EFFECTS OF TURFGRASS AND MULCH ON THE ESTABLISHMENT AND GROWTH OF BARE-ROOT SUGAR MAPLES

by Thomas L. Green and Gary W. Watson

Abstract. Bare-root, 5-6.25 cm (2-2.5 in) diameter Green Mountain sugar maples *(Acer saccharum* 'Green Mountain') were planted with one of four treatments: 1) lawn, 2) an 2.5 m (8 ft) circle of organic mulch on the soil surface, 3) soil tilled and lawn replaced, 4) soil tilled and similar mulch applied. Mulching resulted in significant increases in diameter growth, crown development, and root development. Tilling had no effect. Landscape features around the trees, such as pavement, did have an effect on above-ground growth but not on root development. Mulching can enhance establishment of trees in a minimal maintenance landscape situation.

Résumé. Des érables à sucre 'Green Mountain' (*Acer saccharum* 'Green Mountain') de 5 à 6,25 cm (2 à 2,5 pouces) de diamètre ont été plantés à recines nues avec l'un des quatre traitements suivant: 1) pelouse 2) un cercle de 2,5 m (8 pieds) de paillis organique sur la surface du sol 3) sol ameubli et la pelouse replacée 4) sol ameubli et le même paillis organique appliqué. Le paillage a eu pour résultat des augmentations significatives de la croissance du diamètre et des développements de la cime et des racines. L'ameublissement du sol n'a pas eu d'effet. Les aménagements autour de l'arbre, tel que le pavage, ont eu un effet sur la croissance des parties hors terre mais pas sur le développement recinaire. Le paillage peut accroître l'établissement des arbres dans les situations d'aménagements à entretien minimal.

The benefits of organic mulch are well established. The beneficial effects on soil properties include moisture conservation, structure improvement, temperature moderation, and increased fertility when compared to bare soil (3, 5). The mulched soil environment is very similar to the soil environment found associated with natural forest leaf litter. This favorable soil environment, associated with the use of mulch in the landscape, results in increased top growth (4, 6) and root development (2, 11). Grass competition reduces the root development (11, 12). Reduction of top growth of woody plants is attributed to competition for soil nitrogen (1, 7) and water (3). Allelopathic properties of turfgrass have also been reported to reduce the growth of trees (9, 10).

Despite the well documented benefits of mulch and disadvantages of turfgrass around trees, lawns continue to dominate the urban landscape. Most urban soils in newly developed areas consist of a thin layer of topsoil with compacted, structureless, poorly drained, and poorly aerated subsoils. A relatively small turf-free mulched area around newly planted landscape trees could make a difference in their establishment and growth, particularly if the landscape situation does not allow for intensive maintenance.

Methods

Forty bare-root sugar maples *(Acer saccharum* 'Green Mountain') were planted in the fall of 1981. The planting hole was dug with a 1 m (36 in) diameter auger. The trees were 5-6.25 cm (2-2.5 in) diameter bare-root stock at the time of planting. They were planted in a typical parkway with compacted clay subsoil disturbed by construction activity, with approximately 5-7.5 cm (2-3 in) of topsoil. After planting, the planting hole circle was free of turf. Trees were planted in a single line 2.5 m (8 ft) from the curb. Little, if any, supplemental maintenance or watering was performed after planting.

The experimental design was a 2 × 2 factorial with four treatments. The forty trees were divided into 10 blocks of four trees, with one replication of each treatment in each block.

Treatments were: 1) Sod laid in the bare soil area to the base of the trunk (this treatment represents the "typical" urban landscape tree); 2) Five cm (2 in) each of composted leaves and wood chips applied to the soil surface to a distance of 1.2 m (4 ft) from the trunk; 3) soil tilled with a rototiller outside the planting hole and within a 1.2 m (4 ft) radius of the trunk with sod laid over the tilled area and the planting hole; 4) soil tilled as in treatment 3 and mulch applied as in treatment 2.

Final growth measurements were taken after the 1986 growing season. Diameter measurements were taken 15 cm (6 in) above the ground at the time of planting and again in 1986. Four root samples were taken from each tree in the form of a 7 cm (2.75 in) diameter, 15 cm (6 in) long core divided into three equal parts. Tree root densities were determined by measuring the surface area of fine roots (>3 mm [1/8 in] diameter) with a Delta-T Area Meter after removing the soil and grass roots. Crown development was compared by photographing the trees under standardized conditions and measuring the surface area of the tree silhouettes on photographic prints with the Delta-T Area Meter.

Statistical procedures were performed using the SOLO Statistical System Version 2.0. Analysis of variance (ANOVA) was used to study the effect of treatments and blocks. Separation of means was by the Duncan's Multiple Range procedure with significance at 5 percent (0.05).

Results and Discussion

Survival was good for all treatments. Five of the forty trees failed to establish, but treatment was not considered a factor in survival. Mulched trees were observed to be larger, greener, and less stressed (as judged by leaf scorch) than trees without the turf-free mulch circle. Crown development comparisons showed a signficant increase in size as a result of the mulch treatment (Figures 1 and 2, Table 1). Crowns of mulched trees were almost twice as large as unmulched trees. Tilling had no effect.

Diameter increases were signficantly greater for mulched trees (Table 1, Figure 2). The diameter increase of the mulched trees was approximately three times that of the trees surrounded by turf. Tilling had no effect on diameter growth, whether associated with the mulch or turf treatments.

Though all trees were exposed on one side to the harsh environment caused by pavement, the environment on the opposite side varied. Those at the west end of the planting (block 1) had pavement on both sides. Those at the other end had a grassy area and trees on the opposite side, and the transition in between was gradual. Analysis of diameter increase and crown development by block reflects this gradual change in environment (Figure 3).

Root development was influenced by turf or mulch treatment but not by tilling (Table 1, Figure 4). Mulch treatment root densities were significantly higher. In the natural forest environment fine root development is nearly always best near the soil surface and decreases with depth (8). The root density profile of the mulch treatment exhibits this natural pattern. Root development in the upper 5 cm of soil of the tilled and mulched plot was not as good. There is no clear reason why the initial tilling would have reduced root development. Root samples tend to be highly variable, especially in disturbed soils, and the unexpected low density is probably attributable to this variability.

Turf nearly completely excluded tree roots in the top 5 cm (2 in) of soil, with as much as a 15-

Table 1. The effects of mulch, lawn, and tilling treatments on the growth of bare-root landscape trees.

	Root density at soil depth (mm^2 surface/150 cm^2 soil)				*Diameter*	*Crown*
Treatment	*0-5 cm*	*5-10 cm*	*10-15 cm*	*Total*	*increase (cm)*	*devel.**
1. Lawn	*41.8a***	*161.6a*	*203.7a*	*407.1a*	*0.96a*	*0.920a*
2. Mulch	*634.6b*	*535.8b*	*418.0b*	*1588.4b*	*2.54b*	*1.504b*
3. Lawn & till	*46.2a*	*177.7a*	*206.3a*	*430.2*	*0.60a*	*0.767a*
4. Mulch & till	*251.7ab*	*410.3b*	*415.8b*	*1077.8b*	*2.31b*	*1.362b*

**Relative surface area of the silhouette*

***Values in each column with the same letter are not significantly different at the 5 percent level (P=0.05).*

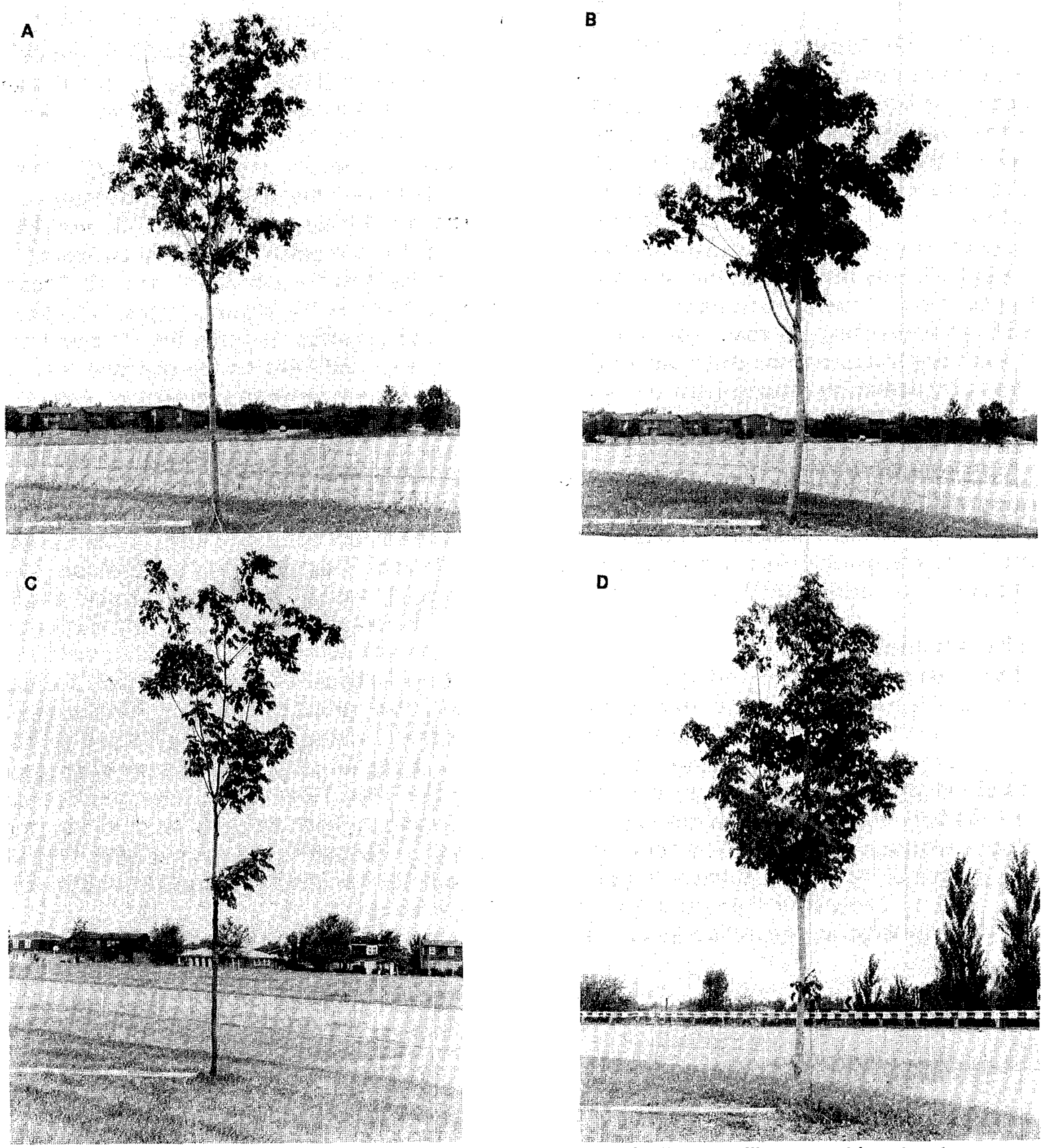

Figure 1. Typical trees from each treatment: A) Lawn over entire root zone; B) 2.5 m (8 ft) diameter mulched circle; C) 2.5 m (8 ft) diameter tilled area with turf replaced. D) 2.5 m (8 ft) diameter tilled area with mulch.

fold difference between the mulch and turf treatments. Root density differences between turf and mulch treatments were also significant at the 5-10 cm (2-4 in) and 10-15 cm (4-6 in) soil depths, though the contrast was not as extreme. It is clear that elimination of lawn and addition of mulch enhances root development and contributes to rapid recovery and vigorous growth of transplanted trees.

The effectiveness of the tilling treatment was disappointing. Though tilling probably reduced compaction and increased porosity temporarily, over time the structureless soil was not able to sustain these improvements. Even high-quality garden soils must be tilled regularly, and perhaps it is not surprising that a single tilling of this clay

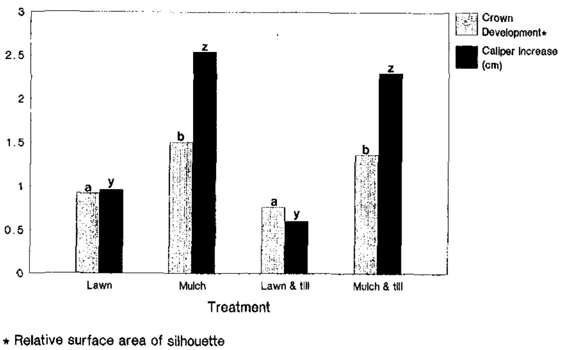

Figure 2. Comparison of lawn, mulch, and till treatments on crown development and caliper increase for four growing seasons. Values with the same letter are not significantly different at the 5 percent level.

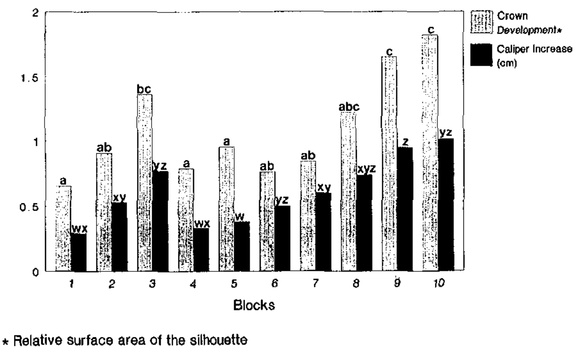

Figure 3. The influence of block (i.e. location and landscape features) on crown development and caliper increase. Values with the same letter are not significantly different at the 5 percent level.

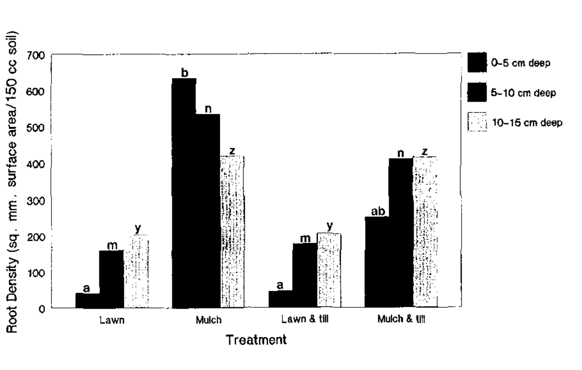

Figure 4. Comparison of lawn, mulch, and till treatments on root density at three depths. Values with the same letter are not significantly different at the 5 percent level.

soil did not affect growth or root development. Incorporation of organic matter, or some other material, to improve aggregation may have produced better results.

There were no significant differences in root density attributed to blocks. The underground environment is resistant to rapid changes and would not be easily influenced by pavement and other above-ground factors. Disturbed soils along roads can be highly variable, but in this case the soil was apparently consistent and caused no differences in root development.

Conclusion

The negative effect of turf on tree growth has been well documented for forest trees and fruit trees. However, the landscape industry has been slower to respond to this knowledge. It is difficult to overcome the common expectations of landscapes with manicured lawns right up to the base of every tree. This presents a challenge to landscape designers to make attractive landscapes without grass around trees. Where plain mulch is not acceptable, plantings of shrubs and perennial groundcovers would be a less competitive alternative to lawns.

The mulch will also help prevent lawnmower injury, which is a most serious problem of newly planted trees. Mulch must be used correctly. Mulch piled up against the trunk can cause damage. Maintenance personnel will have to learn how to control weeds growing in the mulch, mechanically or chemically, without harming the landscape plants.

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SUPRAOPTIMAL ROOT-ZONE TEMPERATURE ALTERS GROWTH AND PHOTOSYNTHESIS OF HOLLY AND ELM

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Abstract. Effects of root-zone temperatures (28°, 35° and 42°C; 6 hrs/day for 12 weeks) on container-grown 'East Palatka' holly *(Ilex x attenuata* 'East Palatka') and 'Drake' elm *(Ulmus parvifolia* 'Drake') were determined under growth-room conditions. Survival rate of elm was decreased by 50% after 12 weeks of daily exposure to 42°C. Temperature did not affect shoot to root ratios of either genus. However, dry weights of holly shoots and roots and elm roots decreased quadratically, and elm shoots decreased linearly with increased temperature. Time trend analysis for holly and elm shoot extension, leaf carbon exchange rates (CER), and stomatal conductance (Cs) revealed reductions at 42°C compared to 35° and 28°C for both genera. Results demonstrate the need for tree growers to execute cultural practices directed at minimizing exposure of tree roots to temperatures at or above 42°C.

Additional key words. *heat stress, Ulmus parvifolia 'Drake', Ilex x attenuata 'East Palatka'*

Résumé. Les effets de la température (28°C, 35°C et 42°; 6 heures/jour durant 12 semaines) sur la zone racinaire dans des godets de houx "East Palatka" (*Ilex X attenuata* 'East Palatka') et d'orme de Chine "Drake" (*Ulmus parvifolia* 'Drake') ont été déterminés dans les conditions d'une chambre de croissance. Le taux de survie de l'orme a chuté de 50% après 12 semaines d'exposition journalière à 42°C. La température n'a pas affecté les ratios pousses-racines des deux genres. Cependant, le poids sec des pousses et racines du houx et les racines de l'orme diminuent de la racine carrée et les pousses d'ormes diminuent linéairement avec la diminution de la température. Des analyses du comportement dans le temps pour la pousse du houx et de l'orme, du taux d'échange de carbone des fuilles (CER), et la conduction stomatale (Cs) ont révélé des réductions à 42°C comparé à 35°C et 28°C pour les deux genres. Les résultats démontrent que les producteurs ont avantage à exécuter les pratiques culturales en minimisant l'exposition des racines à des températures inférieures ou égales à 42°C.

Temperature is a major factor affecting plant growth. Although surface soil temperatures have been observed to surpass critical limits resulting in physiological disorders such as "strangulation sickness" in pine seedlings (12), the outstanding examples of high temperature exposure to root systems are in nursery container media exposed to direct solar radiation. Average medium temperatures during the summer may exceed 40°C for up to 6 HR daily (6), and a mean maximum temperature of 58°C has been recorded on the western exposure (15).

Elevated root-zone temperature below a critical killing threshold can alter plant source-sink rela-

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