Calibration of the FAO-AquaCrop model for the under-utilized crop quinoa (*Chenopodium quinoa* Willd.) in the Bolivian Altiplano

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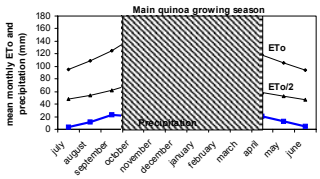
Introduction

- Quinoa
  - Staple food crop in the Andean mountains
  - Very high nutritional value
  - Resistant to extreme conditions of drought, frost, hail and salinity
  - Under-utilized
  - World wide cultivation is increasing
- The Bolivian Altiplano is a harsh cropping environment:
  - Low rainfall, high ET_0, high frost risk
  - Example: mean ET_0 and rainfall in Patacamaya



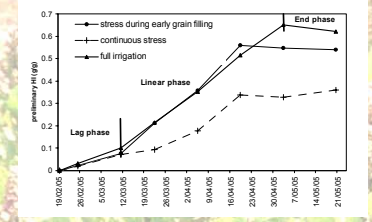
Methodology

- FAO-AquaCrop model
  - Dynamic crop growth in response to environmental stresses
  - Can be calibrated for different crops
  - Limited input requirements and robust

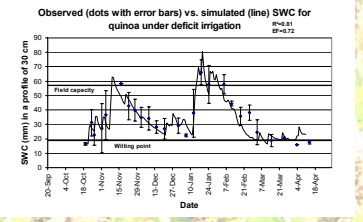
- Container and field experiments 2004-2007
  - In the Bolivian Andean region (Altiplano)
  - Fields under rain fed conditions, deficit irrigation and full irrigation
  - To understand crop responses
  - To obtain calibration and validation data sets
- Calibration and validation of the model
  - Collection of weather data, soil characteristics and management inputs
  - Calibration on basis of observed soil water content, biomass, yield and canopy cover
  - Calibration by adjusting the crop input file

Results

- Building up of the Harvest Index (HI)

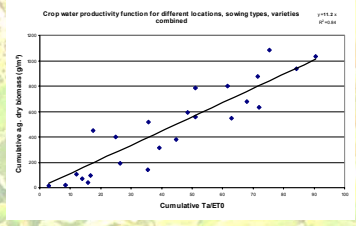


- Soil water content (SWC)

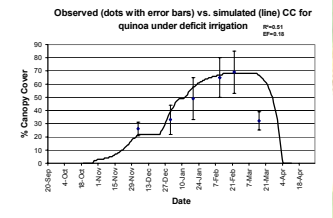


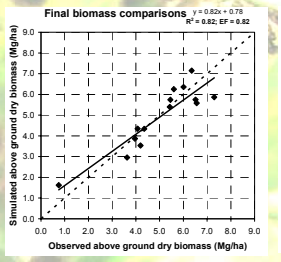
- Important calibration steps:
  - Dormancy before triggering senescence
  - Vegetative and reproductive growth unlinked: indeterminate crop
  - Very high leaf expansion stress p-factor → drought resistance
  - Very high stomatal stress p-factor→ drought resistance
  - Lower WP value for fully irrigated quinoa (nutrient depletion)
- Biomass and total grain yield
  - Good agreement for quinoa under deficit irrigation, full irrigation and rain fed conditions

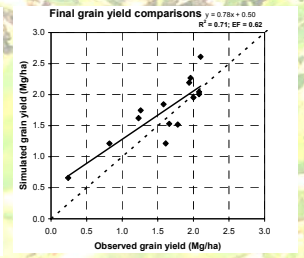
- Water productivity (WP) of quinoa: 11 g/m²



- Canopy cover (CC) development







Conclusion

- Preliminary calibrations and validations gave good results
- Future issues to be studied in the model:
  - Effect of low fertility and N-depletion under fully irrigated conditions on WP
  - Increase in crop cycle length due to water stress before flowering
  - Possible hardening (p-factor increase in model) due to water stress from the 2 till the 12-leaf stage
  - Decrease of HI due to severe nutrient depletion
- The validated model will be useful
  - To refine a deficit irrigation strategy for quinoa under different management conditions
  - To formulate mitigation strategies for drought during El Niño years
  - To formulate mitigation strategies for higher climate variability under climate change

References

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