

The biogeography and evolution of drought tolerance in grasses

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Drought stress

- Limit ecosystem and agricultural productivity
- Influence plant community structure
- Likely to be more frequent and severe in the future



<https://www.chinasmack.com/yunnan-drought-fish-trapped-in-dried-lake-bed-photos>

Grasses

- Present on Earth for over 70 million years (MYS)
- Grassland ecosystems prominent for over 20 MYS
- ~12,000 species (~3% of total vascular plants)
- Account for ~1/4 of terrestrial carbon cycle
- Critical dietary component of humans and grazing animals



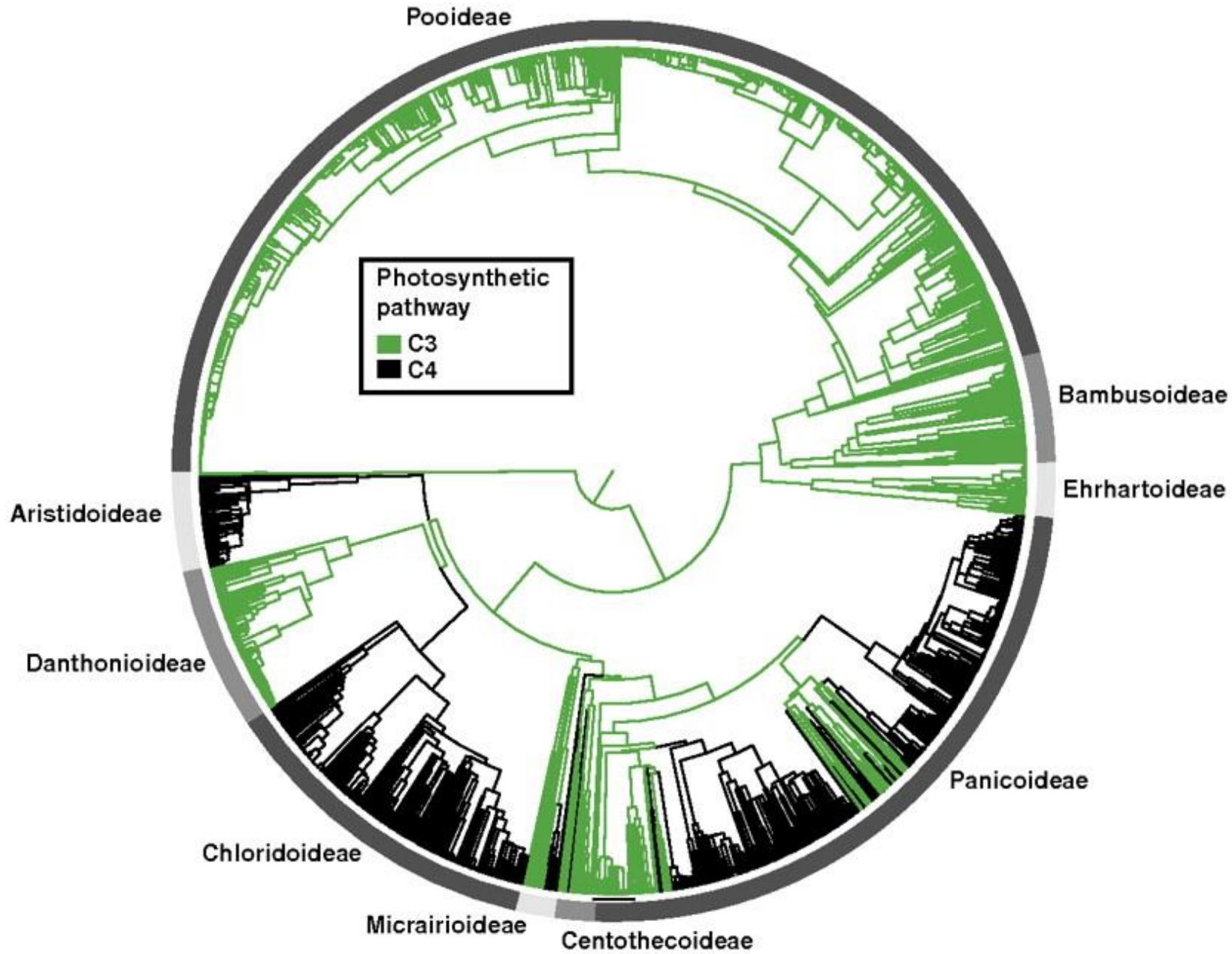
<https://wallpapersafari.com/grassland-wallpaper/>



<http://www.regeneratinggrassland.com/>

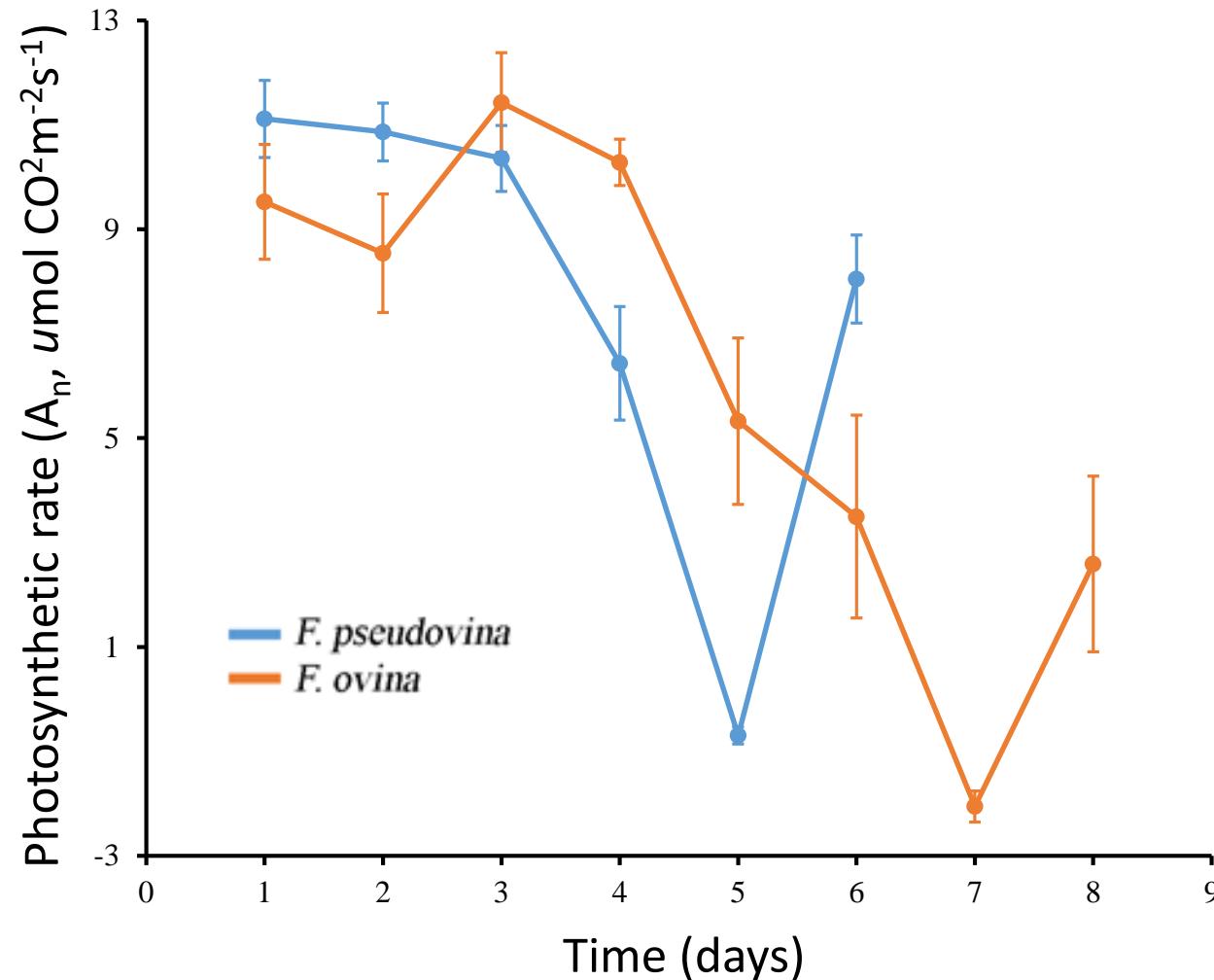
C_3 vs C_4 grasses

- Two photosynthetic pathways
 - C_3 : typical of most plants, dominating in cooler temperate regions
 - C_4 : increased photosynthetic rates, enhanced water use efficiency (WUE), dominating in tropical and subtropical grasslands
- Multiple origins of C_4 pathway

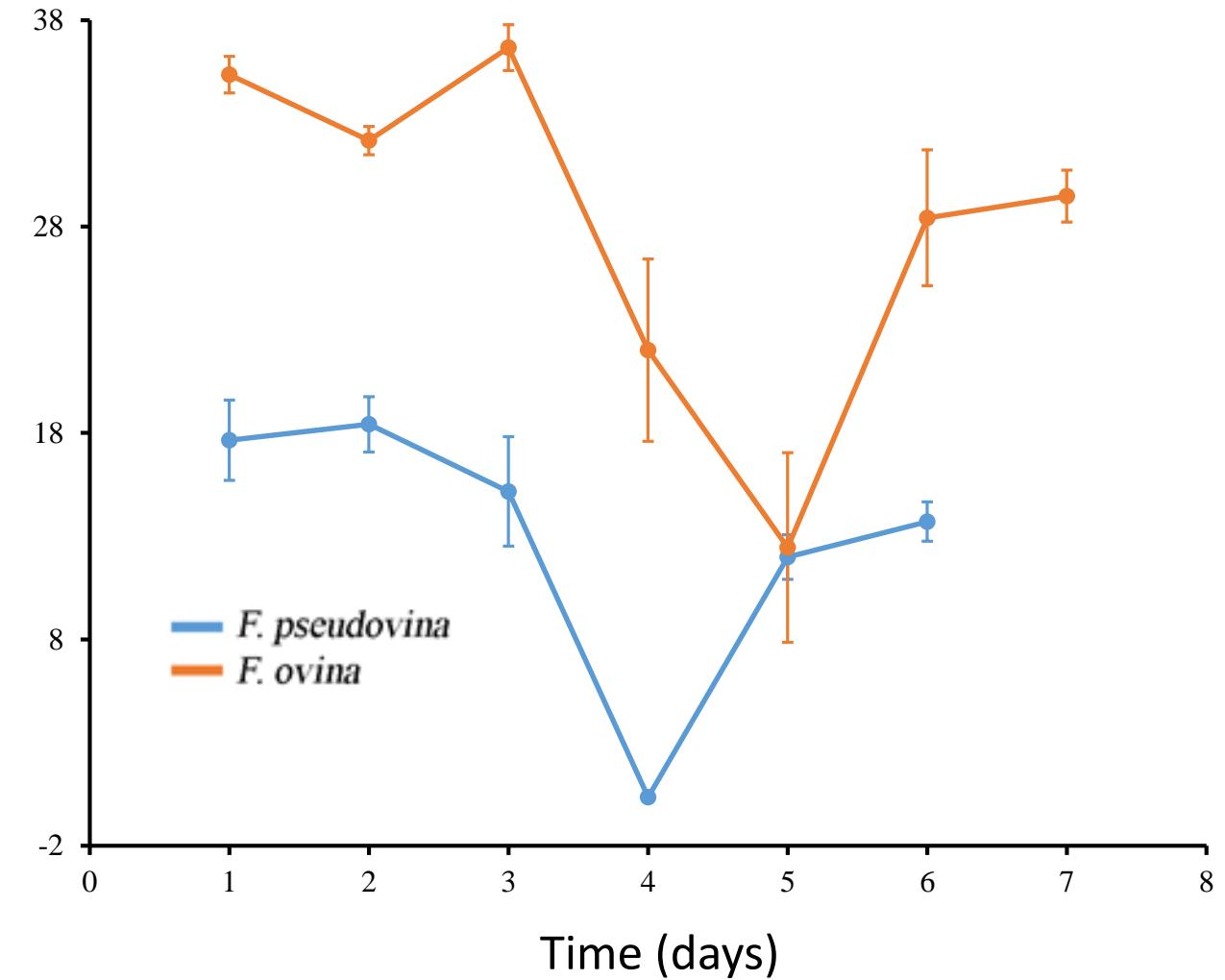


Dry-down experiments

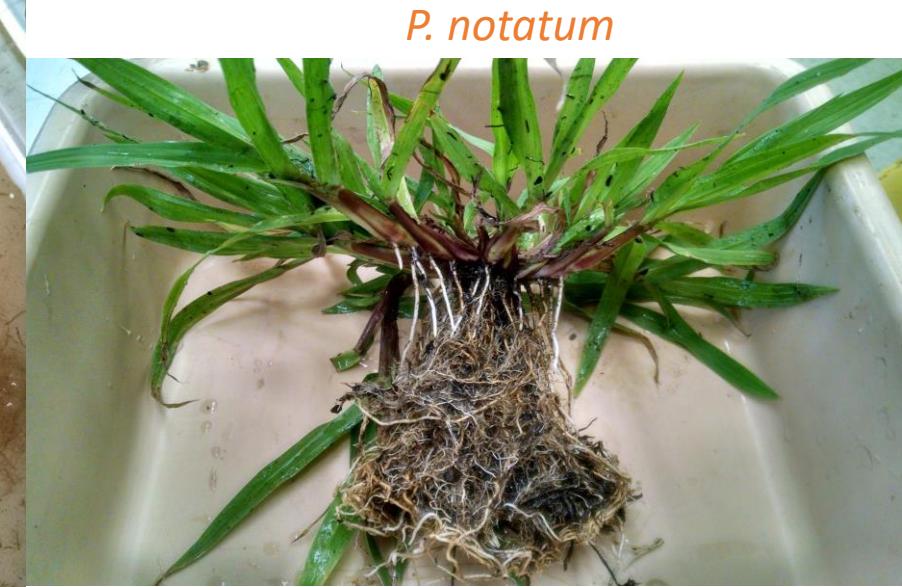
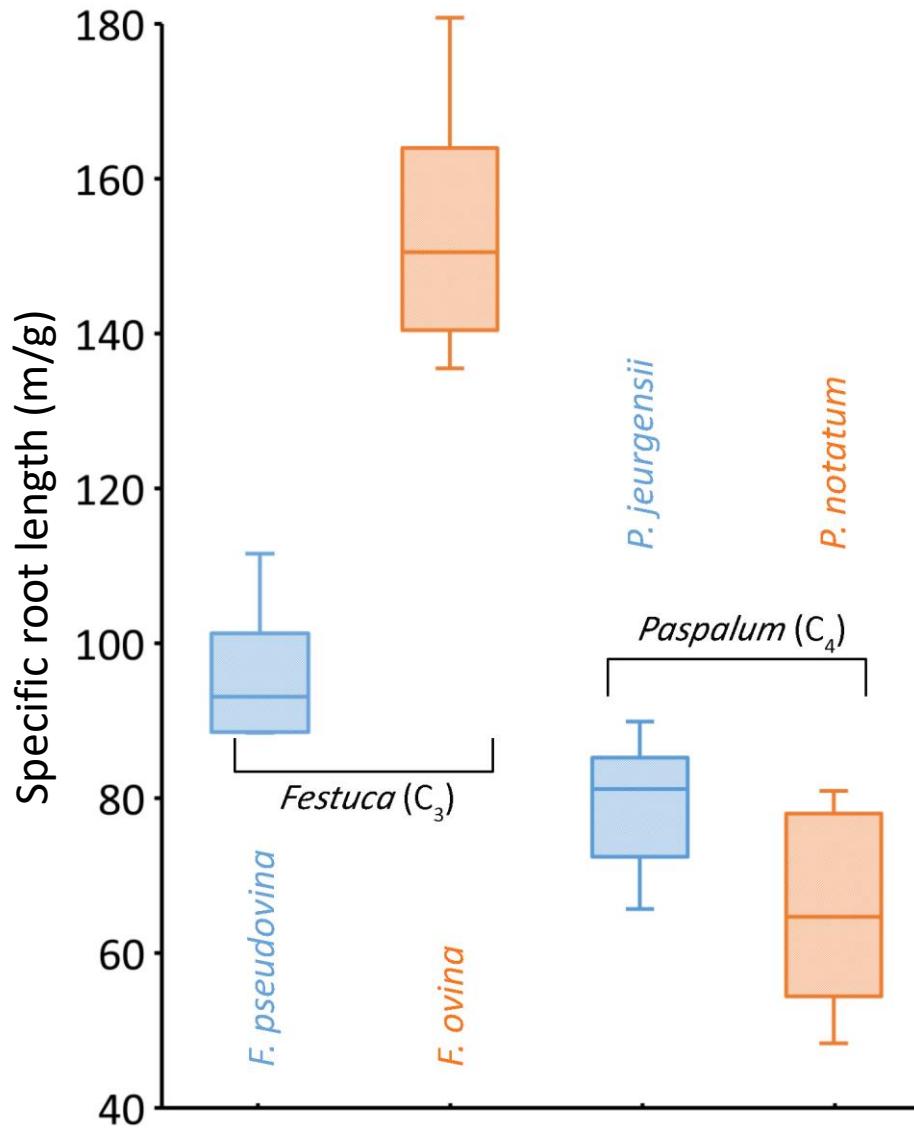
Festuca (C₃)



Paspalum (C₄)

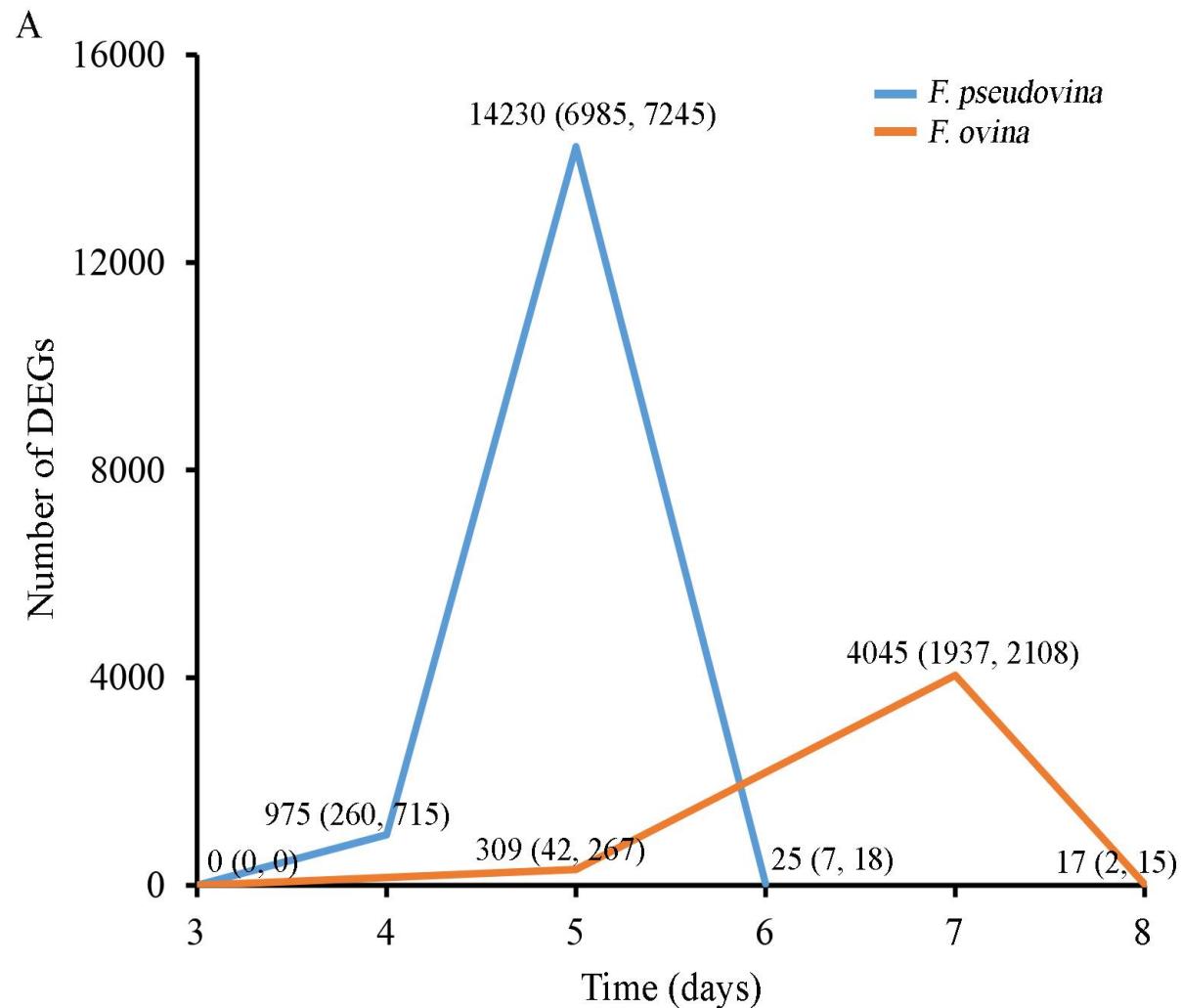


How does root architecture influence physiology during water stress?

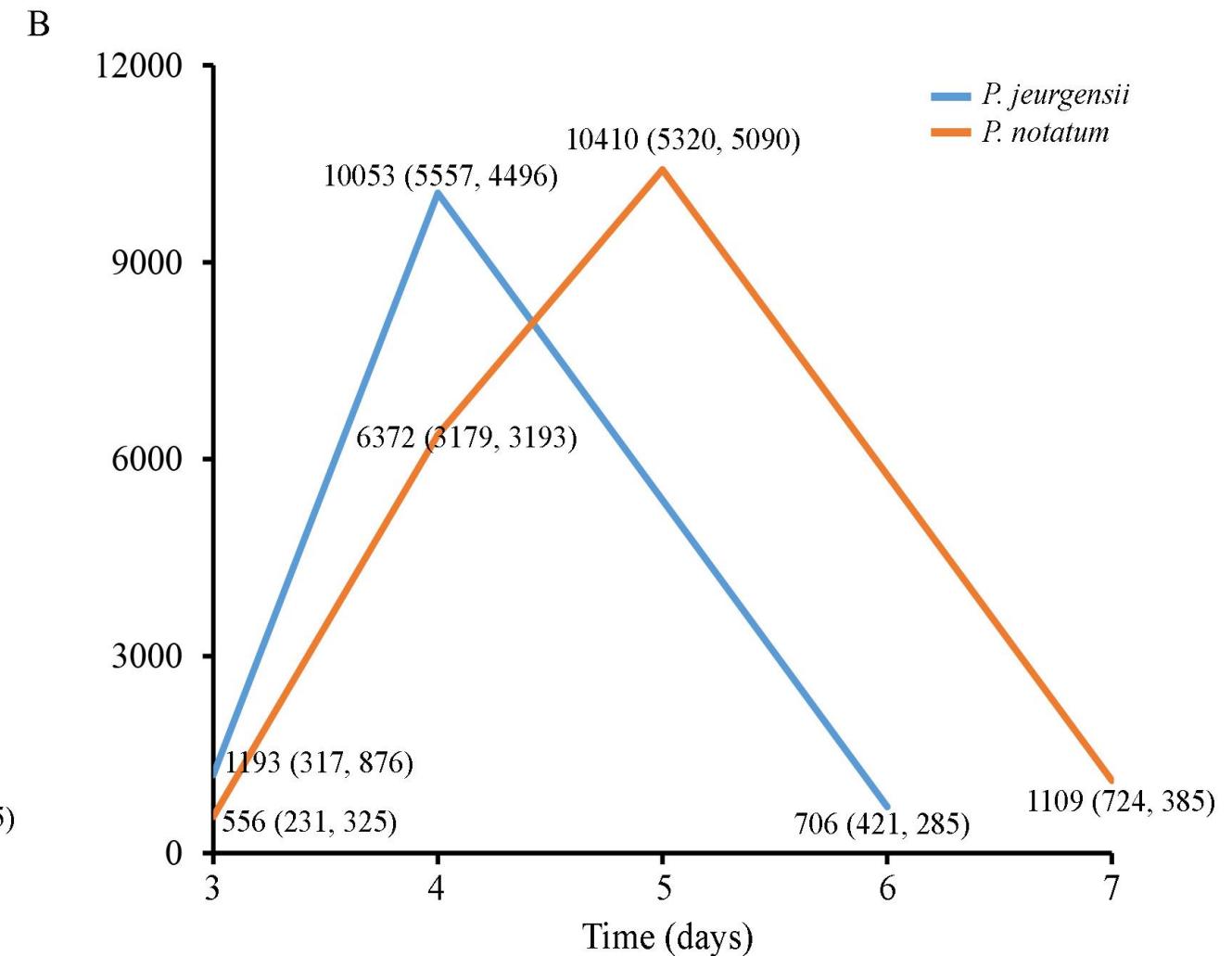


Differential gene expression (RNA-seq)

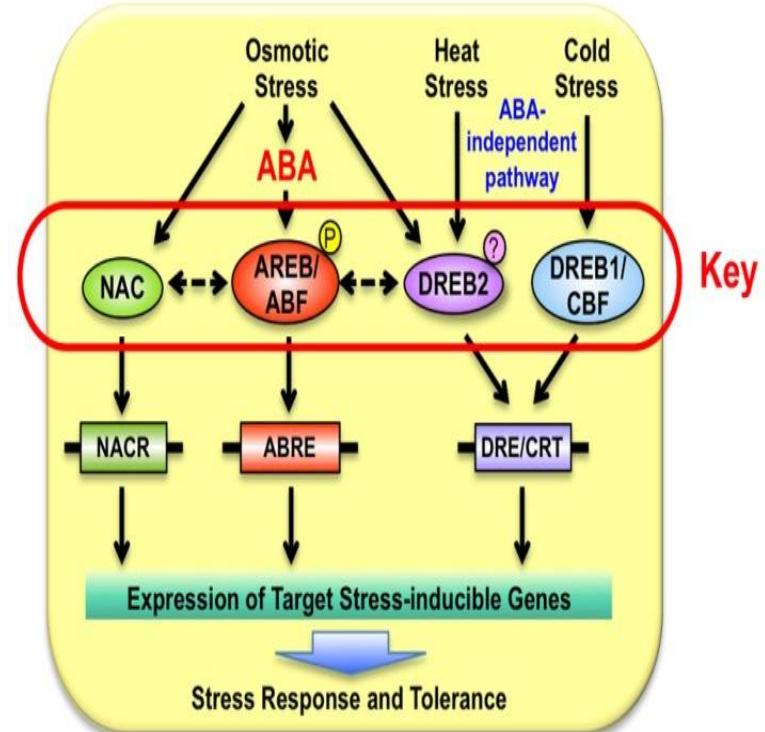
Festuca (C_3)



Paspalum (C_4)

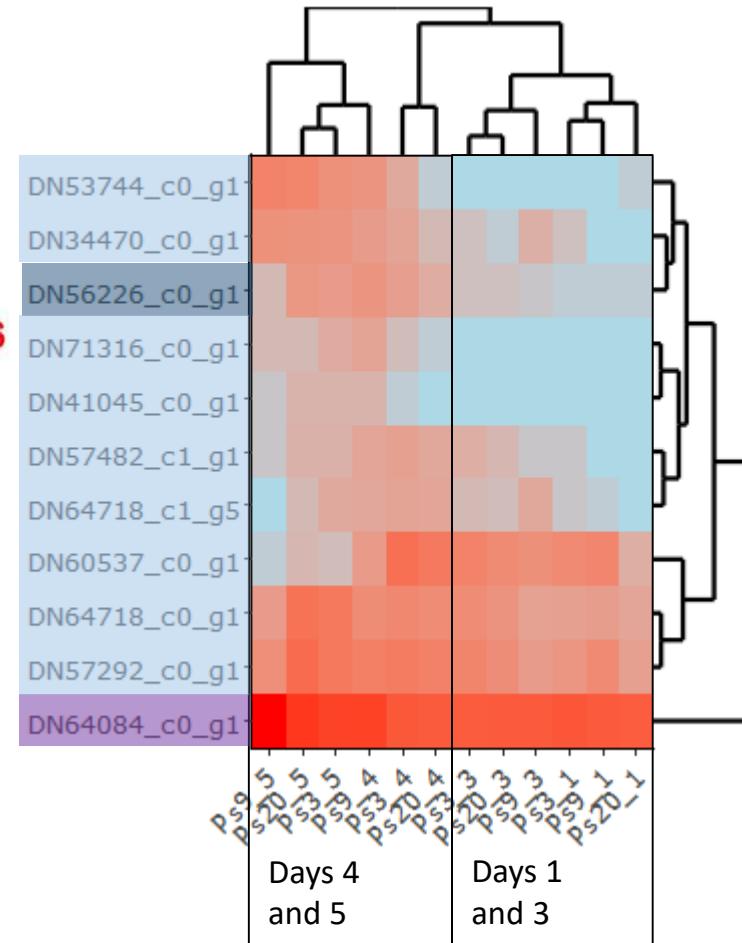


Stress-responsive pathways (DREB)



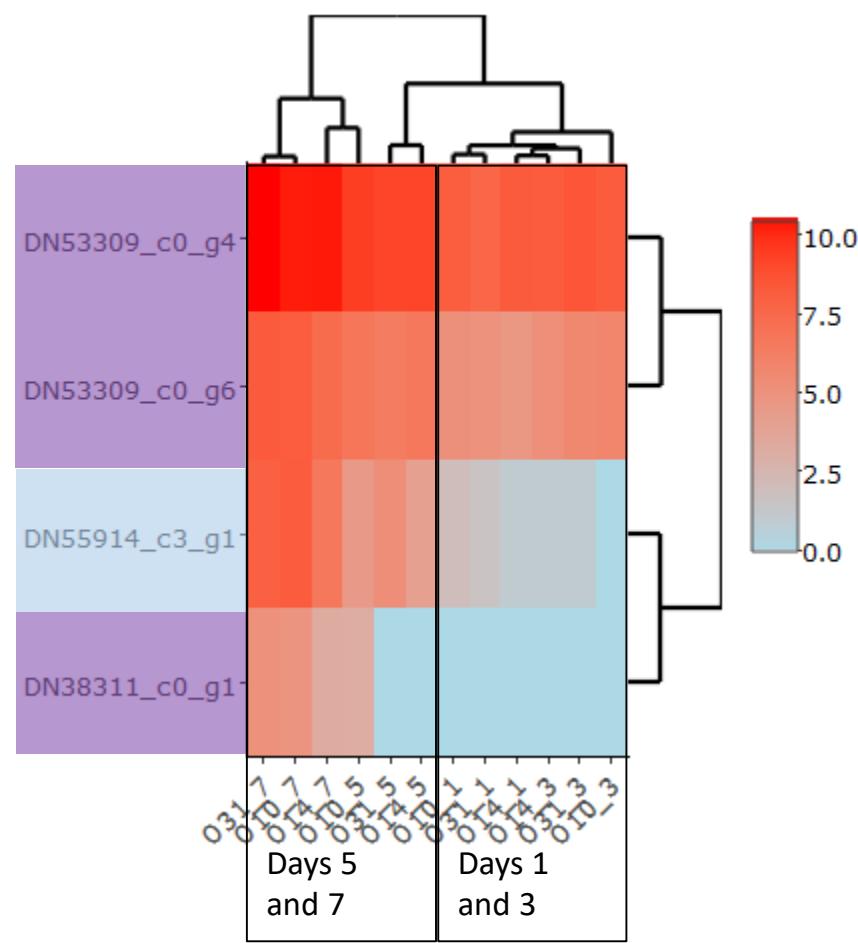
Nakashima et al Frontiers in Plant Science 2014

F. pseudovina (less tolerant)



DREB1: 9 copies
DREB2: 1 copy
DREB3: 1 copy

F. ovina (more tolerant)



DREB1: 1 copy
DREB2: 3 copies

Conclusions

- Leaf shape evolution across the grass family exhibits phylogenetic trends and environmental correlates
- Dry-down experiments of C₃ and C₄ congener species offer insights into physiological, anatomical, and gene expression determinants of tolerance/susceptibility to water stress
 - SRL explains differences in sensitivity to water stress in C₃ congeners only
 - Greater gene expression responses in less tolerant species (C₃ only)
 - Differential recovery of genes involved in photosynthesis between C₃ and C₄
 - Stress-responsive pathways differentially activated between congener species

Acknowledgements



IOWA STATE
UNIVERSITY

OSU
Oregon State
UNIVERSITY

NIU
NORTHERN
ILLINOIS
UNIVERSITY