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Agricultural Outlook Forum

Presented: February 17, 2006

USDA DROUGHT TOLERANCE RESEARCH OVERVIEW

Melvin J. Oliver
Plant Genetics Research Leader
Agricultural Research Service, USDA



Drought Research in ARS

An Overview: *soybeans and maize*

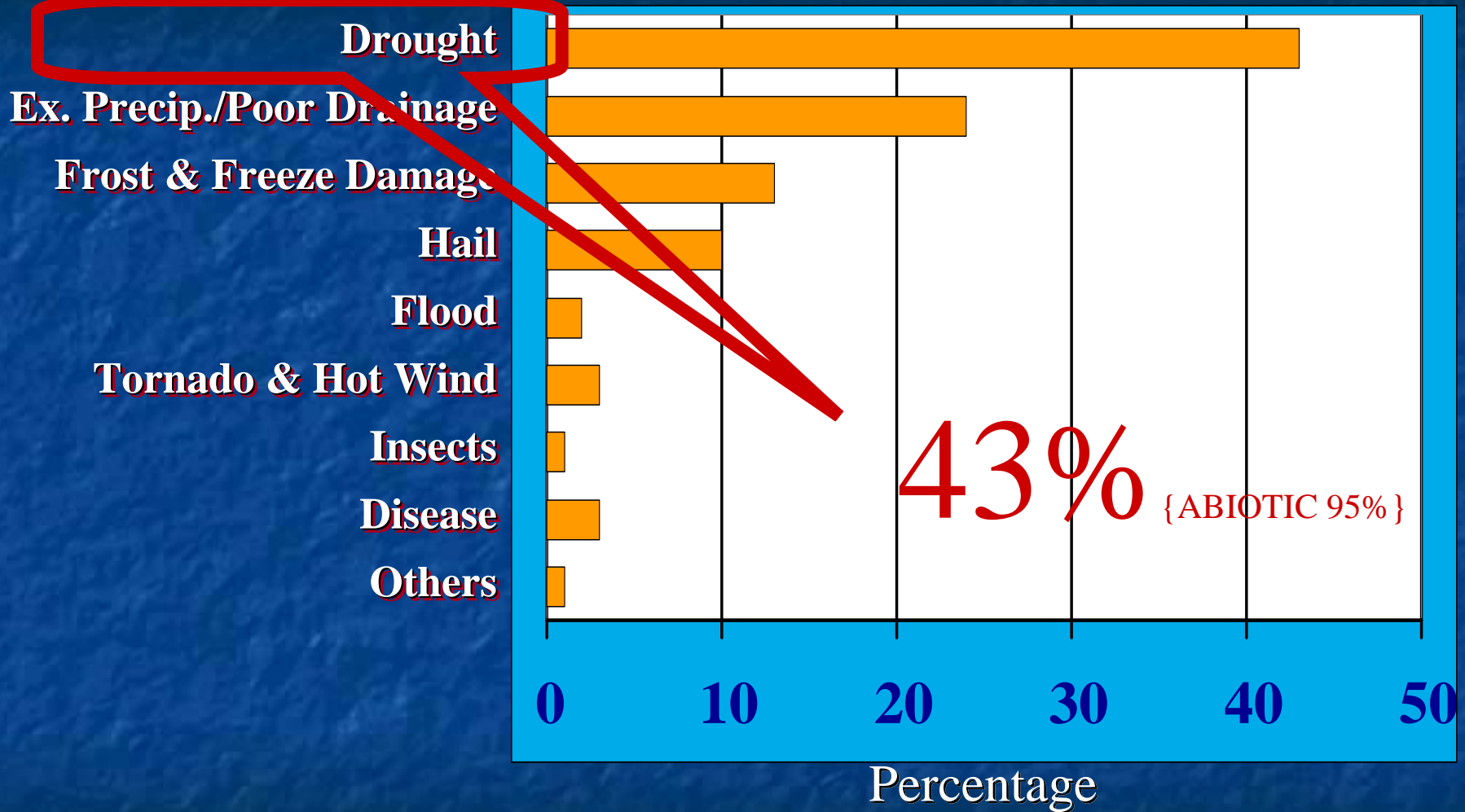
AgForum

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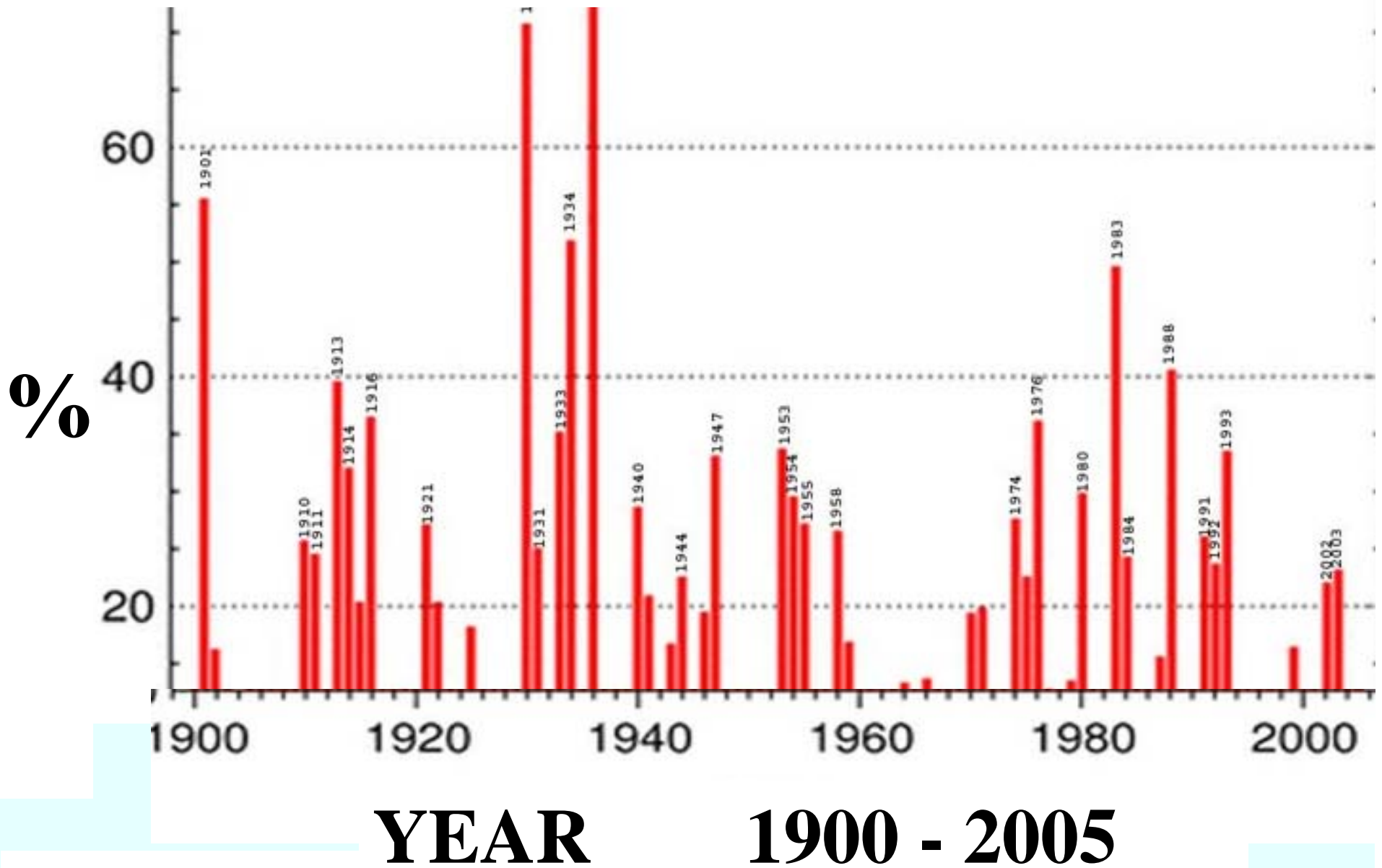
- Tommy Carter - Soybean & Nitrogen Fixation Unit
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- Mike McMullen - Plant Genetics Research Unit, Columbia
MO
- Robert Klein - Crop Germplasm Unit, College Station, TX
- Cleve Franks - Plant Stress Unit, Lubbock TX
- Paxton Payton - Plant Stress Unit, Lubbock TX

Average Percentage of Indemnities by Hazard, all crops, 1948-1996*



(*USDA Agricultural Statistics (1998))

Soy Production affected by drought



Courtesy NOAA

Breeding for Improved Drought Tolerance

- Screening for drought tolerance using laboratory or glasshouse-based assays is notoriously difficult and not always correlated to observed tolerance in the field

Drought Tolerance: Complex Phenotype

- Field Performance!
- Plant Architecture
- Morphology
- Cellular
- Sub-cellular
- Genetic



Integrated Program

**New Sources
of Drought
Tolerance**

**Crop and
Whole Plant
Physiology**

**Genetics, 'Omics'
and Molecular
Biology**

(Biotechnology)

Field Breeding

Better Varieties





Germplasm
to
Genes

Soybean: *Glycine max*



Slow Wilting Trait

Fast
wilting

Slow
wilting



Searching the Globe for drought tolerance

30,000 Strains
Of Soy

Slow Wilting Discovery

Carolina

6 Asian types

Minnesota

6 (more) Asian types

Nebraska

10 (more) Asian types

Arkansas

2 U.S. types

OTHER ADVANCES

Slow wilting related to yield under stress

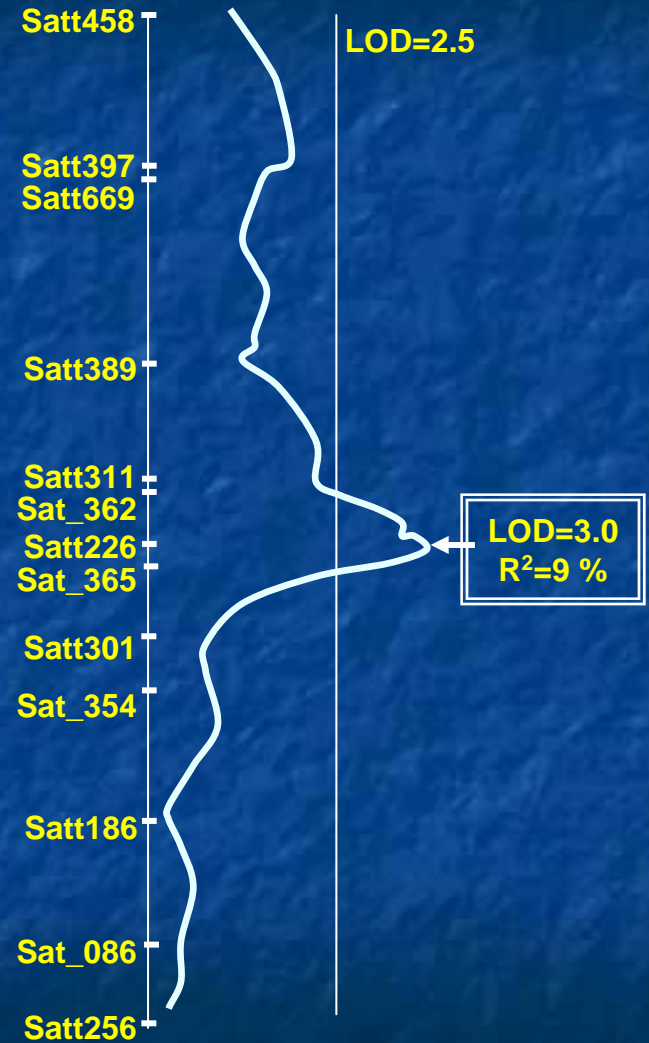
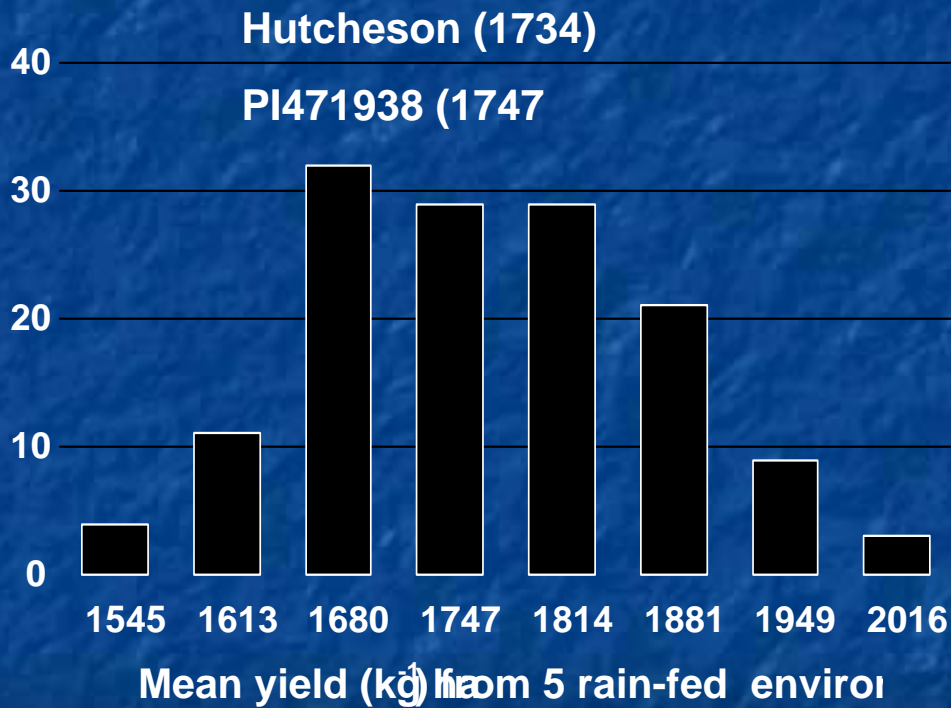
DNA MARKER RESULTS

4 Slow Wilting Genes

identified thus far

More expected soon

QTL's for Yield under Drought: From PI 471938



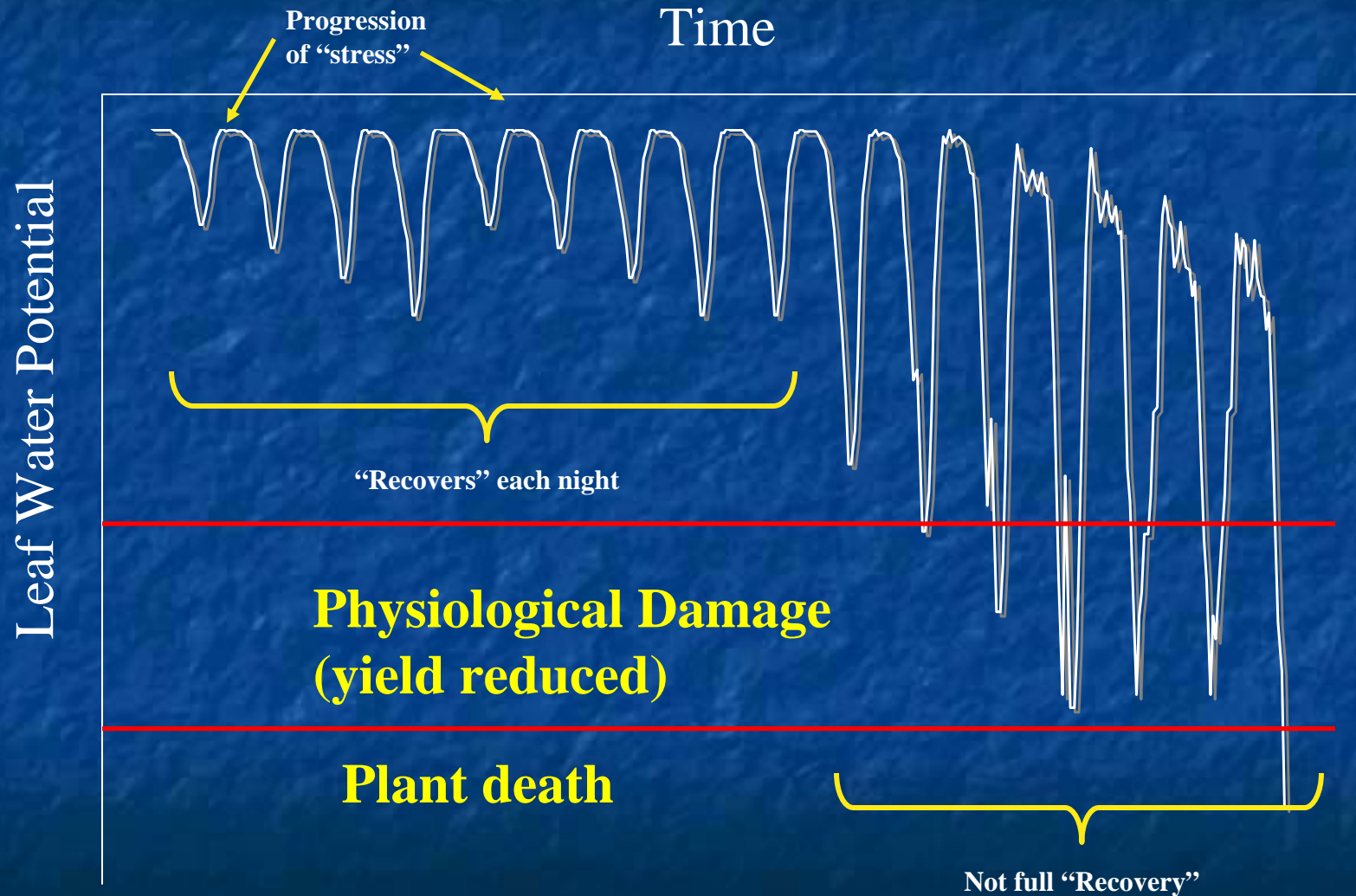
Maize

Zea mays



Genes
to
Germplasm

Water Stress Cycle



Drought and Desiccation Tolerance

Drought tolerance = tolerance of sub-optimal water availability

**Desiccation tolerance = tolerance of complete drying to
equilibrium with the air**

Drought tolerance mechanisms include ways of maintaining cell water content, such as osmotic regulation and stomatal closure, whereas desiccation tolerance consists of ways to survive the complete loss of water.

Sporobolus stapfianus

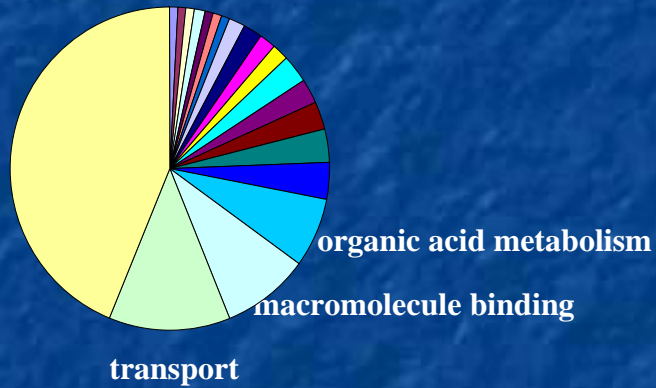


Craterostigma plantagineum

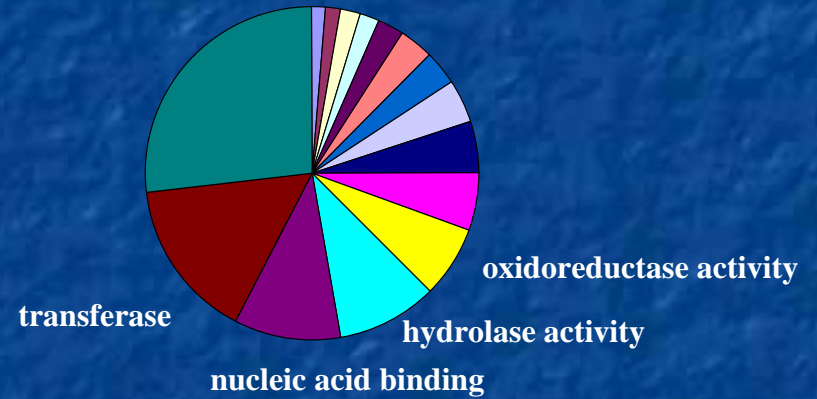


Induction by water stress vs Desiccation

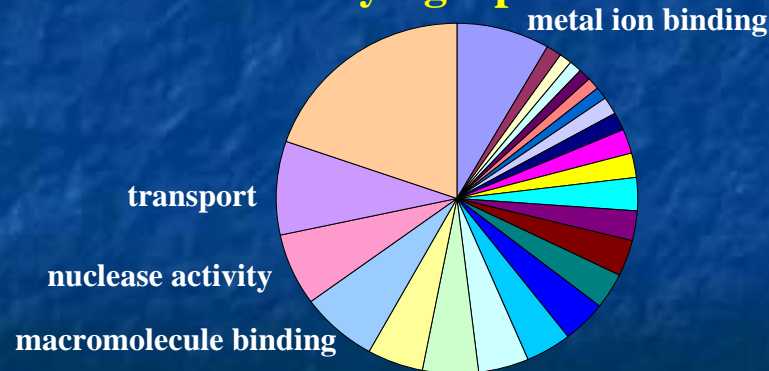
Water Stress Cp 60%



Drought - At



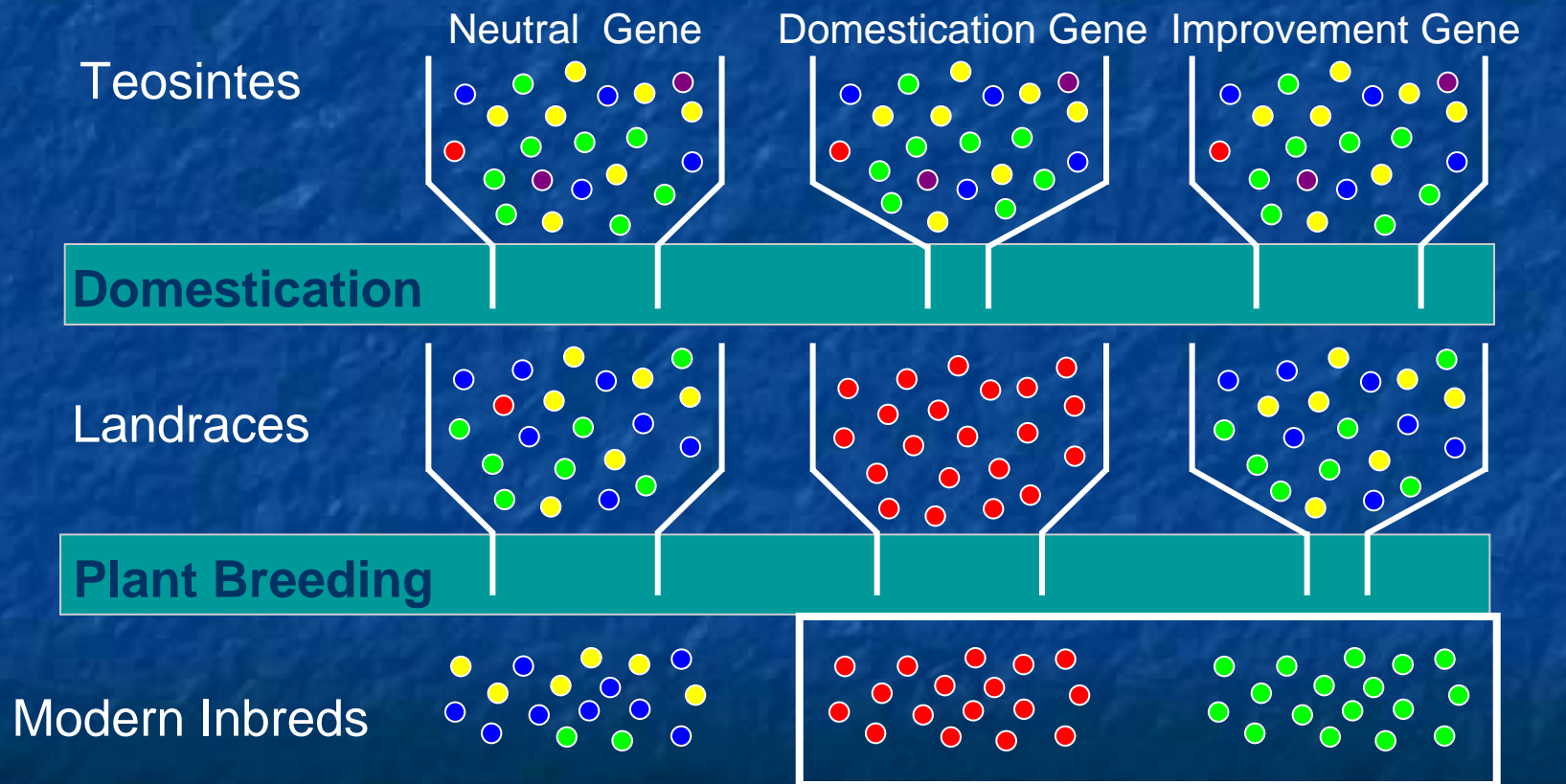
Drying Cp 5%



Genes Ascribed to Drought Tolerance

Selection Screens: Another way to identify genes that have contributed to agronomic traits

Domestication and plant breeding reduced maize genetic diversity



Very low sequence diversity

Slide courtesy of Masanori Yamasaki

NC358

0

P39



0

Ki11

0

CML103

0

Oh43



+

CML228



+

CML52



+

vs. B73

Association

Linkage

Slide courtesy of Ed Buckler

Syntenic Relationships

Sorghum - Rice - Maize

Drought Tolerance in Sorghum

- Two forms of drought tolerance have been observed in sorghum:
 - Pre-flowering
 - Post-flowering (the 'Stay-Green' trait)
- Each is identified by the lack of specific symptoms of water-deficit stress imposed at a particular plant growth phase

Integrated Approach

The Key for Crop Improvement in
Drought Tolerance