Effect of Drought Stress on Crop Development, Growth and Chlorophyll Fluorescence in Five Potato Clones

Leah Kuppinger*[1], Julia Auber[1], M. Awais Khan[2], Evelyn Farfan[2], Merideth Bonierbale[2], Folkard Asch[1]

[1]University of Hohenheim, Garbenstraße 13, 70599 Stuttgart, Germany
[2]International Potato Center, Lima, Peru

*leah.kuppinger@uni-hohenheim.de

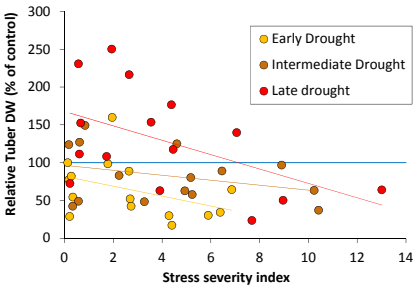
Introduction

Potato production worldwide is frequently affected by water scarcity, a situation that highly constrains crop yields, as potato is known for its susceptibility to drought stress. The ongoing climate change will entail increasing temperatures and further restrain seasonal water availability. Therefore it is important to examine drought resistance traits to sustain potato production. The aim of this study was to investigate the effects of drought during different development stages on plant growth and tuber production in 5 potato clones.

Conclusions

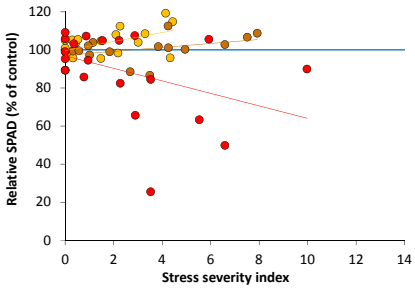
- Genotypic growth and yield performance under drought stress strongly depended on the development stage when the water was withheld
- Drought occuring during tuber initiation reduced partitioning of assimilates to tubers
- Mild drought during late development stages increased tuber yield
- Drought increased PS II quantum yield independent of development stage

Tuber and Leaf Properties



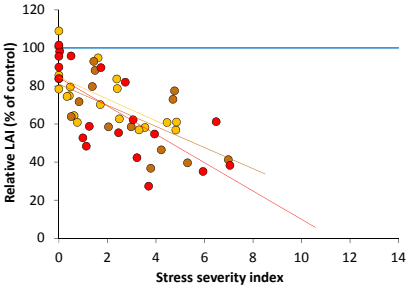
Early mild drought decreased, late mild drought increased tuber yield across genotypes

Early mild drought reduced tuber initiation, late mild drought promoted sink strength of the tubers



Early mild drought increased, late mild drought strongly decreased leaf chlorophyll concentration

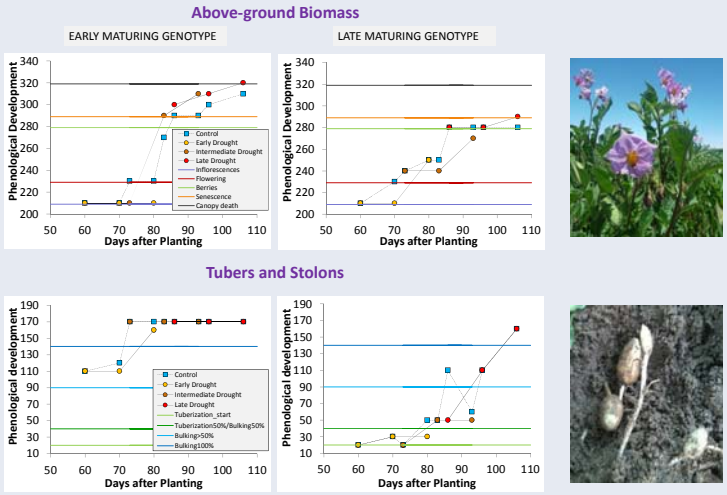
Early mild drought reduced leaf expansion, late mild drought promoted fast leaf senescense



Drought quickly reduced LAI. Late drought had the fastest and strongest effect on LAI

Early mild drought reduced the source for sink formation, late mild drought promoted carbohydrate re-partitioning to tubers

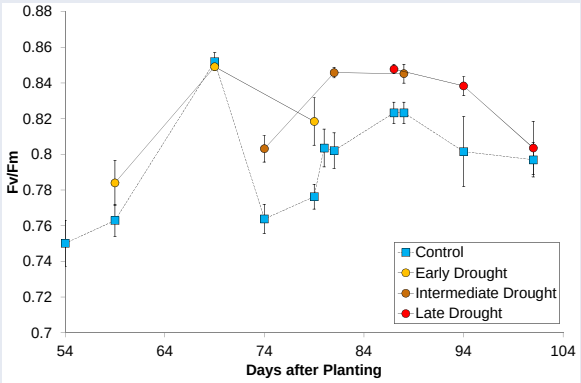
Phenological Development



Phenological development was hastened by drought in early maturing and delayed in late maturing varieties

Broken lines indicate fully watered conditions and solid lines drought treatments. Colored horizontal lines represent start of principal growth stages

Chlorophyll Fluorescence



Drought stress increased quantum yield of PS II (Fv/Fm) after dark adaption in all genotypes particularly during later development stages

Drought conditions probably lead to an increase in photosynthetic efficiency in the young, fully developed leaves under stress combined with smaller leaf area and increased chlorophyll concentration

Materials and Methods

In a field experiment, conducted in 2013 in the coastal arid region in southern Peru, five contrasting potato genotypes (varying for earliness) were subjected to 4 different irrigation treatments (i.e. fully watered throughout, until 54 days after planting (DAP), 67 DAP, and 80 DAP respectively) in a "split-split plot" design . Phenological observations and destructive samplings for above and below-ground biomass determination were conducted 6, 16 and 26 days after withholding irrigation in each treatment. Further, chlorophyll fluorescence, SPAD and LAI measurements were taken regularly during the drying cycles. A stress severity index (SSI) was developed relating the soil water deficit to the treatments and the genotypes relative to fully watered conditions,

where $SSI = \sum_{d=0}^{dn} \frac{(e^{((FCadj - xadj)/FCadj)} - 1)}{(e^1 - 1)}$

(*d*= days after withholding irrigation; *FC*= field capacity; *x*= profile soil water content; *adj*= adjusted values (only plant available soil water)).

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