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Effect of Plant Water Stress on CO_2 Concentrations in the Rhizosphere

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Abstract

Soil respiration consists of autotrophic root respiration and heterotrophic microbial respiration in the rhizosphere. Together with the gas exchange of the bulk soil, they represent the main carbon efflux from the terrestrial ecosystems and – about 25 % of the global carbon dioxide exchange at all. Soil temperature and soil water content are considered to be the two main factors, which can explain most of the alterations in carbon efflux. Many studies have been conducted as how soil temperature and soil moisture affect the soil respiration, but only few focused on the inter-linkages between CO_2 concentration in the soil and plant water stress. The seasonal and temporal variations in soil CO_2 concentration and its relationship with the plant water status remain uncertain.

The main objective of this study was to investigate the relationship among soil CO_2 concentration, soil water content, soil nutrient status, soil temperature, and plant water status of fruit trees. Before being applied in tropical crops like lichi and mango, preparatory field experiments were conducted at an apple orchard located near Nuremberg, Germany. Soil CO_2 concentration was measured with a newly developed soil CO_2 sensor (SCS). Soil water content and soil temperature were measured with dielectric sensors. Plant water status was monitored by stomata conductance (porometer), predawn leaf water potential (Scholander bomb) and canopy temperature (thermo camera) measurements. The SCSs were placed at different distances and depths from the tree's trunks. All the measurements were started at the beginning of the vegetative phase to investigate how the canopy development affects the soil CO_2 concentration. An empirical model for plant water status prediction based on soil CO_2 and soil moisture measurements was established as first step towards a novel plant water status monitoring system.

Keywords: Plant water status, soil respiration, soil water content

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