High Crop Yields in Conservation Tillage Systems?

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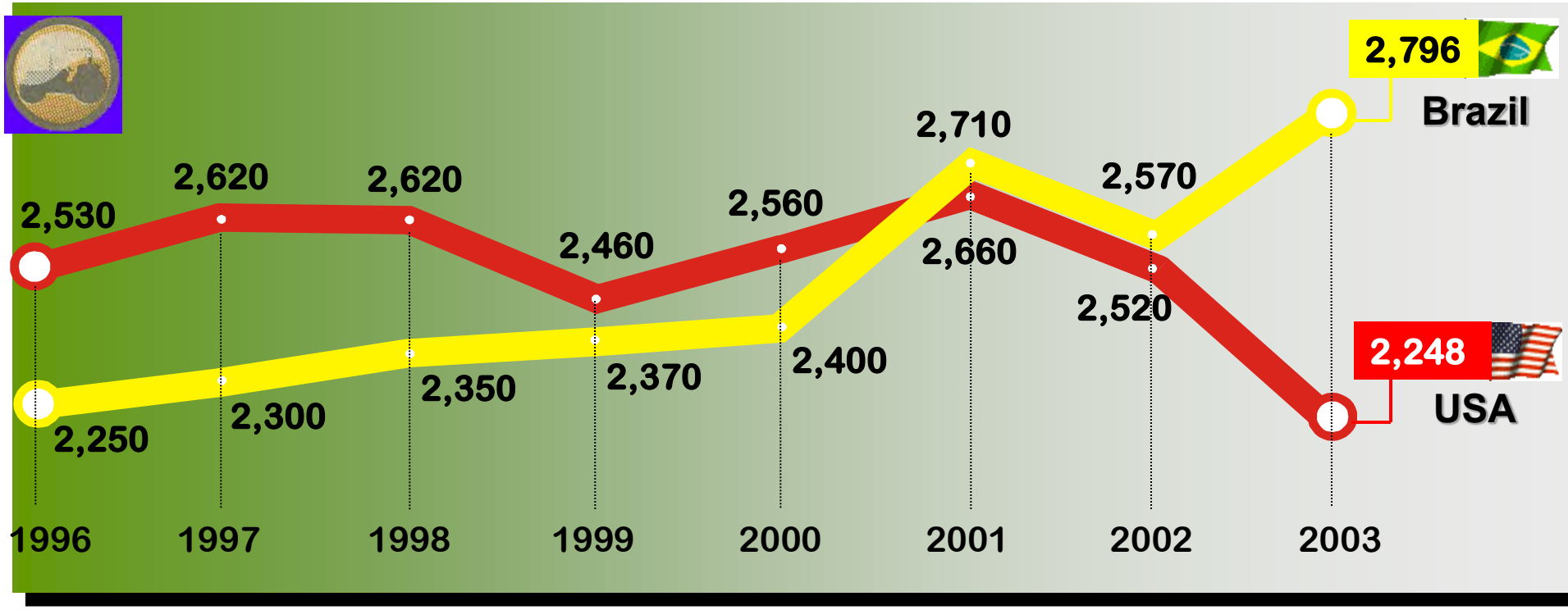
PURDUE
UNIVERSITY

Why is soybean yield in the United States not increasing as in Brazil?

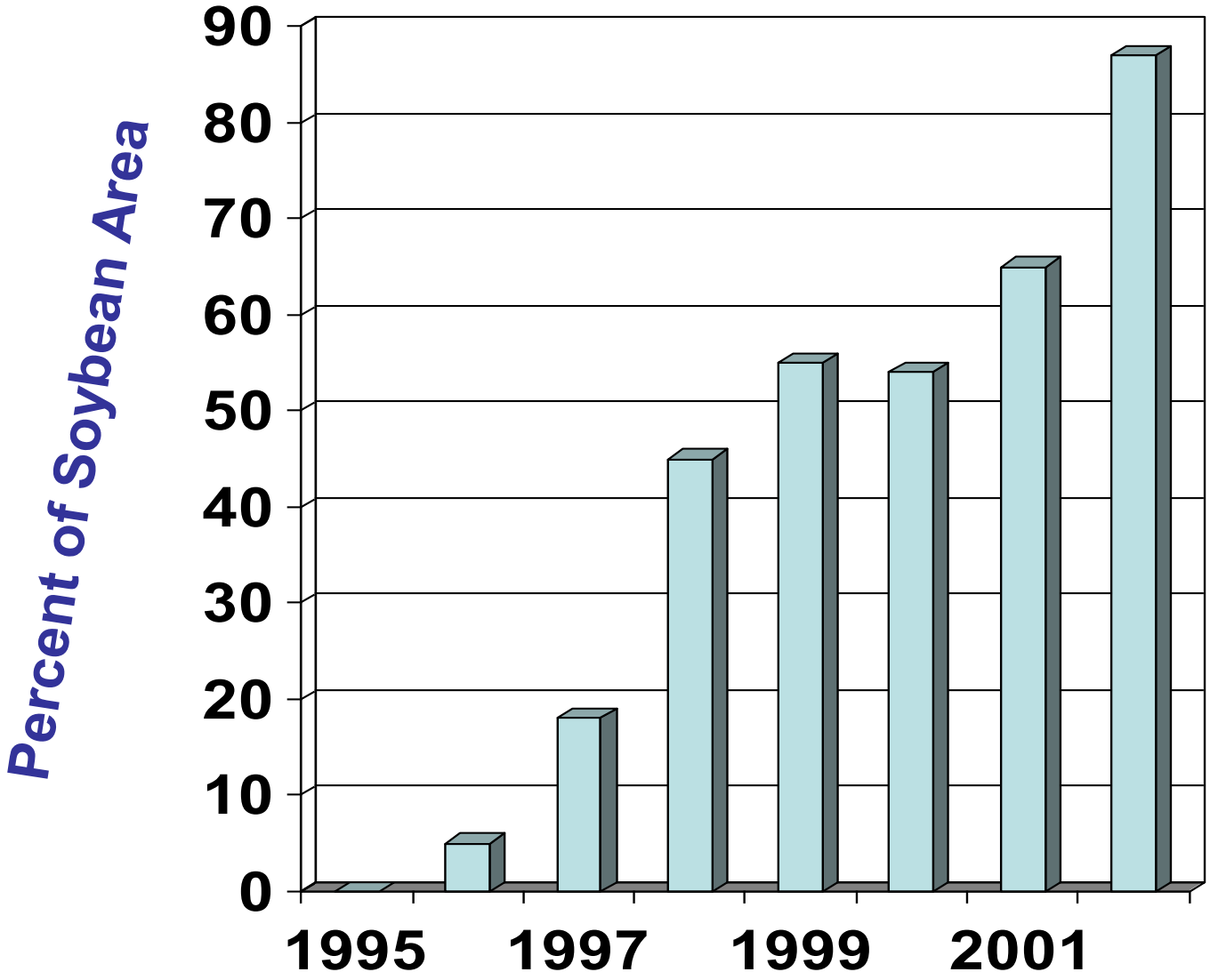


Trend in soybean yield (conventional in Brazil and transgenic in the United States (kg/ha) from 1996 to 2003)

Source: Faosta (www.fao.org/waicent/portal/estatistics_en.asp)

Soybean Harvest and No-till Double-crop Corn: Brazil Style

Glyphosphate-Resistant Soybean Adoption in United States (estimated from USDA sources)



Key Soybean Yield Challenges since 1996

- 1996-99: Normal environmental and disease stresses plus the rapid adoption of Glyphosate-resistant varieties that yielded less than their conventional isolines.
- 2002: Disease pressures.
- 2003: Combined impacts of mid-season excessive rain, soybean aphids, and drought in August-September during pod fill.

Soybean Aphid in 2001, 2003

Threshold for spraying before R-4 is 250 per plant

Soybean Aphid Impacts

Untreated

Roundup UltraMax 26 oz/A

Roundup UltraMax 104 oz/A

Ohio Susceptible

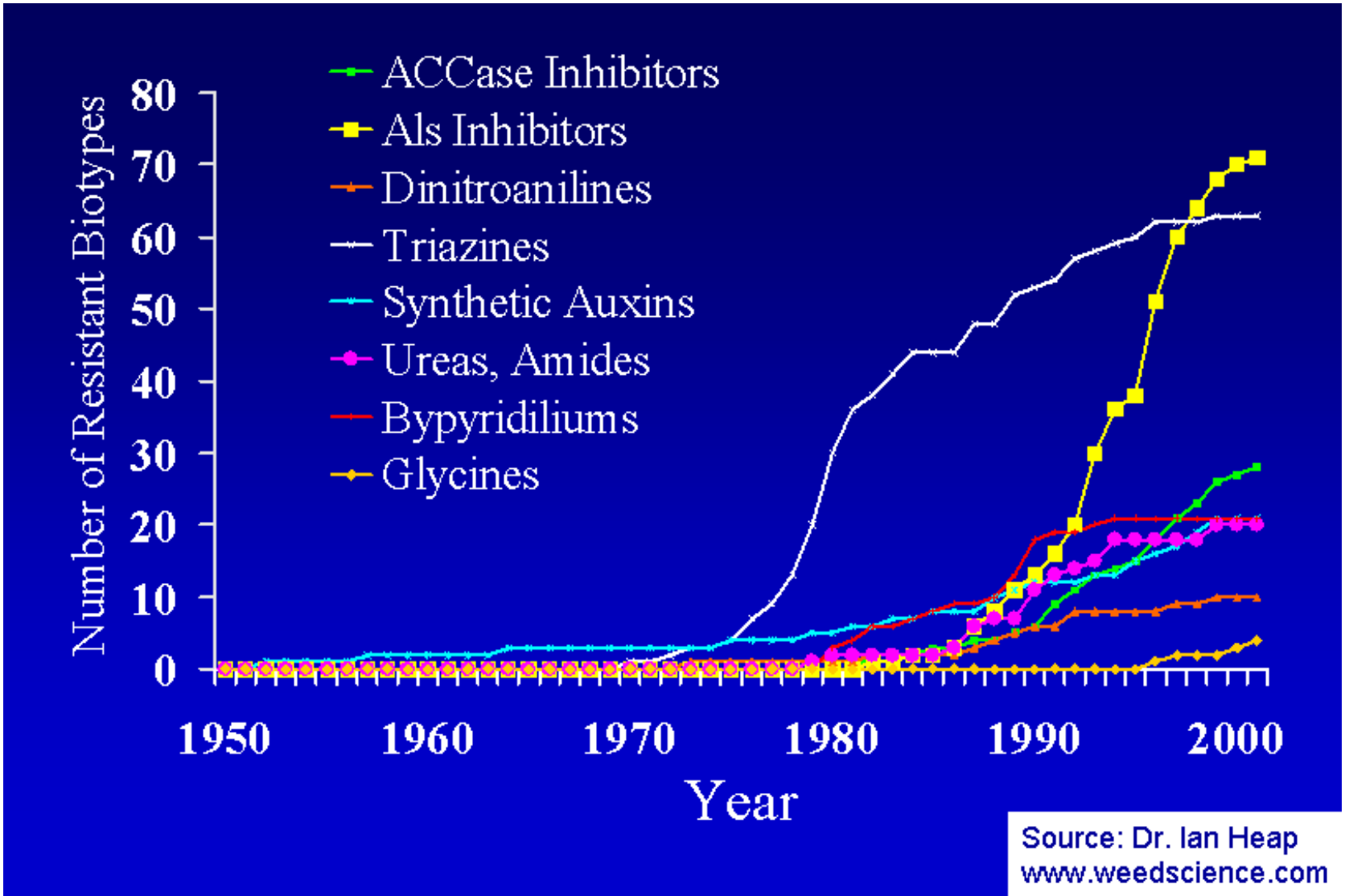
Delaware Resistant

Jackson Co., IN 2

Jackson Co., IN 1

Slide courtesy of Dr. Bill Johnson, Purdue

Herbicide Families with Known Cases of Resistance



Home | Resistant Weeds | Researchers | Herbicides | Add Case | Weed Photos | Contact

GLYCINES (G/9) RESISTANT WEEDS by species and country

#	Species	Country (Click for Details)	Year
1.	***Conyza bonariensis*** Hairy Fleabane	2003 - South Africa	**2003**
2.	***Conyza canadensis*** Horseweed	2000 - USA (Delaware) 2001 - USA (Kentucky) 2001 - USA (Tennessee) 2002 - USA (Indiana) 2002 - USA (Maryland) 2002 - USA (New Jersey) 2002 - USA (Ohio) 2003 - USA (Arkansas) 2003 - USA (Mississippi) 2003 - USA (North Carolina)	**2000**
3.	***Eleusine indica*** Goosegrass	1997 - Malaysia *Multiple - 2 MOA's	**1997**
4.	***Lolium multiflorum*** Italian Ryegrass	2001 - Chile 2002 - Chile 2003 - Brazil	**2001**
5.	***Lolium rigidum*** Rigid Ryegrass	1996 - Australia (Victoria) 1997 - Australia (New South Wales) 1998 - USA (California) 2000 - Australia (South Australia) 2001 - South Africa	**1996**
6.	***Plantago lanceolata*** Buckhorn Plantain	2003 - South Africa	**2003**

Glyphosate resistant weeds as of June 16, 2004

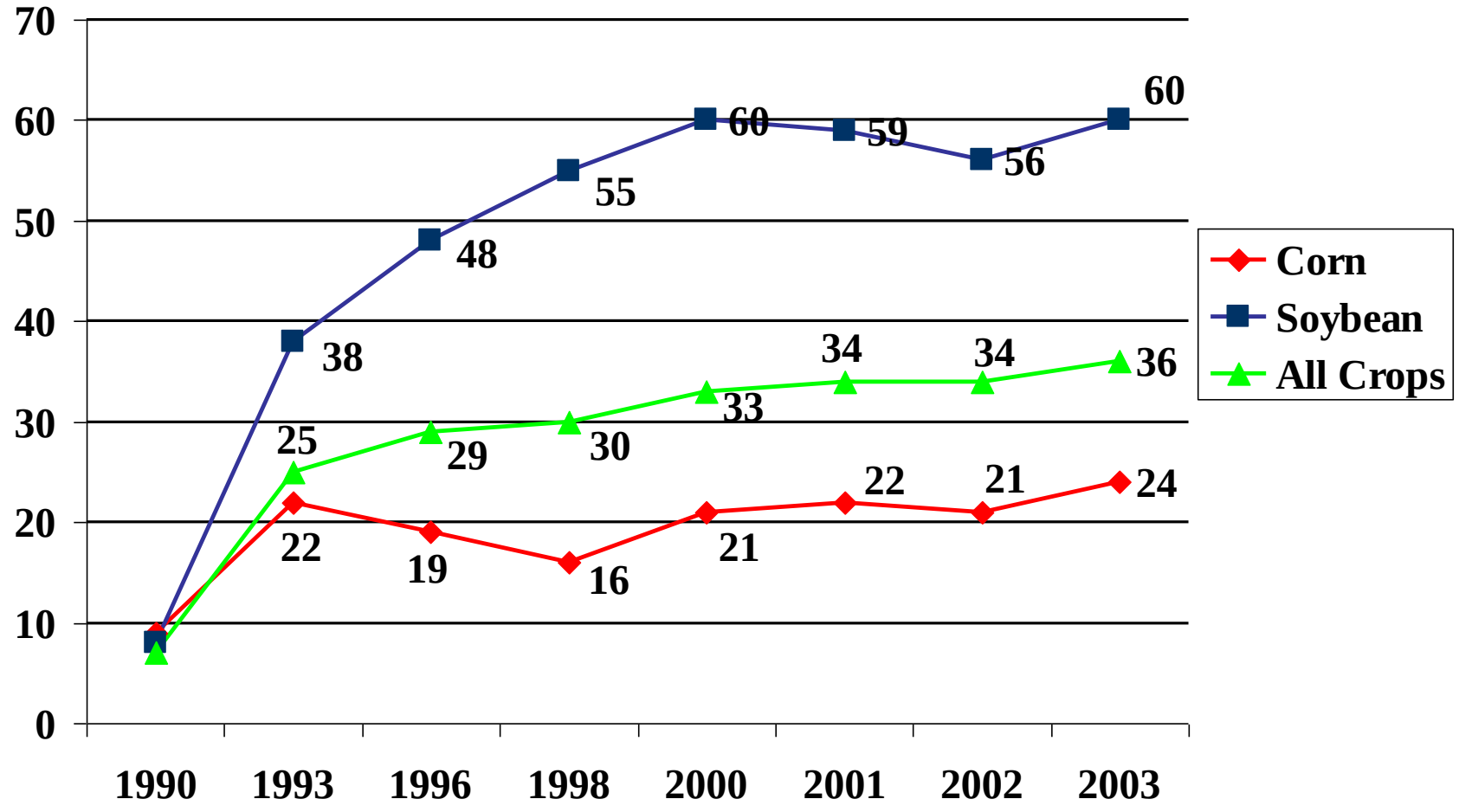
Herbicide Resistant Weeds Website

www.weedscience.org


Photo Credit: Greg Stewart

Indiana Tillage Adoption, 1990-2003

(percent of total cropland for a specific crop in a no-till system)



Source: Purdue University-Transect Data

So What is Problem with No-till Corn?

Yields?

Pests?

Maturity?

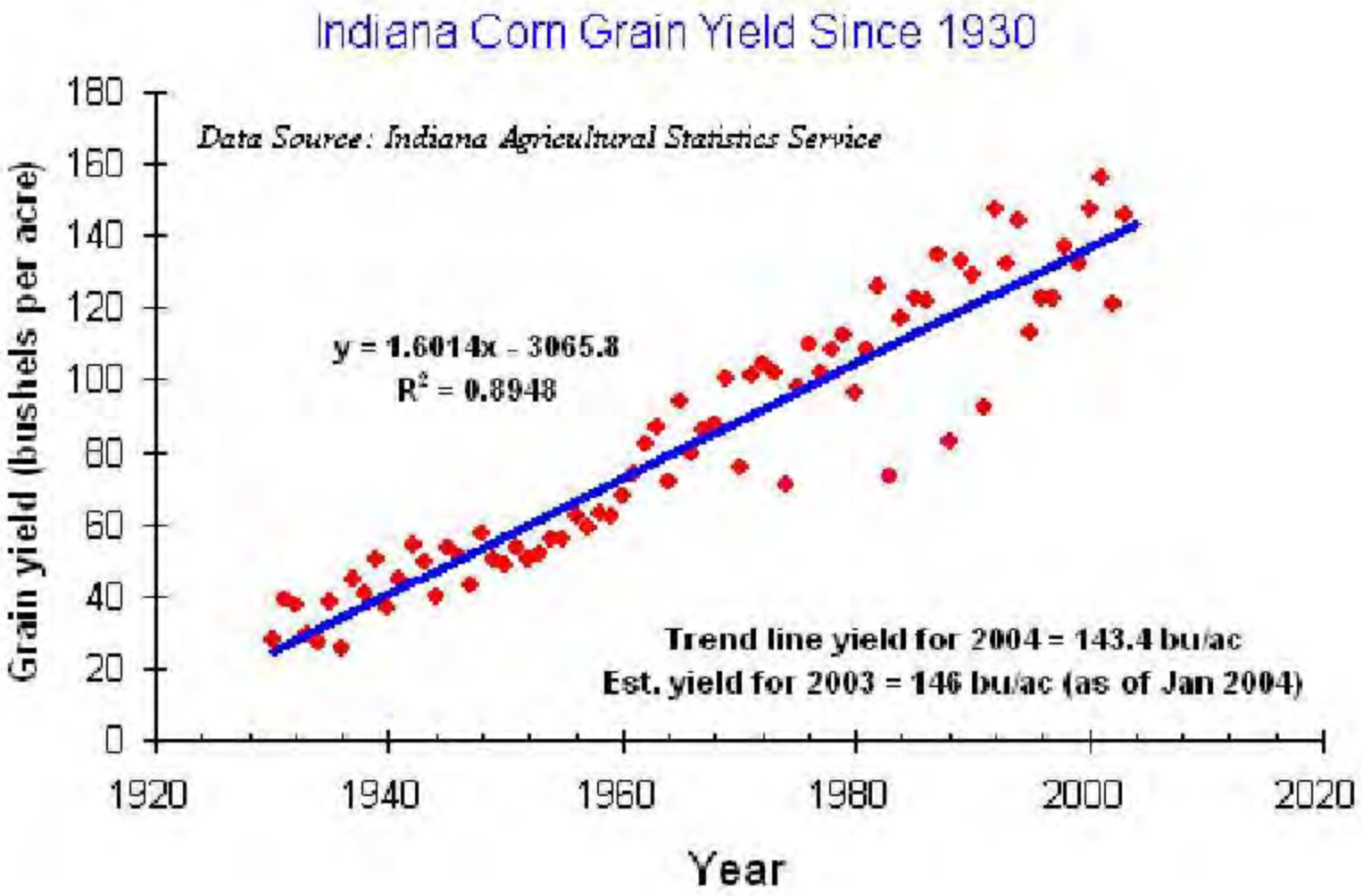
Planting Date?

Nutrient Availability?

Corn Yield Response to Tillage and Rotation, Long-term Tillage Study, IN, 1975-2003.

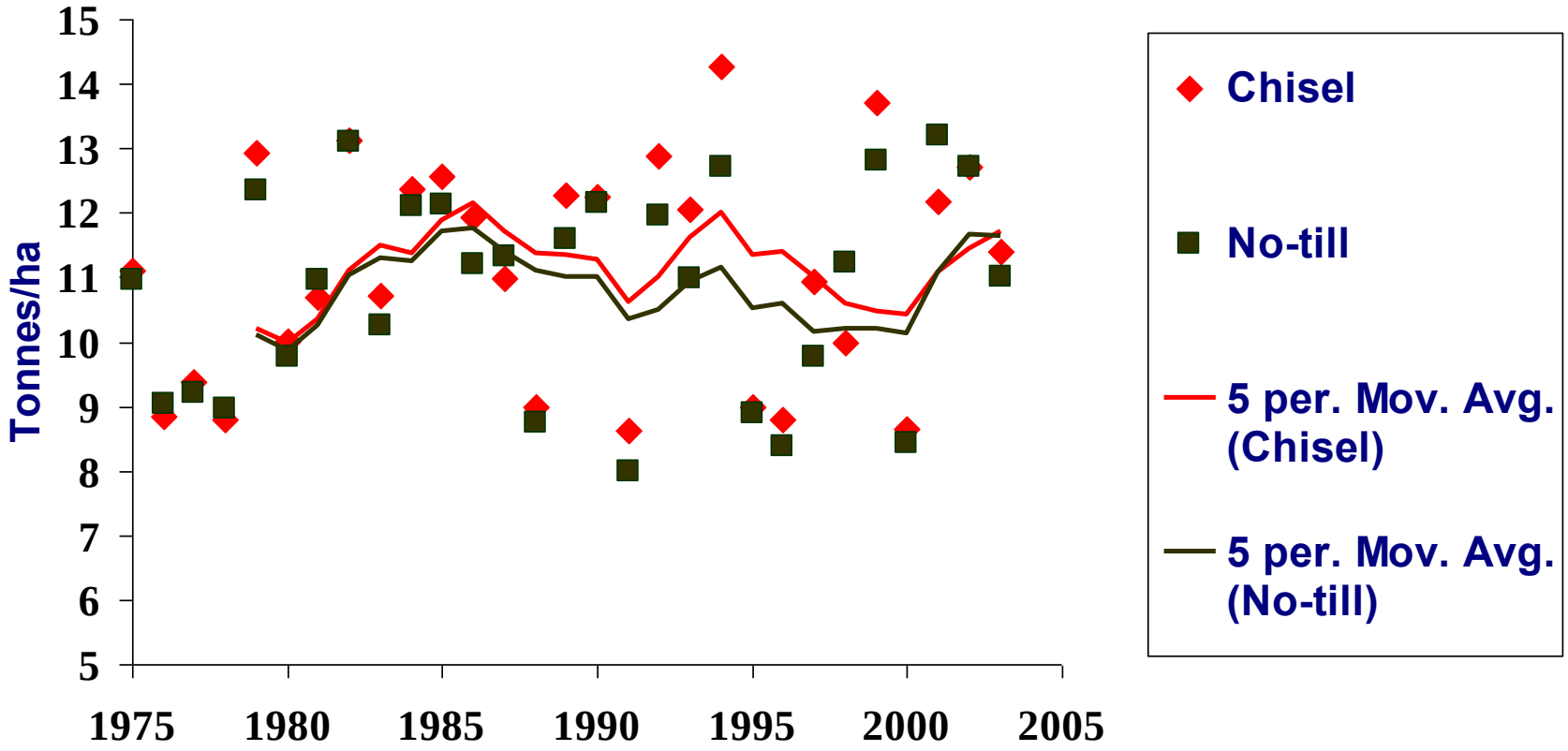
Tillage	Corn/Soybean		Con't. Corn		Yield Gain
	t/ha	%	t/ha	%	
Plow	11.07	- - -	10.58	- - -	5%
Chisel	11.10	100%	10.29	97%	8%
Ridge-til	11.39	103%	10.49	99%	9%
No-till	10.83	98%	9.18	87%	18%

* Since 1980



Source: Dr. Bob Nielsen, Purdue and USDA

Corn Yields Following Soybeans, West Lafayette, IN, 1975-2003.



Strip Tillage for Corn?

What are we after with strip-till?

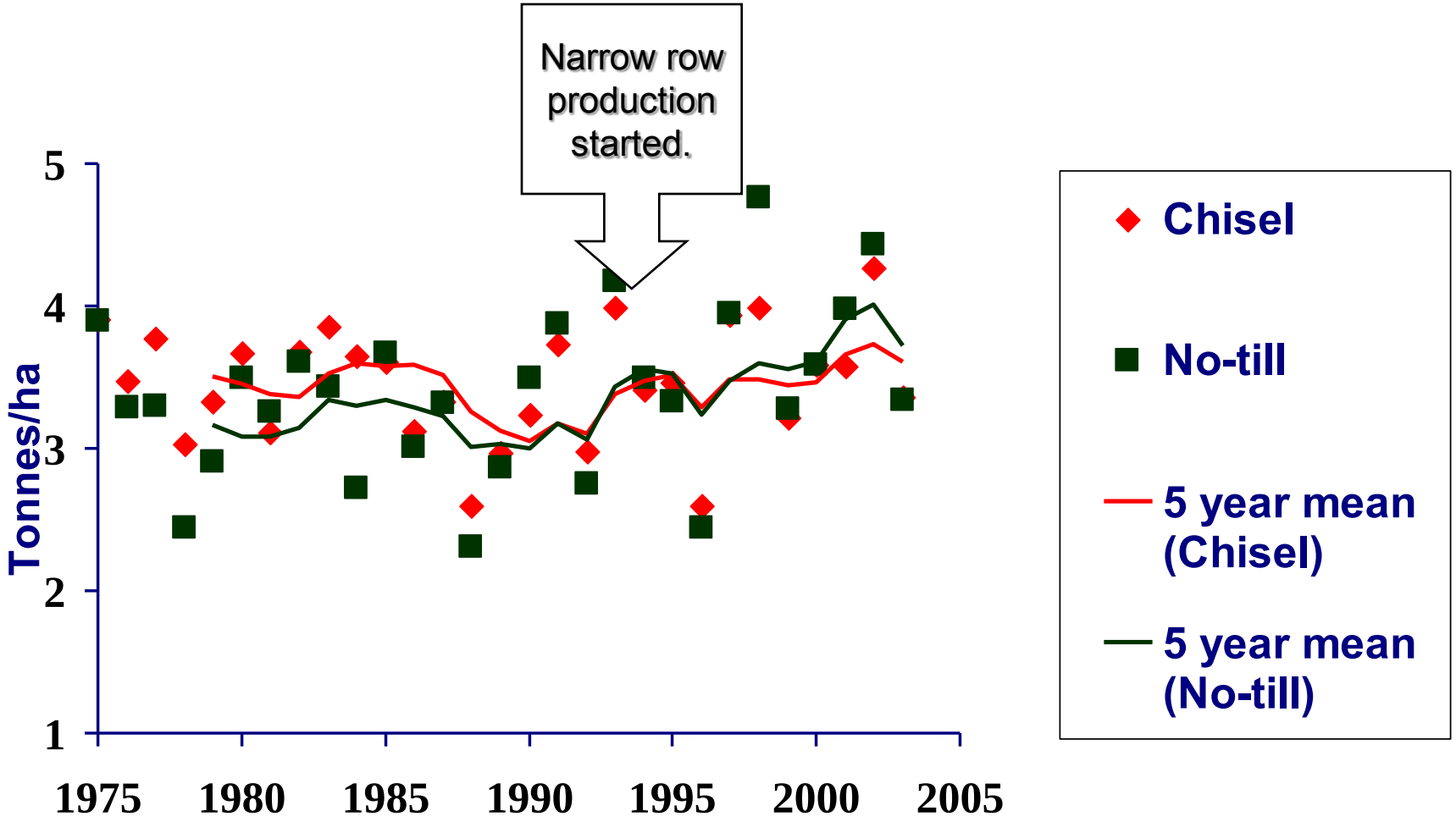
- **Yields**
  (relative to no-till; stability)
- **Planting Timeliness**
  (pre-plant soil conditions)
- **Fertilizer Placement Efficiencies**
  (systems approach)

Soybean Yield Response to Tillage and Rotation, Long-term Tillage Study, IN, 1975-2003.

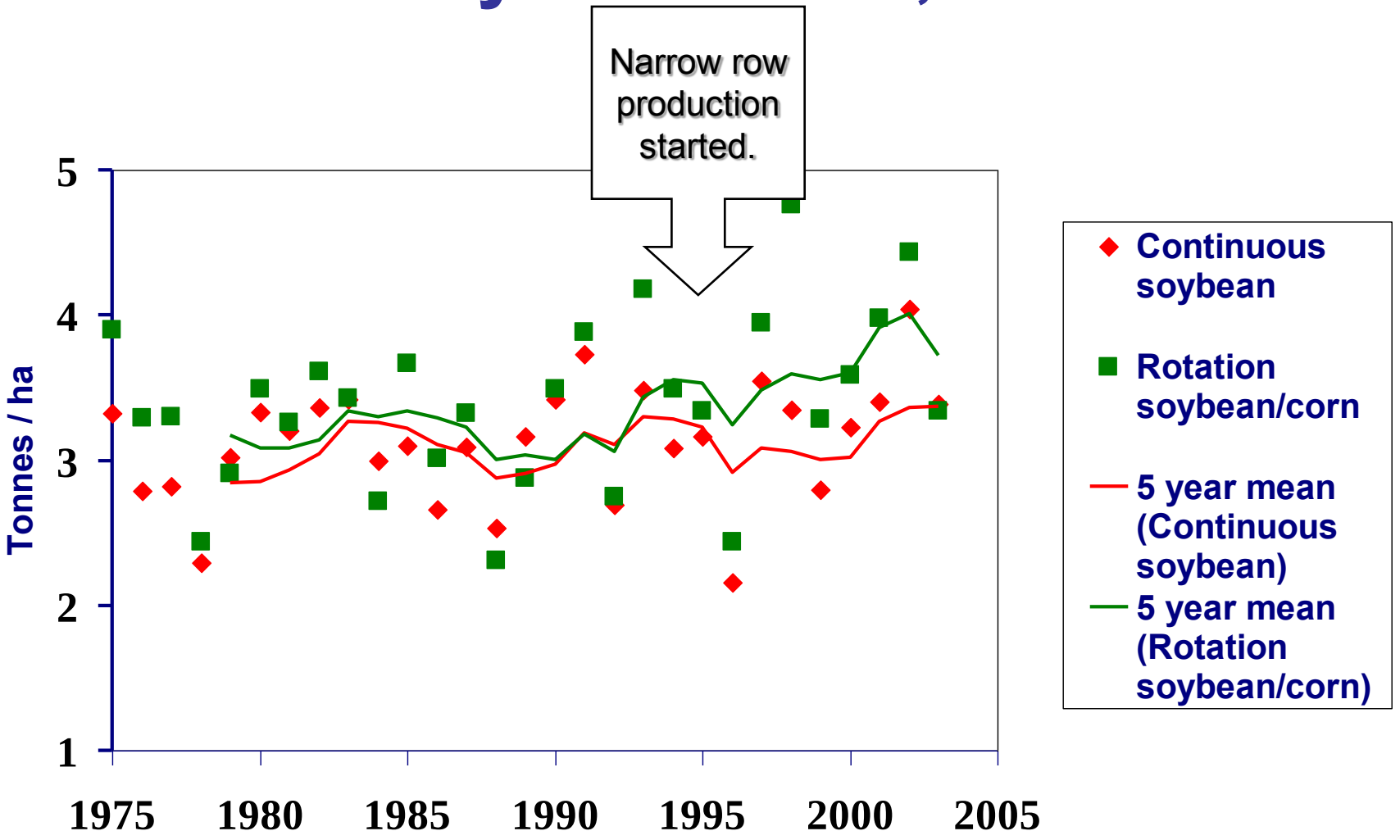
Tillage	Soybean/Corn		Con't. Soybean		Yield Gain for Rotation
	t/ha	% of plow yield	t/ha	% of plow yield	
Plow	3.33	- - -	3.04	- - -	10%
Chisel	3.23	97%	2.89	95%	12%
Ridge*	3.21	96%	2.84	93%	13%
No-till	3.16	95%	2.91	96%	9%

*Since 1980

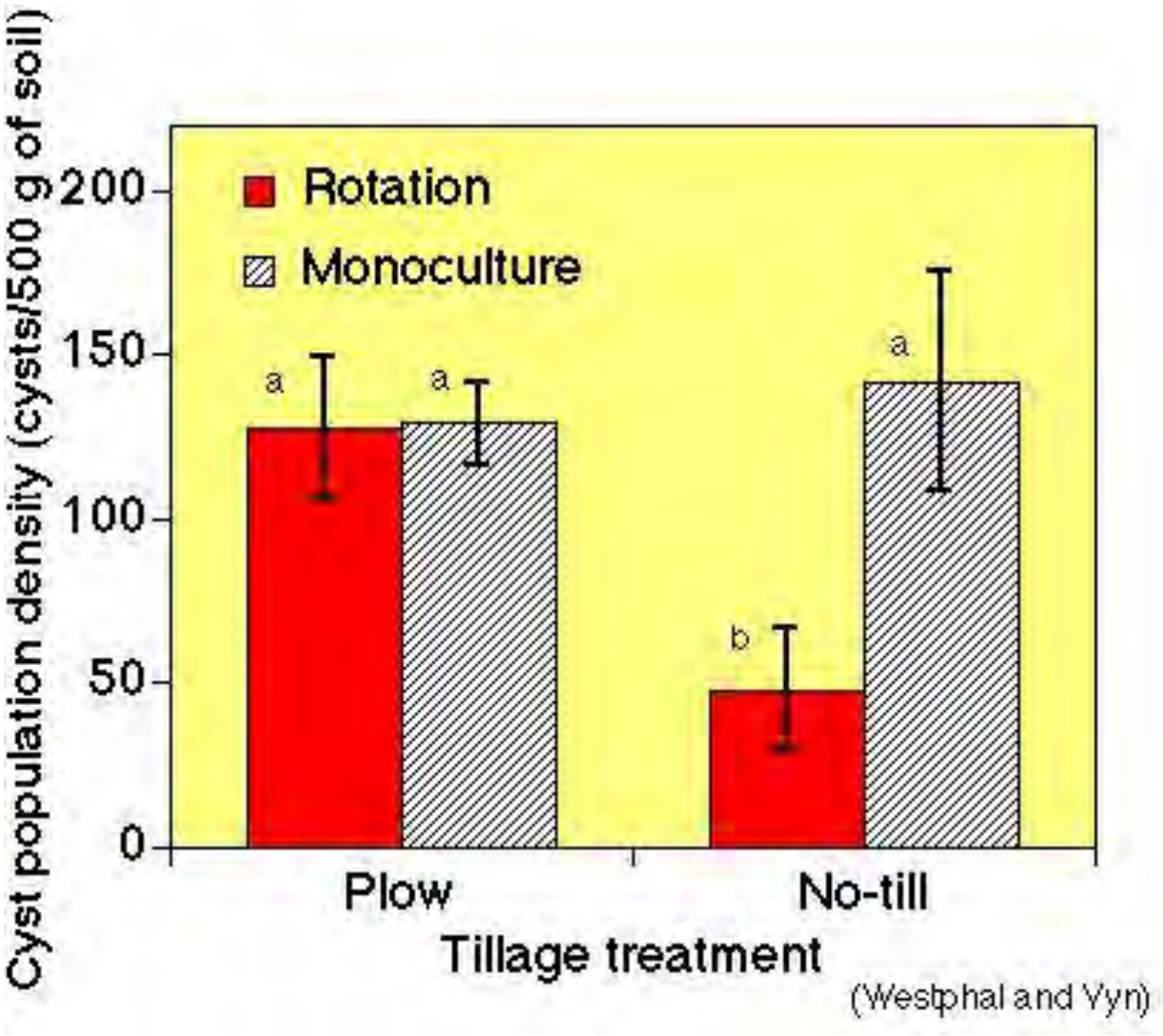
Soybean Yields Following Corn, West Lafayette, IN, 1975-2003.

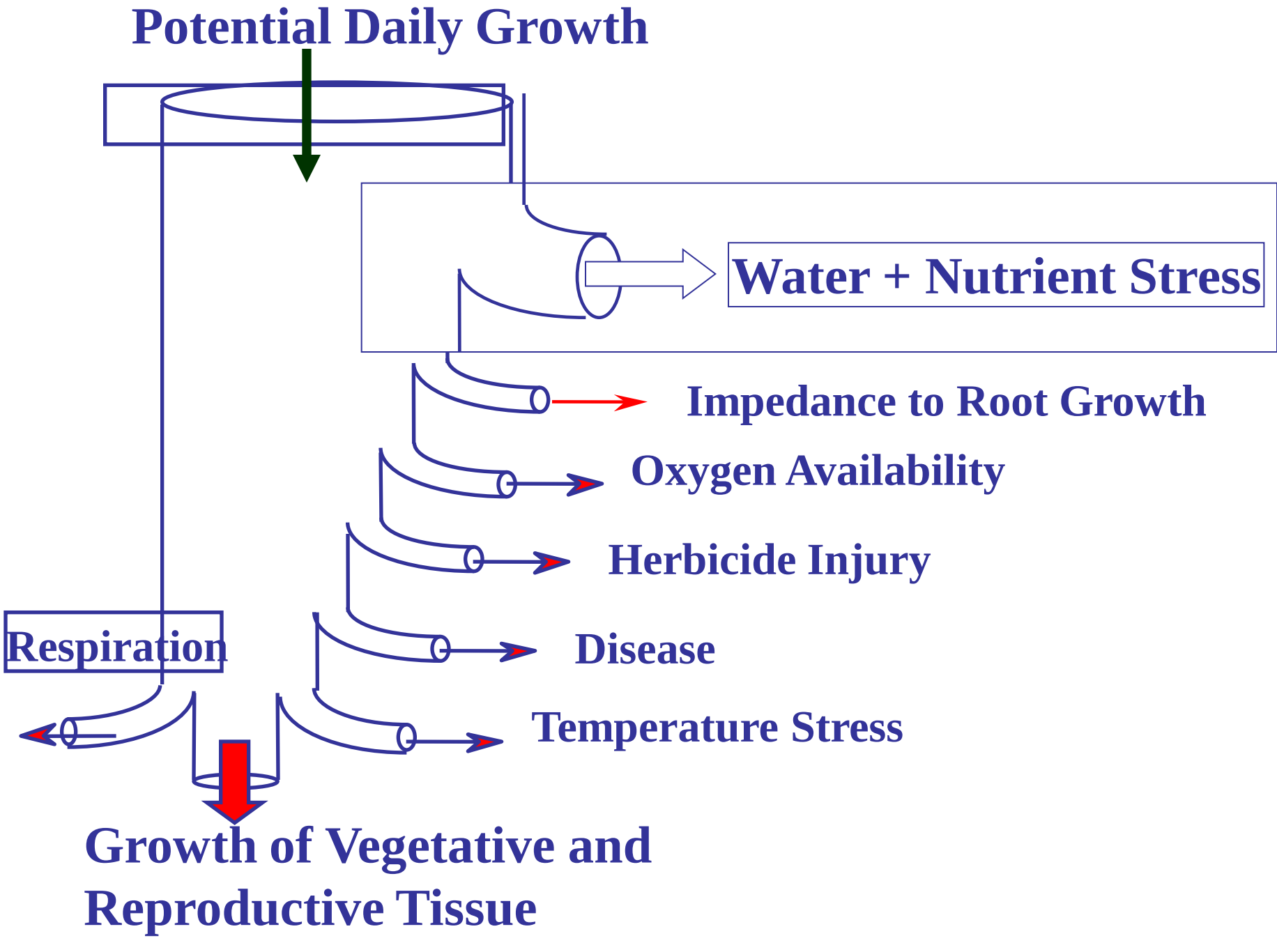


Continuous versus Rotation Effects on No-till Soybean Yield, 1975-2003.



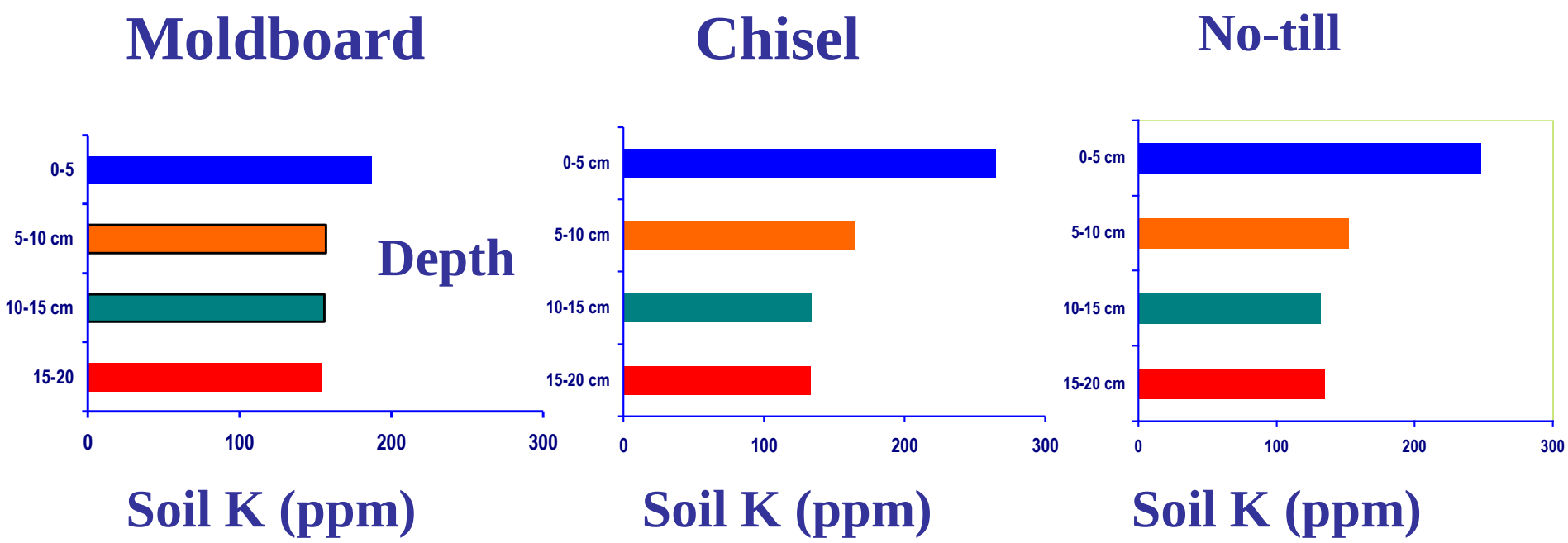
Soybean Cyst Nematode Populations with crop rotation and tillage (2003)




Potential Daily Growth
Water + Nutrient Stress
Impedance to Root Growth
Oxygen Availability
Herbicide Injury
Disease
Temperature Stress
Respiration
Growth of Vegetative and
Reproductive Tissue

Potassium Stratification

Long-Term Tillage (IN, 1975-94)

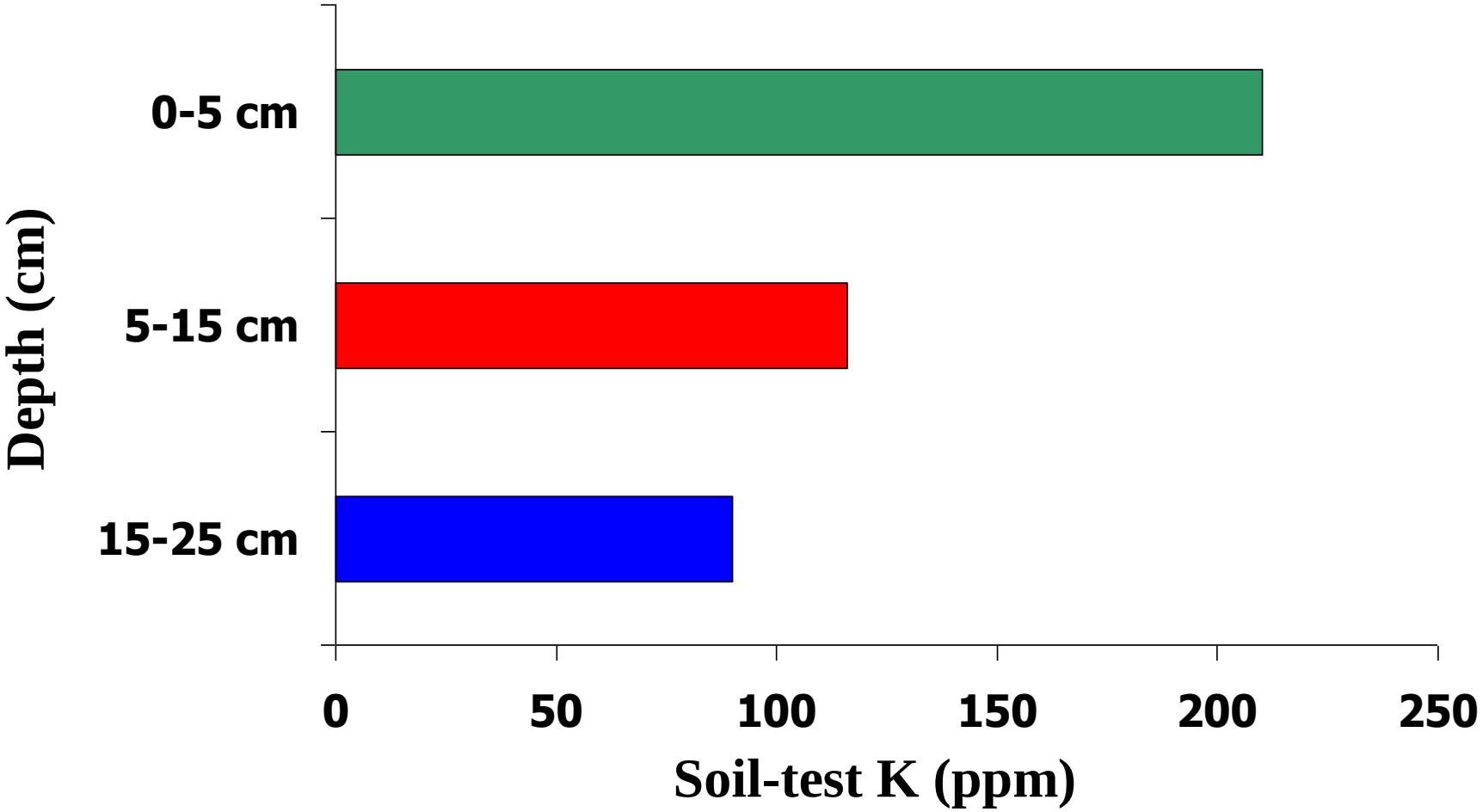


Source: Holanda et al. (1998)

Conservation Tillage Doesn't Alter K distribution appreciably

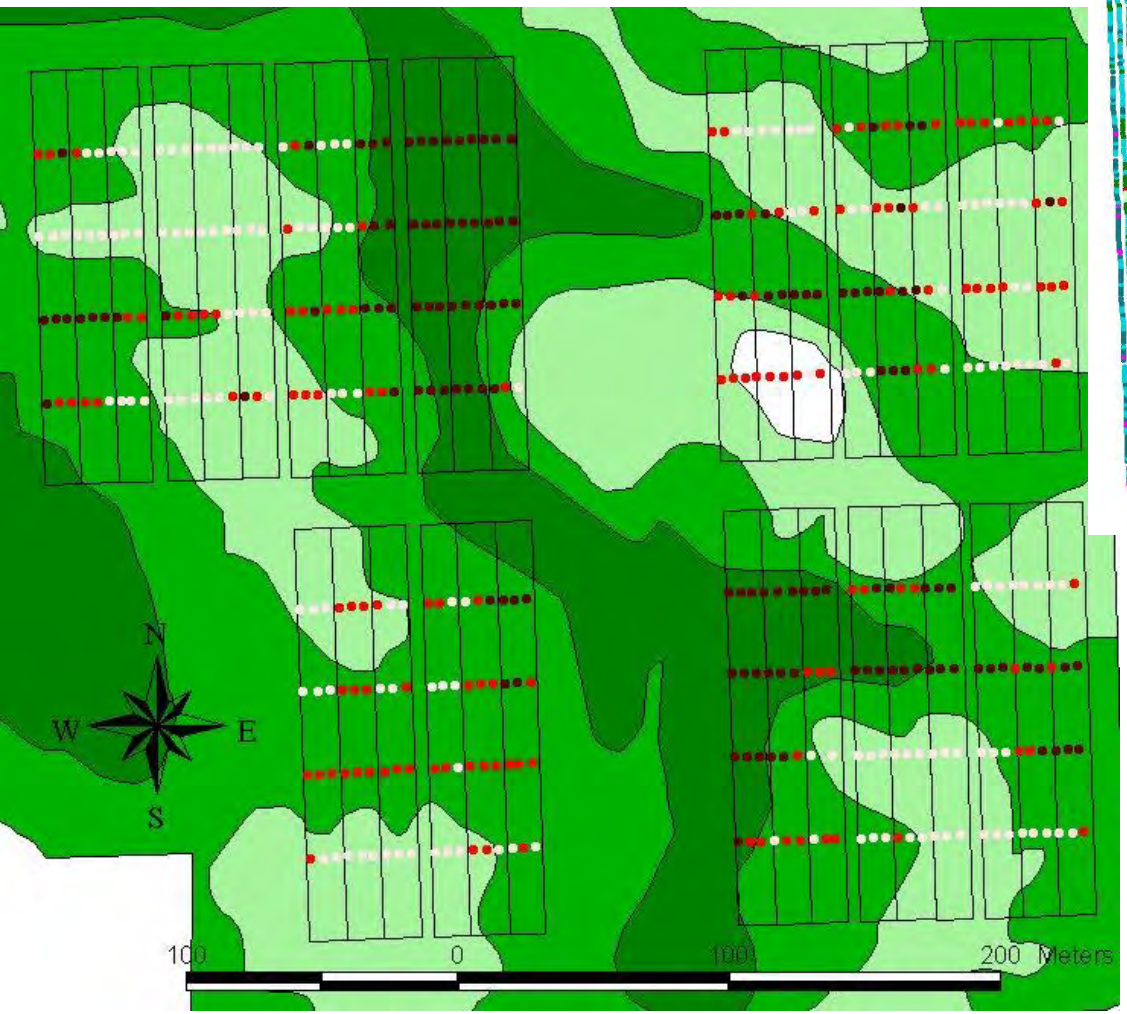
1. Does K placement Matter?
2. Implications for Management?

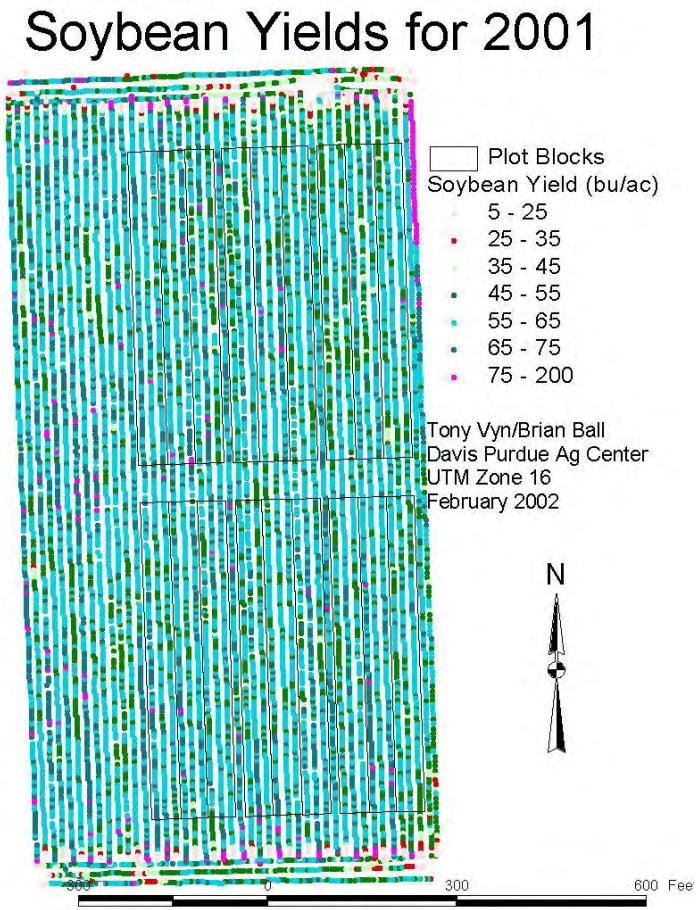
Mean Soil-test K Stratification at Davis-PAC

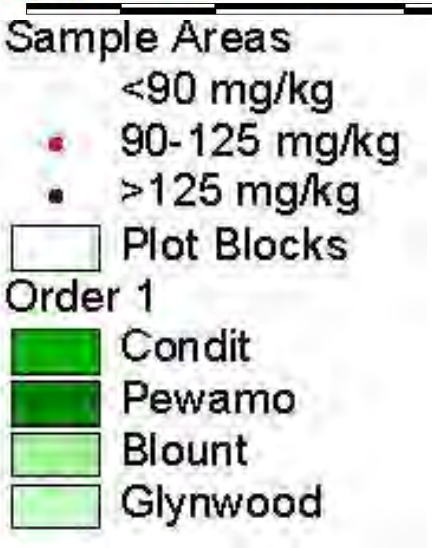


Source: Vyn et al., Better Crops #4, 2002

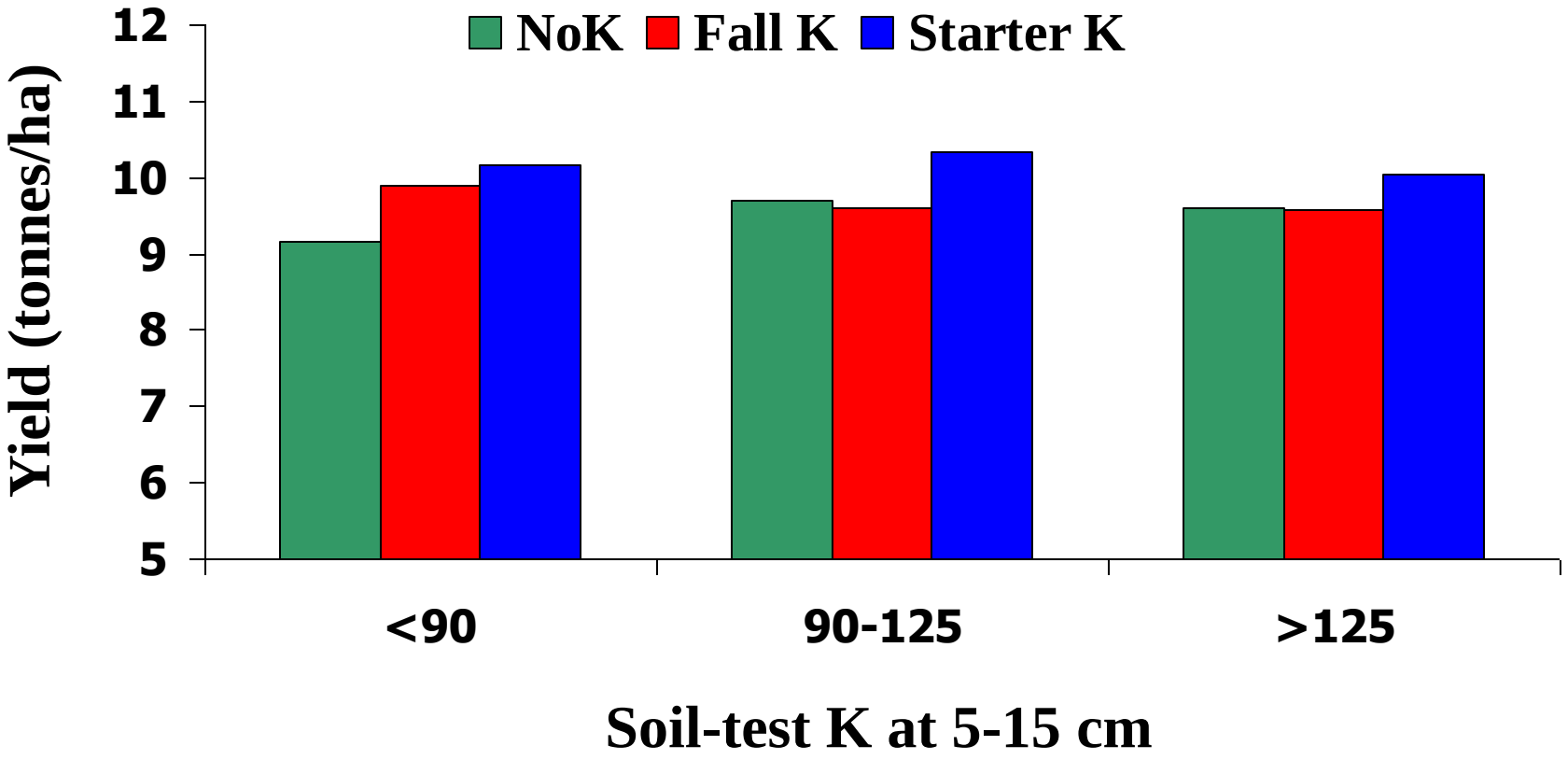
Placement in presence of high soil K variability?







High oil corn yields in response to K placement (Davis, IN, 2000-01)



Source: Vyn et al., Better Crops #4, 2002

No-till Soybean Height Differences at Davis PAC in 2003

No K (2000-2002)

Broadcast plus Starter K (2000,2002

Strip Tillage with Fertilizer Banding

Impact of K Banding Depth in Corn?

High Yield Corn Response to Placement

Hybrids: 1. Pioneer 34B24
2. Pioneer 34M95

Populations: 1. 80,000 per ha
2. 105,000 per ha

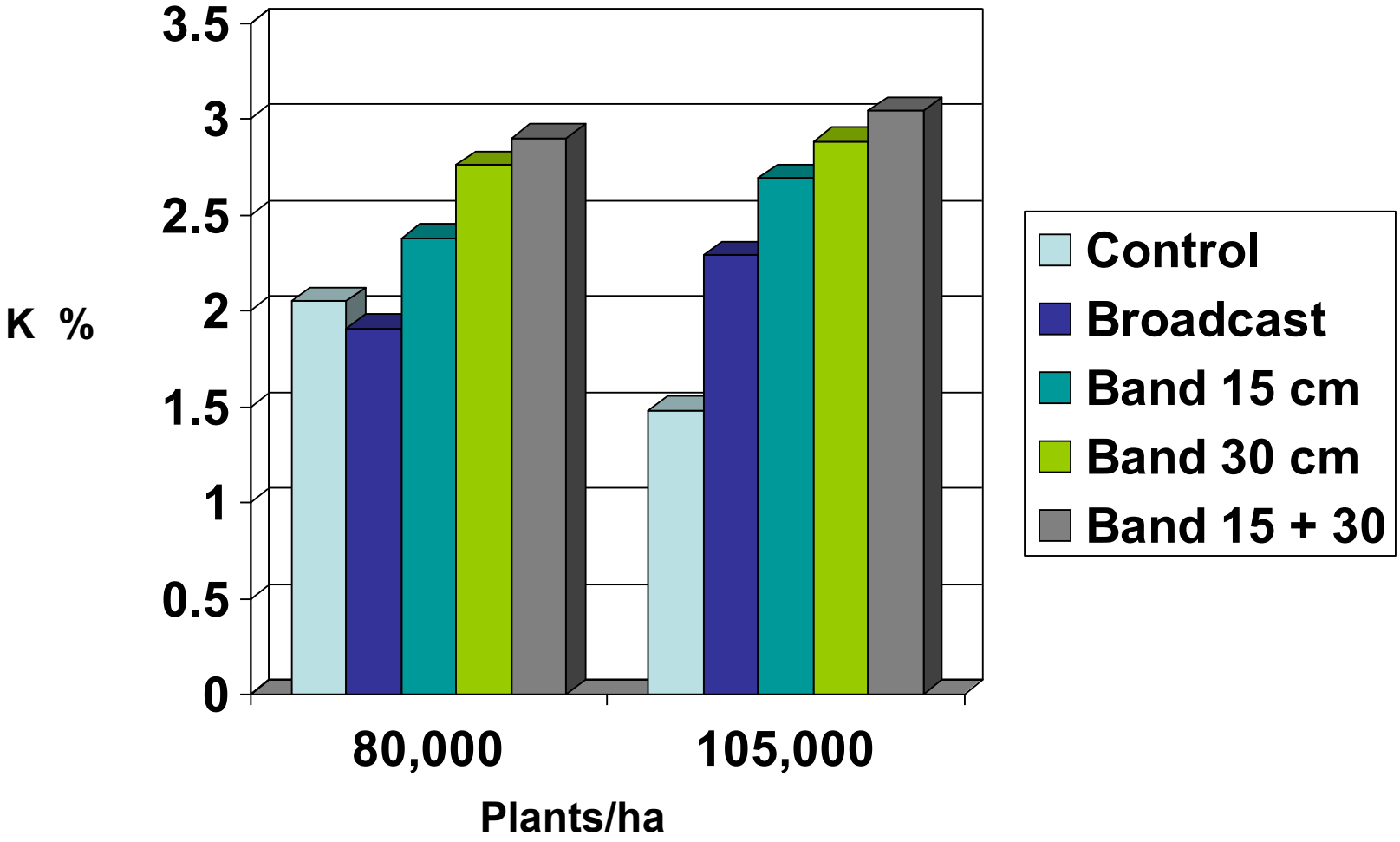
P&K Fertilizer Placements:

1. Control
2. Broadcast
3. Shallow Band (15cm)
4. Deep Band (30 cm)
5. Shallow + Deep (15 cm and 30 cm)

Notes: Soil P was 15-25 ppm and Soil Exchangeable k was 120-160 ppm
P_2O_5 rate was 97 kg/ha and K_2O rate was 125 kg/ha

Sponsor: PPI-FAR 2001-2003

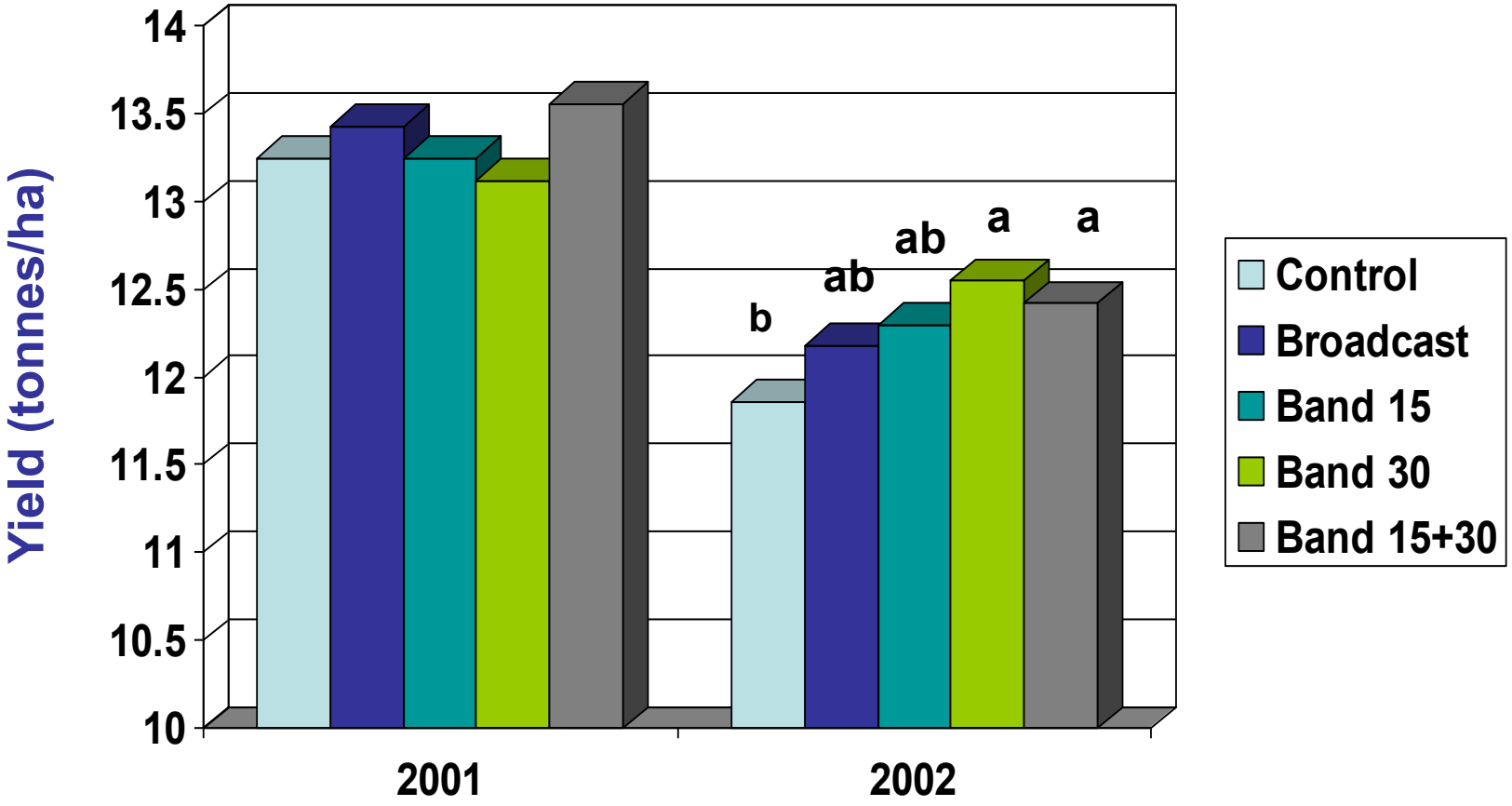
Placement Effects on Leaf K %
Pion. 34M95 in 2003



Yield Evaluation

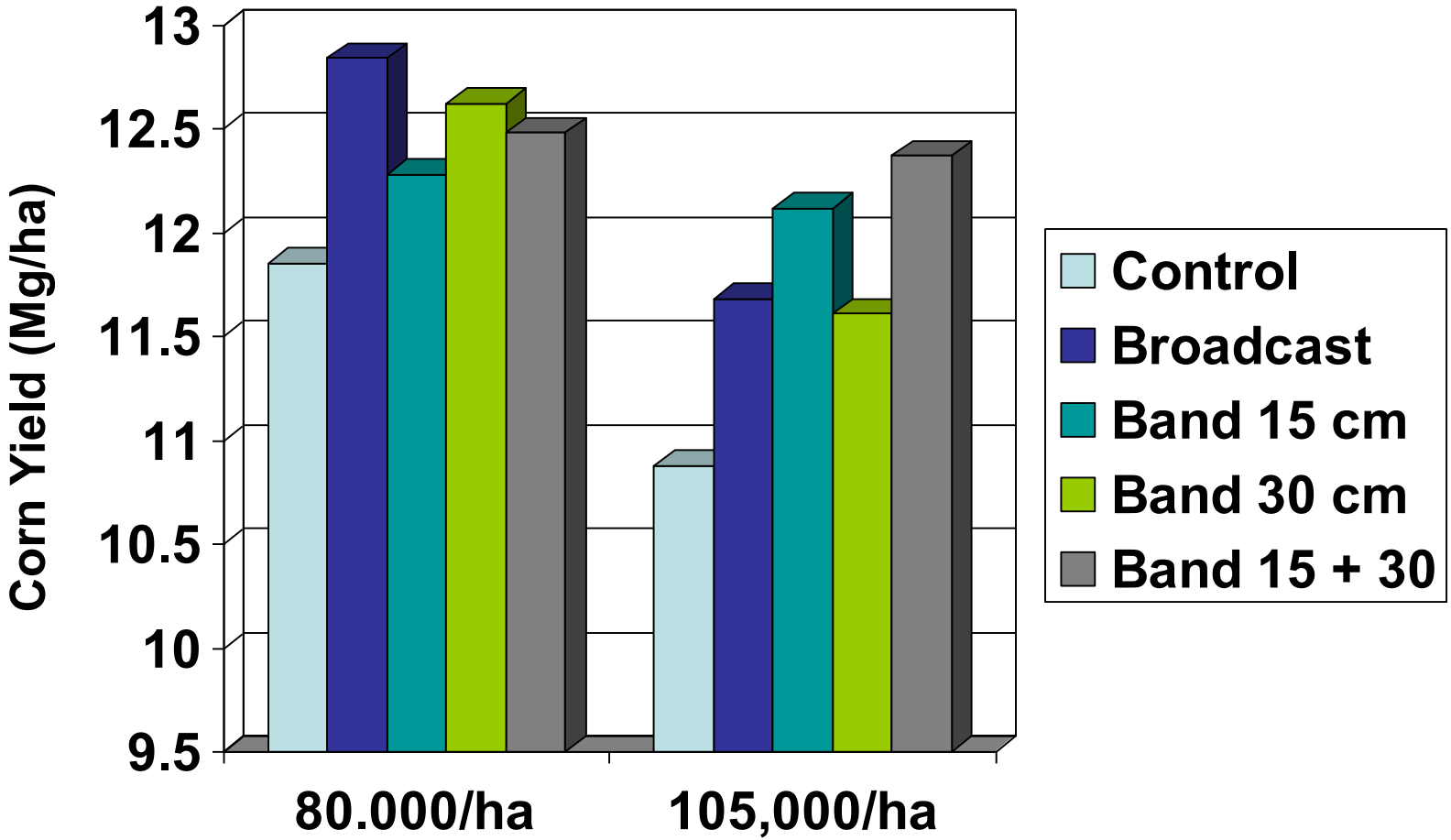
Corn Yield Response to Fertility Placement, West Lafayette, IN, (2001-2002).

(Mean of 2 hybrids and 2 populations)

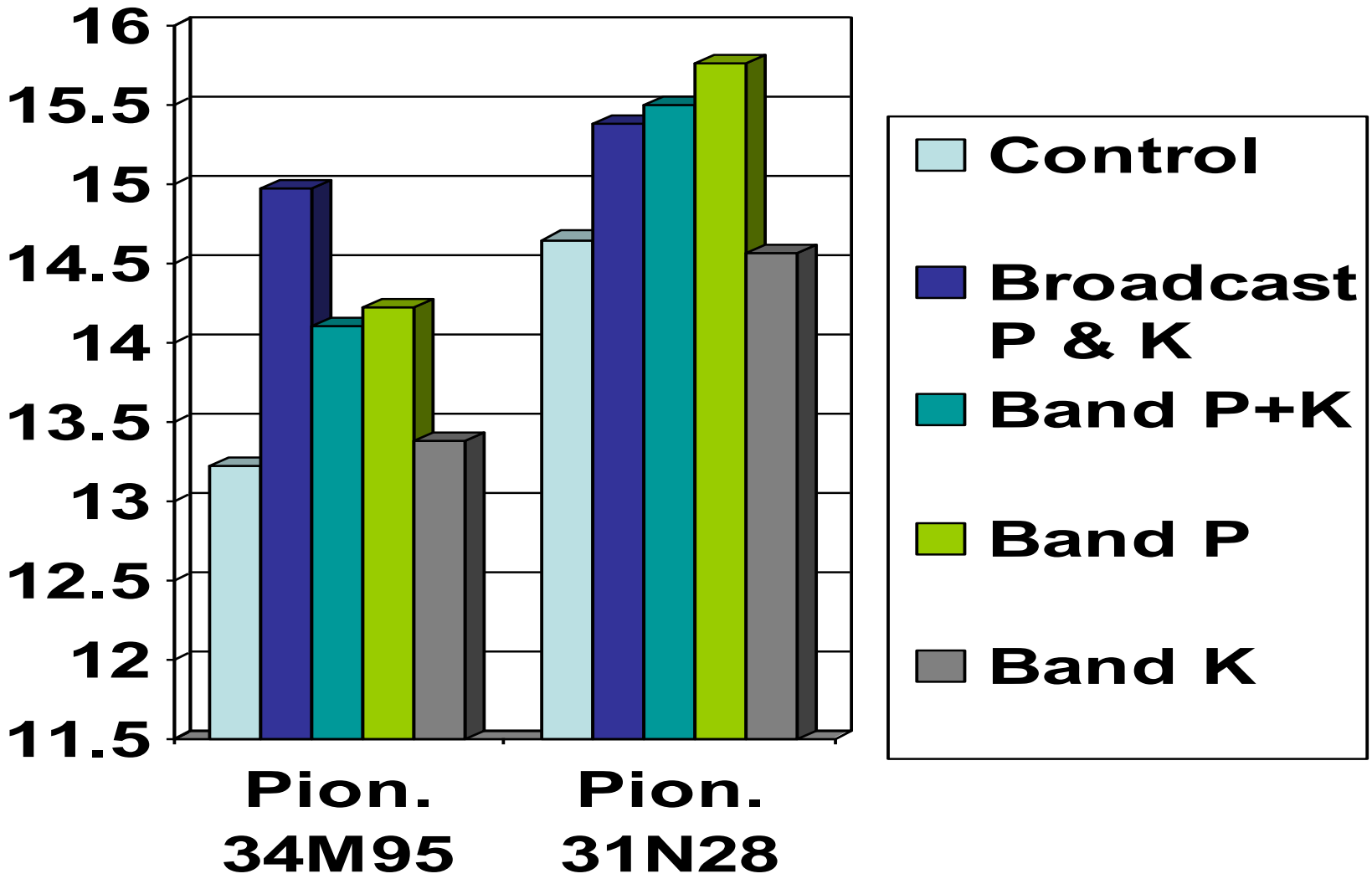


Note: P_2O_5 rate was 97 kg/ha, and K_2O rate was 125 kg/ha

Corn Yield Response of Pion. 34M95 to Alternate P plus K Placements in 2003



15 cm Placement Effects on Corn Yield in 2003

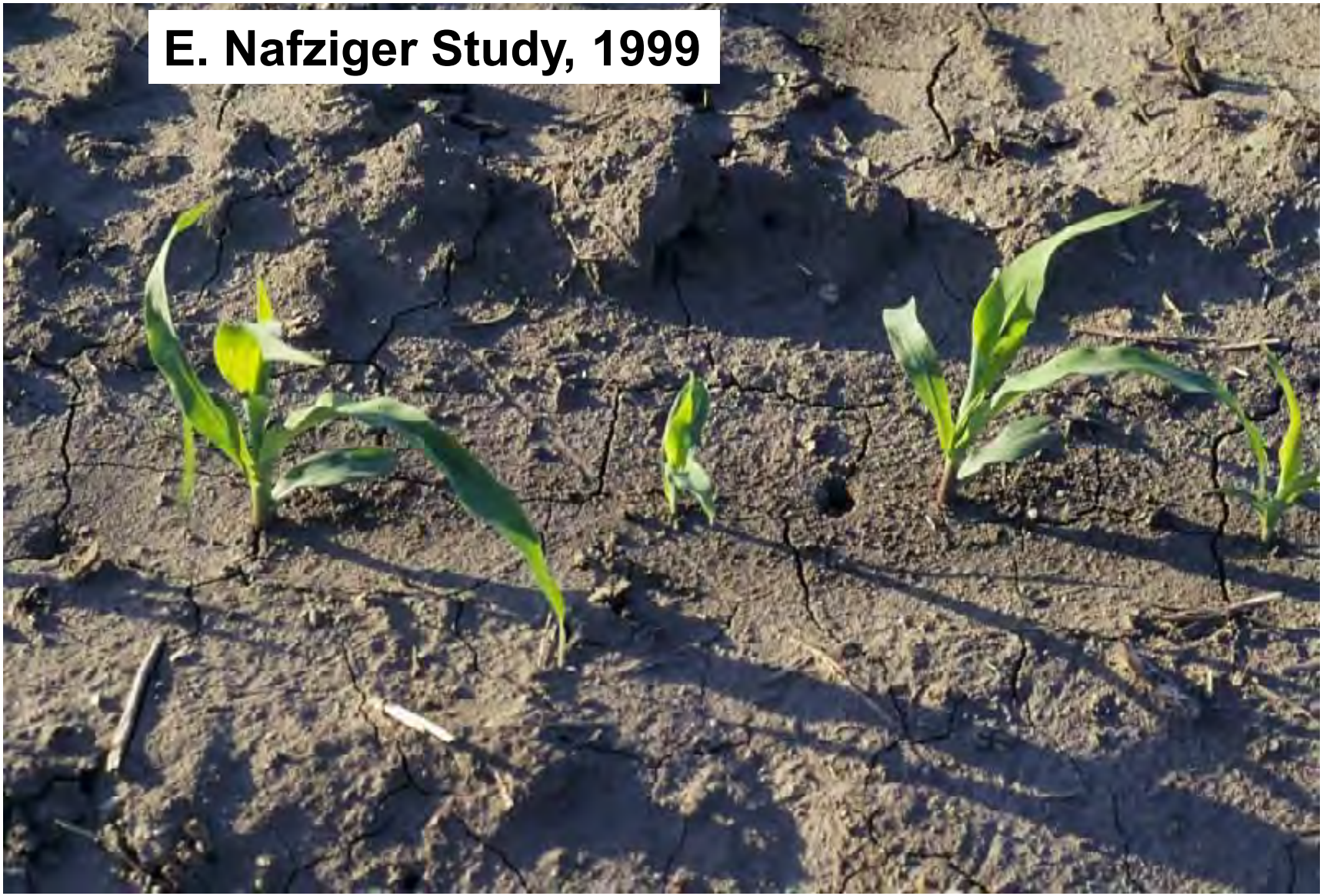


Consistency of Resource Availability in High Population Environments ?

An example from one hybrid at 105,000 plants/ha

No fertilizer

Band 15 + 30 cm


E. Nafziger Study, 1999

Accepted Hypothesis:

Delayed Seedling Emergence

↓

Shorter Plants

↓

↑ Delayed Silk Emergence

↓

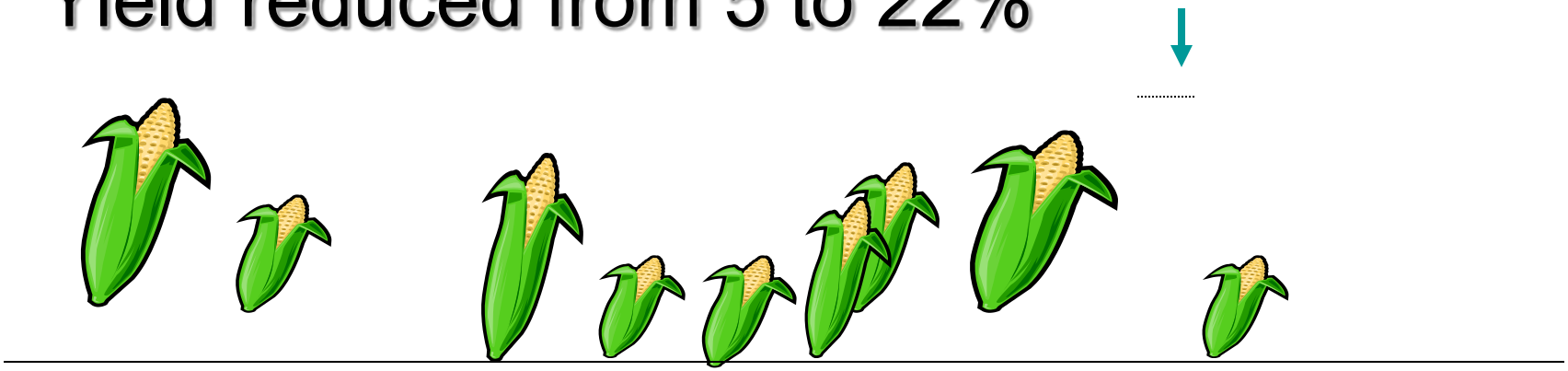
↑ Delayed Maturity

↓

Smaller ears at harvest

Previous Research on Emergence Uniformity

- Part of the stand planted 7-21 days later
  Yield reduced from 5 to 22%



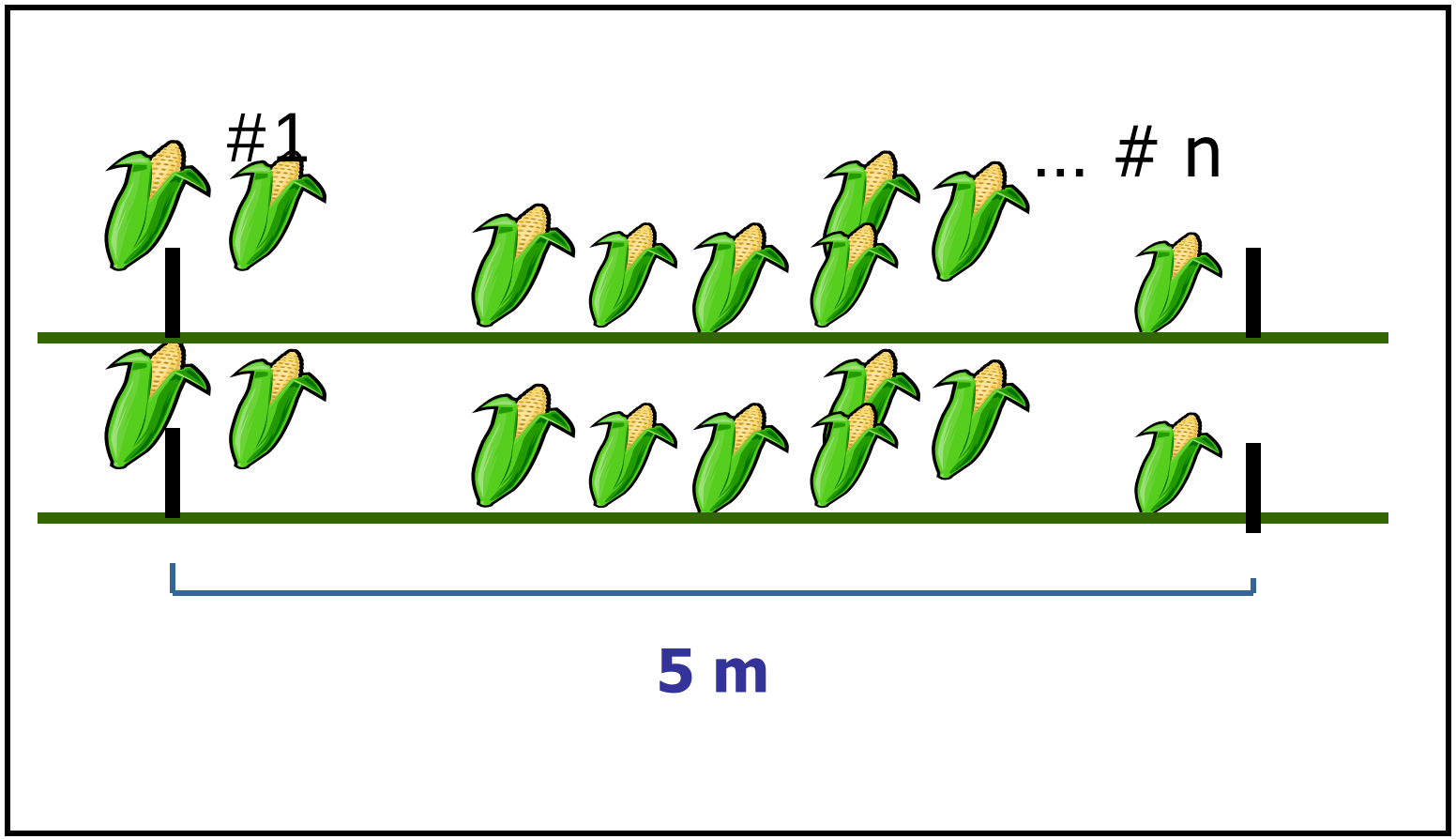
Source: Nafziger *et al*. (1991), Ford & Hicks (1992)

- What about the effects of Emergence variability amongst plants planted on the same day ?????

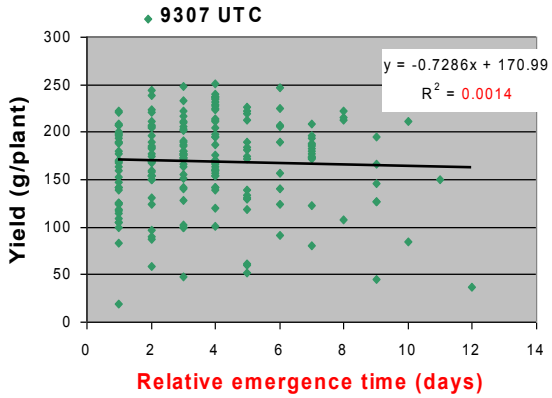
Measurements for corn uniformity experiments (2000-2004)

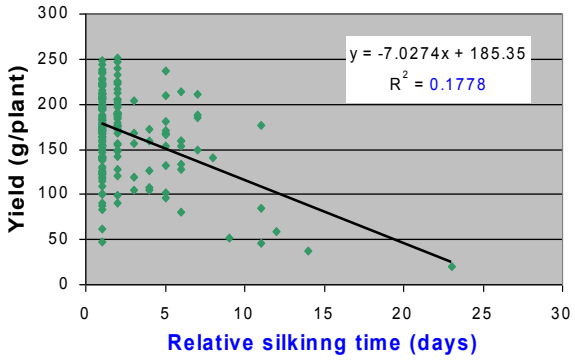
- Daily emergence counts (0 to 100%).
- Plant populations (emergence & harvest).
- Individual plant spacing within row
- Plants heights and V-stages (4-6 and 6-8 weeks).
- Daily silk emergence (0 to 100 %).
- Grain yield.

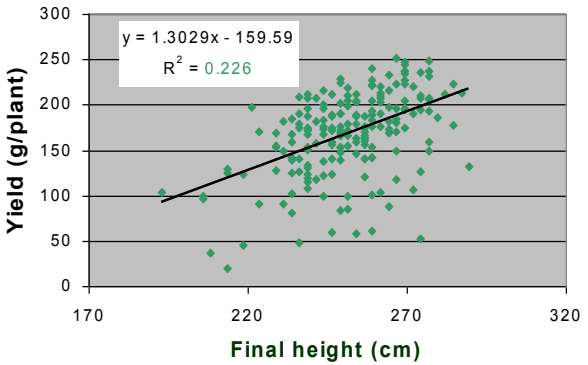
Measurements

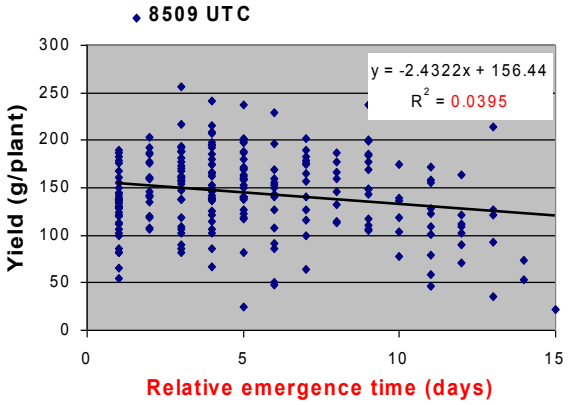


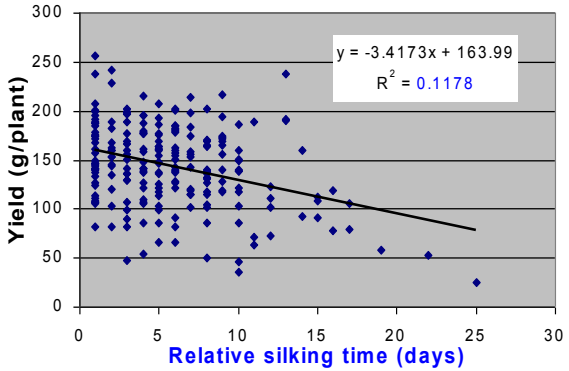
Linear Regressions of Individual Plant Yield for Early Planting in 2000

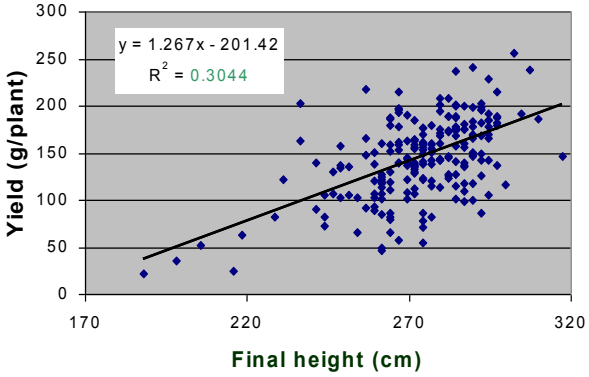




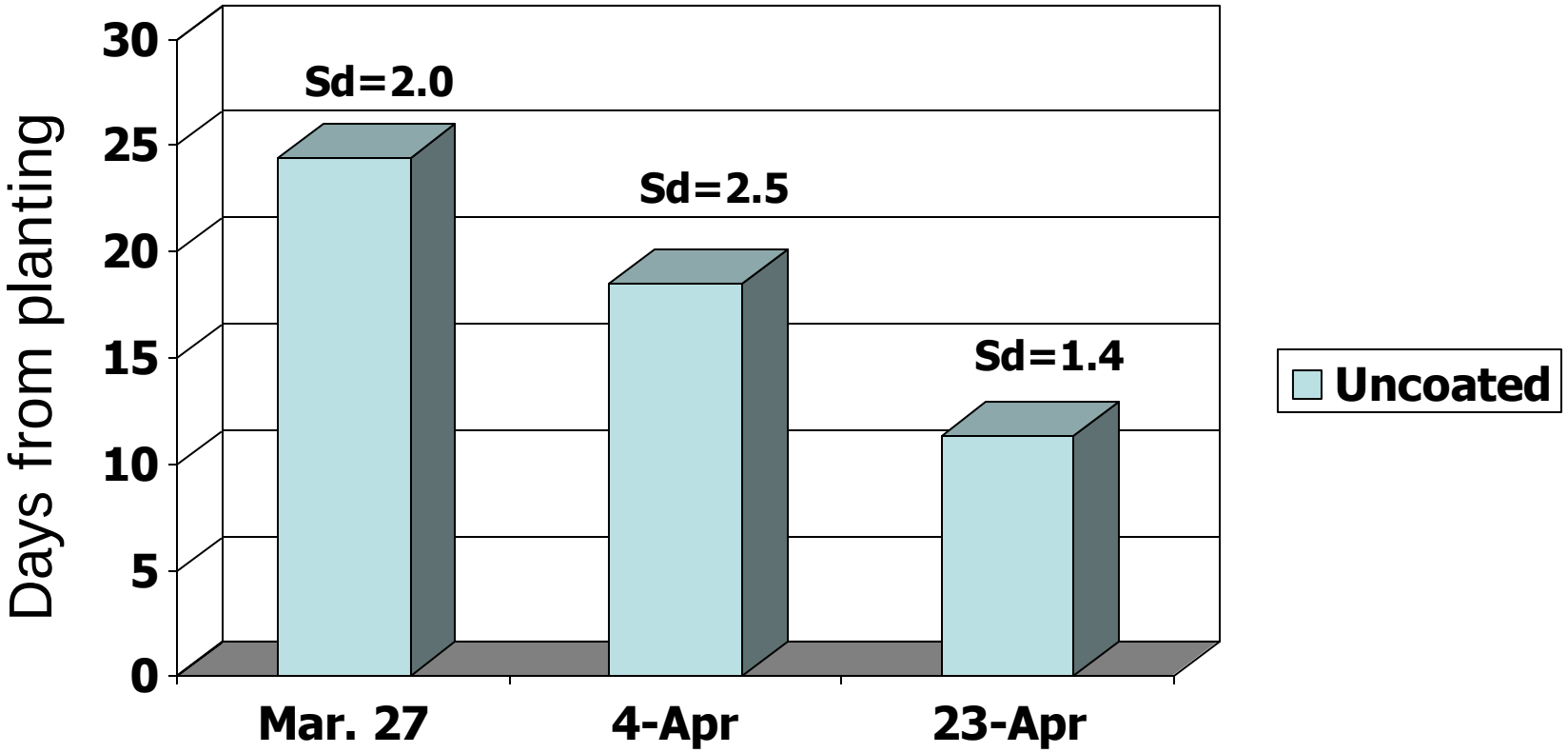




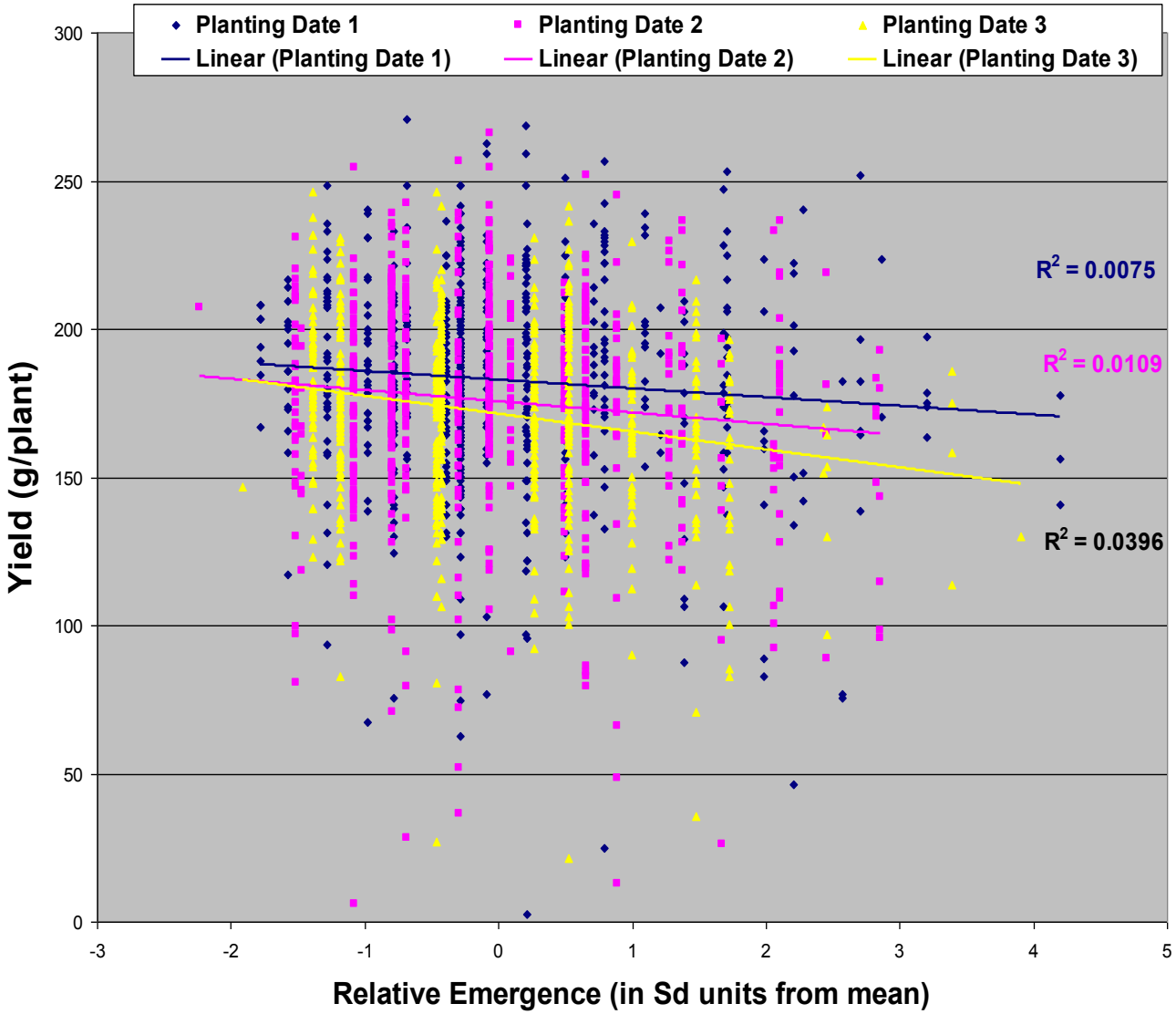




Emergence Time in 2003 (average of 3 hybrids at West Lafayette)



Individual plant Ear Yield versus Relative Seedling Emergence in 2003



Tentative Conclusions:

For consistent individual ear weights and high yields we need to make sure "No Plant is Left Behind!"

Effect

- Emergence date

\+ Silking Date & Plant Height

USB-FAR Projects in 2003

<u>Split-split plot Treatments:</u>

Prior Corn Hybrids (2)

Prior Fertility:
1. Control
2. Broadcast P and K
3. Band P and K (15 cm)
4. Band P alone
5. Band K alone

Potassium in 2003:

1. **None**
2. **Broadcast**

Conclusions:

- **In the short term, there is no guarantee that U.S. farmers who are already capable managers can achieve ever higher corn and soybean yields. Achieving higher yield levels is especially difficult for farmers who are already near the top for their state or county.**

- **Reasons for the "yield plateau" almost always involve plant stress in the growing season, usually associated with weather, pests, or their combination. Newer varieties are superior to the old ones, but sometimes it is less of a "real genetic gain" and more of an increase in tolerance to the ever changing pests.**

- **High Yield Corn Production will require more consistency in individual plant ear weights at high plant populations. That consistency is not just an emergence date factor, but one of competition with adjacent plants for most of the growing season.**

Conclusions (continued):

- Continuous no-till has distinct advantages for soybean in soybean intensive rotations, and for corn which follows soybean.
- Nutrient stratification issues in long-term conservation tillage are encouraging more banded placement, usually before corn, and often with a strip-tillage system.
- Banded P and K placement may indeed be more important for corn in conservation tillage systems planted at higher population densities, and when soil tests for P and K are average.

Thanks for Listening!

I have much to learn from you, and much more research to do!

Funding: PPI-FAR
Purdue Research
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Case

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John Deere
Case-DMI