Breeding for Drought Tolerance in Mid-South

Investigators

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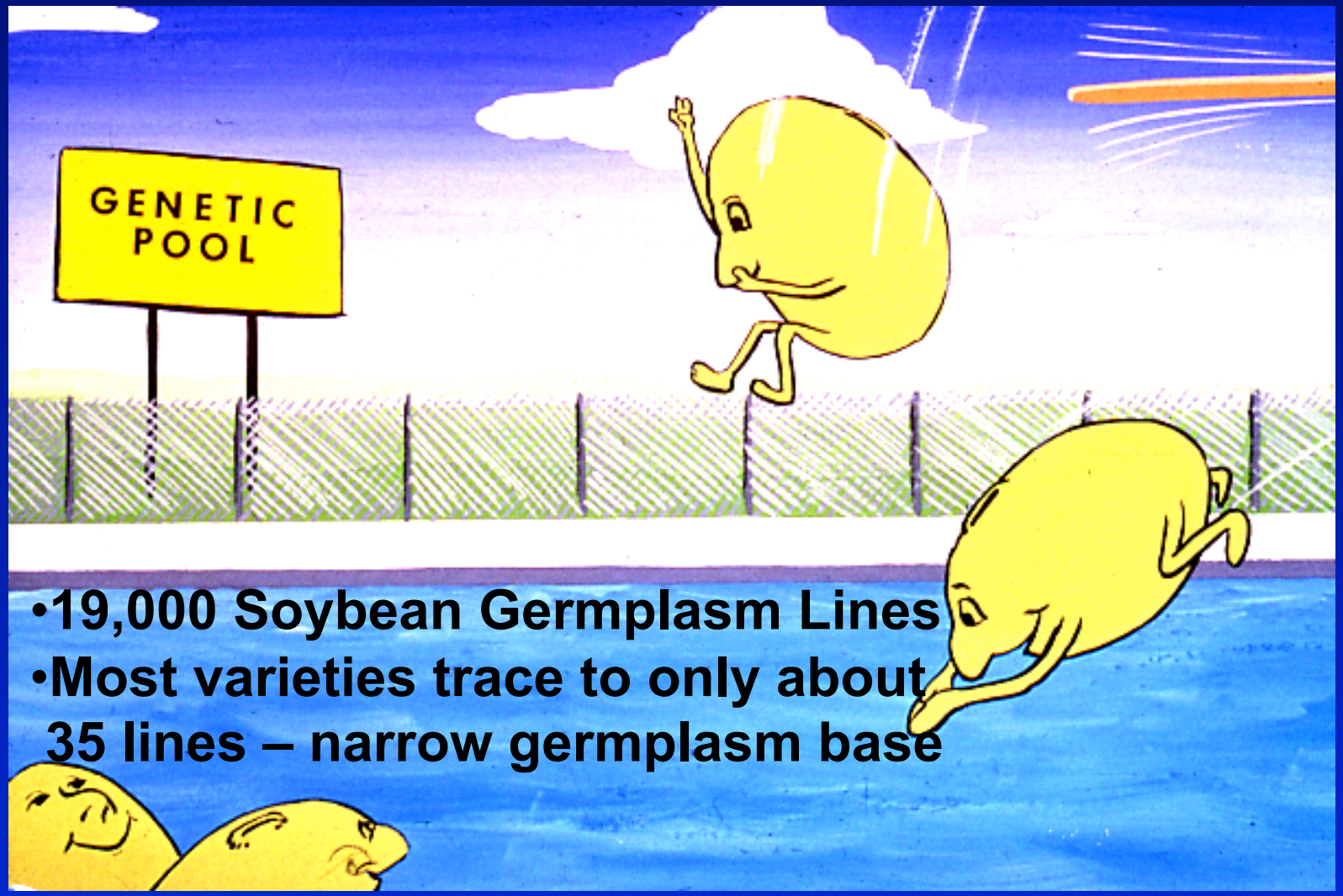
CHALLENGES
Drought is #1 Factor Limiting Production
Most Soybeans Non-Irrigated
Soybeans Needed which Tolerate Drought

Slow Progress in Breeding for Drought Tolerance (Tommy Carter)

1. Testing in high yielding versus droughty locations results in more high yielding varieties- data from low yielding locations discarded

2. Today's varieties were chosen for yield and disease resistance and not drought tolerance.

3. Evaluating for drought tolerance is high risk and difficult. Need fields where drought occurs every year to do field evaluation.


GENETIC
POOL
•19,000 Soybean Germplasm Lines
•Most varieties trace to only about
35 lines – narrow germplasm base

Reasons to Study

- Limited Drought Tolerance in Adapted Varieties in mid-south
- Exotic Soybeans Differ in Ability to Tolerate Drought
- Exotic Germplasm Could Provide Traits
  - –Deeper and Extensive Roots
  - –Greater Water Use Efficiency

Missouri focus on drought- since 2005

- Exotic Group III, IV and some V to avoid overlapping too much with others

Carter and Boerma- NC & GA

Chen, Purcell & King AR

Orf- MN

Specht- NE

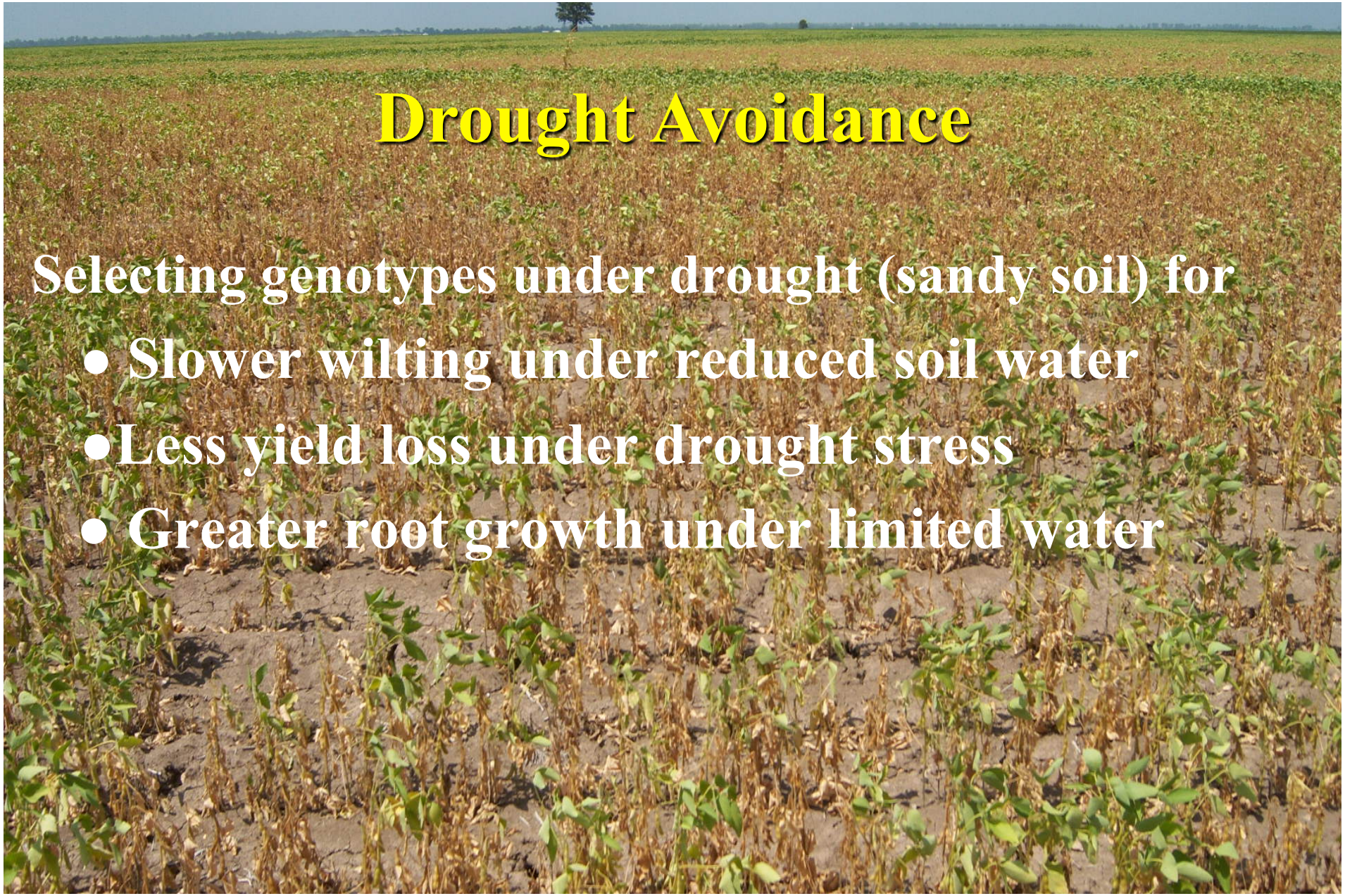
Approaches for Improving Drought Tolerance

- **Drought (dehydration) Avoidance**
- **Sustained Nitrogen Fixation under Low Moisture**
- **Drought (dehydration) Tolerance**

Drought Avoidance

Matching soybean maturity with production systems to time growth and pod fill when seasonal rainfall is greatest.


Average yields in
Mississippi have
Increased 1000
kg/ha from ESPS



Drought Avoidance

Selecting genotypes under drought (sandy soil) for

- Slower wilting under reduced soil water
- Less yield loss under drought stress
- Greater root growth under limited water

Summary of Work 2005-10

1) Screened 884 group III (359), IV (349) & V (176) PIs to identify drought tolerance among lines by measuring canopy wilting and yield loss of each PI and checks under drought versus well-watered field conditions at Clarkton, MO (very sandy soil)

2) Determine traits associated with drought- deep roots, dense roots, N- fixation- Sharp and Fritschi.

3) Develop populations to map genes & put tolerance into soybean varieties

Drought Hill plots Clarkton, MO

Comparison of Wilting Under Drought

Comparison of varieties and PIs for drought

Test lines for least yield loss under drought

Yield loss irrigated vs non-irrigated to measure drought tolerance

Drought Tolerance- based on wilting scores and pod set to narrow tolerant PIs down

Drought Tolerance among PIs

Good variation among PIs for wilting- also variation at maturity for pod set

- 36 of 359 group III PIs looked promising
- 82 of 349 group IVs PIs looked promising
- 18 of 176 group Vs looked promising

- Yield test under no irrig. & Irr to calculate a Drought index= Non Irr yld ÷ Irr yld x 100

Screening 884 Group III, IV & V PIs for Drought Tolerance-

- 359 Group III → 30 → 11 → 5 Group III PI
- 349 Group IV → 82 → 30 → 4 Group IV PIs
- 176 Group V → 18 → 5 → 2 Group V PIs

Out of 882 plant Introductions screened 11 PIs show promise for tolerance

Drought index & wilt scores MO over 3 yrs and wilt scores from KS in 2010 for 2 PIs & Cks

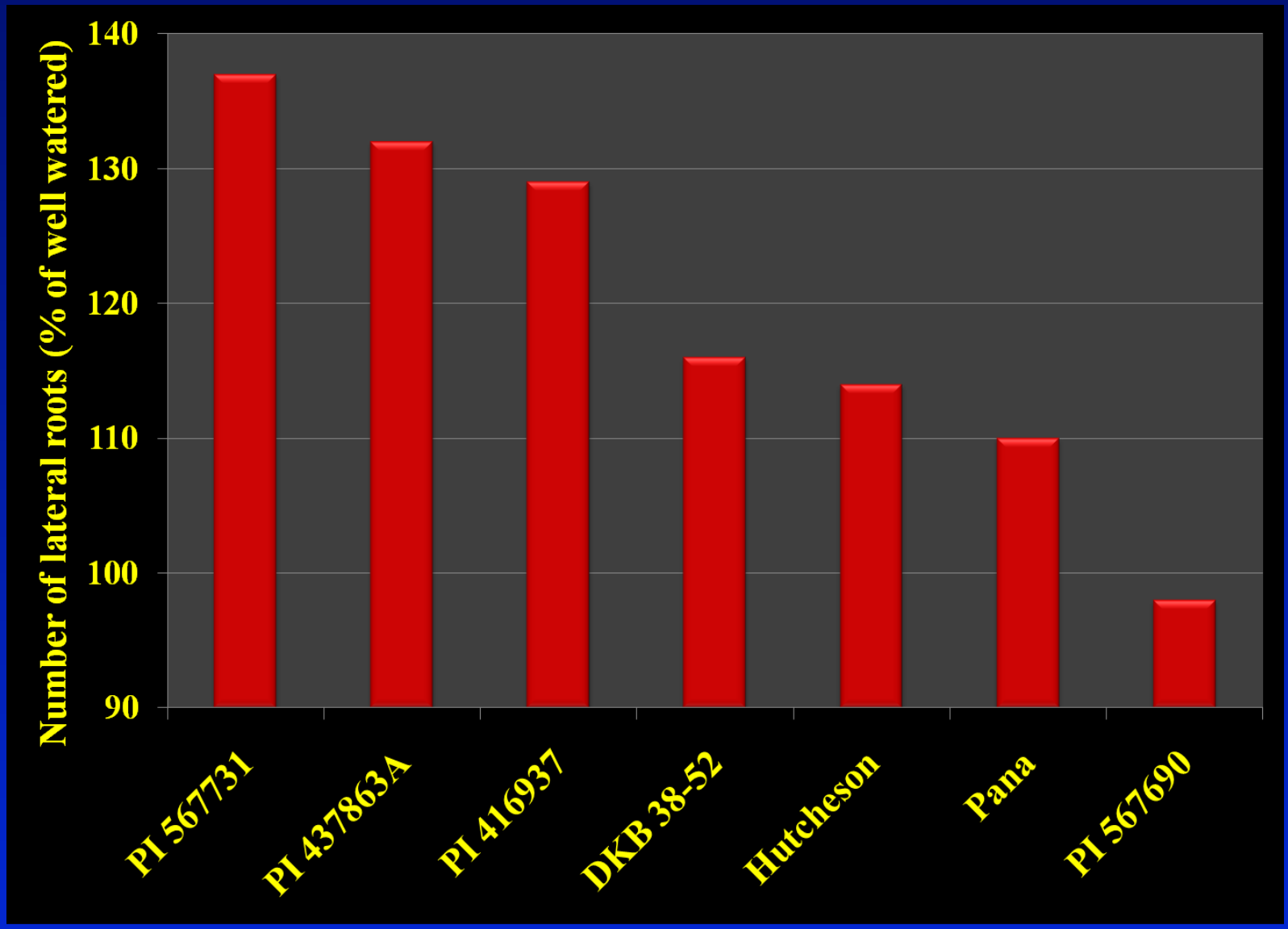
Line	D Idx	Wilt	WS1, KS	WS1, KS
PI567690	100	1.3	28	38
PI567731	99	1.8	32	39
Pana- Ck	72	3.0	38	46
DKB38-52- Ck	78	3.3	37	39

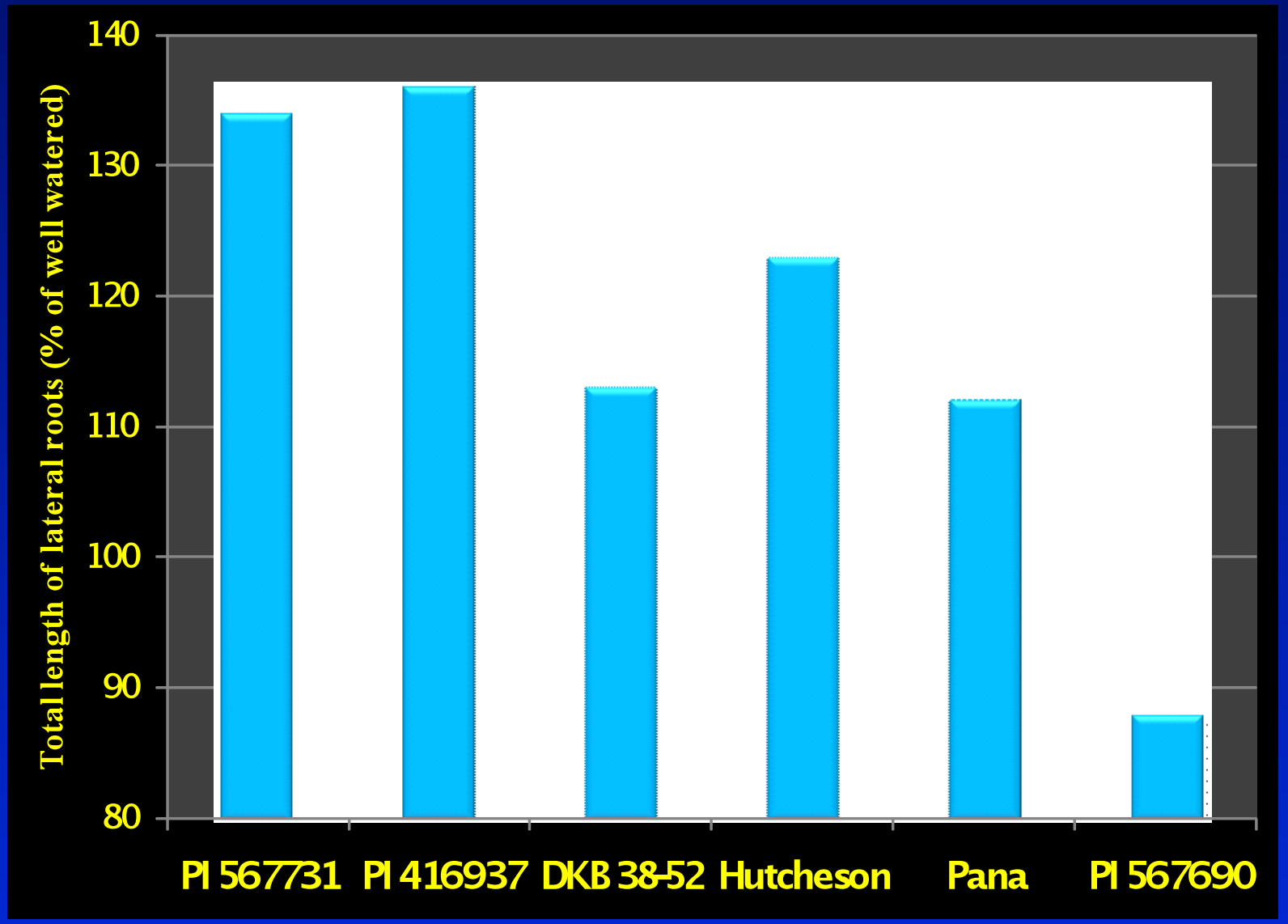
“Deep tube” system

Are results with the seedling system consistent with the root system response in more mature plants?

Comparison of Magellan (superior seedling response) with Pana (inferior seedling response)

Seventeen Days After Withholding Water


Number of lateral roots (% of well watered)
140
130
120
110
100
90
PI 567731
PI 437863A
PI 416937
DKB 38-52
Hutcheson
Pana
PI 567690

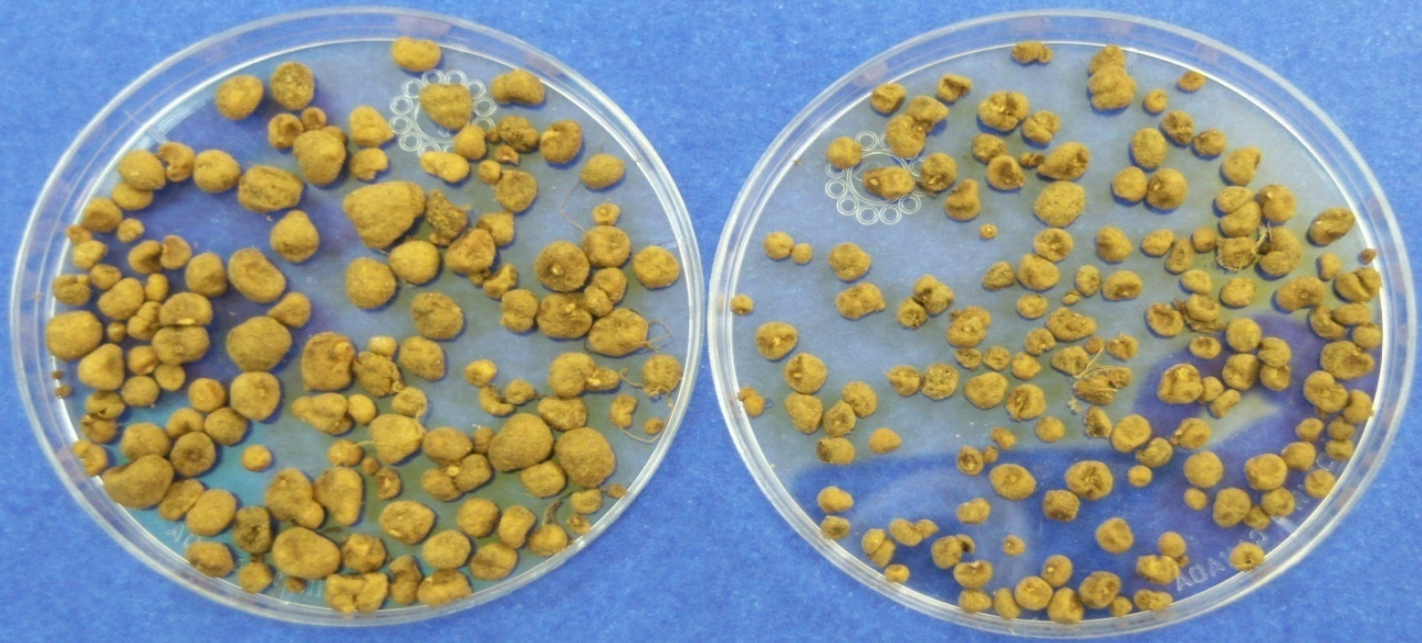

Total length of lateral roots (% of well watered)
140
130
120
110
100
90
80
PI 567731
PI 416937
DKB 38-52
Hutcheson
Pana
PI 567690

U of AR germplasm with sustained N fixation under drought

- **R01-416F**
- **R01-581F**

Show less yield reduction under drought than check cultivars of similar maturity

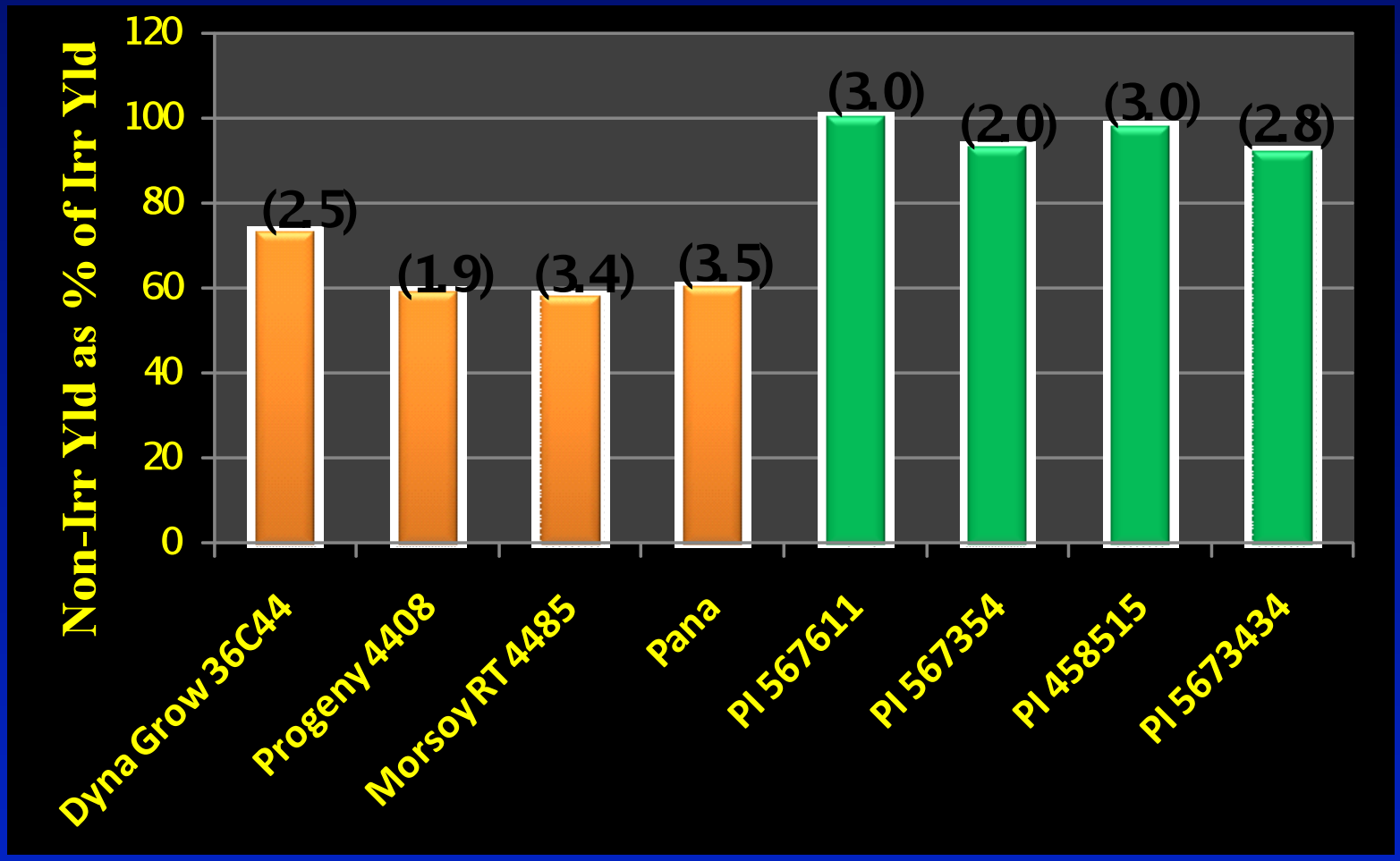
Chen et al., 2007. J of Plant Registrations 1:166-167



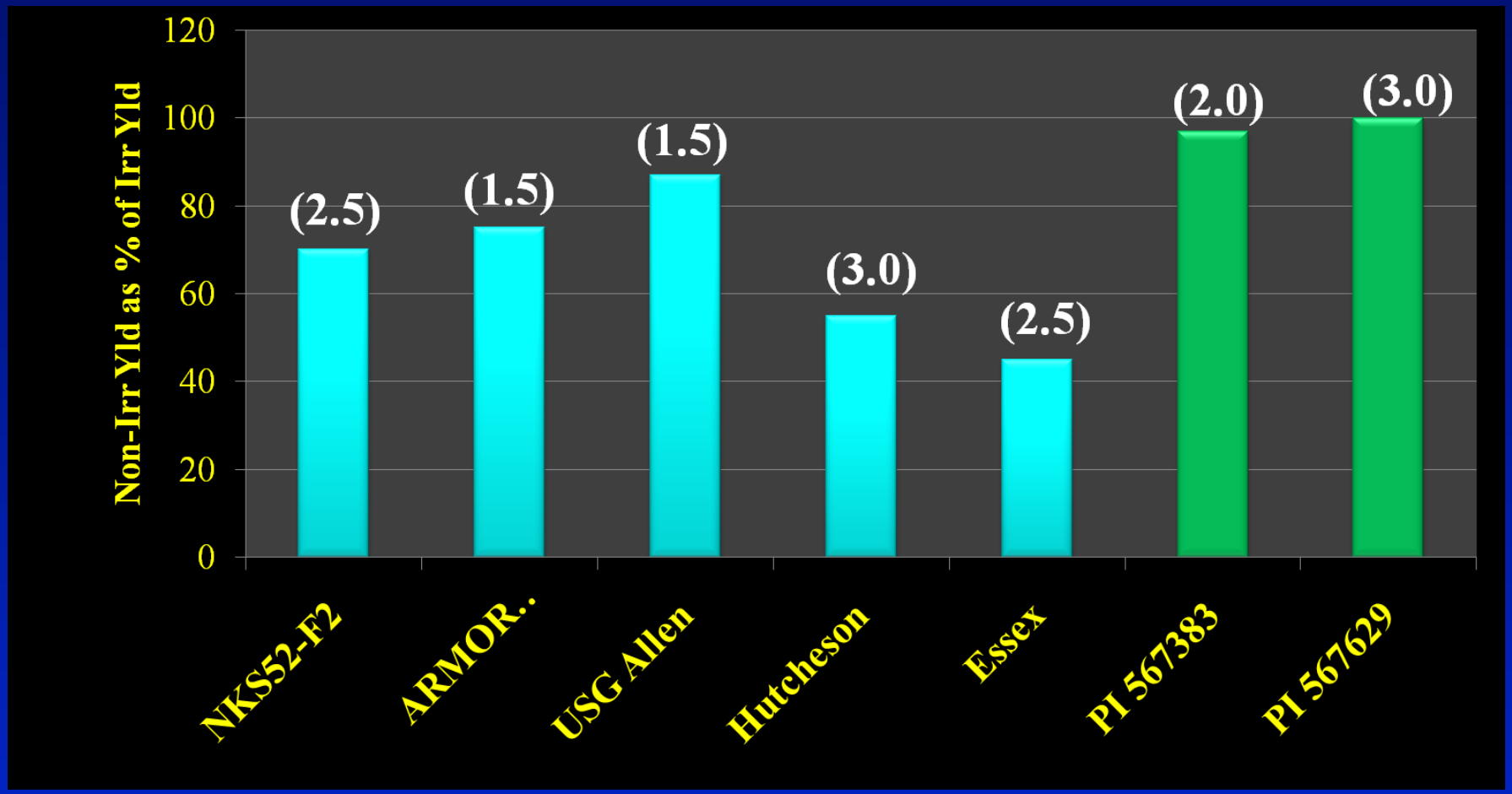
PI567690 Pana

Evaluation of Nodule wgt in tolerant PIs

Line	Drought	Irrigated
PI567690	6.5	5.8
PI567731	6.4	6.8
DKB38-52	2.7	3.5
Pana	4.3	3.4



Yield of group IV varieties and PI's as a % of irrig yield & (wilt score) – Clarkton MO, 2009-10



Yield of group V varieties and PI's as a % of irrig yield & (wilt score)– Clarkton MO, 2009-10

Summary

- Maturity group III-V exotic PIs show promise for drought tolerance based on
  - -wilting scores
  - -less yield loss under drought
- Promising PIs showed very good, average and poor lateral root length and number
- These and more PIs will be evaluated in the future
- Drought research is long term & need good field sites to induce stress

Soybean Checkoff Dollars at Work

Appreciation Extended to the United Soybean Board and the Missouri Soybean Merchandising Council for Research Support