# Cultivated and Wild Tomatoes Responses to Water Stresses

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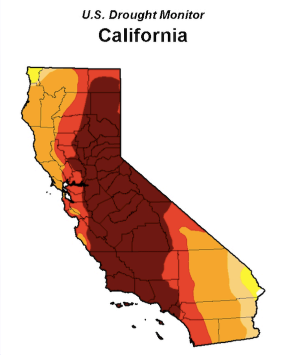
## 1. Phenotypic plasticity of plant roots allows plants to adapt to extreme environment

- Drought and flooding exist globally

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- Both drought and flooding affect crop yields
- Phenotypic plasticity:
    - In drought environment- surface roots tend to grow deeper away from the surface in order to compete for water.
    - In flooding environment- aerenchyma develops to allow exchange of gases.
- **Biological question**: how do roots change its phenotype and gene expression in response to water stresses?

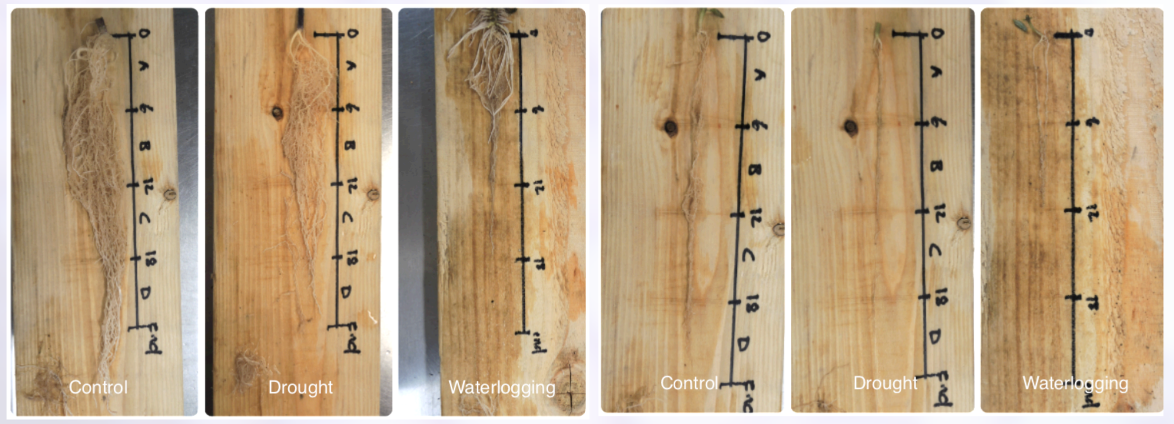
## 2. Phenotypic and gene expression responses of tomatoes

- Cultivated tomato: *Solanum lycopersicum* cv. M82
- Wild and drought tolerant tomato: *S. pennellii*
- Three conditions:
    - well-watered (control)
    - drought
    - flooded
- Applied stress: 12 days after growth of two weeks
- Phenotype: root biomass distribution, anatomy including the cortex layer number, cell size, and formation of aerenchyma.
- Gene expression: quantitative PCR to look at expression of known stress-responsive genes.

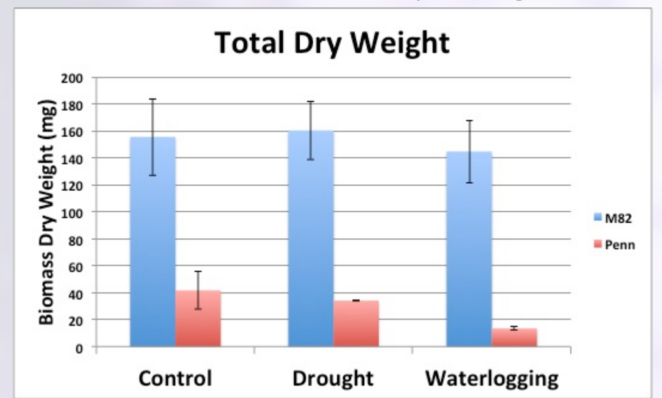
*Experiment setup: tomatoes in growth chamber under water stresses.*

## 3. Different root biomass distributions are shown in three treatments

- Root images after long-term water stress responses
- Cultivated tomato: *S. lycopersicum* (M82)- left
- Wild and drought tolerant tomato: *S. pennellii* (Penn)- right



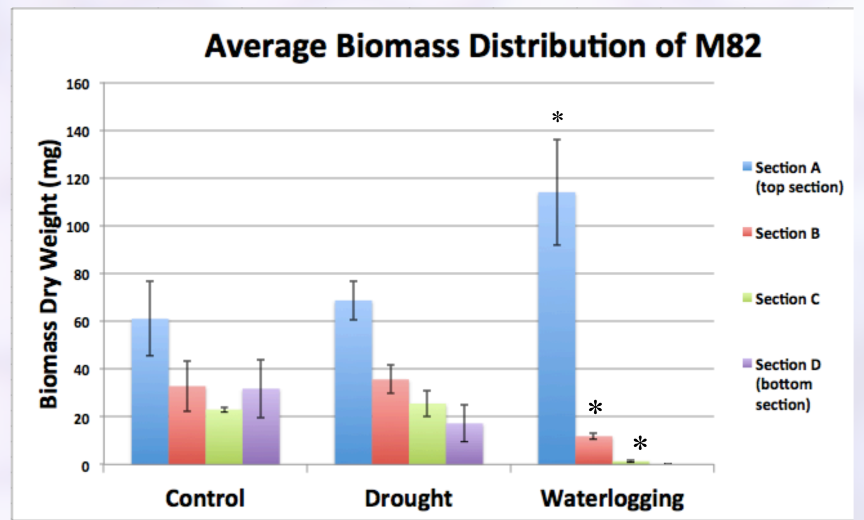

- We measured total dry weight of M82 and Penn.




***M82***: *total dry weight from three treatments are similar.*

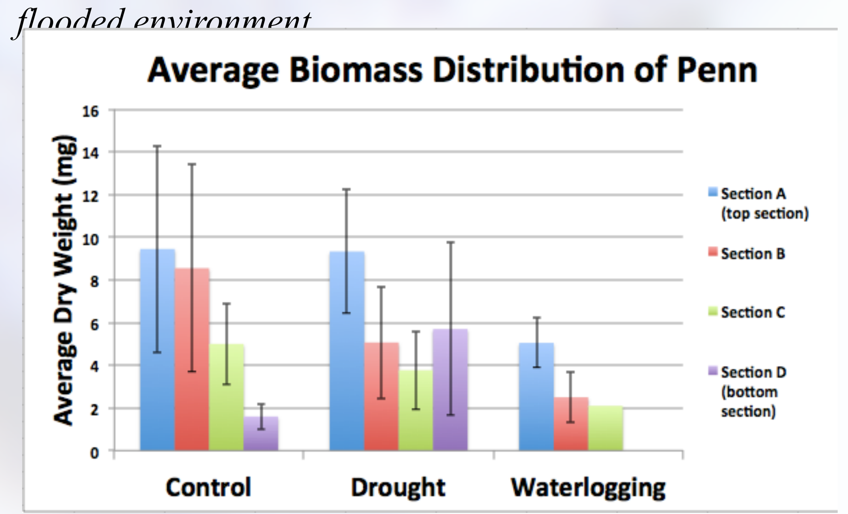
***Penn***: *Total dry weight from waterlogging is significantly less than in control. Penn cannot survive well from a flooded environment.*

- We divided roots into four sections and measure dry weight.




* $p<0.05$

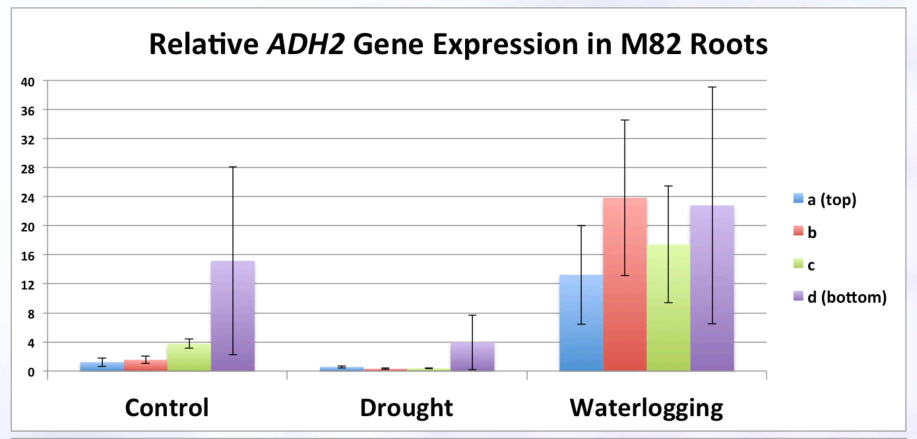
***M82:*** *Biomass distribution of each section from waterlogging is significantly different from control. Also, biomass distribution of each section is significantly different from top section for all three treatments. Most root stay in Section A (top section) to compete for oxygen in a flooded environment.*

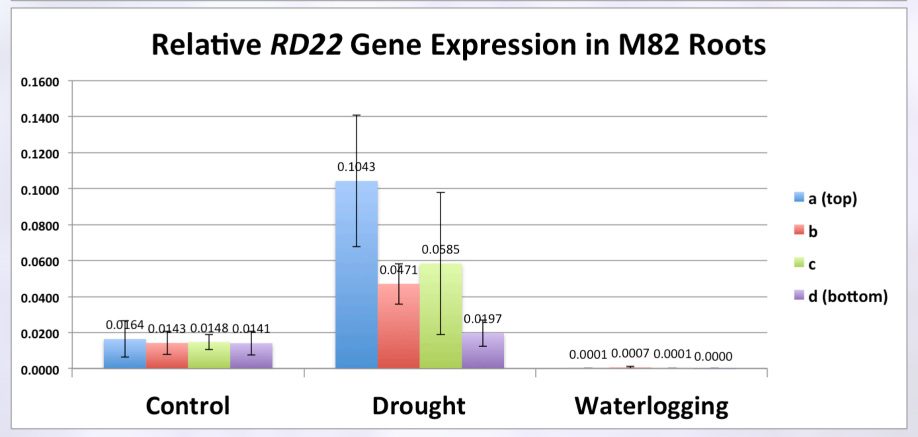


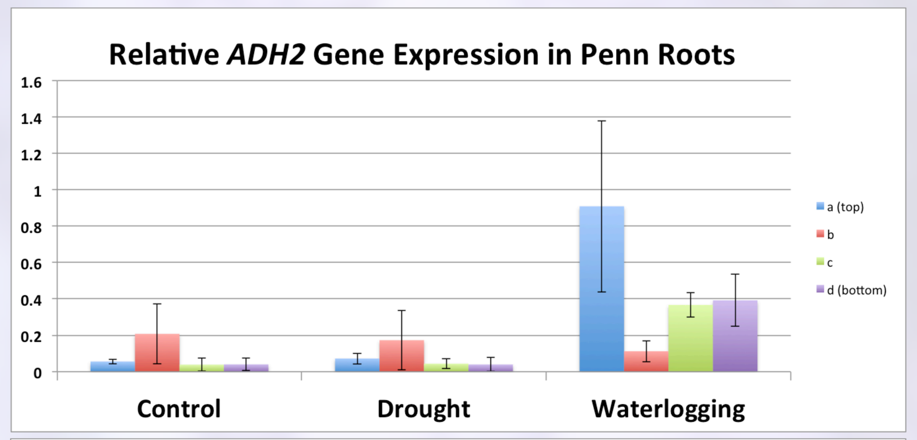

***Penn***: *biomass distribution of each section is significantly different from top section for drought treatment. Since Penn do not survive well in waterlogging, data is not very meaningful for waterlogging.*

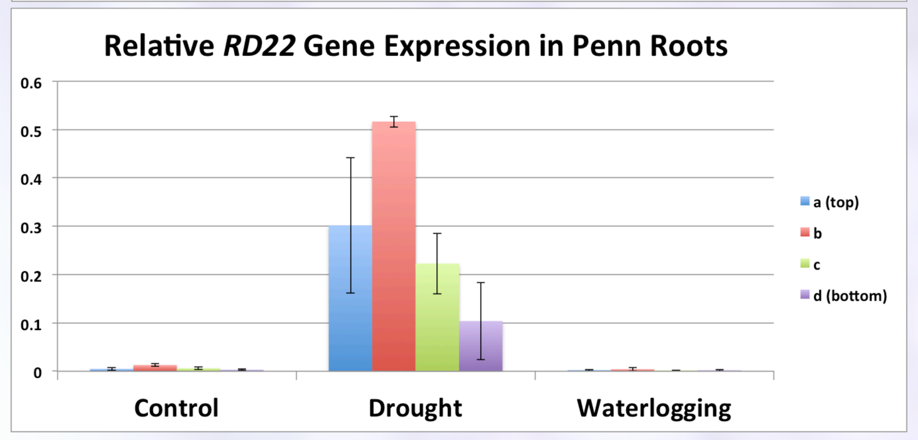
## 4. Drought and anoxia responsive genes are upregulated in drought and waterlogging

- *ADH2*- a gene responsive to low oxygen level
- *RD22*- a gene responsive to desiccation
- I did quantitative reverse transcription PCR to quantify gene expression.



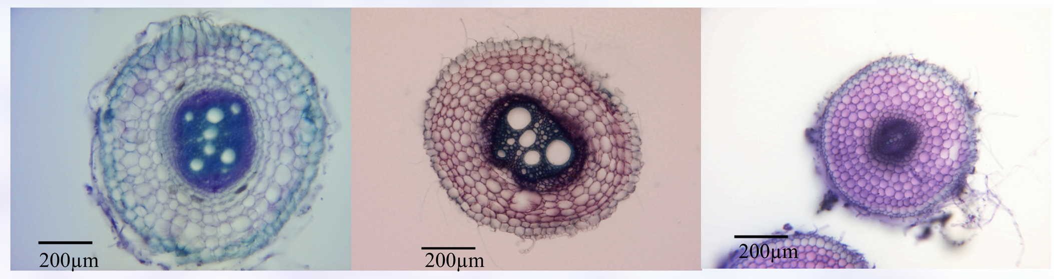



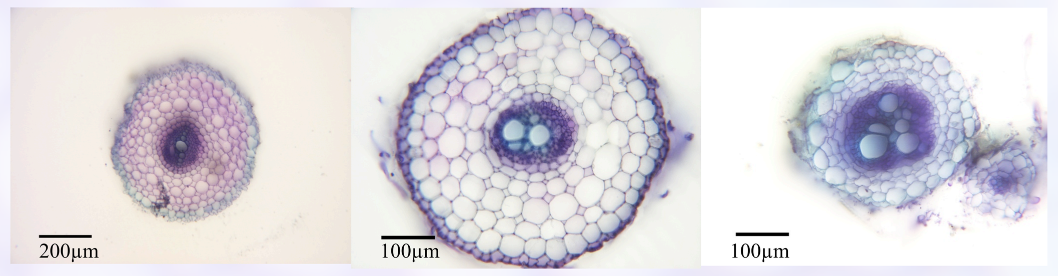

- ***M82 and Penn***:
- *High gene expression level of ADH2 in waterlogged roots. Only waterlogging is significantly different from other treatments for all sections.*
- *High gene expression level of RD22 in drought roots. Each treatment is significantly different from others.*
- *Gene expression level of ADH2 and RD22 are significantly different between two genotypes, M82 and Penn.*
- *Depth is not significant- more samples are needed to increase statistical power and determine the effect of depth.*

## 5. Root anatomy is being studied to show if it responds to water stresses

- I collected two roots of four sections from each treatment.
- I then sectioned roots and image root sections under light microscope.




*M82 (from section c): control, drought, waterlogging*




*Penn (from section c): control, drought, waterlogging*

## 6. Conclusion

- Phenotypic plasticity allows roots to change its root distribution in a flooded environment for cultivated tomatoes, while overall dry weight of roots stays unchanged in extreme conditions.
- Anoxia responsive gene in roots is upregulated in a flooded environment, whereas a drought responsive gene is upregulated in both drought and flooded environment for both cultivated and wild tomatoes.
- Root anatomy shows that roots change its phenotype expression in response to water stressses.
- Roots do response to water stress on genetic and phenotypic level.

## 7. Future Work

- Analyze root anatomy: quantify cortex layers, cell size, and formation of aerenchyma
- Analyze amounts of lignin, suberin and cell death by staining.

## Acknowledgement

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