

ARBORICULTURAL ABSTRACTS

ASSESSMENT OF SEVERITY OF POWDERY MILDEW INFECTION OF SWEET CHERRY LEAVES BY DIGITAL IMAGE ANALYSIS

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A personal-computer-based method was compared with standard visual assessment for quantifying colonization of sweet cherry (*Prunus avium* L.) leaves by powdery mildew (PM) caused by *Podosphaera clandestina* (Wallr.:Fr.) Lev. Leaf disks from 14 cultivars were rated for PM severity (percentage of leaf area colonized) by three methods: 1) visual assessment, 2) digital image analysis, and 3) digital image analysis after painting PM colonies on the leaf disk. The third technique, in which PM colonies on each leaf disk were observed using a dissecting microscope and subsequently covered with white enamel paint, provided a standard for comparison of the first two methods. A digital image file for each leaf disk was created using a digital flatbed scanner. Image analysis was performed with a commercially available software package, which did not adequately detect slight differences in color between PM and sweet cherry leaf tissue. Consequently, two replicated experiments revealed a low correlation between PM image analysis and painted PM image analysis ($r^2 = 0.66$ and 0.46 , $P \leq 0.0001$), whereas visual assessment was highly correlated with painted PM image analysis ($r^2 = 0.88$ and 0.95 , $P \leq 0.0001$). Rank orders of the 14 cultivars differed significantly ($P \leq 0.05$) when PM image analysis and painted PM image analysis were compared; however, rankings by visual assessment were not significantly different ($P > 0.05$) from those by painted PM image analysis. Thus, standard visual assessment is an accurate method for estimating disease severity in a leaf disk resistance assay for sweet cherry PM. (HortScience 2001. 36(1):107111)

EFFECT OF RECLAIMED WASTEWATER ON THE GROWTH AND NUTRIENT CONTENT OF THREE LANDSCAPE SHRUBS

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An experiment was set up to determine the effects of treated municipal wastewater irrigation and fertilization on growth, leaf morphological characteristics, chlorophyll content, and ion uptake of three container-grown landscape shrubs characterized by different growth habits (*Abutilon* 'Kentish Belle', *Viburnum tinus* 'French White', *Weigelia florida* 'Bouquet Rose'). The study was conducted in Tuscany (central Italy) in a typical landscape plant production area. One hundred plants per species were watered with treated sewage effluent from the nearby wastewater treatment facility (RW) and 100 with well water after ponding (WW) from the nursery where the research plots were located. Fifty plants per species and within each irrigation treatment received controlled-release fertilizer application at transplant and 50 received no fertilization. The experiment showed no major limitations to the use of sprinkle-irrigated wastewater for container-grown landscape plant production and a general, positive influence on growth of the plants. However, the species under observation showed a different behavior in response to the effluent irrigation for all the parameters considered. *Weigelia* was the most responsive and *Abutilon* the least. The influence of fertilizer addition at transplanting was less evident and the combined effect of RW and fertilization was rarely found and seemed to be species-specific. (J. Environ. Hortic. 2000. 18(2):108-114)

CARBON ASSIMILATION AND
NITROGEN IN NEEDLES OF FERTILIZED
AND UNFERTILIZED FIELD-GROWN
SCOTS PINE AT NATURAL AND
ELEVATED CONCENTRATIONS OF CO₂
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Effects of elevated CO₂ concentration on carbon assimilation and needle biochemistry of fertilized and unfertilized 25- to 30-year-old Scots pine (*Pinus sylvestris* L.) trees were studied in a branch bag experiment set up in a naturally regenerated stand. In each tree, one branch was enclosed in a bag supplied with ambient CO₂ (360 μmol mol⁻¹), a second branch was enclosed in a bag supplied with elevated CO₂ (680 μmol mol⁻¹), and a control branch was left unbagged. The CO₂ treatments were applied from April 15 to September 15, starting in 1993 for unfertilized trees and in 1994 for fertilized trees, which were treated with N in June 1994. Net photosynthesis, amount and activity of Rubisco, N, starch, C:N ratio, and surface leaf area of needles were measured during the growing season of 1995. Light-saturated net photosynthetic rates of 1-year-old and current-year shoots measured at ambient CO₂ were not affected by growth CO₂ or N fertilization. Elevated CO₂ reduced the amount and activity of Rubisco, and the relative proportion of Rubisco to soluble proteins and N in needles of unfertilized trees. Elevated CO₂ also reduced the chlorophyll concentration (fresh weight basis) of needles of unfertilized trees. Soluble protein concentration of needles was not affected by growth CO₂. Elevated CO₂ decreased the Rubisco:chlorophyll ratio in unfertilized and fertilized trees. Starch concentration was significantly increased at elevated CO₂ only in 1-year-old needles of fertilized trees. Elevated CO₂ reduced needle N concentration on a dry weight or structural basis (dry weight minus starch) in unfertilized trees, resulting in an increase in needle C:N ratio. Fertilization had no effect on soluble protein, chlorophyll, Rubisco, or N concentration of needles. The decrease in the relative proportions of Rubisco and N concentration in needles of unfertilized trees at elevated CO₂ indicates reallocation of N resources away from Rubisco to nonphotosynthetic processes in other plant parts. Acclimation occurred in a single branch exposed to high CO₂, despite the large sink of the tree. The responses of 1-year-old and current-year needles to elevation of growth CO₂ were similar. (*Tree Physiol.* 2000. 20:881–892)

OCCURRENCE OF TREE ROOTS IN
DANISH MUNICIPAL SEWER SYSTEMS
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The occurrence of tree roots in Danish municipal sewer systems was studied via a survey sent to all Danish cities. It consisted of 28 questions focusing on the following three areas: 1) statistical information on the municipal sewer systems, 2) degree of root intrusion into sewer systems, and 3) municipal planning procedures in relation to root intrusions in sewer systems. In general, Danish cities do not perceive root intrusion as a major problem. Root intrusion occurred in both main and combined pipes; it was most severe in service connection pipes. Typically, the problem occurred within 6 m of a tree. The problem is believed to be especially common in residential areas, with species of willow (*Salix* spp.), poplar (*Populus* spp.) and birch (*Betula* spp.) reported as the most commonly troublesome. Root intrusion primarily occurred in pipe systems laid before 1979 but can also occur in post-1979 systems. Problems in newer systems are most common in concrete pipes and in joints between two pipes. Closed-circuit television inspection (CCTV) is used as a preventative tool and in emergency situations of root intrusions. Roots were removed from an average of approximately 1.1 km (±1.4 km) of piping per year per city. Costs were separated into two different categories: 1) costs related to root removal, and 2) costs associated with pipe replacement or renewal due to roots. In total, the annual expense per capita was \$1.73. Based on small, medium, and large cities (< 16,000 inhabitants, 16,000–50,000, and > 50,000 inhabitants, respectively), the costs per capita tended to be higher in medium-sized cities (\$2.19) than in small (\$1.69) or large cities (\$1.31). Total expenses were approximately \$9 M per year (not including the cost of CCTV). Per city root removal costs averaged \$6,530 (±\$11,777) per year and ranged from \$0 to \$65,000 per city per year. However, 83% of all cities had costs of only \$2,521 (±\$2,179) per year, whereas the remaining 17% had costs of \$27,143 (±\$18,576) per year. Costs related to pipe replacement or renewal due to root intrusion averaged \$38,824 (±\$57.37) per year and ranged from \$0 to \$266,666 per city per year. (*Arboric. J.* 2000. 24:283–306)

THE URBAN FOREST OF TOKYO

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The urban forest of the Tokyo metropolitan area was examined through the review of agencies' reports, academic publications, discussions with urban forest managers, and a reconnaissance of urban vegetation in Tokyo. This analysis showed the Tokyo metropolitan area has 420,564 street trees planted along 2,712 km of streets and about 1.5 million trees occur in 4,177 ha of urban parks in Tokyo. Some 14% of the urbanized portion of the Tokyo metropolitan area is in tree or other types of urban vegetation cover. Commonly observed street and park tree include ginkgo (*Ginkgo biloba* L.), oriental plane (*Platanus orientalis* L.), trident maple (*Acer buergerianum* Miq.), flowering dogwood (*Cornus florida* L.), yoshino cherry (*Prunus yedoensis* Matsum.), Japanese zelkova (*Zelkova serrata* Makino), Japanese pagoda tree (*Sophora japonica* L.), camphor trees (*Cinnamomum camphora* Sieb.), Japanese tanoak (*Lithocarpus edulis* Nakai), and Japanese wax myrtle (*Myrica rubra* Sieb. et Zucc.). The Japan Greenery Research and Development Center Foundation, established in 1973, had provided valuable leadership to the overall management of the urban forest in the Tokyo metropolitan area. Curtailments in annual street tree planting, pruning, and inventories are being considered to meet the budget crisis. (*Arboric. J.* 2000. 23:379–392)

BASIC BIOMECHANICS OF SELF-SUPPORTING PLANTS: WIND LOADS AND GRAVITATIONAL LOADS ON A NORWAY SPRUCE TREE

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Mechanical constraints are major determinants of size and shape of self-supporting plants; for instance, upright stems will become mechanically unstable due to their own weight if too slender (Euler buckling). Both gravitational forces and wind loads induce bending

moments that the structure has to be able to withstand. The computation of gravitational loads on side branches and stems leaning to various degrees is straightforward, provided that the geometrical parameters (such as their tapering mode and the number and size of primary and secondary branches) are known. The limit of the structure is reached if at any point the bending moment induced is larger than the critical bending moment. This in turn depends on structural parameters (the geometry of the cross section) and properties of the material (the modulus of elasticity and the critical stresses at which failure occurs). In many cases, depending on the root–soil interaction, the bending moment on the trunk may lead to root lodging. Most important from an economic point of view is the assessment of wind loads. It requires an estimate of the effective sail-area (which due to the flexibility of the branches depends on the wind speed), the drag coefficient, and, particularly, the knowledge of the wind profile, which may be different for a solitary tree than for a tree within a dense stand. Flexibility combined with viscoelastic behavior is the plant's answer to dynamic wind loads. Although our comprehension may still seem fragmentary, one general conclusion emerges from a comparison of biomechanical calculations with empirical data: plants are often structured in such a way that they approach their biomechanical limits within controlled safety margins. This safety factor applies to "normal" environmental loads, either gravitational loads or wind loads, and may be overruled by excessive snow loads or by extreme winds such as hurricanes. For a biologist, it is a challenge to trace the "principle of constant safety factors" to adaptive growth as response to mechanical stimuli. The phenomenon has been demonstrated qualitatively, but neither the mechanoreceptor nor the signal transduction chain has as yet been identified. (*For. Ecol. Manage.* 2000. 135:33–44)