DURUM WHEAT GROWTH UNDER ELEVATED CO₂: FIRST RESULTS OF A FREE AIR CARBON DIOXIDE ENRICHMENT (FACE) EXPERIMENT


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The mixing ratio of atmospheric CO₂ is rising due to the use of fossil fuels, release from industrial production processes and land use change effects. The measurements at the Mauna Loa station (Hawaii) show an increase from below 320 ppm at the start of the measurements in 1958 to 393 ppm in 2011. Further increases are expected during the 21st Century due to continued use of fossil fuels, leading to estimated concentrations around 550 ppm for the mid-Century. The rising atmospheric CO₂ levels are a cause of the ongoing anthropogenic climate warming and thus a matter of concern with respect to global change. On the other hand CO₂ is the main source of organic carbon of living beings. Plant photosynthesis fixes and reduces CO₂, incorporating the carbon into biomolecules. In C₃ plants, the RuBisCo carboxylase catalyses the carboxylation of a C₅ sugar with CO₂. Thus, the historical rise in atmospheric CO₂ as well as the expected further increases during the coming decades have the potential to lead to increased carbon assimilation by C₃ photosynthesis.

Many studies on the effects of elevated CO₂ on C₃ plant photosynthesis and growth have demonstrated a stimulation of photosynthetic production and, subsequently, growth, although not as expected on the base of the enzyme kinetic properties of RuBisCo. Indeed a reduction in photosynthetic capacities under elevated CO₂ has been reported. Interactions with nutrient availability and water use efficiency have been identified. Downstream the changes in demand/supply of carbohydrates in plants growing under elevated CO₂ changes in metabolism lead to changes in the chemical biomass composition and more specifically in the quality of harvested plant organs. So far very little is known about the CO₂ response of durum wheat. Genetic variability in this response needs to be characterized in order to identify the most promising genotypes for breeding of new varieties that optimally exploit elevated levels of atmospheric CO₂. Therefore, a two years field experiment was conceived to study the effects of elevated CO₂ on growth, yield and grain quality of 12 durum wheat genotypes. Genetic variability and GxE interactions under ambient/elevated CO₂ have been observed for plant development and growth, canopy-related traits and yield during the first experimental year. Eco-physiological analyses were carried out to describe the physiological mechanisms modified in response to elevated CO₂. Leaf samples collected from the field experiment in different phases of the plant life cycle and grain will be examined for transcriptomic and metabolomic changes.