The Keys to Urban Tree Establishment: Plant Selection and Site Amelioration - How to Choose?

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The great majority of people live in the nation's cities. In the quest for a reasonable quality of life, the nation's cities must integrate green space into the urban infrastructure so that their benefits are realized. Such tangible benefits are pollution and noise reduction, energy conservation, storm water recharge, CO_2 sequestration, oxygen evolution, wildlife habitat, increased real estate values and civic identity.

The fact that trees have difficulties surviving amid the conditions of urban and suburban environments is not a surprise. Urban areas for the most part are not designed with trees in mind. They are often treated as if they were afterthoughts to an environment built for cars, pedestrians, buildings, roadways, sidewalks and utilities. Studies point out that trees surrounded by pavement in the most urban downtown centers live for an average of 7 years, while those in tree lawns, those narrow strips of green running between the curb and sidewalk, live for up to 32 years. These same species might be expected to live anywhere from 60 to 200 years in a more hospitable setting.

Urban trees experience a virtual litany of environmental insults such as increased heat loads, de-icing salts, soil and air pollution and interference from utilities, vehicles and buildings. Yet the most significant problem that urban trees face is the scarce quantity of useable soil for root growth. A large volume of non-compacted soil, with adequate drainage, aeration, and reasonable fertility, is the key to the healthy growth of trees.

The investment in soil for a healthy tree is paid back by its fulfilling the functions for which it was planted. An adequate soil volume is key considering soils are where nutrients, water and air are held in a balance that allows for root growth, water and nutrient acquisition. Simply put, when soils are inadequate, plant growth suffers and trees die prematurely.

The process of building in a city, or even putting in a sidewalk in an otherwise rural area, necessarily dictates a high level of soil disturbance. Any construction effort requires soil excavation, cut and fill, re-grading and soil compaction. Often highly efficient heavy machinery is brought on site to accomplish this work ensuring the compaction of soils even where it is not required. There are two critical effects of soil compaction, which directly impact plant growth. 1) Soil structure is destroyed, crushing the majority of large interconnected pores (macro pores) which restrict water drainage and subsequent aeration. 2) As the macro pores are crushed, soils become denser, eventually posing a physical barrier to growth. There are numerous accounts of urban soils being literally as "dense as bricks." Where soils are covered by pavement, the needs of the tree come in direct opposition to specifications that call for a highly compacted base on which to lay pavement. All pavements must be laid on compacted bases so that the pavement will not subside, frost heave, or otherwise fail over time.

The Urban Horticulture Institute at Cornell University was founded in 1980 with the explicit mission of improving the quality of urban life by enhancing the functions of plants in the urban ecosystem. Adverse soil conditions are the major ecological limitation to plant growth in cities.

We seek ways to reduce and eliminate this limitation by focusing on two fundamental aspects. *First,* we intend to exploit naturally occurring variation within tree species for traits conferring tolerance for adverse soil conditions including drought, low oxygen levels, and elevated pH. *Second,* we will develop and test techniques for alleviating soil compaction through the addition of organic amendments and by the use of engineered, structural soil mixes. A combined approach, which includes the most suitable germplasm and deliberately designed soils, will result in the most sustainable urban vegetation. Our ultimate goal is to restore the functional role of vegetation (primarily trees) in the built landscape. Not only will this move us toward the practical objective of improving the quality of life for city dwellers, but it will also add to our understanding of ecological and physiological processes in plants.

Selection

Horticultural selection has been spectacularly successful in exploiting naturally occurring variation to produce trees with desirable traits. Selection strategies have taken two broad paths, which we will loosely term "ecophysiological" and "morphological." The ecophysiological approach has yielded a wealth of information on differences among species' tolerances for environmental stresses like de-icing salt, shade, high light, low light and low temperature. This information has emerged from compilations of long term, qualitative observations of plants growing both in natural and amenity landscapes. A well-known and very useful product of this approach is the hardiness zone rating for most woody species in North America based on the minimum ambient temperatures at which they have been observed to survive.

The morphological approach focuses on the variation within a single species for traits like size, branching habit, fall color, flower color, fruitlessness and other characteristics useful in landscape design. The wealth of ornamental cultivars for many tree species is testimony to our ability select for readily observable characteristics. While both approaches have been successful and will continue to be practiced, neither is up to the challenges facing modern horticulture to establish landscapes under stressful, often highly artificial conditions such as along urban streets. Specification of the appropriate plants for these conditions requires an understanding of plant form, gross species traits and the range of physiological tolerances which exist within each species. The unexplored frontier of modern woody plant improvement lies in the intersection of the two approaches: new cultivars need to be selected both for their habit and their ability to tolerate biotic and abiotic stresses.

Site Modification

Professionals such as landscape contractors, horticulturists, and urban foresters are often faced with the question of how to improve growth and reduce the mortality rates of trees existing in compacted soil. This condition frequently occurs both in cases where soils have been disturbed by construction, as well as in urban environments where soils are subjected to high levels of pedestrian traffic and vibrations from vehicular traffic. Compaction (and the correlative stresses of water deficits, poor drainage and low oxygen) is ubiquitous obstacles to new tree establishment in urban and disturbed soils. The landscape management industry requires practical techniques for overcoming this problem. By developing methods of overcoming compaction, in the form of greater root growth and increased soil drainage, managers will have significant tools to use. When these are combined with urban -tolerant plant selection, the health and longevity of the urban landscape may be realized.

Speakers profile

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Nina Bassuk is currently a Professor in the Department of Floriculture and Ornamental Horticulture and Program Leader of the Urban Horticulture Institute at Cornell University. A native New Yorker, Dr. Bassuk received her bachelors degree in Horticulture at Cornell and then went on to receive her Ph.D. from the University of London while carrying out her research at the East Mallling Research Station in Kent, England. Her current work in Cornell's Urban Horticulture Institute focuses on the physiological problems of plants grown in urban environments, including plant selection, site modification and transplanting technology. Currently she is also the Chair of the New York State Council on Urban Forestry.