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“Climbing Above the Yield Plateau”

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Leon G. Streit, Ph.D.
Senior Research Scientist
Pioneer Hi-Bred International, Inc.
Outline

- Soybean Yield Trends
  - Historical trends

- Research Strategies
  - Historical perspective
  - Marker-Assisted Selection (MAS)
  - Biotech approaches to yield enhancement
  - Research on new diseases and pests
  - Maximizing soybean yield potential
Yield Perspectives

• Yield is the most important trait for soybean producers

• Reliability of yield performance from year to year is crucial to build and maintain customer satisfaction

• Key defensive traits are required to ensure realization of yield potential

• Accurate characterization of varieties is critical to aid varietal selection and proper positioning on the farm
Yield Perspectives

• Yield increases based on genetic improvements continue to be made by US soybean breeders (~0.4 bu/acre/year)

• Increasing incidence of diseases and pests and recent droughts have prevented the realization of full yield potential in some regions

USA Trend: \( y = +0.412x - 785 \quad R^2 = 0.678 \)

Production Year

Seed Yield (bu/ac)

Source: Jim Specht, University of Nebraska, Data from National Agricultural Statistics Service
Current USA soybean improvement rate is 0.4 bu/ac yr. Due to:
1. Producers continually adopt ever-higher yielding varieties.
2. Improved field/pest management methods.

**USA Trend:** \( y = +0.412x - 785 \)  \( R^2 = 0.678 \)

Source: Jim Specht, University of Nebraska, Data from National Agricultural Statistics Service

USA Trend: \( y = +0.412x - 785 \)  \( R^2 = 0.678 \)

Seed Yield (bu/ac)

Best ever (to date) soybean yield year - 1994

Source:  Jim Specht, University of Nebraska, Data from National Agricultural Statistics Service
USA & NE Soybean Yield Trends (1972-2003)

USA Trend:  \(y = +0.412x - 785\)  \(R^2 = 0.678\)

Source: Jim Specht, University of Nebraska, Data from National Agricultural Statistics Service
USA Soybean Yield Trends (1972-2003)

USA Trend:  

\[ y = +0.412x - 785 \quad R^2 = 0.678 \]

\[ y = -0.290x + 617 \]

Source: Jim Specht, University of Nebraska, Data from National Agricultural Statistics Service

USA Trend: \[ y = +0.412x - 785 \]  \[ R^2 = 0.678 \]

Source: Jim Specht, University of Nebraska, Data from National Agricultural Statistics Service
Historical Yield Improvement Strategies

• Cross high-yielding parental lines
• Evaluate large numbers of experimental lines derived from the parental crosses
• Commercialize the best experimental lines based on wide-area yield performance
• Rate of yield improvement (about 0.4 bu/year)
Yield Testing Strategies - Today

• Yield testing
  - Over 1 million research yield test plots planted annually by Pioneer soybean researchers in North America
  - Use marker-assisted selection (MAS) to front-end load yield trials with experimental lines that possess disease/pest traits customers need

• On-farm comparison trials
  - More than 10,000 plots planted on customer and sales rep farms
  - Improves our ability to position varieties
Genetic Fingerprinting

- Ensure the presence of key defensive traits prior to yield testing (Marker-Assisted Selection)
- Identify genes governing yield potential and discover untapped sources of yield potential in exotic germplasm
- Map disease/pest resistance genes
SCN Resistance: Marker Approach

• A patented technique developed by Pioneer
  – biotechnology
  – robotics
  – information management

• Gene mapping used to identify the location of SCN resistance genes on specific chromosomes

• Marker-assisted selection to confirm the presence of these genes in experimental varieties

• Requires only a leaf tissue sample; no nematodes required

• Can be used in off-season nurseries

• Rate of Genetic Gain = 2X Historical Rate of Gain
Biotech Approaches to Yield

• Genetic fingerprinting (molecular markers) to track yield genes

• Transgenic approaches to enhance yield potential and/or stability

• Genomics to understand gene function and interactions
Selecting for Yield Genes

Variety X

Allele “A” (+)

51.5 bu/a

Allele “a” (-)

48.5 bu/a

Selection using genetic markers
Transgenic Approaches

- Improve the efficiency of photosynthesis – "source"
- Improve the yield "sink"
- Improve resistance to drought, heat, insects and diseases
Chinese Soybean Aphid
Aphid Screening
Reproduction of *Aphis glycines* on 10 soybean entries after seven days of infestation

Bars with the same letter are not significantly different (*P*<0.05, Tukey's test).

Source: Kansas State University
Asian Soybean Rust
Extended period of sowing makes rust control difficult

Tapurah, Mato Grosso, Feb. 23, 2004
Maximizing Genetic Yield Potential

• Yield Expectation
• Field History
  - Diseases
  - Pests (Aphids, SCN, etc.)
• Product Selection
  - Maturity
  - Herbicide Resistance
  - Disease and/or Pest Resistance Traits
  - Agronomic Traits
• Increased Management of Pests
• Select a “Package of Products” to reduce risk
92M91 vs. 92M92

No SCN

High SCN
White Mold Damage
Wellman, IA – 8/24/04

93M11
WHD = 6

Competitor
WHD = ???
Sudden Death Syndrome Damage
Keota, IA 8-24-04

- Competitor
  SDS = ???

- 93M50
  SDS = 6

- 93B68
  SDS = 6
Take Home Messages

• We continue to seek new strategies to add to soybean performance, minimize grower risk, and add value

• Yield improvement will remain a primary focus of our research efforts

• We are confident that the application of biotechnology tools will increase the rate of yield improvement in soybeans

• We are working diligently to develop varieties that will handle key disease and pest challenges facing growers today and in the future

• Teamwork Across Disciplines