ATSAF - CGIAR++ Junior Scientists Program Final Report

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Start and end date of stay at IARC: 15 Feb 2022 - 15 Aug 2022

Start and end date of remotely supervised project: -

Title: Genotype x Environment effects on leaf properties and pigment composition in tropical bread wheat

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My research work sponsored by ATSAF Junior scientist program was at CIMMYT Mexico. The project "Genotype x Environment effects on leaf properties and pigment composition in tropical bread wheat" has been supervised by Prof. Dr. Folkard Asch from the University of Hohenheim and Dr. Francisco Pinto, senior scientist at CIMMYT.

The internship lasted six months, from 15th February 2022 till 15th August 2022. It was split in 4 months at the research station of Obregon, Sonora. Here the experiments were carried out. And the remaining two at CIMMYT headquarters in El Batan, Texccoo, Mexico state, where I mainly worked on the data.

At the research station I mainly focus on measurements, mostly based on remote sensing in the experimental trial in the water deficit and well-watered treatment, till the plants reached grain filling at the end of March. From early April till end of May on the heat trial.

Only 13 genotypes of the first two treatments will be object of my final MSc thesis. However, another object of the internship was offering support with the data collection to the PhD candidate, Geckem Dambo, so we worked together in a larger panel.

During my stay I got acquainted with different equipment such as Poromoter Licor, ASD field spectrometer, Spad, PRI PlantPen and procedures leaf sampling for following pigment extraction and relative water content, phenotypical recording. Due to the nature of the measurements, week frequency and the size of panels, we were supported by several assistants working at the research station.

The help offered by CIMMYT was organized by Dr. Pinto. He had a pivotal role during the stay, offering full support at and out of work.

In particular, there has been a lot of space for scientific discussion and share of expertise with Dr. Pinto, other scientists of CIMMYT physiology team, engineers and visiting scientists. Dr. Pinto aimed for his students to have a critical and proactive approach. This contributed extremely to my learning curve during my stay.

The environment at the research station was vibrant, despite the intense field work. It was a really dynamic context. Out of the field I was sharing the office with five PhD candidates from different European and US universities. We had a continuous learning exchange. In addition, in spare time collaboration occurred naturally, therefore I got familiar with other procedures, such as sampling of roots and soil and assessment of rust damage.

The help from my supervisor from Hohenheim, Prof. Folkard Asch and Dr. Alejandro Pieters has been continuous and efficient throughout the period with biweekly online meetings for updates and solving doubts.

In Batan, my work was less dynamic and more independent. However, I received continuous support, for logistics, pick up, house. The working space was ideal for concentrated work therefore I had time to start the analysis of my data. In addition, I had the opportunity to interact with experts from other department, such as social-economic, breeding and seed quality.

Research description and objectives

Thirteen wheat genotypes from the Best PT panel developed by CIMMYT, were grown in the field at CIMMYT research station in Obregon, Mexico, and exposed to two different environments: water deficit and well-watered. The lines were selected according to their contrasting evapotranspiration performance, estimated through canopy temperature measurements, and estimation of yield in previous water deficit experiments in the field.

This research aims at identifying genotype x environment interaction effects on the leaf properties, described above and investigate links with pigment composition of the selected genotypes and their resistance to water deficit. Thus, measurements on the youngest fully expanded leaf and the third leaf at different crop developmental stages

Thus:

1. Measuring spectral reflectance indexes, especially related to carotenoids and photosynthesis, of the leaves, through a field spectrometer. The Changes in spectral indices will be linked to changes in canopy temperature and soil moisture.

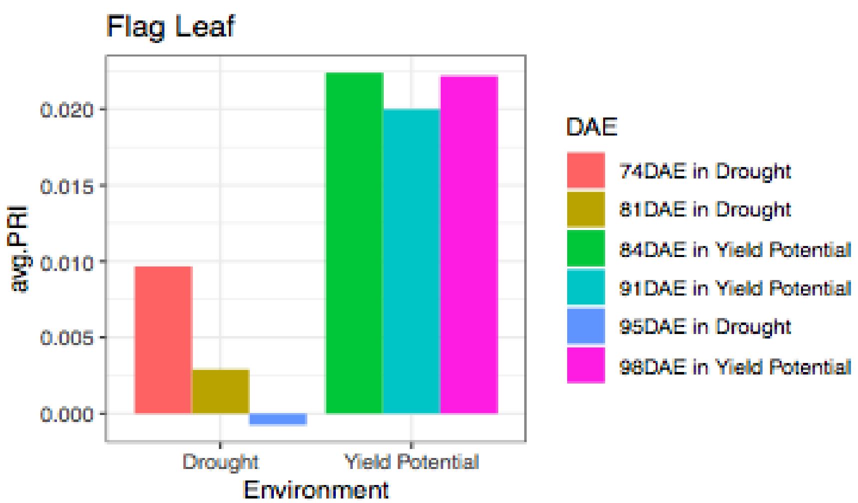
2. Measuring PRI, by a PlantPen PRI, and relative chlorophyll content measured with SPAD.

3. Determining the temperature of canopies to draw information on both the effective rooting depth and the transpiration efficiency.

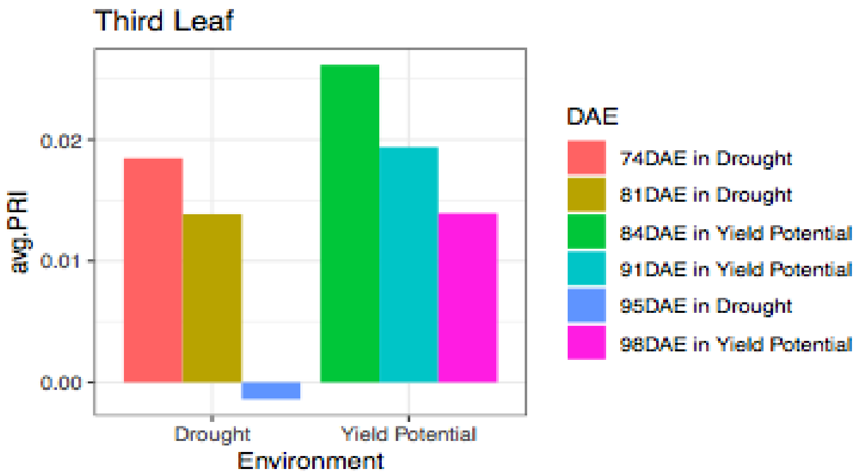
4. Regular destructive samplings of specific leaves on the main tiller will allow for pigment composition analyses, which will be used to corroborate the previous results.

Preliminary results

Below preliminary results of average Photochemical Reflectance Index (PRI), calculated as "(R531-R570)/(R531+R570)" on the flag leaf and on the third leaf on three different dates. The index was derived by the hyper spectral data retrieved by the leaf clip ASD field spectrometer. The dates are express in Days After Emergency (DAE). All the measurements were carried out between anthesis and maturity. The three dates are comparable in the two different environments.



Graph 1: Average PRI measured on Flag Leaf under water deficit and well-watered treatment.



Graph2: Average PRI measured on Third Leaf under water deficit and well-watered treatment.

The average PRI measured on flag leaf is between -0,001 and 0.009 in the water deficit environment. Otherwise, under well-watered the values are between 0.02 and 0.025.

All the measurements were carried out between anthesis and maturity, Aparicio et al. showed through their research that the progressive senescence of photosystems from anthesis onwards can be linked to the decreased PRI. The senescence is more highlighted under water deficit due to stress.

However, this tendency was not displayed for flag leaf under yield potential (Graph 1). The difference between the second and the other two dates is not consistent.

Similarly, the reduction that occurred in the two environments in PRI from anthesis to maturity was probably associated with a progressive senescence of photosynthetic organs during grain filling. (Aparicio et al. 2000).

Additionally, low values of PRI under water deficit treatment can be explained as the consequential closure of the stomata and therefore decreased CO2 absorption, decreased flow in the mesophyll and consequent inhibition of the Calvin cycle.

Regarding the third leaf, a few data is available in the literature, therefore further investigations are needed. However, a research from Khamis et al. (1990) showed that third leaf in maize has a larger PRI due to the leaf’s horizontality and therefore higher exposition to the sun radiations.

References

Aparicio, N., Villegas, D., Casadesus, J., Araus, J.L. and Royo, C. (2000), Spectral Vegetation Indices as Nondestructive Tools for Determining Durum Wheat Yield. Agron. J., 92: 83-91. https://doi.org/10.2134/agronj2000.92183x

Khamis S., Lamaze T., Lemoine Y., Foyer C. (1990). Adaptation of the Photosynthetic Apparatus in Maize Leaves as a Result of Nitrogen Limitation : Relationships between Electron Transport and Carbon Assimilation, *Plant Physiology*, 94(3), 1436–1443, https://doi.org/10.1104/pp.94.3.1436