PIONEER®

Understanding & Increasing Soybean Yields

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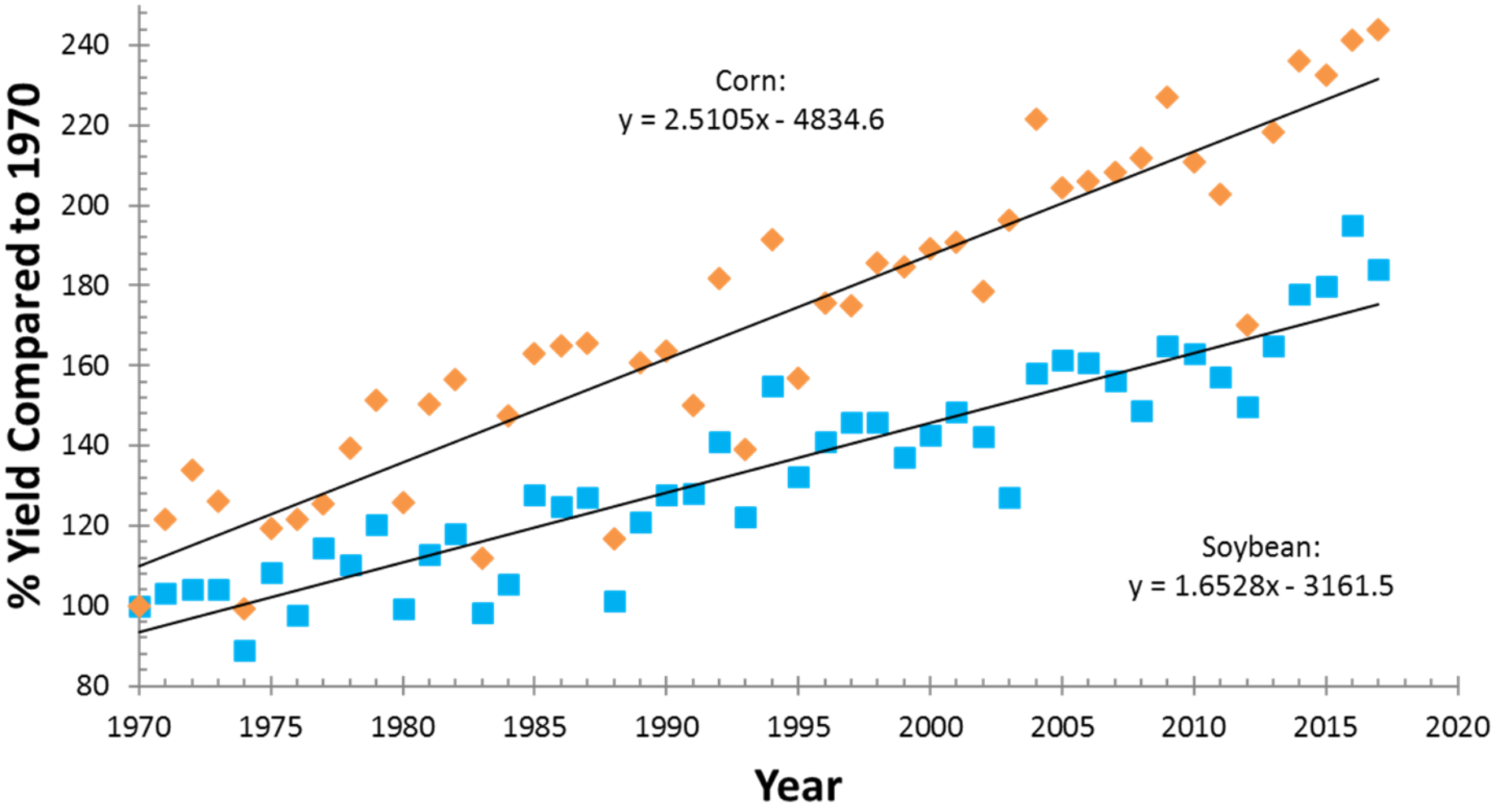
Pioneer Agronomist, Southern IA

National Rate of Yield Increase: Corn vs Soybean



Current Yield Record

- Kip Cullers, Missouri
  - 2006 – **139.4** bu/ac
  - 2007 – **154.6** bu/ac
  - 2010 – **160.6** bu/ac

- Randy Dowdy, Georgia
  - 2016 – **171.8** bu/ac

Harvesting 100+ Bu/A Soybeans in Arkansas

Perry Galloway Pioneer® variety P47T36R

Glyphosate Tolerant

Always follow grain marketing, stewardship practices and pesticide label directions. Varieties with the Glyphosate Tolerant trait (including those designated by the letter "R" in the product number) contain genes that confer tolerance to glyphosate herbicides. Glyphosate herbicides will kill crops that are not tolerant to glyphosate.

What percent of flowers on a soybean plant typically become pods?

√ A. 25%

B. 35%

C. 45%

D. 75%

Self pollinated
Near 100% fertilization
Higher yield = more flowers

Example

Add 1 pod to each main stem node on a plant that has 17 nodes

Each pod contains 3 average size seed (2900 seed per lb)

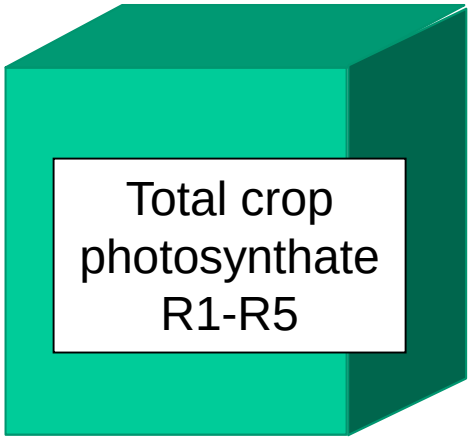
Final Stand of 120,000 plants/A

+35 Bu/A

Seed Number Determination

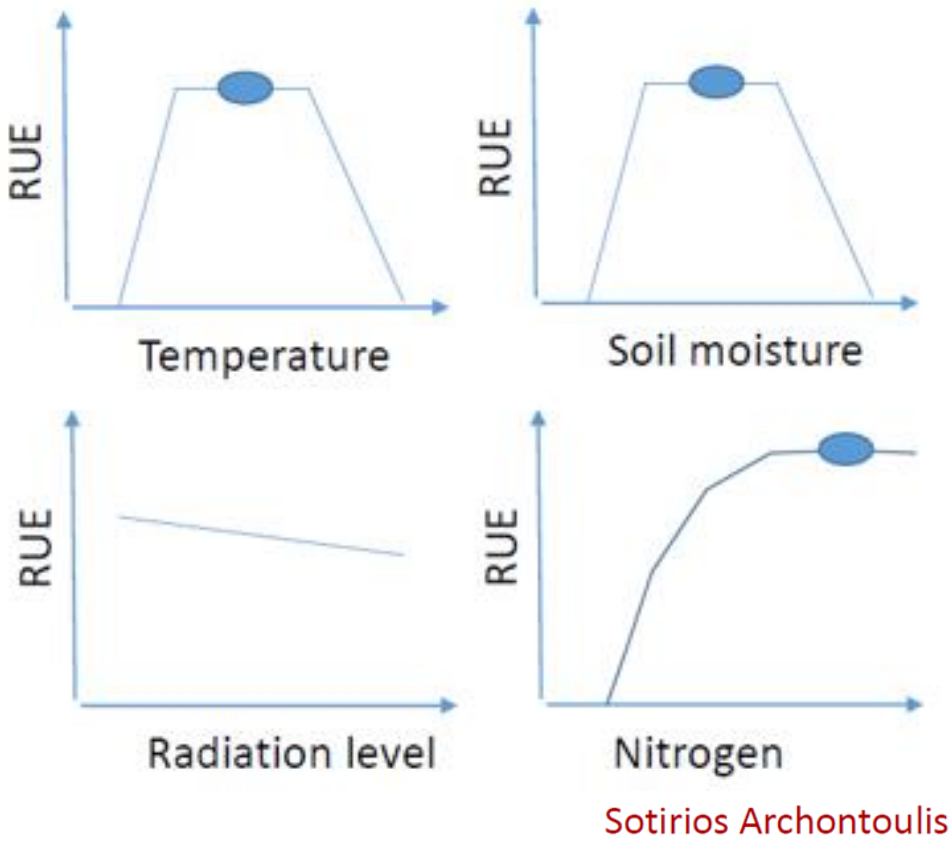
$$seed\ m^{-2} = \left(\sum_{R1}^{R5} IR\right) * RUE * \gamma * {A_g}^{-1}$$

Seed number =



Factors Influencing Photosynthesis

- Water balance
- Temperature
- Nutritional status
- Weed, insect,
  disease pressure
- Light quantity and quality



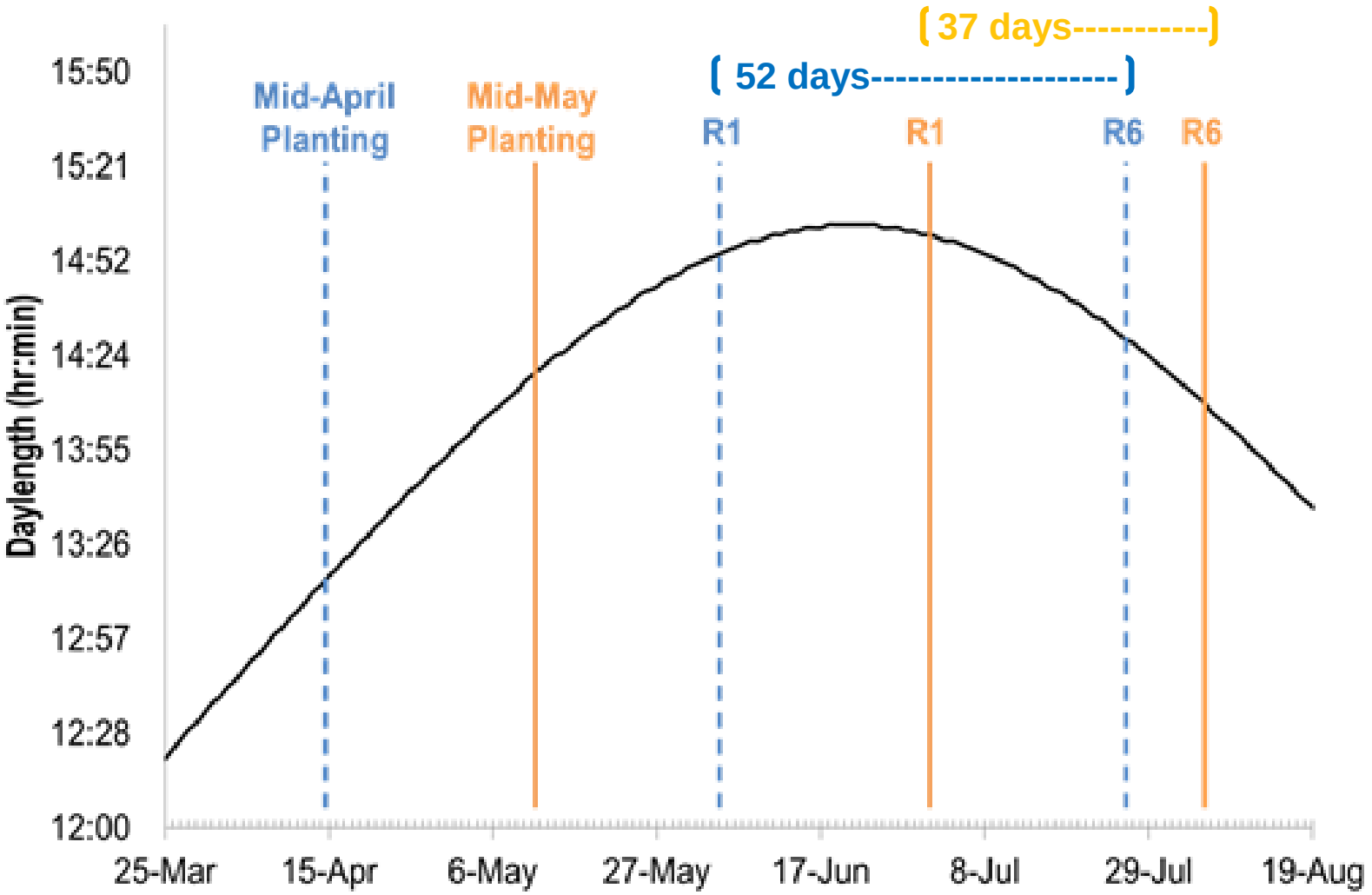
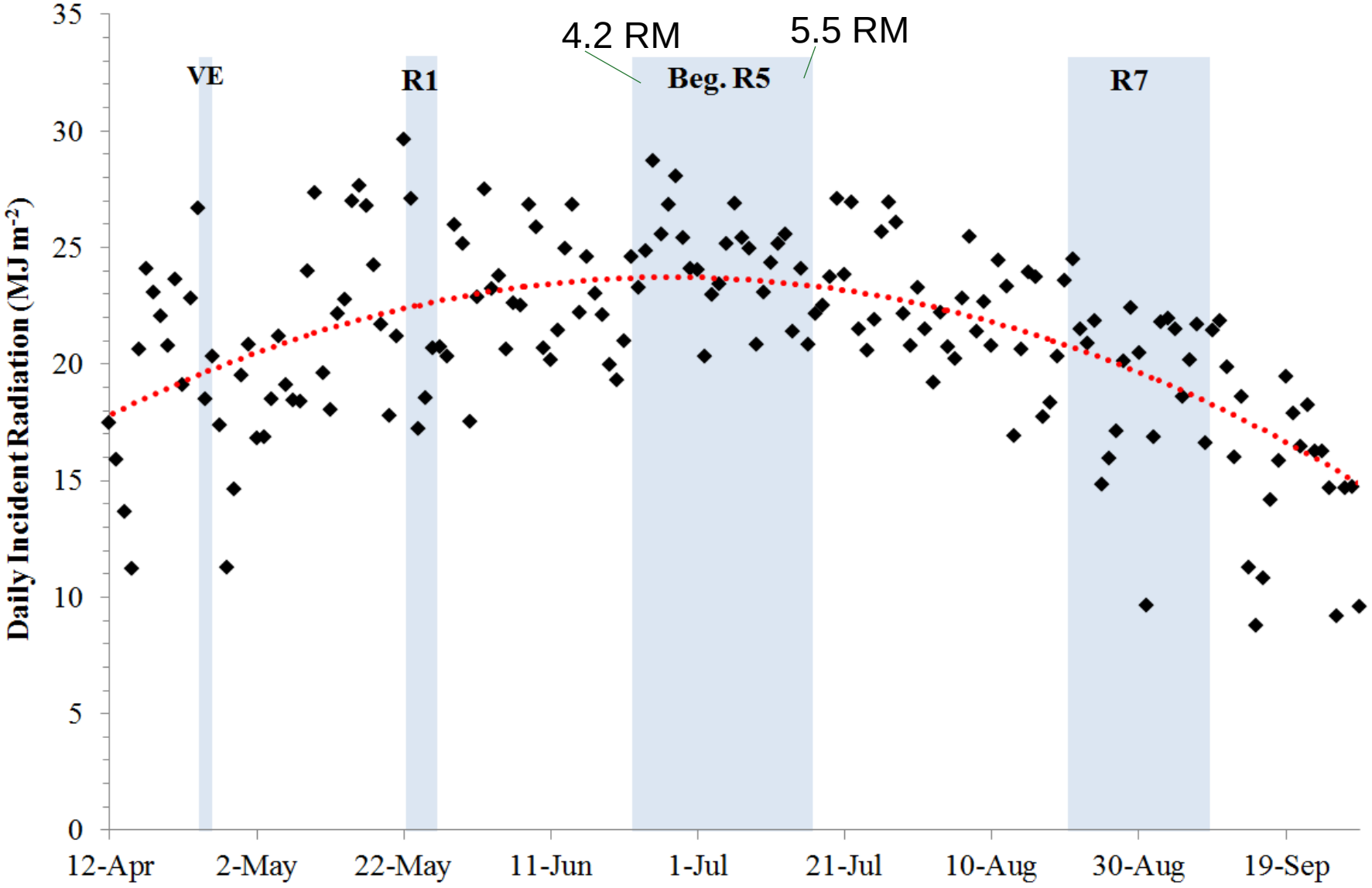


Figure 4. Daylengths during the growing season for Pittsburg, PA (40.4° N) with example planting, R1, and R6 dates from Parker et al. (2016).

Arkansas Growing Season



Factors Influencing Photosynthesis

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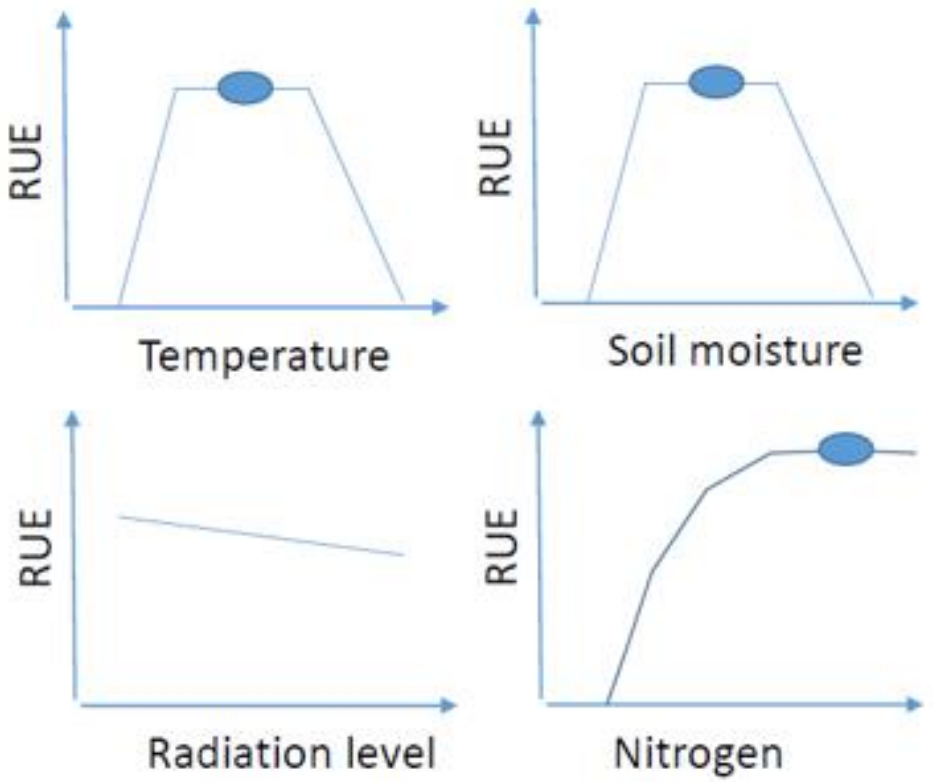
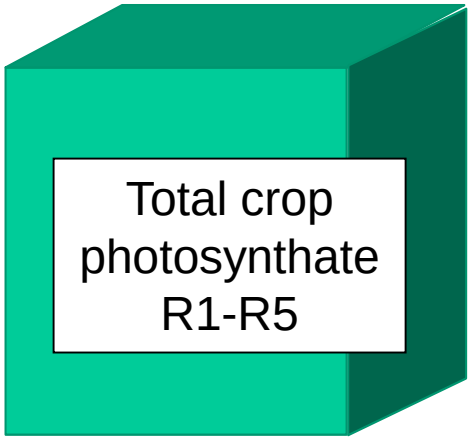


Sotirios Archontoulis

- Supplemental sugar?
  - *Hula's ½ lb/ac = 54 seconds of photosynthesis*

Seed Number Determination

$$seed\ m^{-2} = (\sum_{R1}^{R5} IR) * RUE * \gamma * {A_g}^{-1}$$

Seed number = 

Allocation to reproductive growth

X γ

Probability of flower abortion

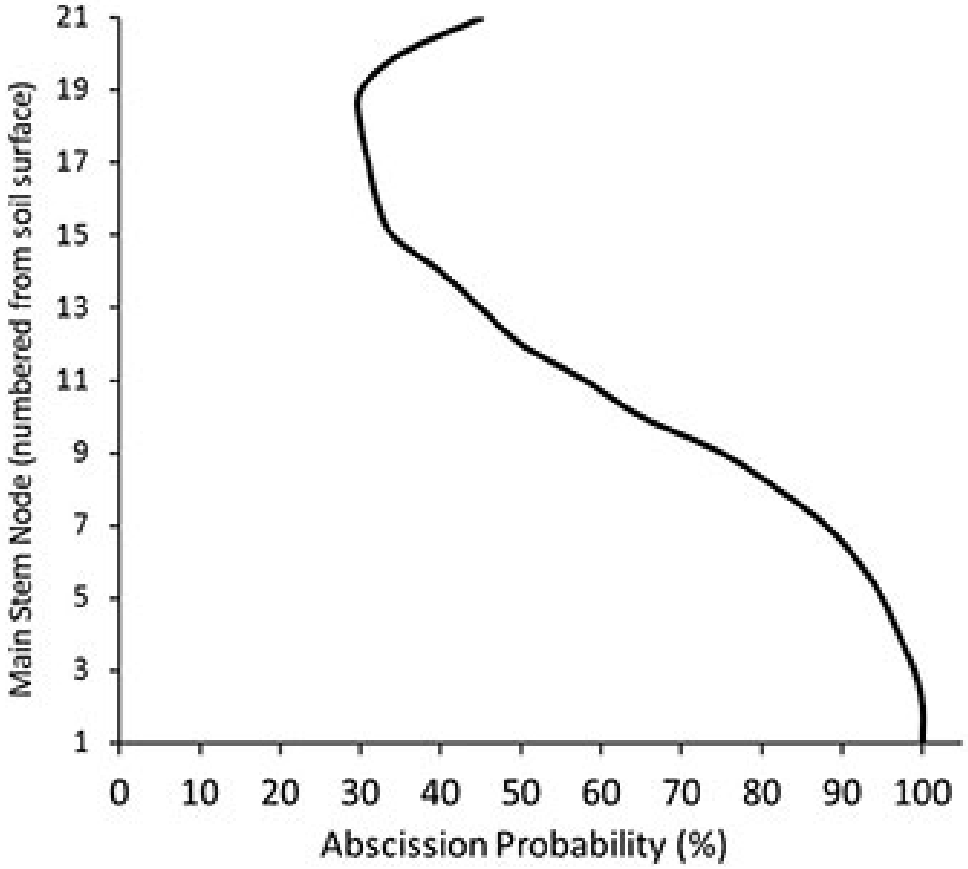


Figure 6: Effect of position within soybean canopy on flower abscission probability. Node 1 is closest to soil surface.

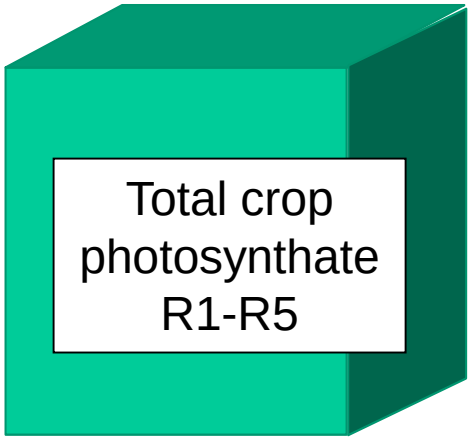
http://ipm.missouri.edu/ipcm/2012/10/Arrested-Development-in-the-Soybean-Field/

Seed Number Determination

$$seed\ m^{-2} = (\sum_{R1}^{R5} IR) * RUE * \gamma * A_g{}^{-1}$$

Seed number = Total crop photosynthate R1-R5 X γ ÷ Photosynthate needed per seed

Allocation to reproductive growth



Probability of pod abortion

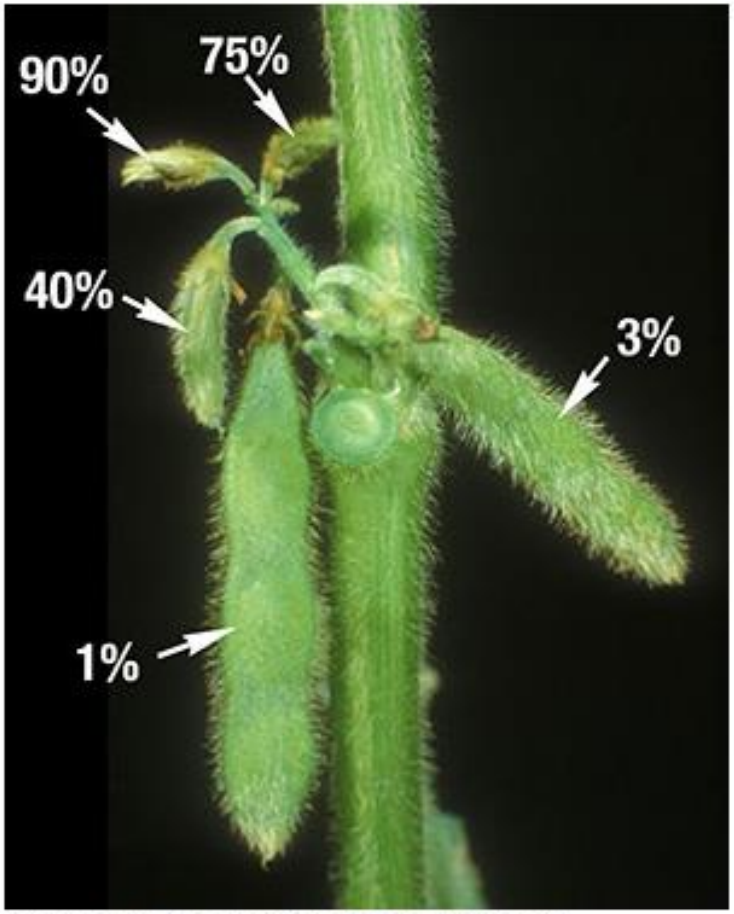


Figure 7: Abscission probability of flowers/pods within a raceme. Picture is from Iowa State University.

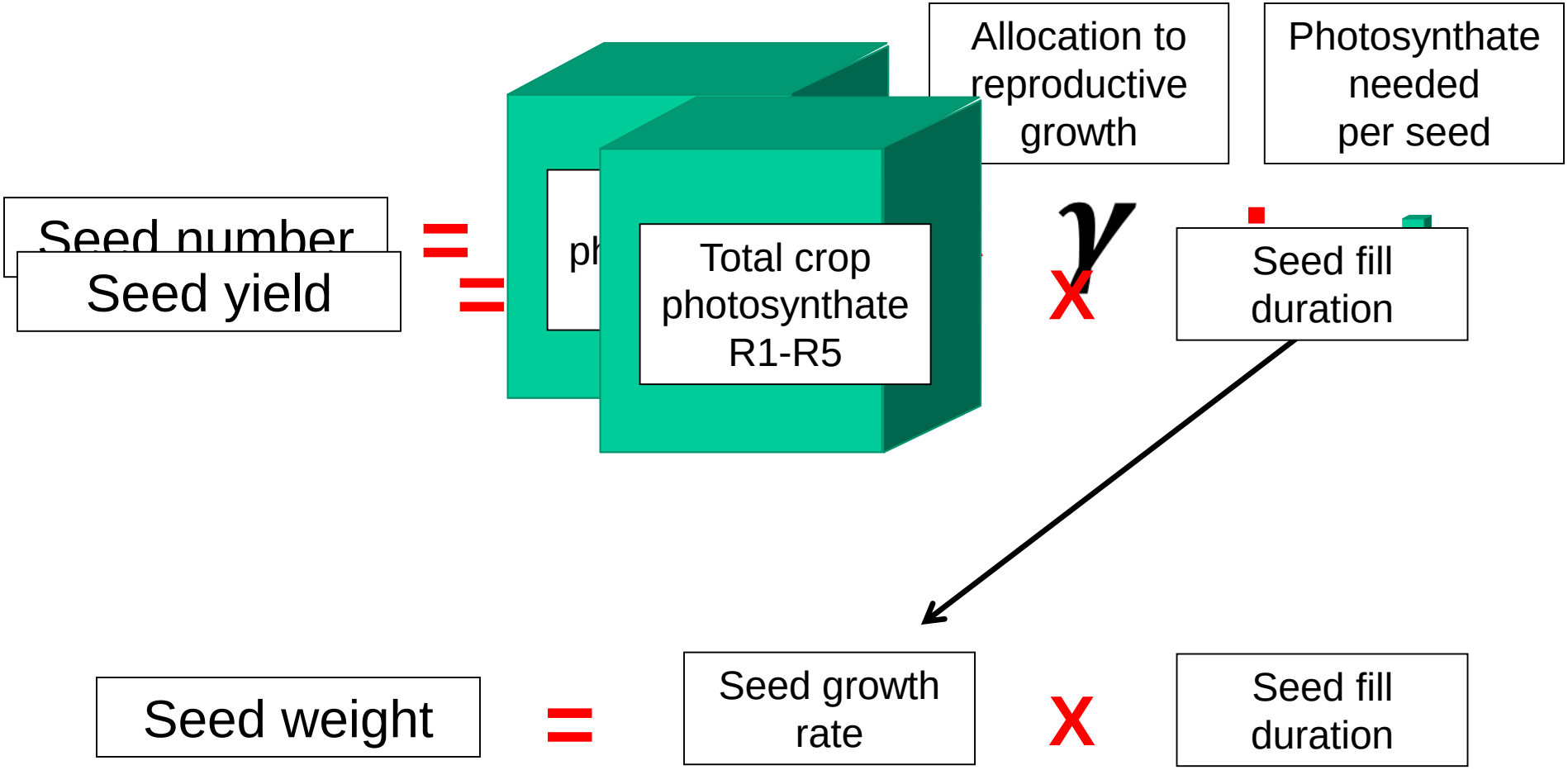
http://ipm.missouri.edu/ipcm/2012/10/Arrested-Development-in-the-Soybean-Field/

Seed Weight Determination

- Late season conditions and management influence seed growth rate and fill duration

Seed weight	=	Seed growth rate	X	Seed fill duration

Seed Yield Determination



Seed Yield Determination

Seed yield = Total crop photosynthate R1-R5 X Seed fill duration

Management options:

- Earlier planting
- *Later maturity*
- *Narrower rows*
- *Higher population*
- Irrigation/drainage
- Fertility
- Pest control (weeds, insects, diseases)

- Irrigation/drainage
- Fertility
- Pest control (weeds, insects, diseases)

Weather can trump all

Pause for Questions

Current Yield Record

- Kip Cullers, Missouri Soybean Association
  - ➢2006 – **139** bu/ac
  - ➢2007 – **155** bu/ac
  - ➢2008 – **118** bu/ac
  - ➢2009 – N/A
  - ➢2010 – **161** bu/ac
  - ➢2011 – **109** bu/ac
  - ➢2012 – N/A
  - ➢2013 – **115** bu/ac
  - ➢2014-2018 – N/A

http://agwired.com/2010/10/13/kip-cullers-sets-new-world-record-soybean-yield/

Research with Kip Cullers

- Establish four “plots” within each variety
  - Radiation use efficiency (RUE)
  - N accumulation rate
  - Rate of harvest index (HI) increase and seed fill duration
  - Leaf N during seed fill
  - Yield and components

N Accum Rate & RUE

- N accumulation rate (NAR) with a full canopy
- Radiation use efficiency (RUE) during vegetative growth

- **Both NAR and RUE are highest ever reported for soybean**

2013

Variety	NAR	RUE
	g N m^{-2} d^{-1}	g MJ^{-1}
1	1.88 AB	508 lbs/ac/day
2	1.66 AB	1.73 A
3	1.43 B	1.46 B
4	18 lbs N/ac/day	1.89 A
5	2.07 A	1.80 A
6	1.51 B	1.83 A

<10% of N was derived from N_2 fixation

Van Roekel and Purcell. 2014. Crop Sci. 54:1189

Kip Cullers' Management

- Rotates between two contest fields of Newtonia silt loam
- Perennial poultry litter applications
- Fertigation

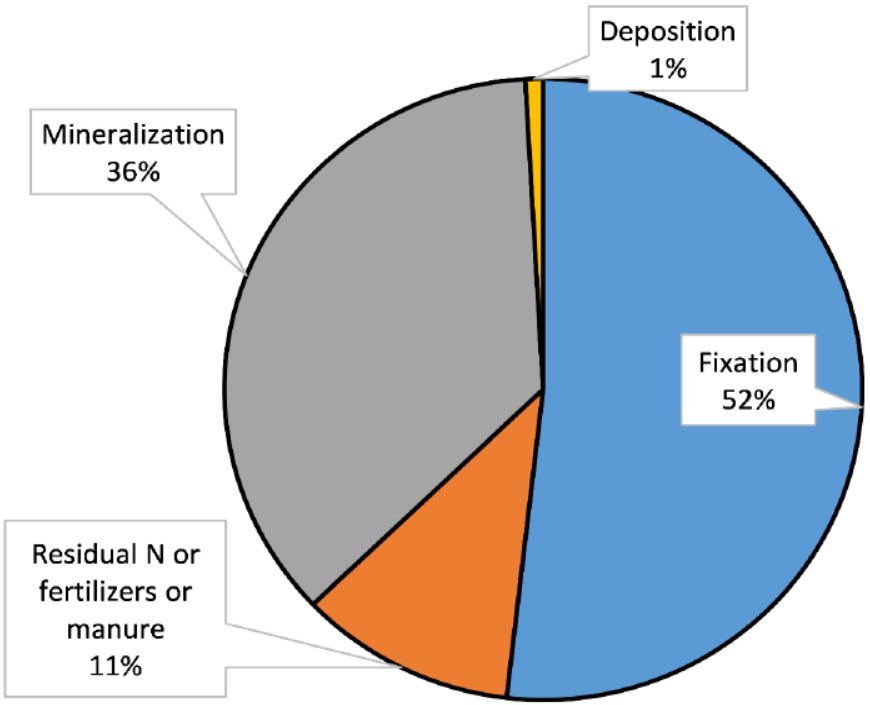
Picture taken in 2010 from Kip Cullers' contest field

Sotirios Archontoulis
Assistant Professor of Integrated Cropping Systems

Where does this nitrogen come from?

Iowa Field

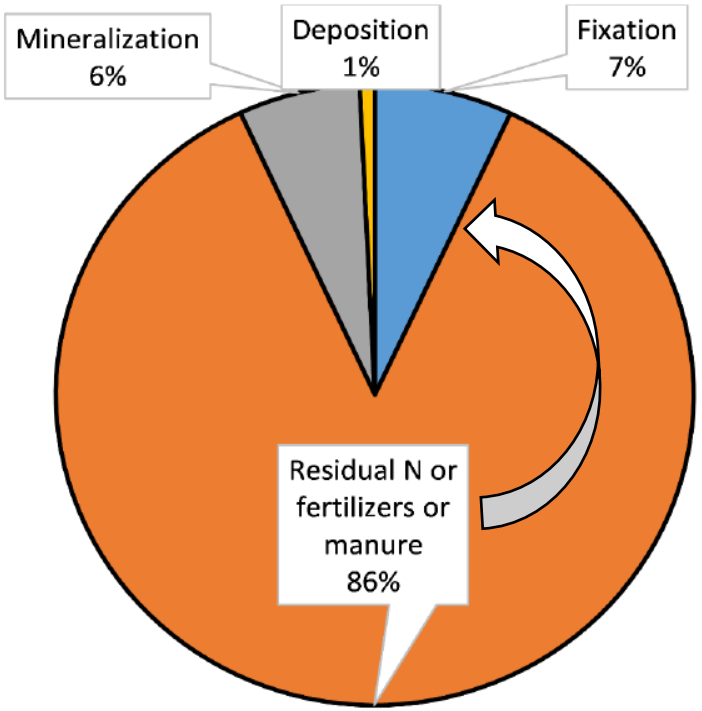
60 bushels yield, 250 lbs plant N uptake



Cullers Field

120 bushels yield, 650 lbs plant N uptake

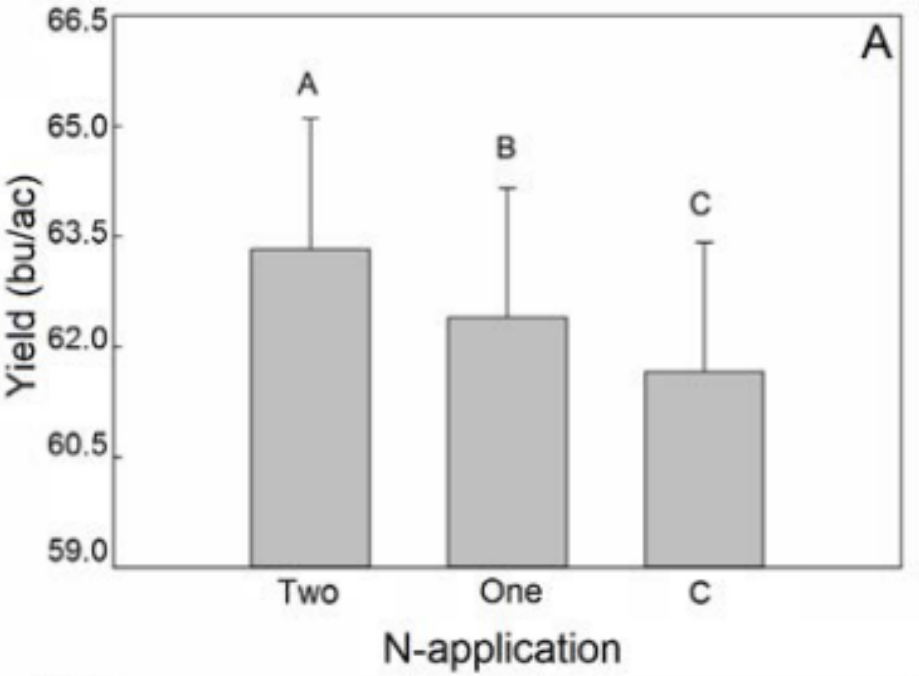
18 lbs N/ac/day

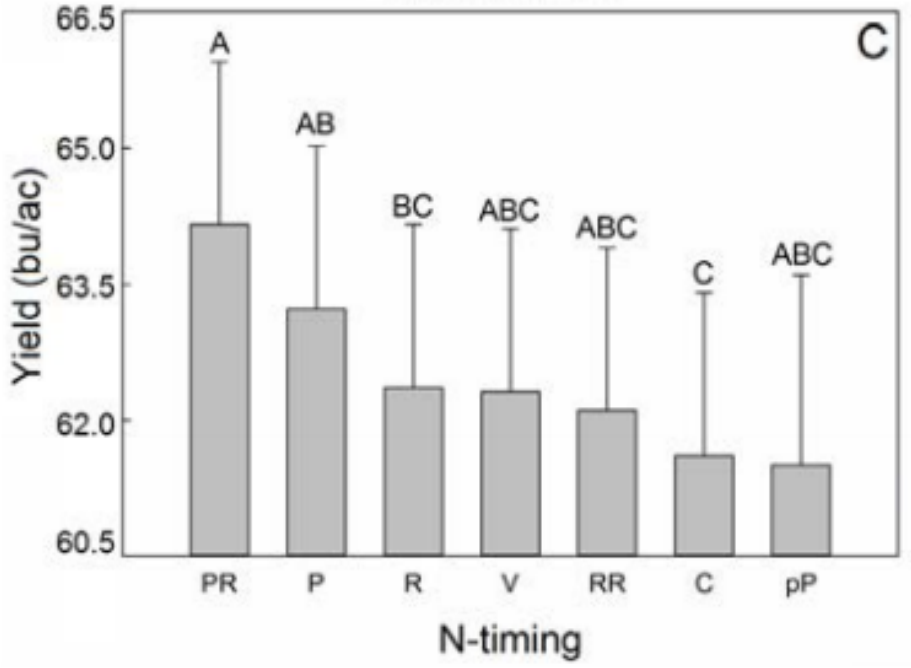


Supplemental N on Commercial Soybeans

1996-2016 nationwide summary:

<1% of total variability explained by N treatment





http://coolbean.info/library/documents/Nstudy.pdf

Nutrient Requirements for 80 bu/ac Soybeans

Gaspar & Conley, 2017

Total Uptake at Maturity (lbs/ac)										
N	P_2O_5	K_2O	S	Mg	Ca	Fe	B	Cu	Mn	Zn
302	73	200	19	44	83	0.61	0.20	0.09	0.46	0.24

Total Removal with Grain (lbs/ac)										
N	P_2O_5	K_2O	S	Mg	Ca	Fe	B	Cu	Mn	Zn
274	59	98	13	13	11	0.17	0.09	0.09	0.17	0.17

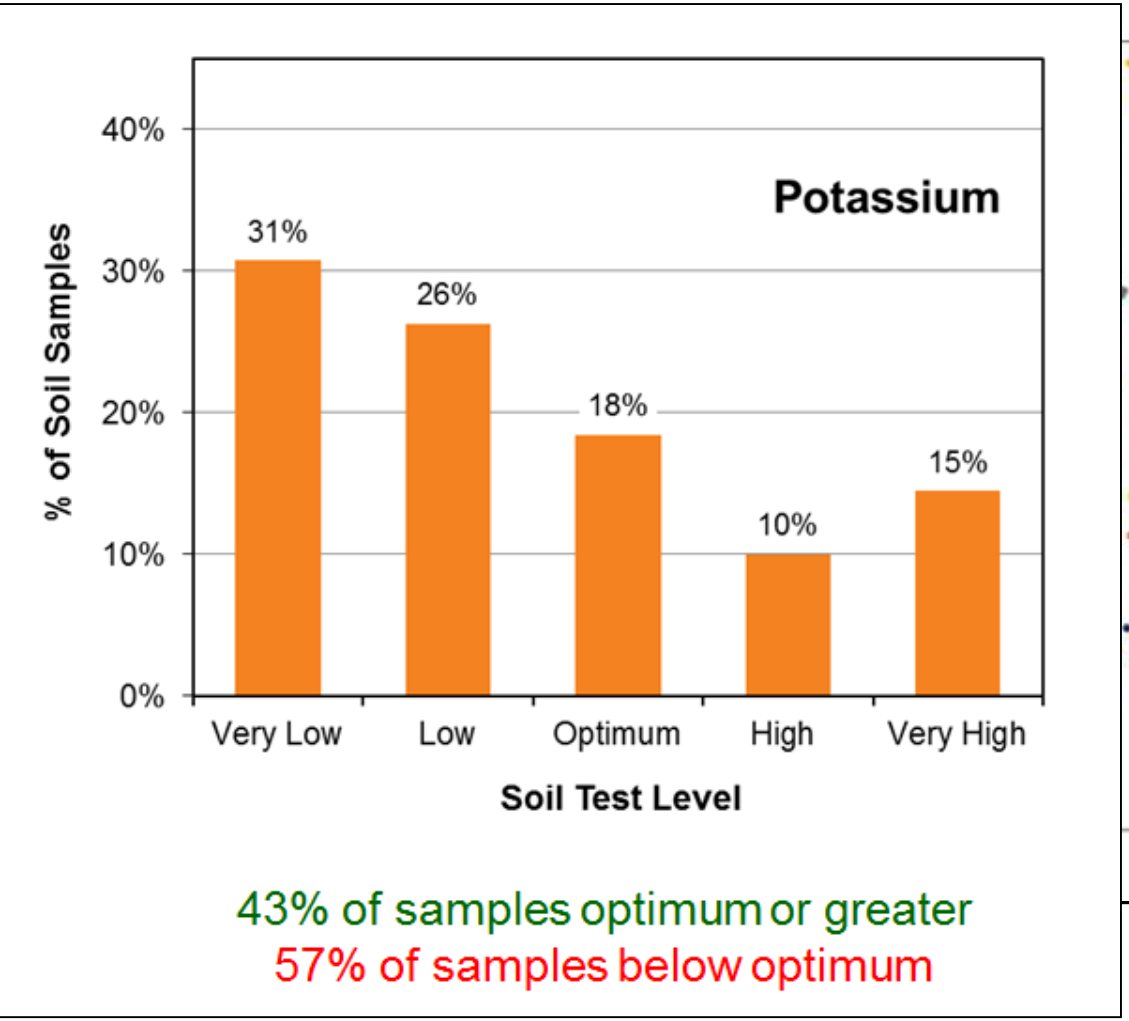
- 80 bu/ac crop removal maintenance would need ~**0-60-100-15(S)**

Building A High Yield Fertility Plan

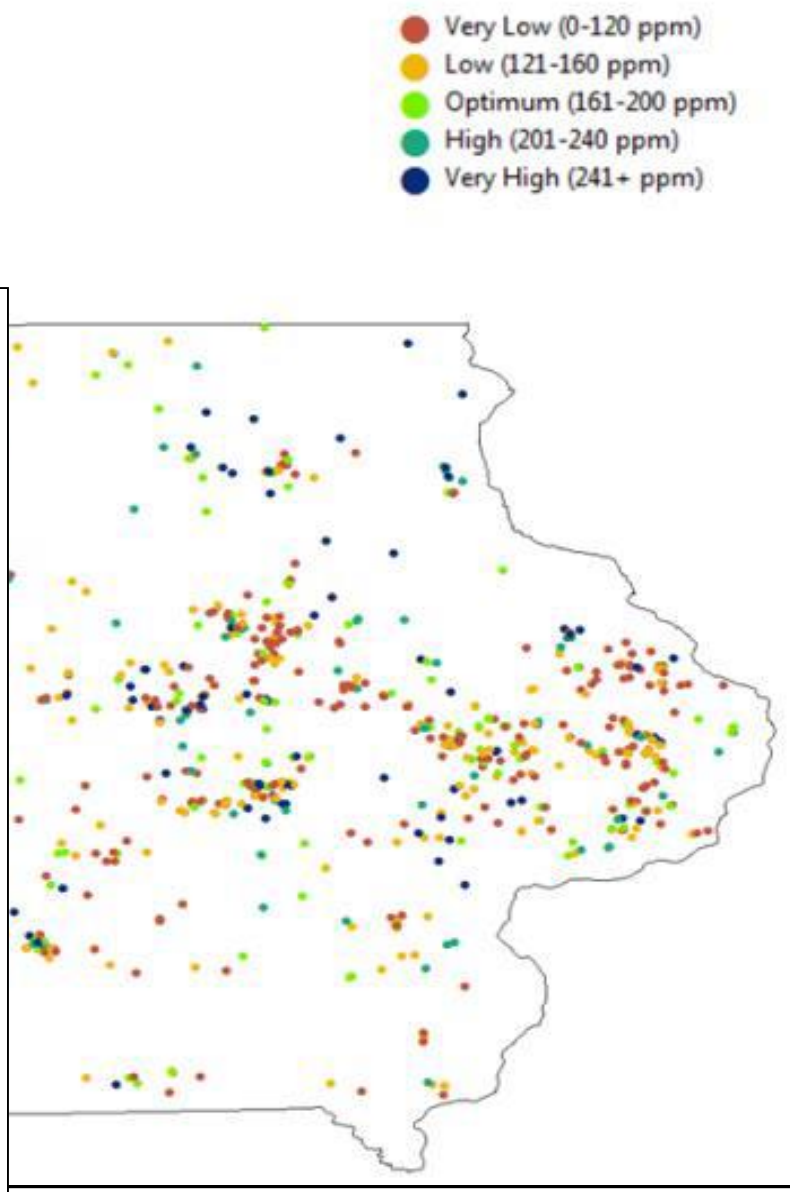
1. pH & Macros (N, P, K)
2. Secondary's (S, Mg, Ca)
3. Micros (Cu, Mn, Zn, B, Fe)

Iowa Soil Test Potassium

2,002 Fields
6,647 Soil Samples



43% of samples optimum or greater
57% of samples below optimum



Nutrient Uptake and Partitioning

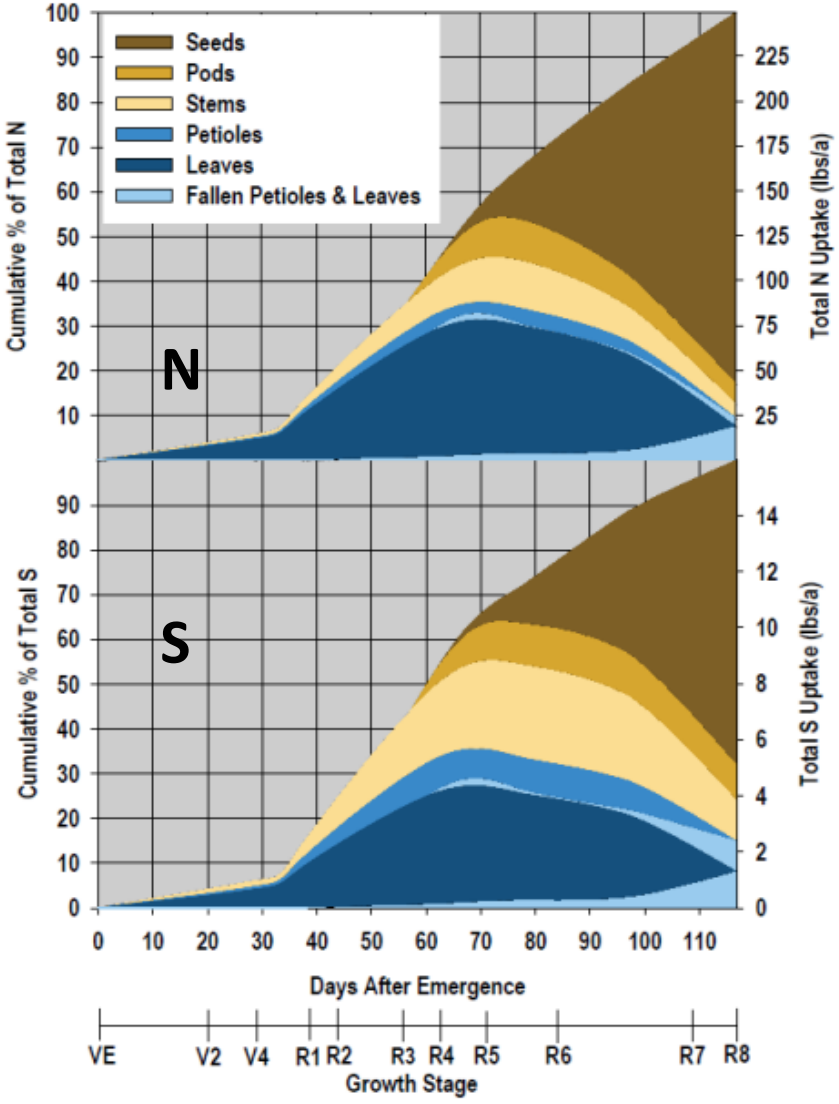


Figure 3. N and S uptake, partitioning, and remobilization through the growing season for a 66 bu/acre soybean crop.

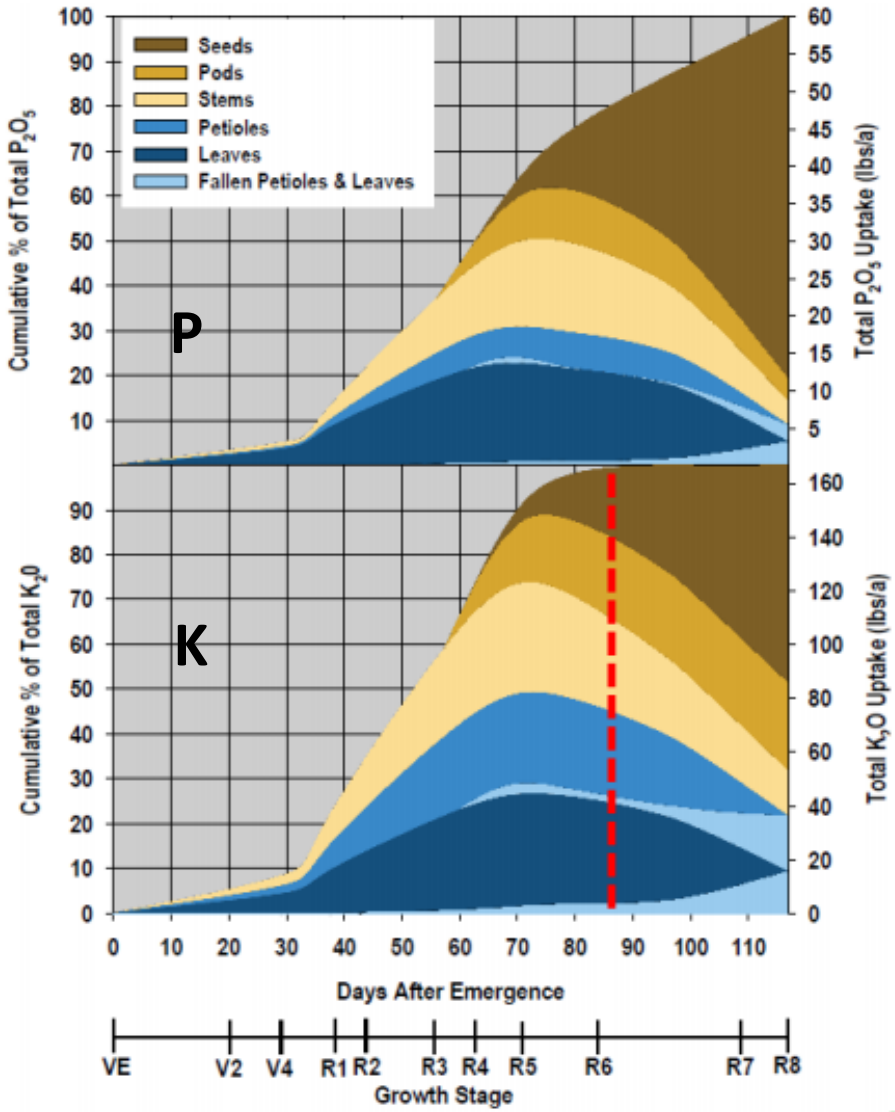
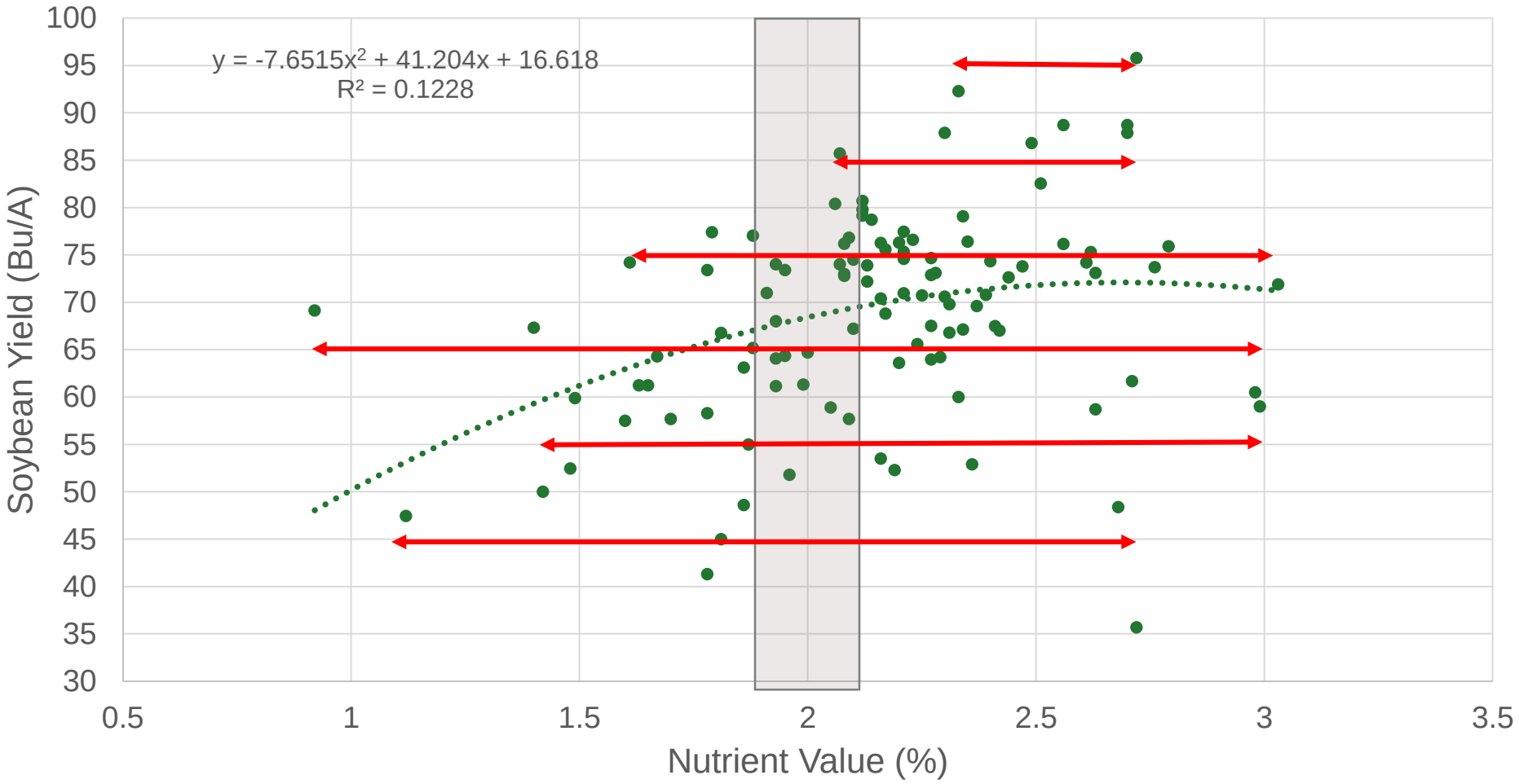


Figure 3. P_2O_5 and K_2O uptake, partitioning, and remobilization through the growing season for a 66 bu/acre soybean crop.

% Leaf Potassium – Early Bloom (R1)



Cullers' Management

- Rotates between two contest fields of Newtonia silt loam
- Perennial poultry litter applications
- Fertigation
- Early planting
- Modest plant density ~140,000 plants/ac
- 9 inch twin rows on 30 inch centers
- Indeterminate Pioneer® brand varieties from 4.2 – 5.1 RM
- Frequent (daily) overhead irrigation
- Multiple seed treatments, herbicides, insecticides, fungicides, and others…

Research in Fayetteville

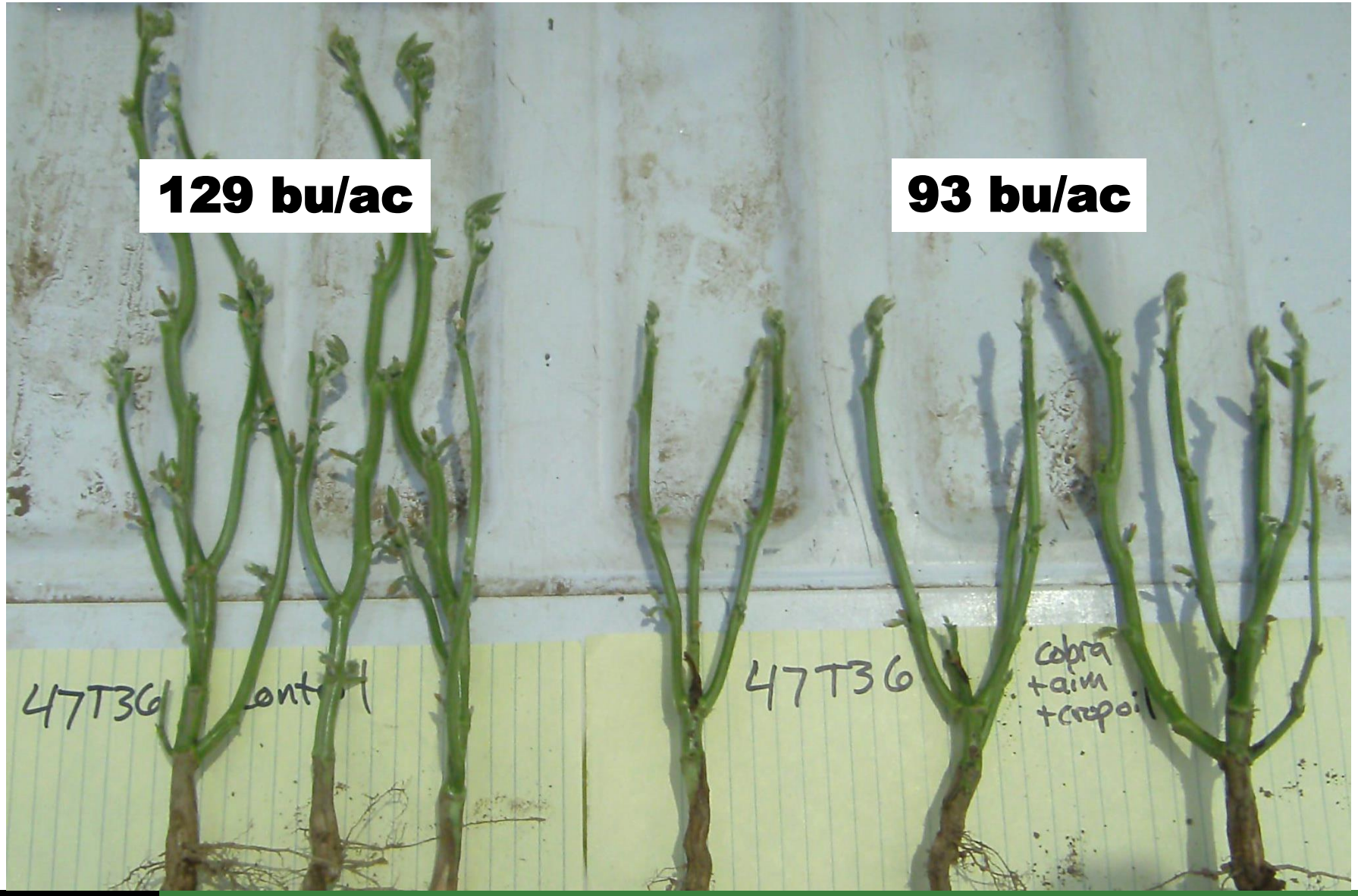
- Establish maximum yield environment
- Plots 30ft x 4 rows, center 20ft for yield, RCBD with 4 replications
- Characterize 12-14 varieties of 4.2 to 5.5 RM from Pioneer, Asgrow and NK

Fayetteville Management

- Soil test + 200 bu yield goal (250 lbs Potash, 250 lbs K-Mag)
- 5 or 7.5 dry tons/ac poultry litter
- N, K, & S fertigation
- Sprinkler irrigation @ 1 in. deficient (26”)
- April planting
- 18 inch rows
- 175,000 seeds/ac
- Deep tillage ≥ 14 in.
- Preventative fungicides
- Strict pest control

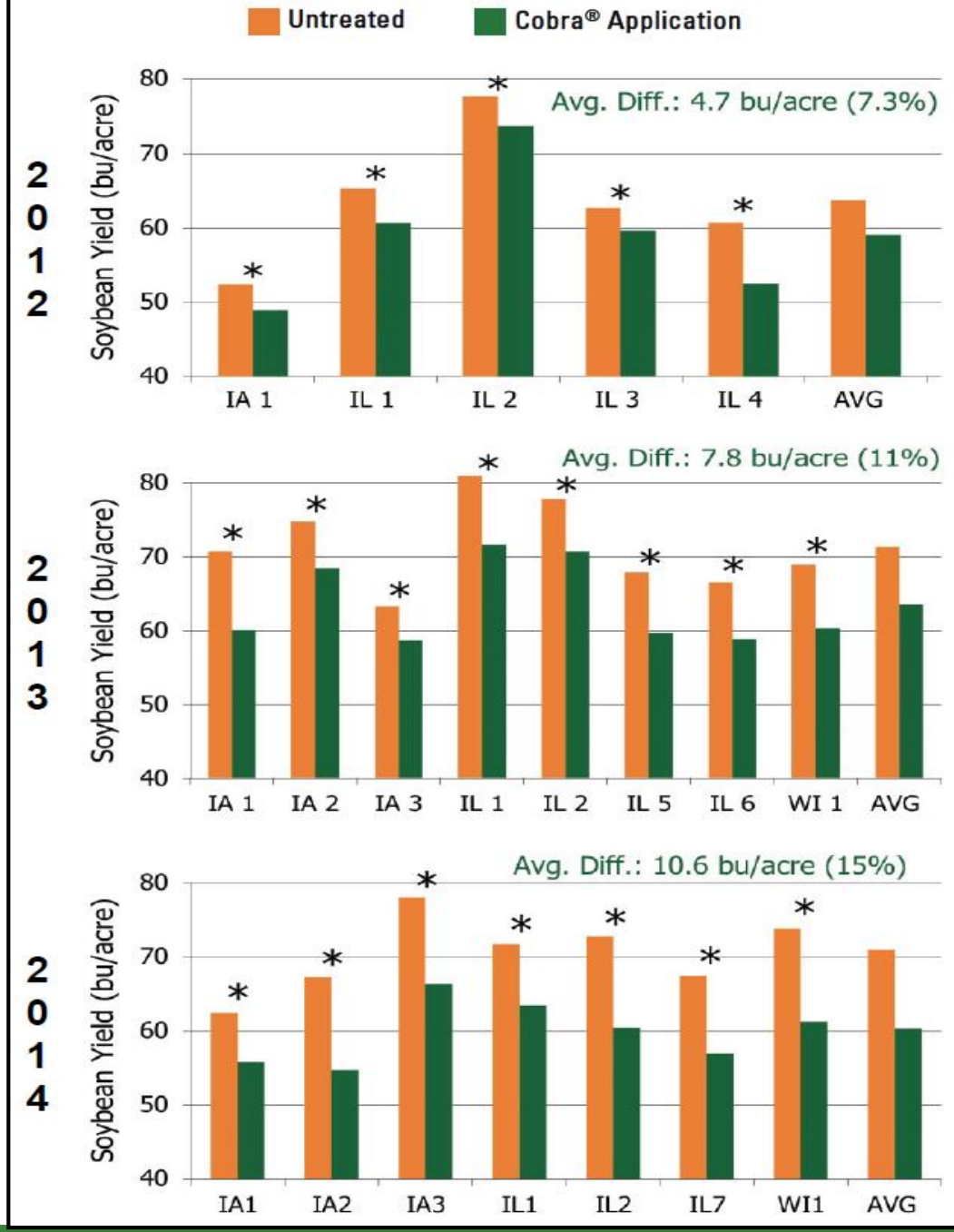
Fayetteville Lodging

Cobra + Aim + Crop Oil



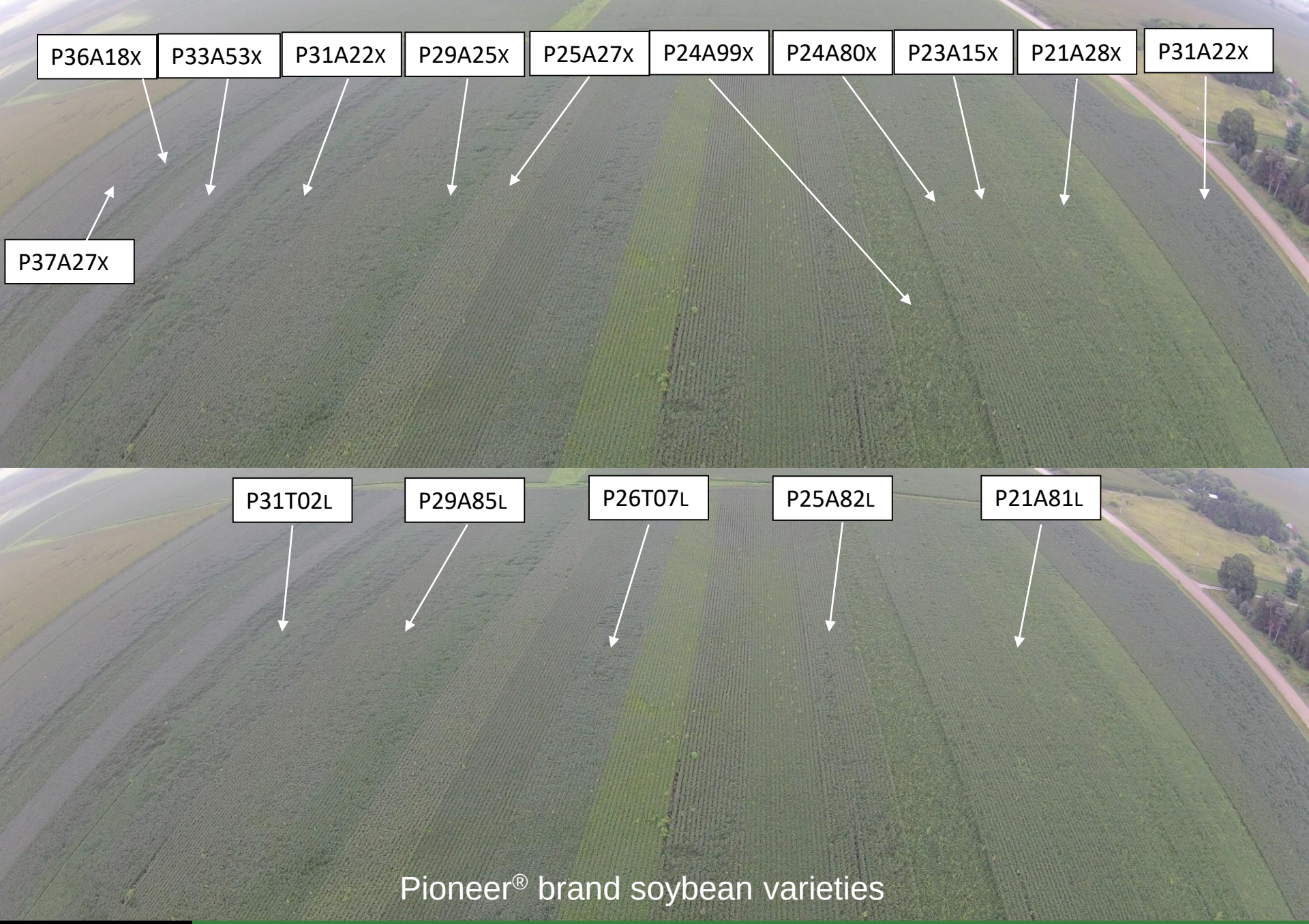
Pioneer data:

- 8 oz Cobra with crop oil at V3-4
- 4-6 varieties
- No weed pressure or white mold
- Only reduction in plant height & lodging in 2014



Management For Lodging

- Variety Standability



Pioneer® brand soybean varieties

Management For Lodging

- Variety Standability
- Earlier Relative Maturity^
- Extremely Early Planting or Late Planting
- Lower populations~
- Delay Water & Nutrient Applications
- Sufficient (+supplemental?) Potassium

Yield Components

- Cullers' 2011-13
  2900 seeds per lb
- Fayetteville 2012-13
  2800 seeds per lb

USA avg. 2012 & 13: 2800 seeds per lb

Seeds m^{-2}: 3600

Seeds m^{-2}: 3800

USA avg. 2012 & 13: 1700 seeds m^{-2}

More PODS

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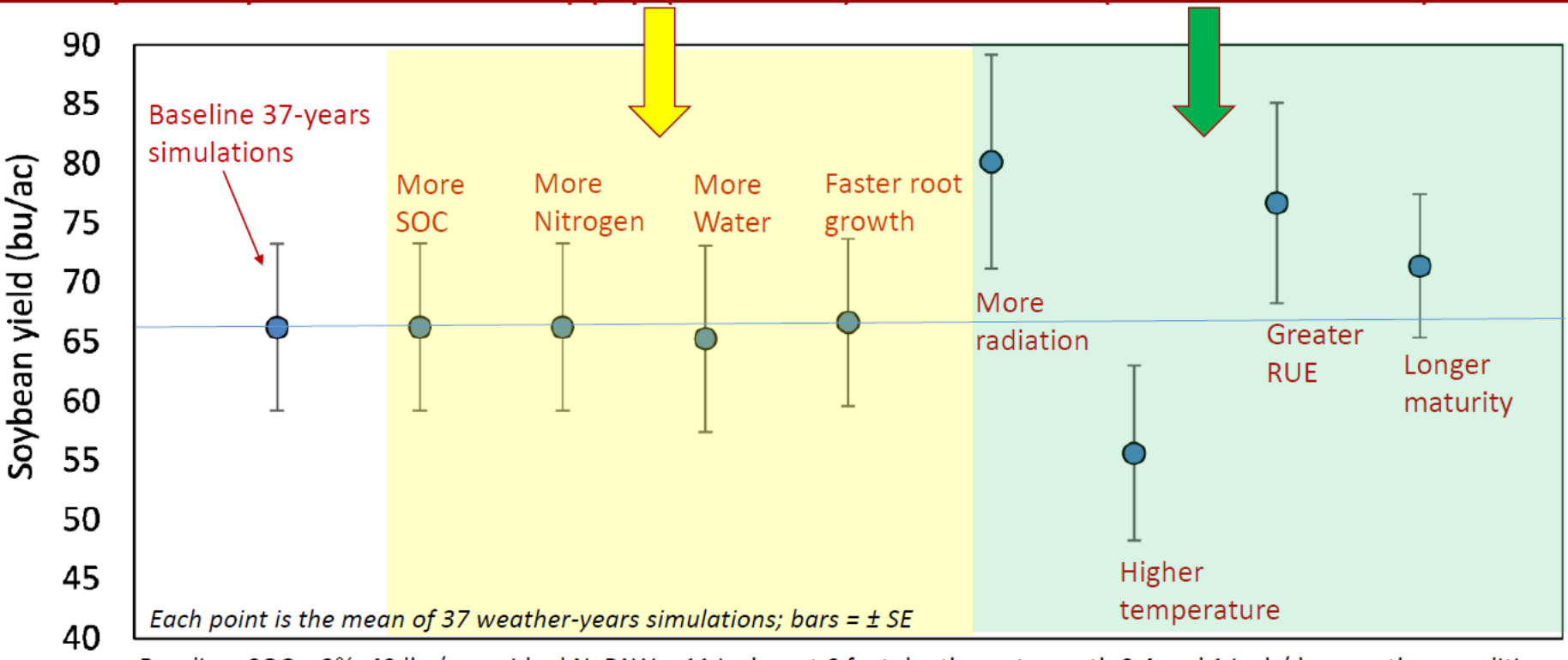
Assistant Professor of Integrated Cropping Systems

Are soybean yields in Iowa supply (root-soil) or demand (cultivar-climate) limited?



Baseline: SOC = 3%, 40 lbs/ac residual N, PAW = 11 inches at 6 feet depth, root growth 0.4 and 1 inch/day, weather conditions = Ames 1980-2016, RUE = 0.88 g/MJ, maturity = 2.7, row spacing 30 inches, plants/acre = 130 K, planting date = May 5 every year

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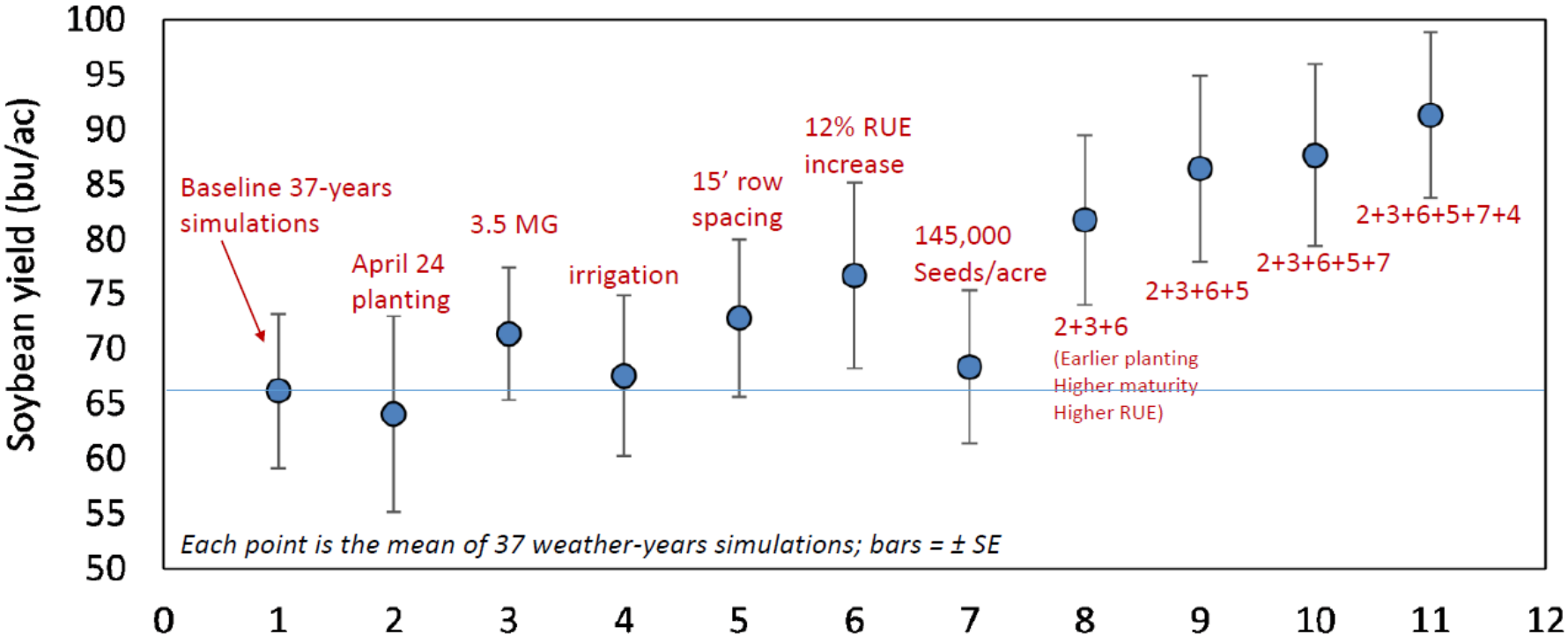
Model scenario analysis



Baseline simulation with Ames weather conditions (1980-2016):
planting date = May 5 every year, maturity = 2.7, irrigation = none, RUE = 0.88 g/MJ, row spacing 30 inches, plants = 130,000/acre

Top Ten For High Soybean Yields

1. **Water**, Solar Radiation & Temperature
2. Variety Selection
3. Early Planting Date
4. Narrow Row Spacing (≤ 22 in)
5. Fertility
6. Extended Rotations
7. Foliar Fungicides & Insecticides
8. Fungicide + Insecticide + ILeVO® fungicide seed treatments
9. Weed Management
10. Timely Harvest

ILeVO® is a registered trademark of Bayer.

Thank You

ryan.vanroekel@pioneer.com

Always follow grain marketing, stewardship practices and pesticide label directions. **Varieties with the Glyphosate Tolerant trait** (including those designated by the letter "R" in the product number) contain genes that confer tolerance to glyphosate herbicides. Glyphosate herbicides will kill crops that are not tolerant to glyphosate.

Varieties with the LibertyLink® gene (LL) are resistant to Liberty® herbicide.

Liberty®, LibertyLink® and the Water Droplet Design are trademarks of Bayer.

DO NOT APPLY DICAMBA HERBICIDE IN-CROP TO SOYBEANS WITH Roundup Ready 2 Xtend® technology unless you use a dicamba herbicide product that is specifically labeled for that use in the location where you intend to make the application. IT IS A VIOLATION OF FEDERAL AND STATE LAW TO MAKE AN IN-CROP APPLICATION OF ANY DICAMBA HERBICIDE PRODUCT ON SOYBEANS WITH Roundup Ready 2 Xtend® technology, OR ANY OTHER PESTICIDE APPLICATION, UNLESS THE PRODUCT LABELING SPECIFICALLY AUTHORIZES THE USE. Contact the U.S. EPA and your state pesticide regulatory agency with any questions about the approval status of dicamba herbicide products for in-crop use with soybeans with Roundup Ready 2 Xtend® technology.

ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Soybeans with Roundup Ready 2 Xtend® technology contain genes that confer tolerance to glyphosate and dicamba. Glyphosate herbicides will kill crops that are not tolerant to glyphosate. Dicamba will kill crops that are not tolerant to dicamba.

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