# TREES ARE GOOD, BUT...

**Proximity to trees and urban greenspace has been correlated with numerous indicators of positive physical and mental health. For instance, a recent study found that the likelihood of children walking or biking to school increased with a greater number of street trees (Larsen et al. 2009).**

**By E. Gregory McPherson and Francesco Ferrini**

We know that "trees are good," and most people believe this to be true. But if this is so, why are so many trees neglected, and so many tree wells empty? An individual's attitude toward trees may result from their firsthand encounters with specific trees. Understanding how attitudes about trees are shaped, particularly aversion to trees, is critical to the business of sustaining healthy urban forests. Social scientists can play a large role by helping us understand the complex origins and impacts of tree antipathy. For example, attitudes about trees can be influenced by socio-cultural factors (e.g., trees keep witches away), hereditary traits (e.g., allergies), and chance experiences (e.g., trip and fall). Physical scientists can play a role by further clarifying relations between the trees we plant, their management, and human health and well-being.

Truthful and accurate information about trees is important to trustworthy communication. Science and research can provide credible information you can use to knowledgably plan and manage trees. We provide a few examples in this article.

## Trees Are Good . . . but they use too much water

Nearly every tree requires supplementary irrigation, if only to aid establishment. Once established, the duration and amount of water required depend on tree species, size, and site. Selecting species with minimal irrigation requirements not only saves water, but promotes survival in times of drought. Soil management, mulching, and efficient irrigation help ensure water isn't wasted. Perhaps the most important point is what a tree does with the water it receives.

For example, a controlled experiment in two courtyards compared the "cooling efficiency" of trees, grass, and overhead mesh in a hot dry climate (Shashua-Bar et al. 2009). Shade trees, in this case *Prosopis juliflora* and *Tipuana tipu*, provided the highest cooling efficiency (57 percent), measured as the relative air temperature cooling obtained from evaporating a given amount of water. The combination of shade trees over grass had an efficiency of 20 percent, while grass alone was only three percent efficient. This study indicates trees provide the most efficient means of reducing outdoor air temperature in hot urban environments by far, as measured by water consumption. Cooler air temperatures improve human comfort, reduce air conditioning demand, and lower ozone concentrations, all of which help to make our cities more livable. Climate variability has resulted in recent heat waves that have resulted in numerous deaths. Increasing trees and greenspace can promote a greater sense of well-being during heat waves, as well as reduce morbidity from such events (LaFortezza et al. 2009).

## Trees Are Good . . . but they pollute the air

Most trees emit biogenic volatile organic compounds (BVOCs) such as isoprenes and monoterpenes that can contribute to ozone ($O_3$) formation, with the potential adverse affect differing considerably for different tree species (Benjamin and Winer 1998). Also, contributing BVOC emissions from city trees to $O_3$ formation depends on complex geographic and atmospheric interactions.

For example, increased planting of low BVOC-emitting tree species would reduce $O_3$ concentrations in the Los Angeles basin, whereas planting of medium and high emitters would increase overall $O_3$ concentrations (Taha 1996). A study in the northeastern United States, however, found that species mix had no detectable effects on $O_3$ concentrations (Nowak et al. 2000). Although new trees increased BVOC emissions, ambient VOC emissions were so high that additional BVOCs had little effect on air quality. Continuing research demonstrates BVOCs could protect plants against high temperatures (Peñuelas and Lluisà 2003). BVOC emissions will probably increase as urban heat islands grow due to changing land cover. These increases in BVOC emissions could contribute in a significant way (via negative and positive feedback) to the complex processes associated with global climate change, but on this subject there are still many unanswered questions (Dicke and Loreto 2010).

The tree species with the highest isoprene emission rates should be planted with caution where ozone is a health hazard: most broad-leaved species from genera *Eucalyptus*, *Casuarina,*, *Liquidambar*, *Robinia, Liriodendron*, *Populus*, *Quercus*, *Nyssa, Platanus, Salix*, and many conifers are important emitters of BVOCs, while others such as *Acer, Betula, Crataegus, and Larix* have low emitting potential (Donovan et al. 2005; Niinemets and Peñuelas 2008).

Similarly, some trees release pollen that can trigger allergic reactions. Asthma is a multi-factorial disease, with allergenic substances one of many determinants. The severity of an individual's reaction varies considerably, and depends on the allergenicity and quantity of pollen, as well as meteorological factors influencing its diffusion.

The few studies exploring effects of trees on respiratory health are inconclusive. For example, in New York City, an increase in street tree density was associated with lower prevalence of early childhood asthma (Lovasi et al. 2007). However, there was not a significant association between trees and hospitalizations. It is important

to note that other types of plants release pollen. For example, grasses (*Graminaceae* family) which at the top of the list in terms of allergenicity are widespread in cities, and are often highly concentrated (Tomalak et al. *in press*).

Of course, trees can improve air quality by removing ozone, particulate matter, and other pollutants that threaten human health. Judicious species selection can minimize the potential adverse impacts of certain trees on air quality and human health, as well as enhance their ability to remove air pollutants. Proximity to trees and urban greenspace has been correlated with numerous indicators of positive physical and mental health. For instance, a recent study found that the likelihood of children walking or biking to school increased with a greater number of street trees (Larsen et al. 2009). Increased physical activity has many well-known health benefits (Maas et al. 2006). In most cases, the potentially negative effects of trees on ozone and allergies are more than offset by their benefits to air quality and human health.

## Trees Are Good . . . but they drop icky things in my yard

Litter from urban trees is another widespread problem, although it varies in magnitude among tree species. Fallen fruits can dirty the environment, produce unpleasant odors (e.g., *Ginkgo biloba*), or, in cases of large or particularly hard fruits (e.g., cones of the Italian stone pine, *Pinus pinea*), they can cause damage to contacted surfaces. Even normal falling of leaves can be hazardous, or at least cause trouble when pavement becomes slippery.

The American sweetgum (*Liquidambar styraciflua*) is sometimes extensively planted along urban streets, yet its fruits are a vexing litter problem (Barker 1986). Lavalle hawthorn (*Crataegus* × *lavallei*) is frequently recommended for street planting (especially in narrow streets) because of its stress tolerance, but its fruits can increase the risk of slipping. Full-grown purple-leaf plums (*Prunus cerasifera*), are among the most appreciated ornamental trees, but their fruits can be a nuisance. In general, fleshy fruits are usually troublesome, but other types of fruit can also be annoying. Best examples for this group are pods of carob (*Ceratonia siliqua*), honeylocust (*Gleditsia triacanthos*), black locust (*Robinia pseudoacacia*), and Japanese pagoda tree (*Styphnolobium japonicum*), or ball-like fruits of plane trees (*Platanus* × *acerifolia*). Frequently, little can be done to prevent fruit litter from existing trees. Selection of non-fruiting species and cultivars, such as males of dioecious species (e.g., *Ginkgo biloba*, *Gymnocladus dioicus*) is the best solution for newly developed areas (Barker 1986).

Sometimes it is not litter from trees that bothers people, but animals that live in the trees. Examples include occasional outbreaks of brown-tail moths and their caterpillars covered with poisonous hairs, aphids on street trees and their production of honeydew that covers cars and pavement with sticky dirt, and the dropping of ticks that can carry human pathogens. Careful species selection and proper placement of trees can minimize these problems. The principle of "right tree, right place, with right management" is always valid.

## Trees Are Good . . . but their roots heave my sidewalk

Tree roots can cause severe damage to sewer or septic pipes, stormwater drains, water supply lines, building foundations, sidewalks, streets, parking lots, curbs, walls, and swimming pools (Randrup et al. 2003). Each year the repair of such damage is a major cost to cities. There is a potential for a range of tree species to cause root-related problems. The Italian stone pine (*Pinus pinea*), sycamore maple (*Acer pseudoplatanus*), Siberian elm (*Ulmus pumila*), dawn redwood (*Metasequoia glyptostroboides*), wing-nut (*Pterocarya fraxinifolia*), and some species of poplar (*Populus* spp.), are known to interfere with paving and sidewalks. However, it must be stressed that although tree roots are blamed for cracking concrete and invading sewer lines, it is equally valid to point out these structures fail because they have not been properly engineered to function in a landscape that contains growing trees and their roots. To prevent and remediate conflicts between roots and infrastructure, arborists can apply an assortment of tree, soil, and pavement management strategies (Costello and Jones 2003).

## Conclusion

As science drives arboriculture knowledge forward, we discover new ways that trees can positively and adversely affect human health

**Trees can improve air quality by removing ozone, particulate matter, and other pollutants that threaten our health. Judicious species selection can minimize potential adverse impacts of certain trees on air quality and human health.**

►

and the environment. Arborists should fully understand the good and the bad about trees, then take a proactive approach to management and communication. Without a fundamental knowledge of the science behind how trees affect our lives, it is very difficult to tell the difference between what is true and what is false.

**Litter from urban trees is another widespread problem, although it varies among tree species. Fallen fruits can dirty the environment, and fleshy fruits are usually troublesome. Selection of non-fruiting species and cultivars may be the best solution.**

**Literature Cited**


Barker, P.A. 1986. Fruit litter from urban trees. *Journal of Arboriculture.* 12(12):293-298.

Benjamin, M.T., and A.M. Winer. 1998. Estimating the ozone-forming potential of urban trees and shrubs. *Atmospheric Environment* 32:53-68.

Costello, L.R., and K.S. Jones. 2003. *Reducing Infrastructure Damage by Tree Roots: A Compendium of Strategies*. Western Chapter of the International Society of Arboriculture, Cohasset, CA. 119 pp.

Dicke, M., and F. Loreto. 2010. Induced plant volatiles: from genes to climate change. *Trends in Plant Science* 15(3):115-117.

Donovan, R.G., H.E. Stewart, S.M. Owen, A.R. Mackenzie, and C.N. Hewitt. 2005. Development and application of an urban tree air quality score for photochemical pollution episodes using the Birmingham, United Kingdom, area as a case study. *Environmental Science & Technology* 39:6730-6738.

Lafortezza R., G. Carrus, G. Sanesi, and C. Davies. 2009. Benefits and well-being perceived by people visiting green spaces in periods of heat stress. *Urban Forestry & Urban Greening* 8(2):97-108.

Larsen, K., J. Gilliland, P. Hess, P. Tucker, J. Irwin, and H. Meizi. 2009. The influence of the physical environment and sociodemographic characteristics on children's mode of travel to and from school. *American Journal of Public Health.* 99:520-526.

Loreto F., and J.P. Schnitzler, 2010. Abiotic stresses and induced BVOCs. *Trends in Plant Science* 15(3):154-166.

Lovasi, G.S., J.W. Quinn, K.M. Neckerman, M.S. Perzanowski, and A. Rundle. 2008. Children living in areas with more street trees have lower prevalence of asthma. *Journal of Epidemiology & Community Health* 62:647-649.

Maas, J., R.A. Verheij, P.P. Groenewegen, S. de Vries, and P. Spreeuwenberg. 2006. Green space, urbanity, and health: how strong is the relation? *Journal of Epidemiology & Community Health* 60:587-592.

Niinemets, V., and J. Peñuelas. 2008. Gardening and urban landscaping: significant players in global change. *Trends in Plant Science* 13(2):60-65.

Nowak, D.J., K.L. Civerolo, S.T. Rao, G. Sistla, C.J. Luley, and D.E. Crane. 2000. A modeling study of the impact of urban trees on ozone. *Atmospheric Environment.* 34:1601-1613.

Peñuelas, J., and J. Lluisà. 2003. BVOCs: plant defense against climate warming? *Trends in Plants Science* 8(3):105-109.

Randrup, T.B., E.G. McPherson, and L.R. Costello. 2003. A review of tree root conflicts with sidewalks, curbs, and roads. *Urban Ecosystems* 5:209-225.

Shashua-Bar, L., D. Pearlmutter, and E. Evyatar. 2009. The cooling efficiency of urban landscape strategies in a hot dry climate. *Landscape and Urban Planning.* 92:179-186.

Taha, H. 1996. Modeling impacts of increased urban vegetation on ozone air quality in the South Coast Air Basin. *Atmospheric Environment* 30:3423-3430.

Tomalak, M., E. Rossi, F. Ferrini, and P. A. Moro, in press. Negative and hazardous aspects of forest environment and human health. In: *Trees, Forest, Human Health and Well-Being.* COST Action C39.



*E. Gregory McPherson is with the USDA Forest Service Pacific Southwest Research Station (Davis, CA).*

*Francesco Ferrini is with the Department of Crop, Soil and Environmental Science at the University of Florence (Florence, Italy)*