CHOOSING TREES AND GROWING MEDIA FOR INTENSIVE GREEN ROOFS

BY DARBY MCGRATH, PHD, VINELAND RESEARCH AND INNOVATION CENTRE

TREES PRUNED FOR ROOFTOP APPLICATION

Photo courtesy D McGrath

Incorporating trees into green roof designs and building facades is not only appealing, but there is more demand than ever to plant rooftop trees. The Bosco Verticale (a.k.a. "vertical forest") in Milan, Italy is home to 700 trees, 4,500 shrubs as well as 15,000 herbaceous plants. Designing for tree survival and longevity, however, is challenging.

Intensive green roofs, which can include trees and shrubs, require deeper planting mediums and more maintenance than extensive green roofs. The new vertical forest design movement integrates trees, shrubs and other plant material into multiple façades of a building and requires treating each floor differently because of variable micro-climate conditions.

Harsh microclimatic conditions can include varying sun and wind exposure, which result in higher rates of evapotranspiration. Low nutrient availability due to the absence of natural soil-derived inputs and limited soil volumes make the planting medium critically important. As more buildings are designed with trees taking centre-stage, arborists, urban foresters and landscape architects will be tasked with creating conditions that can support tree growth, as well as selecting trees that can withstand other conditions not easily ameliorated. Here are some key considerations for selecting growing media and trees for rooftop projects.

GROWING MEDIA QUALITY AND VOLUME

Growing media quality is a primary determinant of the success of tree plantings. Substrates should have the right air and water balance, which is easily achieved by ensuring mixes have adequate amounts of organic matter. Organic matter is also a critical component of plant-microbial interactions which help trees access nutrients and tolerate challenging conditions (e.g. drought stress). The substrate needs to be dense enough to anchor tree roots in fixed volumes, as well as light enough to fit the design requirements. The width of the growing space is critical for the structural roots of trees to become properly anchored in the soil. Therefore, space for lateral root spread is more important than having a very deep container. Tree selections should be made with this volume in mind; compact, non-tap-rooting species are preferable. The substrate volume has to match the trees requirements in terms of rooting space required and moisture regime. According to James Urban, FASLA, mature shade trees require at least 30 m3 of soil to

meet their physiological requirements in the built environment.

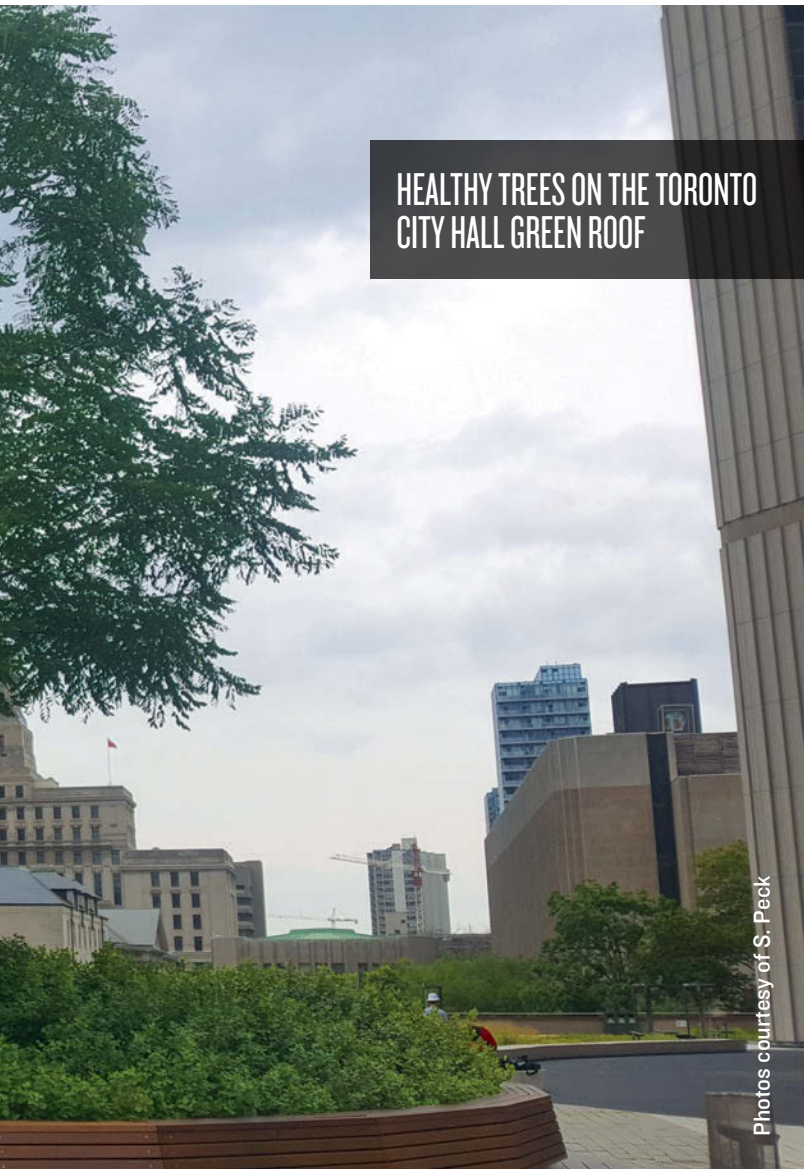
Trees in settings where root extension is impeded by restricted soil depth or width are container trees. Water losses can often exceed stored water in a container and quickly result in water stress. Calculating the required soil volume for the candidate species can be accomplished using climatological data and provides important thresholds for irrigation.

ROOT QUALITY AND TREE ARCHITECTURE

For all installations, but especially when trees are being transplanted onto roofs or balconies, close attention should be paid to cultivation practices. Proper tree root quality starts in the nursery and influences survival in the landscape. For instance, in Sweden, nursery growers have standards for "pre-establishing trees" dictating root management. Repeated root pruning is one way to ensure good root quality, effectively removing circling or otherwise malformed structural roots, increasing fine root mass. Trees that receive root pruning treatments suffer less transplant shock and establish more quickly. Nursery suppliers should be able to provide information about what pre-conditioning techniques have been used and are often willing to share their knowledge on characteristics of different candidate species. In Europe, nurseries commonly provide information and guidance on selections of trees for green roof use.

Nursery stock should also be evaluated for proper pruning to maintain good branch architecture, spacing and to encourage strong branch unions. Research has shown that properly pruned trees experience less damage in wind storms (sensu Gilman et al. 2008). Structural pruning to manage branch aspect ratio, branch union strength (branches smaller than trunk form stronger unions) and maintain narrower and more balanced canopies is essential for trees slated for green roof use.

Trees with narrower, more balanced canopies or multi-trunk



HEALTHY TREES ON THE TORONTO CITY HALL GREEN ROOF

Photos courtesy of S. Peck

selections are used prominently in green roofs in Europe. Multi-stem trees are especially preferred in areas where wind is factor. Generally, trees chosen need to be amenable to pruning but preference should be given to lower maintenance trees in some scenarios. Topiary trees are commonly used in Europe on green roofs, but require frequent pruning to maintain their shape. Therefore, consideration should be given before using on private balconies or areas with restricted access. Species that are susceptible to pests and diseases due to open wounds or that experience stress after pruning should be avoided.

SPECIES SPECIFIC TRAITS TO CONSIDER

Drought tolerance, light levels, heat and cold tolerances all need to be considered for tree selections. Planting selections from the Bosco Verticale were made floor-by-floor to account for changes in humidity, temperature and wind exposure. A deeper understanding of the environmental conditions from the ground to the top of a building may require floors to be treated as distinct planting zones with different micro-climates. In areas where wind and evapotranspiration is high, designers should consider trees with anatomical leaf characteristics that are well-suited to these conditions. For example, research has shown that alpine plants possess a thicker leaf epidermis when found growing at higher altitudes. Species that capable of adapting to changing environmental conditions at higher elevations should be considered.

Finally, but not of least importance, is the socio-ecological benefit that can be derived from trees in the design. Form and aesthetic quality are, of course, important. Trees that do not readily reproduce from seed or root suckers should be chosen. Flowers and fruits are often desirable for aesthetic as well as ecological reasons, as habitat for birds and pollinators, but careful selection should be made to avoid allergens to residents and minimize risks from falling debris.

Dr. Darby McGrath is the Program Lead for Greening the Canadian Landscape at Vineland Research and Innovation Centre and is the Research Scientist for Nursery and Landscape. Her work integrates nursery production research with ecological restoration principles to address challenges of urban tree survival. Darby.mcgrath@vinelandresearch.com

References:

Bengtsson, L. Grahn, L. and Olsson, J. (2005). Hydrological function of a thin extensive green roof in southern Sweden. Hydrology Research. 36, 351-360.

Buckland-Nicks, M. Heim, A. and Lundholm, J. 2016. Spatial environmental heterogeneity affects plant growth and thermal performance on a green roof. Sci. Tot. Environ. 553, 20-31.

DeGaetano, A.T. 2000. Specification of soil volume and irrigation frequency for urban tree containers. Journal of Arboriculture. 26, 142-151

Dunnett, N. and Kingsbury, N. 2008. Planting Green Roofs and Living Walls. Portland, OR. Timber Press.

Fulthorpe et al. (2018) The green roof microbiome: improving plant survival for ecosystem service delivery. Frontiers of Ecological Evolution. 2.

Gilman, E.F. 1992. Effect of root pruning prior to transplanting on establishment of southern magnolia in the landscape. Journal of Arboriculture.18, 197-200.

Gilman, E.F. 2008. Pruning affects tree movement in hurricane force wind. Arboriculture & Urban Forestry, 24, 20-28.

Gilman, E.F. et al. 2002. Root pruning but not irrigation in the nursery affects live oak root balls and digging survival. Journal of Environmental Horticulture. 20, 122-126.

Hawke, R. 2015. An evaluation study of plants for use on green roofs. Plant Evaluation Notes. Chicago Botanic Gardens. 38, 1-22.

Urban, J. 2008. Up by Roots: Healthy Soils and Trees in the Built Environment. Champaign, IL. International Society of Arboriculture.