Tropentag, September 14-16, 2010, Zurich

"World Food System —
A Contribution from Europe"

Influence of Nitrogen and Water Availability on Biomass Yield, Water Relations and Leaf Gas Exchange of *Chenopodium quinoa* (Willd.)

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Abstract

Global climatic changes already affect crop yield, water relations and nutrient availability. Drought lowers the H_2O availability in the soil and decreases also the uptake of nutrients such as nitrogen and carbon (in form of CO_2). Latter one is mainly a consequence of an increased stomatal resistance to reduce the water loss.

Some crops, such as Quinoa (*Chenopodium quinoa* Willd.) are able to withstand drought stress up to an impressing level. Quinoa is a cash crop of the Andean regions of South America. It is cultivated for its balanced nutrient content and moreover for its high acclimation to temperature, drought and atrophy.

The aim of this study was to determine the physiological mechanisms enabling this plant to solve the contradicting demand for photosynthesis activity (CO_2-uptake) and plant water relations (minimising water loss) at low soil water availability and the impact of N-availability and elevated atmospheric CO_2 concentration (Ca).

An increase of N availability led to an increased water absorption by lowering the leaf water potential from -2.32 $\pm$ 0.16 MPa to -2.93 $\pm$ 0.03 MPa. However, low H_2O supply (down to 12.6 $\pm$ 6.2 % WC in the soil) led not only to a significant decrease of biomass yield and total-N-content, but to an increase in RuBisCO-, proline- and chlorophyll concentration as well as to an increase of the nitrate reductase activity ($p < 0.001$).

The reduced photosynthesis activity was partially compensated by the above mentioned increase of the RuBisCO content (large sub unit) leading to a high water use efficiency of photosynthesis which could even be enhanced by an elevated C_a (up to 2000 ppm). Either the increase of N content or of C_a led to an increased drought tolerance of Quinoa, an increased assimilation rate of photosynthesis and consequently to an increase in biomass yield and carbohydrate content. The drought tolerance and the benefit in biomass yield at elevated C_a proof the potential of *C. quinoa* to become a suitable crop in times of global climatic changes.

Keywords: *Chenopodium quinoa*, drought tolerance, elevated CO_2, hydrological balance, leaf gas exchange, nitrogen availability

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