

Challenges and Opportunities for Enhancing Crop Adaptation to Stressful Environments

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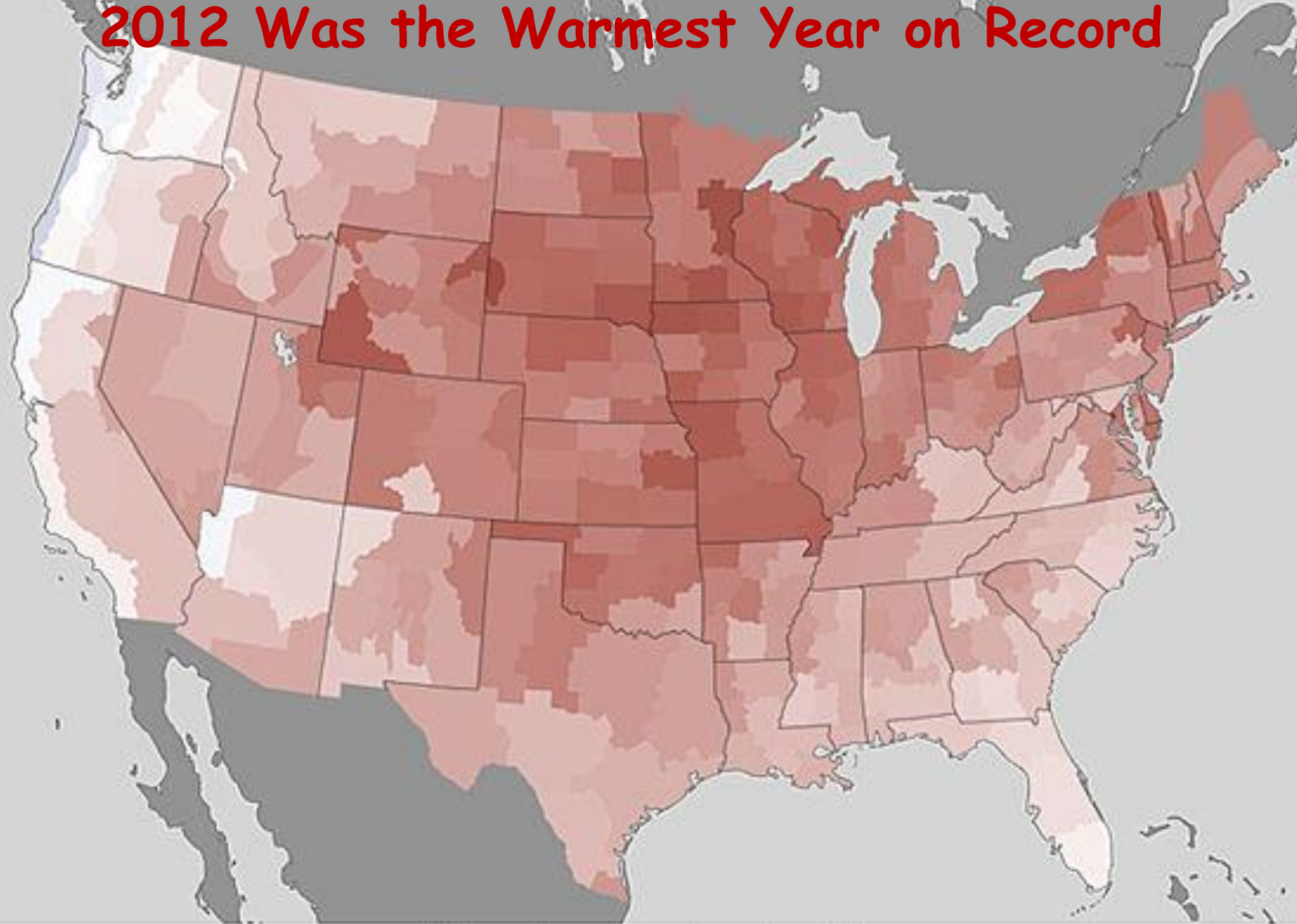


Overview

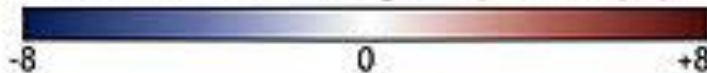
- Climate resilient agriculture
- Current trends in adaptation of crops to environmental stresses
- Challenges in efforts to integrate multiple climate adaptation traits
- Opportunities for comparative analyses of crops that exhibit unique adaptation characteristics



2012 Was the Warmest Year on Record



Difference from average temperature (°F)



Climate Resilient Agriculture

- Agriculture is highly sensitive to climate variability.

Distribution of insurance indemnities for crop losses in the U.S. from 1939 to 1978.

Cause of crop loss	Proportion of payments
Drought	40.8
Excess water	16.4
Cold	13.8
Hail	11.3
Wind	7
Insect	4.5
Disease	2.7
Flood	2.1
Other	1.5

J. S. Boyer, 1982. Science 218: 443-448.



Climate Resilient Agriculture

- Agriculture is highly sensitive to climate variability.
- Genes and sources of germplasm that contribute to heat and drought tolerance are being mobilized to develop improved crop cultivars.





Genes for Abiotic Stress Tolerance in Crops

Flooding tolerance

- *Sub1A* is a pivotal gene for submergence tolerance in rice.

Salinity tolerance

- *Saltol* rice for wet, saline regions

Nitrogen use efficiency (NUE)

- Alanine aminotransferase (AlaAT) from barley is being used as a transgene to improve NUE

Genes for Abiotic Stress Tolerance in Maize

- Elite temperate pool
 - Agrisure Artesian™ Technology
 - Optimum® AQUAmax™ hybrids



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- Wild relatives
- Transgenic traits
 - Genuity® DroughtGard™ Hybrids



Challenges to Integration of Multiple Climate Adaptation Traits

- Additional efforts are needed to integrate or stack multiple climate adaptation traits into new cultivars.
- Two major challenges for crop improvement
 1. Genotype by environment and stage of development interactions for abiotic stress tolerance are complex
 2. Efforts to combine multiple stress tolerance into a single genotype can be challenging

Harrison et al., 2014. *Global Change Biology* (2014) 20, 867–878, doi: 10.1111/gcb.12381

Cairns et al., 2013. *Crop Sci.* 53:1335–1346, doi: 10.2135/cropsci2012.09.0545

Challenges to Integration of Multiple Climate Adaptation Traits

- Late-season drought stress in maize



Challenges to Integration of Multiple Climate Adaptation Traits

- Heat-stress tolerance in maize



Challenges to Integration of Multiple Climate Adaptation Traits

- Successful crop improvement efforts for multiple stress tolerance will require a clear understanding of component traits and how they impact plant growth and development.



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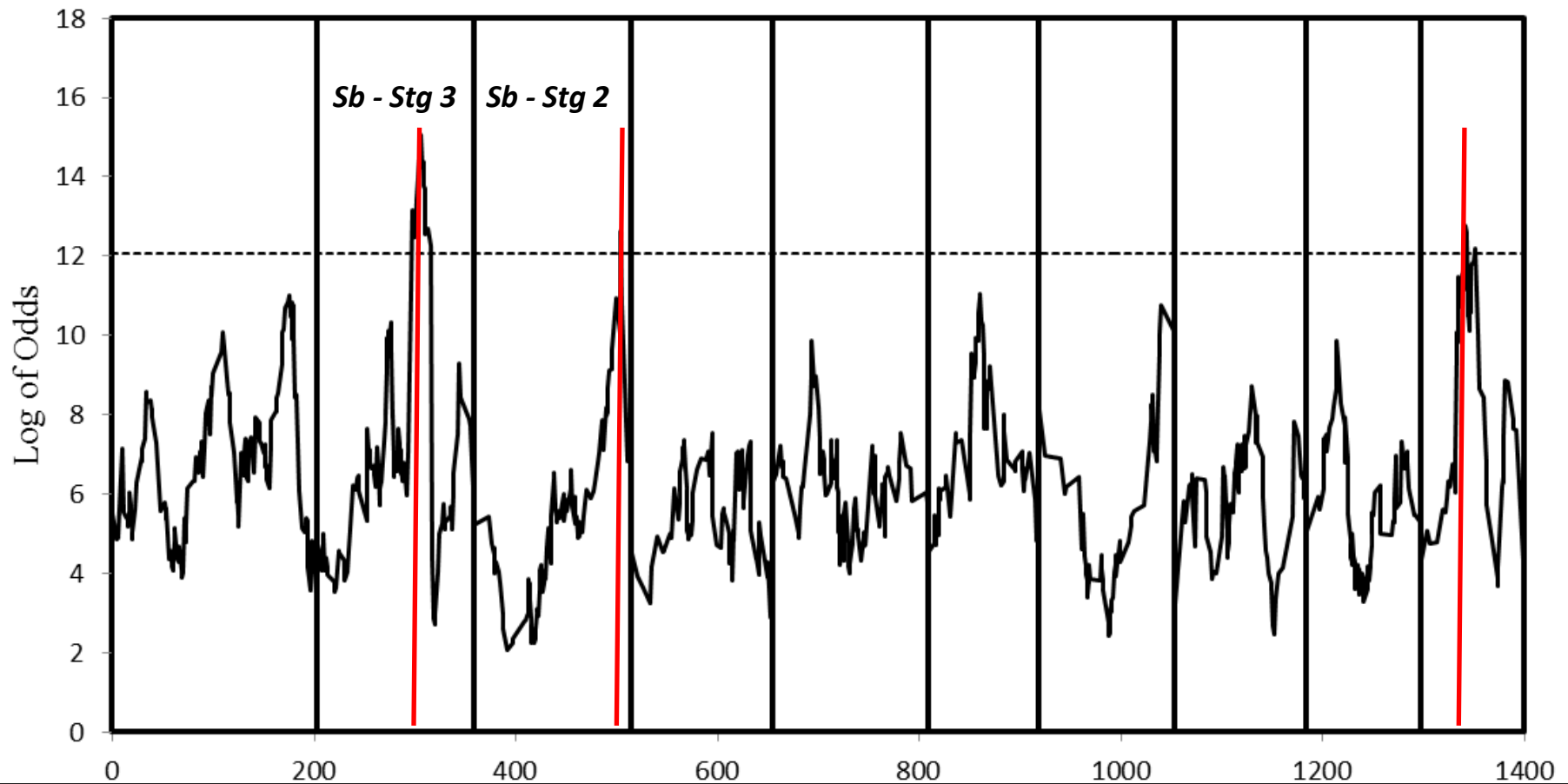
Comparative analyses of crops:

Deployment of stay-green in sorghum and corn

- The “stay-green trait” of sorghum is one of the most important and commercially relevant drought tolerance traits in sorghum, also important in corn.



Genetic analysis of stay-green in corn hybrids



Popelka and Renaud, Unpublished



Closing Thoughts ...

- Considerable opportunities remain for identifying and deploying genes that SUSTAINABLY ENHANCE PRODUCTIVITY of corn and other crops in hot and dry environments.
- Continued adaptation of our important food crops to ever-changing production environments will be crucial to ensuring Global Food Security.

Acknowledgements

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Thank You

