Grain quality characteristics of Ethiopian barley genotypes as affected by climate change

CLIFOOD
SDG Graduate School

PhD student: Mekides W. Gardi; Supervisor: Prof. Dr. Petra Högy

Institute of Landscape and Plant Ecology

Introduction

- Climate change alters growth environments around the world and challenges the agricultural production.
- By the end of the 21st century, temperature is expected to increase by 3-5 °C and future atmospheric CO_2 increase will be about 2 ppm year^{-1} (IPCC, 2013).
- Ethiopia is recognized as a secondary gene center of diversity for barley (Tolbert et al., 1979). Barley grain is used for human consumption, malt production and feed.
- As barley is one of the four major cereal crops in the world, studies on the drought tolerance of this species under increasing CO_2 levels are important.
- In a future climate scenario of elevated CO_2 and extreme events such as heat waves the grain yield quantity and quality of barley will be affected. However, variation will be identified within the individual barley genotypes in terms of response to climate change, which will be introduced into cultivars to achieve climate resilience.

Materials and Methods

A subset out of fifty Ethiopian barley genotypes will be used. Plants will be grown in pots in six growth chambers in two different experiments, in which the climatic variables photon flux density (PFD), temperature, humidity and CO_2 concentration could be controlled. The supply of nutrients will be adequate according to Weichert et al. (2017) and plants will be regularly watered.

Experiment 1: Climate profiles will be applied (Fig. 1) and the CO_2 concentrations will be set to values of 400 ppm ambient concentrations and 550 ppm expected concentration in 2050 (Meehl et al., 2007) using three chambers each.

Canopy height and phenology of plants (BBCH decimal code) will be measured weekly. Greenness index of leaves will be measured in weekly intervals using a SPAD meter and chlorophyll concentrations will be determined in penultimate leaf discs. The flag leaves and the lowest green leaves will be used for determining leaf gas exchange and photosynthetic CO_2 response curves (A/ci) will be measured. Dry weights (DW) of the different biomass fractions will be determined and analyzed for C and N concentration. Data will be used for crop growth modelling as well.

Experiment 2: Contrasting genotypes in terms of CO_2 responses will be identified and the performance will be tested in terms of CO_2 and heat waves. Ecophysiological measurements as in experiment 1 will be performed during the whole growing period. In addition, analysis of carbon, minerals, non-structural carbohydrates, total protein, total amino acids (protein hydrolysates), total lipids and crude fiber will be performed at crop maturity as described by Högy et al. (2009).

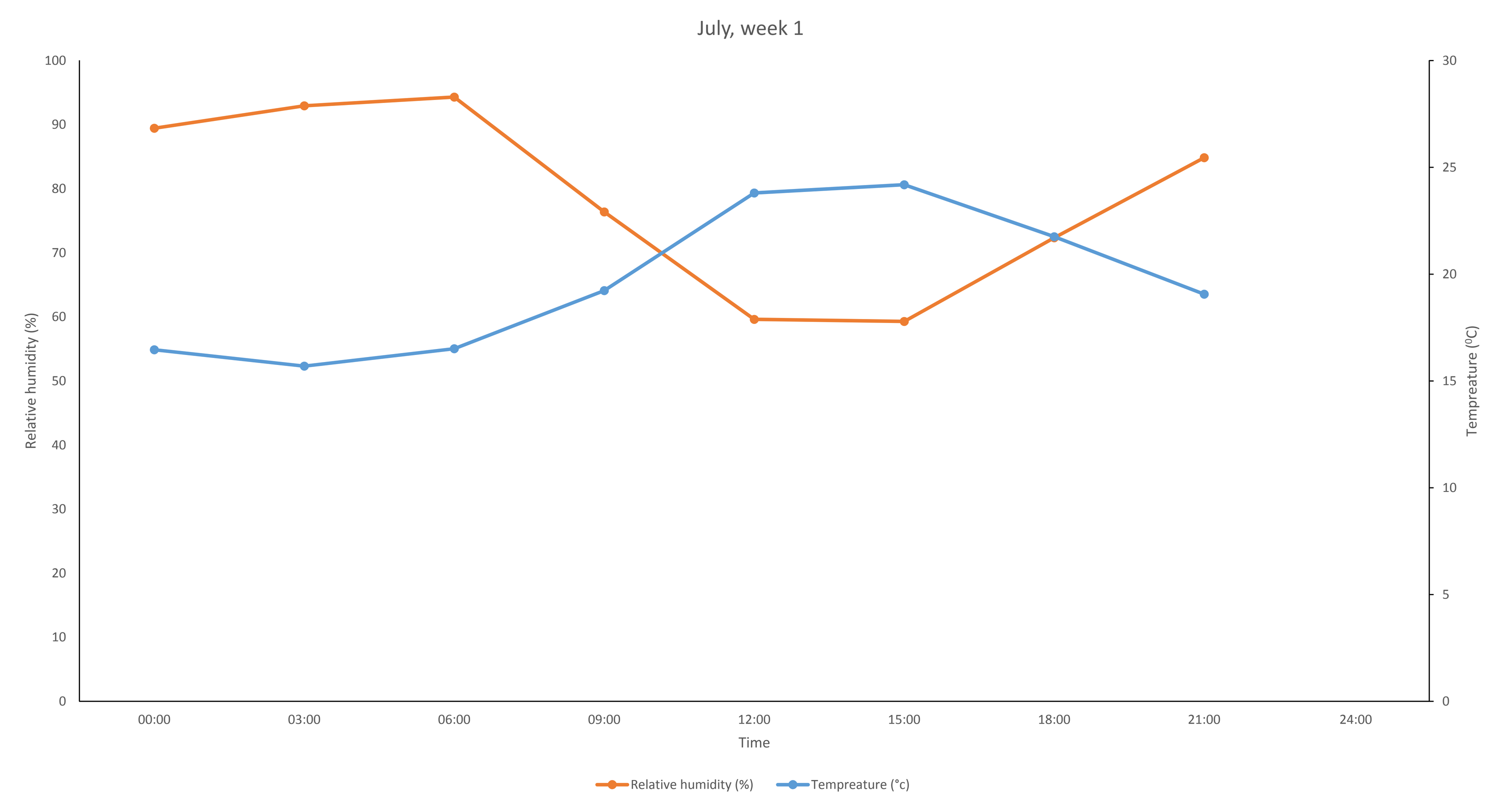

Figure 1: Climate chamber profile (first week of July)

10-year average temperature and humidity for Holetta (2008-2017). The first week of July is presented as an example for weekly changing climate chamber profiles. https://www.worldweatheronline.com/holetta-weather-history/et.aspx

Expected results

- The performance of genotypes will be identified under climate change
- Parental genotypes for further breeding will be identified
- The performance of the new hybrids of Ethiopian barley will be determined

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Mekides W. Gardi, Institute of Landscape and Plant Ecology, University of Hohenheim, Germany
Mekides.gardi@uni-hohenheim.de

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