# Effect of rooting space volume with stromwater supply on the tree vitality

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The main stress factors of the urban underground environment are changes in soil physical properties and soil compaction, limited air exchange, water capacity and infiltration and resistance to root penetration. The period of tree active growth is primarily influenced by the size of the rooting space. The optimal volume of the rootable soil is related to the ability to use rainwater within the root zone and its own accumulation in a given soil volume, the field water capacity. When using substrates with components with high water holding capacity together with an efficient rainwater management system (HDV), it is possible to plant trees in smaller soil volumes. A structural soil covered with a permeable surface can be used when constructing the space adajacent to the tree planting pit. In the Czech Republic, the use of a structural soil is only rarely followed by a rainwater management (HDV). Vegetation provides the following key services in relation to HDV: infiltration, accumulation, filtration and evaporation. In turn, sufficient rainwater in the root zone ensures the growth and survival of vegetation and therefore the fulfillment of aesthetic and environmental functions. By retaining water in a rootable space, the runoff of rainwater can be reduced by 90%, for this case, tree pits must reach 2.5% - 8% of the total runoff area with a paved surface.

#### **Objectives**

- Examine if the optimal rooting space can be reduced when a constant volume of rainwater is supplied, without affecting the tree vitality.
- Monitoring the water regime and tree vitality parameters on a site constructed with the use of the structural soil.
- Description of the relationship between the size of the constructed rooting space (given by the volume of the structural soil) and tree vitality parameters with the same volume of added rainwater in different volumes of the structural soil

### Material

- 5 *Tilia cordata* trees are monitored for each volume and 3 control trees of the same species in a natural soil also with rainwater supply.
- 3 sizes of **rooting volume: 2m<sup>3</sup>, 3m<sup>3</sup> and 6m<sup>3</sup>** with a 0,8m depth, filled with a structural soil.
- Tree pits covered with a 5cm of gravel surface.



• The size of the rainwater collection area determined according to the calculation of water consumption, according to the dimensioned rainfall.

Figure 1: Trees in different volumes of structural soil.

#### **Structural soil**



- Structural soil is a **mixture of soil and aggregate of medium or coarse-grained fraction**, which ensures the required load-bearing capacity and aeration.
- Structural soil can retain 7-10% moisture (by volume), similar to sandy loam soil, has greater infiltration capacity, good drainage and good aeration.
- Structural soil used in project contains: 85% gravel of fraction 32/64 5% compost 10% biochar
- Soil moisture is monitored to a depth of 1 m with a PR2 profile moisture probe (Delta-T Devices, Ltd., Cambridge, UK).

Figure 2, 3: Structural soil components. Tree root hair in structural soil.

#### **Vitality measurements**

- Physiological vitality of trees is monitored by visual assessment and measurement of these parameters: currently leaf water potential (Plant Moisture Stress – PMS, measured in a Scholander pressure chamber PMS 1000 - PMS, USA), in next years: growth, photosynthesis and fluorescence (Dendrometer and PhotosyncQ measurements).
- During the summer day measurements of PMS on trees: in structural soil range from 18 to 19 bar in natural soil show 22 bar.
- Measurements of PMS during the fall day on trees **in structural soil range from**



8 to 13 bar and trees in natural soil show 16 bar. Predawn fall measurements of PMS on trees in structural soil range from 4 to 5 bar and trees in natural soil show 10 bar.

• As PMS increases above 20 bar plant vigor declines.

Figure 4: Plant moisture stress.

#### Conclusions

- Already in the first year of the experiment, the difference in Plant Moisture Stress between the trees planted in the structural soil and the control trees in the natural soil was confirmed.
- The effect of different volume of structural soil is not significant yet, as the root system has not yet hit the limits of volume provided.
- The difference in visual assessed vitality is less noticeable in the phase of tree establishment, but corresponds with the leaf water potential measurement. Further measurements will follow within next 15 years, when the effect of a rooting within the provided volume is expected.

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