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CONTENTS

Abstract. Background: As long-lived organisms, urban trees often encounter development and redevelopment activities during their lifespans. These activities can damage tree roots, often through methods like root severing during trenching or excavation. Methods: In 2017, we simulated trenching damage on mature *Quercus virginiana* Mill. trees at 3 different distances from the base (3, 6, or 12 times the stem diameter). After 5 years, we revisited these trees to assess root regrowth based on the cut root's cross-sectional area (CSA) and distance from the base. Results: We observed regrowth in all but 38 (6.7%) of the 557 cut roots revisited. The lack of regrowth in some roots was not associated with our original treatments, the CSA of the roots at the time of trenching, or distance between the cut root end and the trunk (minimum *P*-value = 0.841). On average, the observed CSA of the regrowth was 22.2% of the original root's CSA. Only our initial trenching treatments (*P*-value = 0.024) and the distance between the trunk and the cut root end (*P*-value = 0.002) significantly predicted the level of regrowth observed 5 years after pruning. Conclusions: In summary, our findings indicate that root systems require many years to recover from trenching damage. Increasing the distance between trenching activities and trees may have a minor effect on root regrowth.

Keywords. Best Management Practices; Construction; Root Growth; Root Severing; Southern Live Oak; Tree Protection.

Abstract. When considering the establishment of tree protection zones in construction, or in assessing relative damage to a tree for risk or penalty, it would be useful to have a method to predict total root area at some distance from the tree. With such a method, the arborist can assess the level of damage in comparison to some estimate of the total rather than from a loss of possible root zone space based on land area. We used a modification of the pipe model approach to estimate the root cross-sectional area at different distances from the tree as defined by the edge and center of the trunk. We discuss two early studies. The first considers root systems excavated from a limited set of 9 trees over 50 years post-establishment across 3 species. Trees were excavated and roots harvested, cataloged, and imaged for measurement at 1, 2 and 3 meters from the trunk edge of the respective tree. The second study considered 29 digitally mapped root systems of *Fraxinus pennsylvanica* 'Patmore' 9 years post-transplant by developing code for a virtual dissection at specific distances from the tree trunk. The second study observed variability across a tightly defined set of trees. There was a weak relationship between root area at set distances by species, and we found 3 m was a useful distance in the first study. We have a long way to go in development before having a method as a tool for practice, but the approach may be useful with additional observation and study.

Keywords. Construction; Damage; Protection; Risk.

Abstract. Background: Urban trees provide many environmental benefits but often face challenging growing conditions like waterlogged soils. How tree root systems respond to waterlogging impacts tree performance and survival, yet this has received little attention. Our goal was to identify how the roots of temperate urban tree species respond and recover to waterlogging. Methods: We monitored the responses and recovery of 2 contrasting maple and magnolia species pairs that differ in their reported waterlogging tolerance to a 2-week waterlogging period,

measuring belowground stress indicators, fine-root mortality, and aboveground responses including leaf-level photosynthesis, leaf loss, and stem growth. Results: Though silver maple experienced a temporary reduction in photosynthetic activity during waterlogging, it exhibited no fine-root mortality, and photosynthetic activity recovered after a 10-day recovery period. In contrast, sugar maple showed high fine-root mortality, decreased photosynthetic activity, and significant leaf loss, with no recovery in fine-root growth or photosynthetic activity after the recovery period. Both magnolia species showed high fine-root mortality and reduced photosynthesis during the waterlogging period. However, after the 10-day recovery period, both magnolias also showed new fine-root growth and increased photosynthetic activity. Conclusion: The species studied here showed a wide range of fine-root response and recovery strategies to waterlogging, and this was mirrored in their aboveground performance. Future work clarifying the mechanisms driving these different strategies, such as silver maple's ability to maintain fine roots and mitigate internal tissue damage, will help us to further understand species differences in waterlogging tolerance and better inform urban tree selection for repeatedly flooded soils.

Keywords. Anoxic; Flooding; Photosynthesis; Root Trait; Tree Selection; Urban Tree.

Abstract. The demand for saplings has risen in recent years as a consequence of massive planting campaigns targeted at increasing canopy cover. To test the hypothesis that seaweed extract can improve root biomass and length, an experiment was carried out at the ERSAF Regional Forest Nursery in Curno, Italy. The seeds of 5 woody species were planted in trays using a substrate amended with 0×, 1×, 2×, or 3× the label dose of a pure *Ascophyllum nodosum* extract. After germination, 6,400 seedlings were arranged according to a randomized complete block design with 10 blocks. After 1 growing season, plants were transplanted into 1.7-dm^3 forest containers for 1 additional growing season. Root, stem, and leaf dry weights, total leaf area, total root length, and specific root length were measured over an 80-week period. Leaf gas exchange and greenness index were monitored for 78 weeks using an infrared gas analyser and a SPAD meter. Species differed for growth rate, biomass allocation to roots, and specific root length. The algal biostimulant increased stem and whole plant dry weights for 1 year only when applied at 3x the label dose. Significant effects on leaf gas exchange were found only at the highest dose and were mostly due to higher leaf greenness index than to lower diffusional limitations to photosynthesis. Results suggest that substrate amendment with *Ascophyllum* extracts may have short term positive effects on plant growth, likely due to a nutritional boost. However, they did not trigger structural changes in plant traits that can enhance transplant tolerance in the long run.

Keywords. *Ascophyllum nodosum*; Leaf Gas Exchange; Plant Production; Root Line Intersect Method.

Abstract. Background: Mature oaks across Northeastern Illinois declined unusually rapidly, and many died, starting in 2019 and 2020. Investigation into the cause was initiated in 2021. In the absence of signs of disease or insect infestations aboveground, site soil characteristics and precipitation history that could facilitate root problems were investigated. Methods: Eighteen sites with rapidly declining oaks were identified. Root samples were collected and tested for the presence of *Phytophthora* spp. using DAS-ELISA. An investigation of soil conditions was conducted on one of the sites with declining and healthy trees growing on lower and slightly elevated ground, respectively. Results: DAS-ELISA results were positive in 87% of the samples. All sites had fine textured soils classified as moderately to poorly drained, with high spring water tables. Topography was always very flat. The water table was near the surface for most of the spring on poorly drained sites with declining trees, and significantly higher than in the slightly elevated sites with better drainage and healthy trees. From 2018 to 2020, the region experienced the highest average spring rainfall for any 3 consecutive years in the last 70 years. This created soil conditions conducive to root disease development. Conclusions: Predominantly positive ELISA results on fine roots indicated that *Phytophthora* species are present in root systems when growing in moderately to poorly drained, fine textured soils across the Chicago region. The consecutive years of above-normal rainfall and poor soil drainage appears to have facilitated the development of root disease leading to rapid decline of oaks in the region.

Keywords. *Quercus* spp.; Root Rot; Waterlogged Soil.

Abstract. Background: Paclobutrazol (PBZ) is used in the arboriculture industry to reduce the growth of trees. It works by inhibiting gibberellin biosynthesis, a group of phytohormones associated with cell elongation. A substantial amount of variation exists within the literature as to the impact of PBZ on woody plant root systems. The purpose of this study was to assess the impact of PBZ on belowground growth and biomass allocation among plant species with varying levels of PBZ sensitivity in a controlled setting. Methods: We treated containerized silver maple, white oak, pecan, laurel oak, and stone pine trees with Cambistat® at the full label rate, one category lower, two categories lower, or

water-only controls. After a 14-month incubation period, leaf, stem, and root tissue dry mass were quantified, root:shoot ratios were calculated, the length of the longest root quantified, and total root length of a subset of replicates was estimated. Species were statistically analyzed separately and collectively to assess trends. Results: Paclobutrazol application resulted in significantly lower root dry mass and total root length for all species analyzed, and significantly reduced longest root length of all species except for silver maple. Across species and dosage combinations, we saw few dose effects on any response variable and no major trends in root:shoot ratios. Conclusion: The impact of PBZ on trees in the landscape appears to be influenced by a number of factors, but we observed relatively consistent results on belowground biomass when growing conditions were uniform in our controlled experiment.

Keywords. Anti-Gibberellin; Growth Reduction; Paclobutrazol; Plant Growth Regulators; Root Growth.

Abstract. The expansion of the use of induced resistance (IR) has been, and remains, an attractive prospect for the management of woody plants, but little research has occurred assessing the ability of elicitors to induce the root defenses of woody plants. Eastern white pine (*Pinus strobus*) was used as a model plant to assess IR elicitation. Containerized plants were treated with phosphite (Phi), chitosan, curdlan (a β-1,3-glucan polymer), or silicon (Si) on 2022 June 7. The soluble phenolic levels, tissue levels of major resin acids (abietic and neoabietic), as well as the activities of peroxidase (POX), chitinase (CHI), and β-1,3-glucanase (βGLU) of fine roots were compared across elicitor treatments and nontreated controls on June 10, June 14, and June 27. There were no changes post-treatment to soluble phenolics or resin acids at any sampling point, but chitosan treatment resulted in an increase in POX and CHI activities, while curdlan increased CHI activity on June 10. On June 14, curdlan-treated plants had significantly higher POX and CHI activities, while Phi-treated plants had significantly higher POX activity. By June 27, curdlan- and Phi-treated trees had significantly higher CHI activities. Our data suggest that chitosan, curdlan, and phosphite stimulate biochemical responses and potentially prime root systems to respond to subsequent stresses, but there appears to be variation between these elicitors regarding rapid versus longer lasting IR effects.

Keywords. Defense Elicitors; Defense Induction; Induced Resistance; Pest Management; Root Defenses.

Abstract. Background: Urban trees are commonly impacted by construction activities. Often, damage occurs below ground, as trenching, grading, and excavation activities disrupt tree root systems. Methods: In this study, 30 *Acer rubrum* L. were intentionally damaged by simulated trenching treatments. Treatments were randomly assigned at 1× (n = 10), 3× (n = 10), or 5× (n = 10) stem diameter away from the base of the tree. Root systems and severed roots were excavated, cleaned, and digitized using photogrammetry to assess losses in root volume. This measure, as well as changes in bending stress, were compared among the 3 treatments. Results: The 1× and 3× treatments exhibited the highest bending stress loss (%), correlating with the highest observed root loss. A positive relationship was noted between root volume loss and bending stress reduction (r^2 = 0.5466). Conclusions: These results support previous studies that utilized similar trenching treatments on different tree species.

Keywords. Construction; Photogrammetry; Tree Biomechanics; Tree Preservation; Tree Protection.