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Soil Aeration deficiencies in urban sites

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On urban tree sites reduction of soil aeration by compaction or sealing is an important but frequently underestimated factor for tree growth.
Up to 50% of the CO2 assimilated during the vegetation period is respired in the root space (Qi et al. 1994). An adequate supply of the soil with oxygen and a proper disposal of the exhaled carbon dioxide are essential for an undisturbed root respiration. If the soil surface is smeared, compacted or sealed, soil aeration is interrupted.
Several references show that root activity and fine root growth are controlled by the carbon dioxide concentration in soil air (Qi et al.1994, Burton et al. 1997). Gaertig (2001) found that decreasing topsoil gas permeability leads to reduced fine root density and hence to injury in crown structure of oaks. In forest soils a critical CO2 concentration of more than 0.6 % indicates a bad aeration status (Gaertig 2001).
The majority of urban tree sites are compacted or sealed. The reduction of soil aeration may lead to dysfunctions in the root space and consequently to stress during periods of drought, which has its visible affects in crown structure. It is reasonable to assume that disturbances in soil aeration lead to reduced tree vigour and roadworthiness, resulting in high maintenance costs.

The assessment of soil aeration in urban sites is difficult. In natural ecosystems the measurement of gas diffusivity and the gas-chromatical analysis of CO2 in soil air are accepted procedures in analyzing the state of aeration (Schack-Kirchner et al. 2001, Gaertig 2001). It has been found that these methods can also be applied for analyzing urban sites. In particular CO2 concentration in the soil atmosphere can be considered as a rapidly assessable, relevant and integrating indicator of the aeration situation of urban soils.

This study tested the working hypothesis that soil aeration deficiencies lead to a decrease of fine root density and tree vigour on urban soils. For that purpose gas diffusivity, soil CO2 concentrations and fine root density were measured on typical urban sites in the German cities of Göttingen, Mannheim, and Kassel.
The known characteristics of soil aeration on forest sites could be affirmed for urban soils. A negative correlation was found between gas diffusion coefficients and CO2 concentration as well as between fine root extension and CO2 concentration. Changes in crown structure of beech indicating a loss of vigour were found at sites with disturbed aeration.
Diffusivity patterns and CO2 concentrations of different specific urban soil sealing types were found. On more natural sites (mulch, grass) increased gas diffusion and low CO2 concentration were present. In contrast, on more compacted or sealed areas (asphalt, paving stone, macadamised road surface) the exchange between soil air and atmosphere was nearly disconnected and soil CO2 concentrations partly exceeded the known critical value of 0.6 % up to tenfold.

Literature
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