry	26.2	0.5	T	1.12	0.38a	0.96a	0.69a	0.66a
	23.4	—	C	——[3]	0.74b	1.72b	1.32b	1.12b
Sweetgum	28.2	2.6	T	1.73a	0.61a	1.45a	1.83a	1.04a
	28.4	—	C	1.96a	0.91a	1.55a	1.83a	1.34b
Sugar Maple	29.5	0.9	T	0.58a	0.36a	0.94a	1.09a	0.69a
	29.0	—	C	0.91b	0.23a	0.94a	0.84a	0.74a
Honeylocust	44.9	1.8	T	0.79a	0.51a	0.83a	0.76a	0.74a
(Site #1) 47.7	—		C	1.04a	0.53a	0.74a	0.76a	0.81a
Honeylocust	36.6	3.3	T	1.12a	0.96a	0.74a	0.96a	0.51a
(Site #2) 31.8	—		C	1.04a	0.69b	0.81a	0.71b	0.69a

1. Mean dbh measurements of all four tree species for trenched and control trees taken prior to the 1987 growing season.
2. Linear distance from the center of the trunk of the affected tree to the center of the trench.
3. No data available due to the replacement of the original control set with a new control set. (Refer to Materials and Methods for details).
4. Paired treatment values for each tree species for each growing season followed by the same letter are not significantly different. ($p<0.05$; Two-Tailed T-test).

exhibited growth increases of 39% and 44%, respectively (Table 1). As in 1988, drought-like conditions again prevailed during the growing season in 1991. Rainfall levels were 18 cm (7 in) below normal for June-August. Temperatures during this same period were 4°C (9°F) above normal with 46 consecutive days with temperatures equal to or greater than 32°C (90°F). Trenched and control trees grew 27% and 10% less than in1990.

Trenching and growth effects. Results from this study indicate that reduction in growth is affected by the proximity of trenching. The greater the distance of trenching from the trunk, the less reduction in growth. Hackberry with trenching within 0.5 m (1.5 ft) of the tree trunk had an overall mean growth reduction of 45% over five consecutive growing seasons (Table 1). In contrast, sweetgum, maple, and honeylocust trees, with trenching at greater distances, had growth reductions of less than 15%. Honeylocust trees (site #2), trenched 3.3 m(11 ft) from the trunk, had a growth reduction of only 7% (Table 1).

Recommendations by the British Standards Institute (BSI) (2) and Watson (5) suggest a distance of 0.2 m (0.5 ft) for each 2.5 cm (1 in.) dbh of tree trunk when trenching along one side of a tree. Harris (3), citing work by Kimmel (1978, personal communication), and ASCA (1) specify for utility installation a minimum distance for trenchesof 0.3 m (1 ft) per 2.5 cm (1 in) dbh of trunk. Trenching on the U of I campus occurred much closer than the recommended BSI and Watson distance for the hackberry, sugar maple and honeylocust (site #1) trees. Trenching for honeylocust (site #2) trees occurred slightly beyond the minimum distance recommended by BSI and Watson. The data from this study support these minimum trenching distance recommendations since less than 15% growth reduction occurred in three of the four species examined. In addition, field observations revealed no apparent differences in the shape of the crowns of trenched trees as compared with control trees.

Tree mortality. Only seven out of 98 trees (trenched and controls) died during the course of the study for an overall mortality rate of 7.1%; five of the trees were honeylocust. Two of the trees (one hackberry and one honeylocust) were removed due to ice storm damage in the spring of 1990 and two honeylocust trees were removed due to cankers. The remaining three trees were removed for causes unknown. Six of the seven trees that died had been trenched. With the exception of the cankers on honeylocust, which may have developed due to stress, no major insect or disease problems were observed on any of the tree species throughout the five year study.

Conclusions

Results from this study indicate that as the trenching distance from the trunk increased, the impact on tree growth decreased. Trenching did not predispose trenched trees to readily evident diseases or insect infestations in spite of two growing seasons with drought-like conditions nor was there extensive mortality of any of the tree species after five years of observations. The trees adapted and survived. However, in no way do these findings minimize the importance of stress factors, such as trenching, on woody plant health and the plant's vulnerability to insect and disease infestations. It is fully recognized that other variables such as tree species, genetic differences, climate, soil conditions, and environmental effects may play a role in annual incremental growth. Further biological studies are needed to determine the relationship between these factors and overall tree growth and plant health.

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Résumé. De nouvelles lignes téléphoniques ont été installées des tranchées sur le campus de l'Université de l'Illinois à Urbana-Champaign au printemps 1987. Les tranchées étaient à proximité immédiate des troncs d'arbres. Des données sur la croissance annuelle et la mortalité ont été prises au cours de 1991 sur *Celtis occidentalis, Liquidambar styraciflua, Acer saccharum* et *Gleditsia triacanthos*. Seulement 7 des 98 arbres sont morts durant la période d'étude. Le creusage des tranchées à des distances variant de 0.5 à 3.3 mètres n'a pas prédisposé les arbres à des infestations catastrophiques d'insectes ou de maladies. Seul dans le cas du *Celtis* a-t-on noté une différence statistique de croissance pour toute la saison végétative entre les arbres où il y a eu présence de tranchées et les arbres contrôles.

Zusammenfassung. Im Frühling 1987 wurden auf dem gesamten Campus der Universität Illinois in Urbana-Champaign neue Telefonleitungen in Gräben verlegt. Diese Gräben befanden sich in unmittelbarer Nähe von Baumstämmen. Die jähr liche Wachstums und Sterberate von Celtis occidentalis, Liquidamber styraciflua, Acer saccharum und Gleditsia triacanthos für das Jahr 1991 wurde aufgenommen. Nur 7 von 98 Bäumen sterben in diesem Zeitraum. Obwohl sich die Gräben im Abstand von 0,3 bis 3,3 Metern von den Stämmen befanden, machte dies die Bäume nicht anfalligen für verhängnisvolle Krankheiten oder Insektenplagen. Nur an Celtis ergaben sich statistische Unterschiede im Wachstum zwischen den grabenumzogen Bäumen und den Kontrollbäumen während der gesamten Wachstumsperiode.