Drip Irrigation System Aids in Mitigating Effects of High Temperature Stress in Wheat

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Introduction

- Changes in temperatures and precipitation has serious impact on availability of water resources and crop growing conditions affecting production and productivity in wheat
- Uncertainty in global water reserves necessitates judicious application of irrigation for increasing productivity
- Timing and method of irrigation can be a key to conserve water and improve the grain yield performance per mm of applied water and adapt to high temperature stress
- Transpiration, a key process maintains physiological and metabolic functions in irrigated high temperature wheat growing environments

Objective

- Evaluate grain yield performance of bread and durum wheat variety sown under flood and drip irrigation system across years
- Assess the impact of temperature across years on the performance of varieties under different irrigation methods

Materials and Methods

- One bread and one durum wheat variety (Boralug F100 and CIRNO C2008 respectively) were evaluated as a part of the yield potential trial in Norman E. Borlaug Research Station in Ciudad Obregon, Sonora, Mexico from 2013-2016
- Trials were sown in mid-November under two management systems
  - Flat Planting with drip irrigation system–600mm of water applied through weekly subsurface drip irrigation, 300kg of N applied
  - Flat planting with flood irrigation system – 600mm of water applied through 4 irrigation events, 150 kg of N applied
- Days to heading (DH), days to maturity (DM) and grain yield (GY) was estimated
- Climate data was obtained from CIMMYT weather station located near the research station

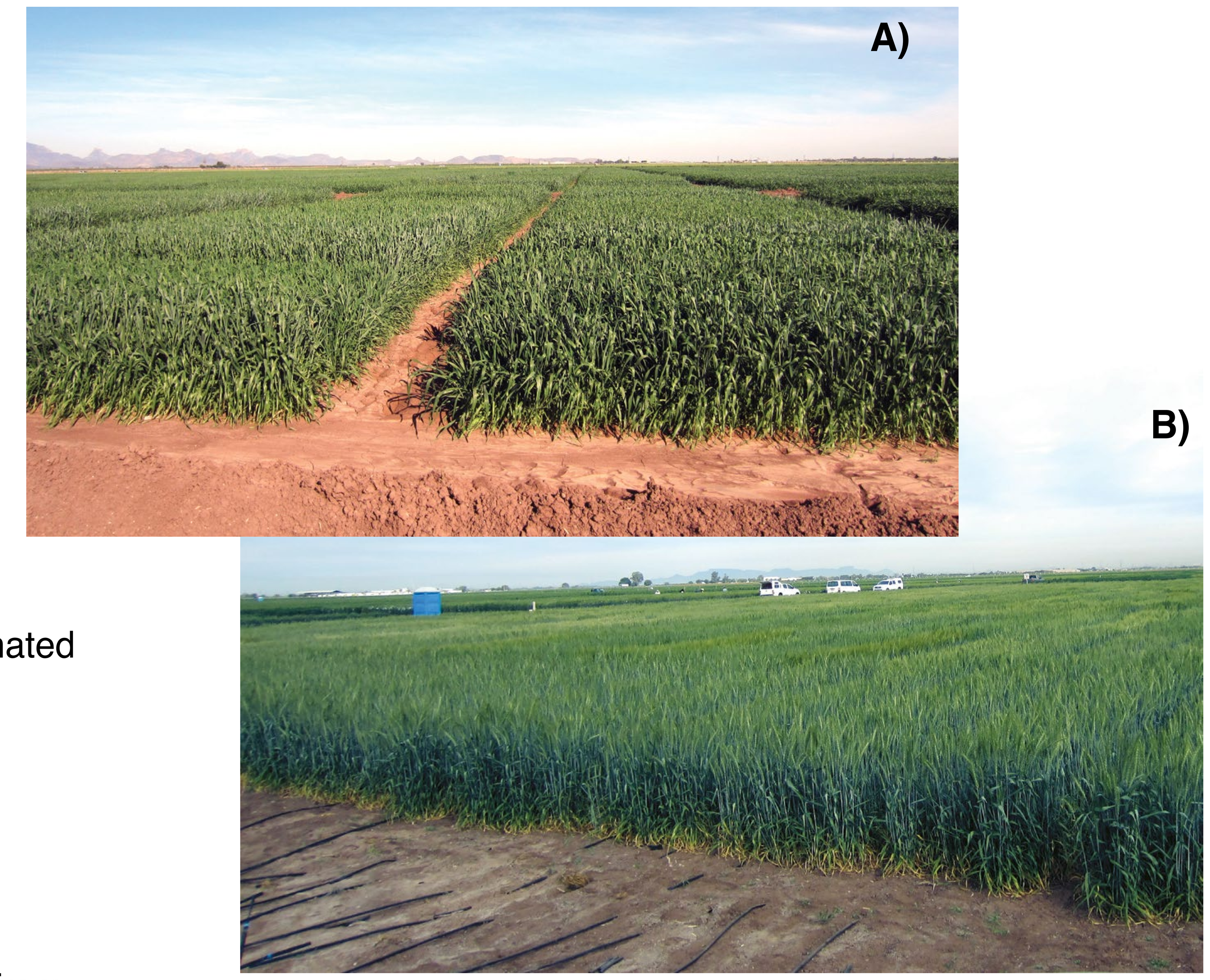

Figure 1. A) flat planting with flood irrigation B) flat planting with subsurface drip irrigation

Results and Discussion

The mean monthly maximum and minimum temperatures varied significantly from 2012-2016 during the crop season (Figure 2). The mean maximum temperatures were warmer in the experimental years compared to 10 year mean of the maximum temperatures specially at booting (February).

For the mean minimum temperatures, 2015 was an exception with 1-3°C higher minimum temperatures in February and March compared to other years and the 10 year average while 2013 was the coolest during booting and grain filling.

This increase in minimum temperatures in 2015 resulted in significant grain yield losses for farmers in the Yaqui valley of Sonora, Mexico. A comparison of the mean grain yield of check varieties (234 plots each year) in the CIMMYT field station from 2012-2016 also shows the impact of the minimum temperatures on grain yield (Figure 3).

The performance of the two varieties from 2012-2016 under the different irrigation schemes shows interesting differences (Figure 4). Significant reduction in mean grain filling duration (GFD) of the lines under flood irrigation is observed in 2015 compared to drip irrigation trial. Comparison of the GY of each line in two irrigation schemes across years indicates that regular application of irrigation through drip system maintains the grain yield of the lines even in the warm years. Availability of water may have enabled the plants to cool via transpiration maintaining grain yield under high temperatures.

Summary

Increasing temperatures and availability of irrigation are major concerns for improving genetic gains in wheat. While development of heat and drought tolerant varieties are crucial for maintaining grain yields, management of available water resources can also assist in the unpredictable years. The varieties in this study are known high yielding heat and drought tolerant bread and durum wheat developed at CIMMYT and their consistent performance under the drip irrigation scheme brings forward a new approach for the farmers in Yaquii valley to mitigate threat of climate uncertainties. This approach is still under evaluation and may benefit irrigated wheat growing areas suffering from high temperature stress.

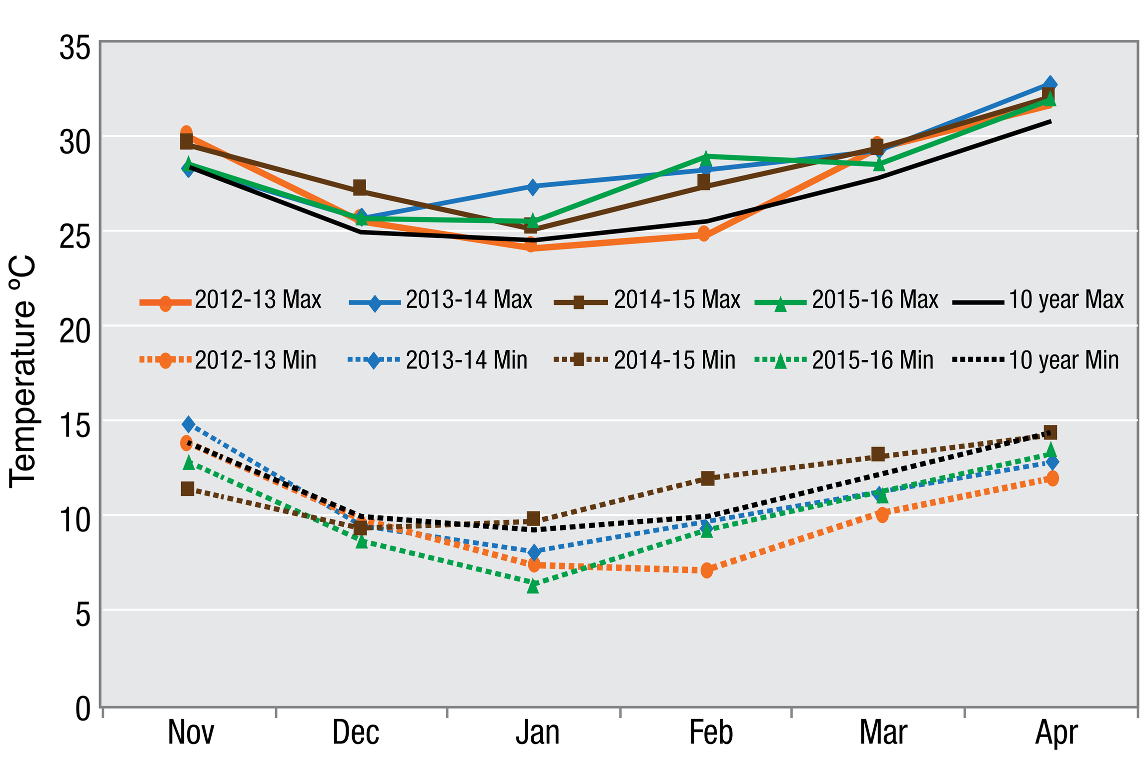

Figure 2. Mean monthly maximum and minimum temperatures for the crop growing season (November - April) from 2012-2016 and the 10 year mean monthly maximum and minimum temperatures during the crop season.

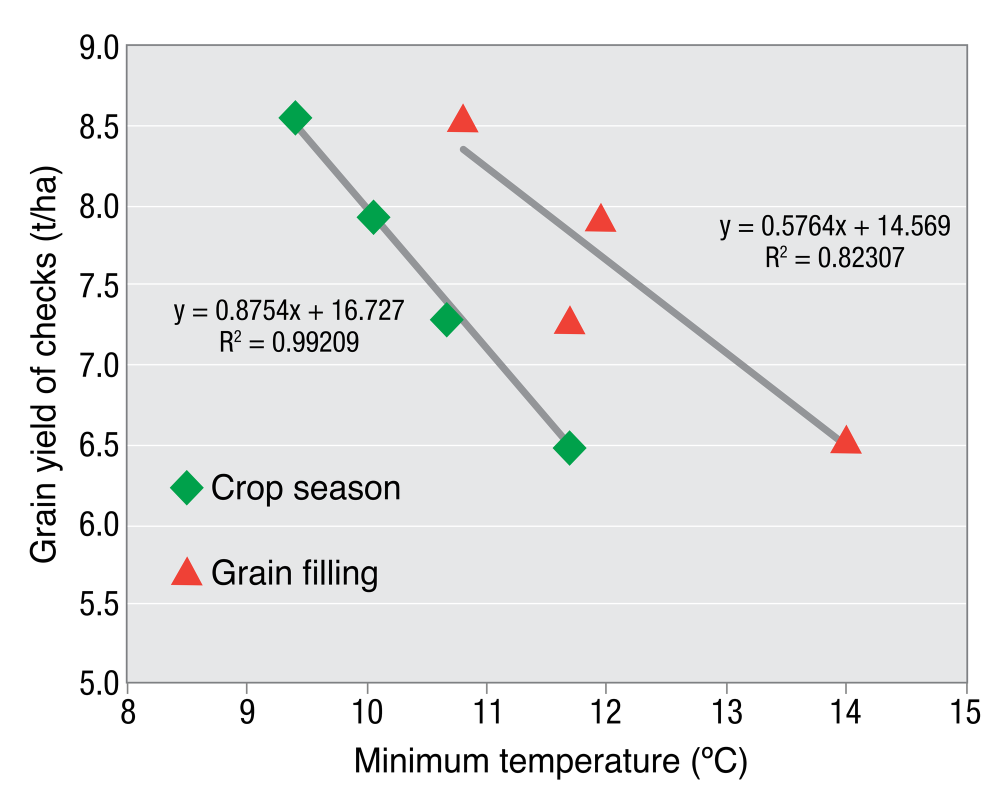

Figure 3. Association of mean minimum temperatures during crop season and during grain filling and the grain yield of the checks at the CIMMYT Research station, Cd. Obregon, Mexico.

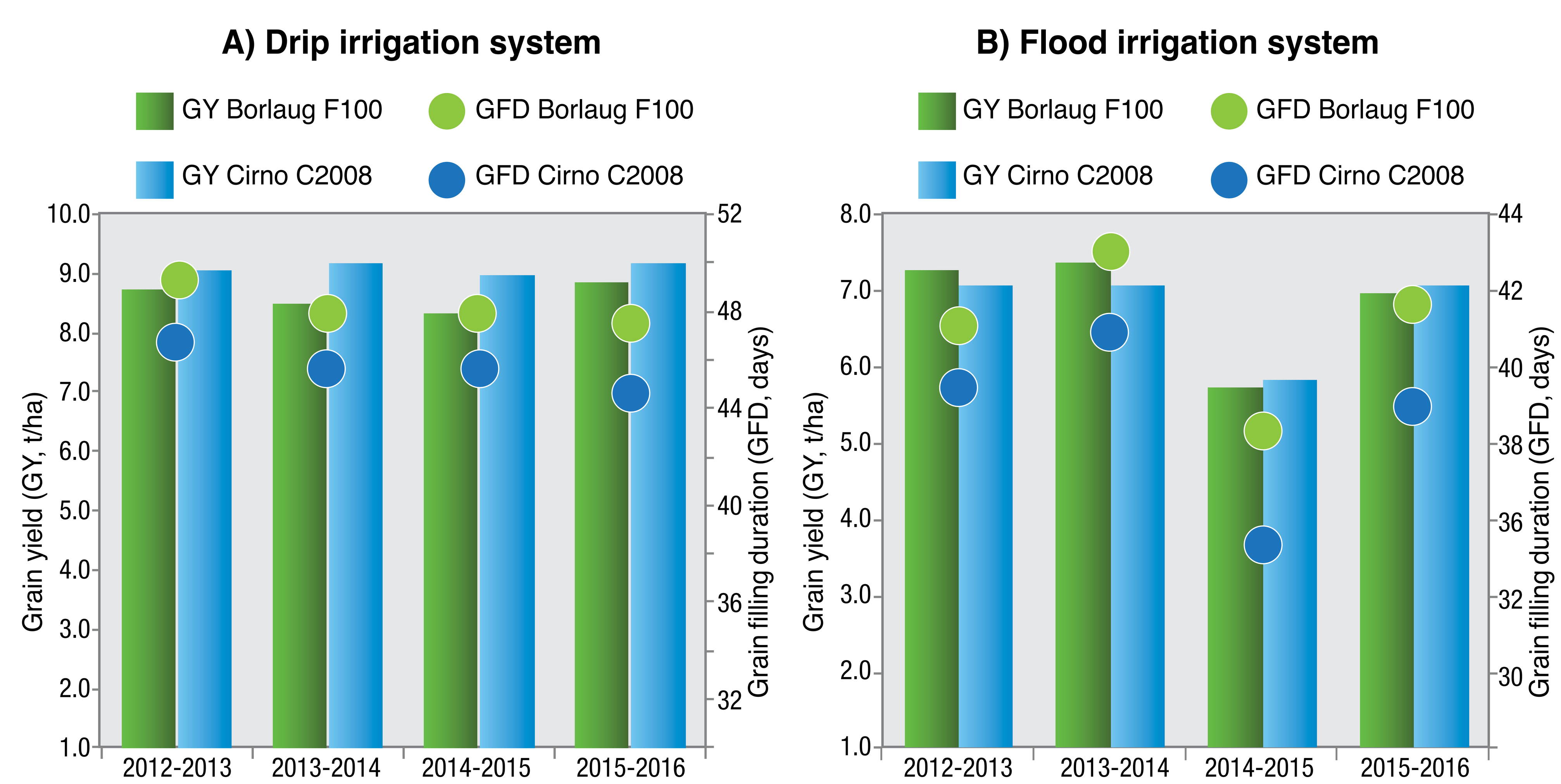

Figure 4. Mean grain yield and grain filling duration of the bread wheat (Borlaug F100) and durum wheat (Cirno C2008) in the cropping seasons from 2012-2016 under A) drip irrigation scheme and B) flood irrigation scheme

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