Differential Responses of Advanced Potato Clones to Primed Acclimation for Drought Tolerance in a Peruvian Potato System: Yield and Physiological Effects of Irrigation Timing

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CENTRO INTERNACIONAL DE LA PAPA CIP

Introduction

What is Primed Acclimation?

- Management technique using reduced irrigation rates to take advantage of stress memories or acclimation responses in crops to improve drought tolerance
- Mild to moderate deficit irrigation (DI) during vegetative growth (Rowland et al., 2012)
- Can cause changes in root architecture, biomass partitioning, water use efficiencies, and yields

Why potato?

- Grown as a staple crop in areas prone to drought and that are susceptible to predicted climate change
- Very sensitive to water deficit
- Potential of primed acclimation to improve environmental and economic sustainability of production (Byrd, 2012)

Objectives

To identify variability among potato cultivars to the use of two distinct timings of primed acclimation, using physiological, morphological and yield variables as indicators of drought tolerance.

Materials & Methods

- Field study completed in 2014 in a coastal desert environment at the International Potato Center experimental station in Lima, Peru located at 244 m above sea level (Figure 1).
- Three advanced potato clones, Clon 16, Tacna, and UNICA were subjected to four irrigation timing treatments using surface drip irrigation:
  1. Production Potential: maintained at field capacity (FC) through the entire season
  2. Priming Before Tuber Initiation Onset (TIO): DI of 50% of FC from emergence to TIO, maintained at FC from TIO to the midpoint of the season, followed by no water application until harvest (severe drought)
  3. Priming After TIO: maintained at FC from emergence to TIO, DI of 50% of FC for two weeks beginning at TIO, followed by rewatering to FC before the severe drought
  4. No Priming: maintained at FC until the severe drought
- Yield (total fresh weight of tubers) and the total number of healthy and deformed tubers produced per plant were recorded for three rows of each plot.
- Net assimilation of carbon dioxide (photosynthesis) was measured at TIO and two weeks after the onset of severe drought.
- Canopy development (% ground cover) was measured weekly from emergence using digital photography and WinCAM 2007d Color Area Meter Software (Regent Instriments, Inc., Québec, QC, Canada, 2007).

Figure 1. Photograph of experimental site at the International Potato Center in Lima, Peru. Taken June, 2014. K. Racette

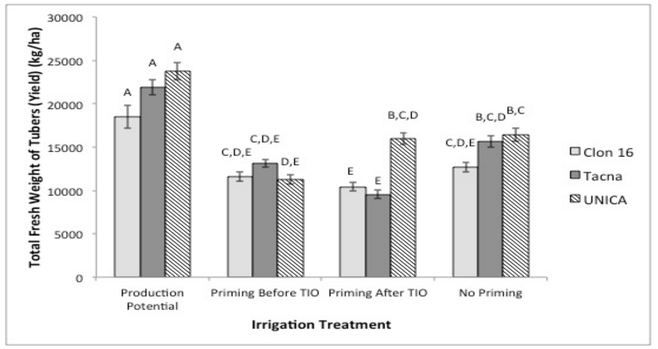

Figure 2. Average yield of potato cultivars Clon 16, Tacna, and UNICA (harvested at 111, 99, and 118 DAP, respectively). Includes connecting letters report of Tukey's HSD post-hoc multiple comparisons test on least square means of irrigation treatment*cultivar interaction. n=48, α= 0.05, p= 0.0131

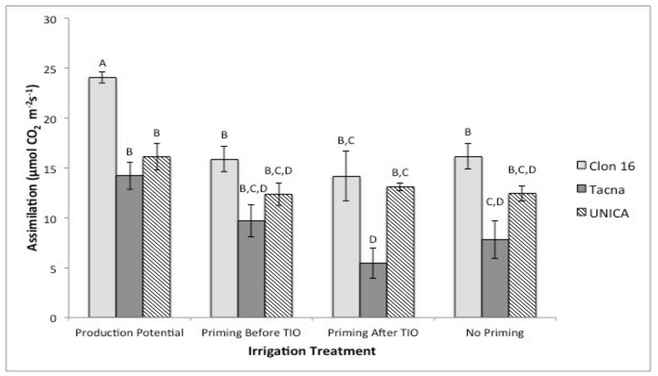

Figure 3. Average net assimilation of carbon dioxide two weeks after the onset of severe drought. Includes connecting letters report of Tukey's HSD post-hoc multiple comparisons test on least square means of irrigation treatment*cultivar interaction. n= 36, α= 0.05, p= 0.0103

Results & Summary

- Average yield was maintained in all primed plants of Clon 16, in plants receiving Priming Before TIO of Tacna and in plants receiving Priming After TIO of UNICA in comparison to plants that received No Priming, despite receiving less water overall (Figure 2).
- Average photosynthetic rate was maintained during a severe drought in plants across all irrigation treatments of UNICA, but was decreased in all treatments experiencing drought compared to that of the Production Potential of Clon 16 and Tacna (Figure 3).
- Canopy development differed between cultivars, where UNICA reached maximum % ground cover two weeks later than Clon 16 and Tacna (Figure 4A). However, canopy development did not differ between treatments (Figure 4B), indicating that differences in responses to the timing of primed acclimation may be impacted by cultivar differences in development.
- Results indicate that while primed acclimation can be used to maintain yields compared to non-primed plants under drought conditions, differential responses between cultivars necessitate cultivar-specific timing of irrigation management in improving drought tolerance.

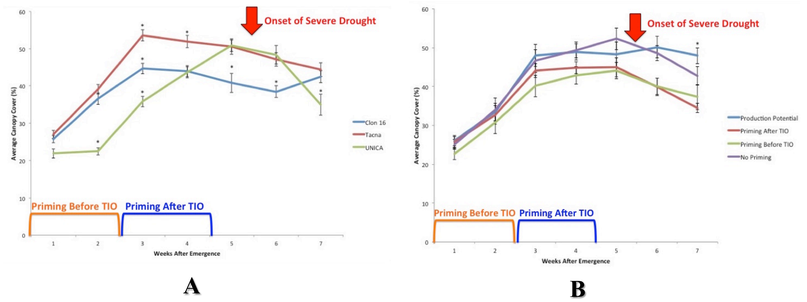

Figure 4. Average canopy cover (%) of potato cultivars Clon 16, Tacna, and UNICA subjected to four irrigation treatments taken f or seven weeks following emergence by A: Variety (p< 0.0001) and B: Irrigation Treatment (p= 0.0022). * indicates significance

Literature Cited & Acknowledgments

Byrd, S. A. (2012). *Management of center pivot irrigation on Florida potato: Impact on plant physiology and yield components* (Doctoral dissertation, University of Florida).

Rowland, D. L., Faircloth, W. H., Payton, P., Tissue, D. T., Ferrell, J. A., Sorensen, R. B. and Butts, C. L. (2012). Primed acclimation of cultivated peanut (*Arachis hypogaea* L.) through the use of deficit irrigation timed to crop developmental periods. *Agricultural Water Management, 113*, 85-95

This work was supported by the USDA National Institute of Food and Agriculutre and the International Potato Center of Lima, Peru through the project, "Improved potato varieties and water management technologies to enhance water use efficiency, resilience, cost-effectiveness and productivity of small holder farms in stress-prone Central Asian environments" BMZ/GIZ.