

The Six Secrets of Soybean Success

Fred Below

Crop Physiology Laboratory

Department of Crop Sciences

University of Illinois at Urbana-Champaign

Illinois Soybean Association Better Beans
Champaign, IL February 21, 2019



Test Your Knowledge of Agriculture and US Politics

- **Which crop does President Trump like better, Soybean or Corn?**

President Trump Likes Corn



Do Growers Adequately Manage Soybean?



Test Your Knowledge of High Yield Soybean

- **What is the world record soybean yield and what is the soybean yield gap?**

The Soybean Yield Gap

- **World record soybean yield of 171.8 bushels in 2016 (IL record of 110.9)**
- **US average soybean yield of 52 bushels/acre in 2018 (IL average of 64)**
- **Yield Gap = Record Yield – Average Yield = 120 bushels**

The Six Secrets of Soybean Success

What Factors Have the Biggest Impact on Soybean Yield?



Not Secrets of Soybean Success, but Important to Overall Crop Productivity

- Corn yields 25 bushels better when it follows soybean and needs 40-50 lbs less nitrogen fertilizer**

Not Secrets of Soybean Success, but Important to Overall Crop Productivity

- **Soybean improves soil tilth compared to corn**
- **Soybean root system is a taproot while corn roots are fibrous**

Soybean Improves Soil Tilth

CORN

SOYBEAN



Crucial Prerequisites, but not Secrets of Success

- **Drainage**
- **Weed Control**
- **Proper Soil pH**

The Six Secrets of Soybean Success

Rank

Factor

1

Weather

2

3

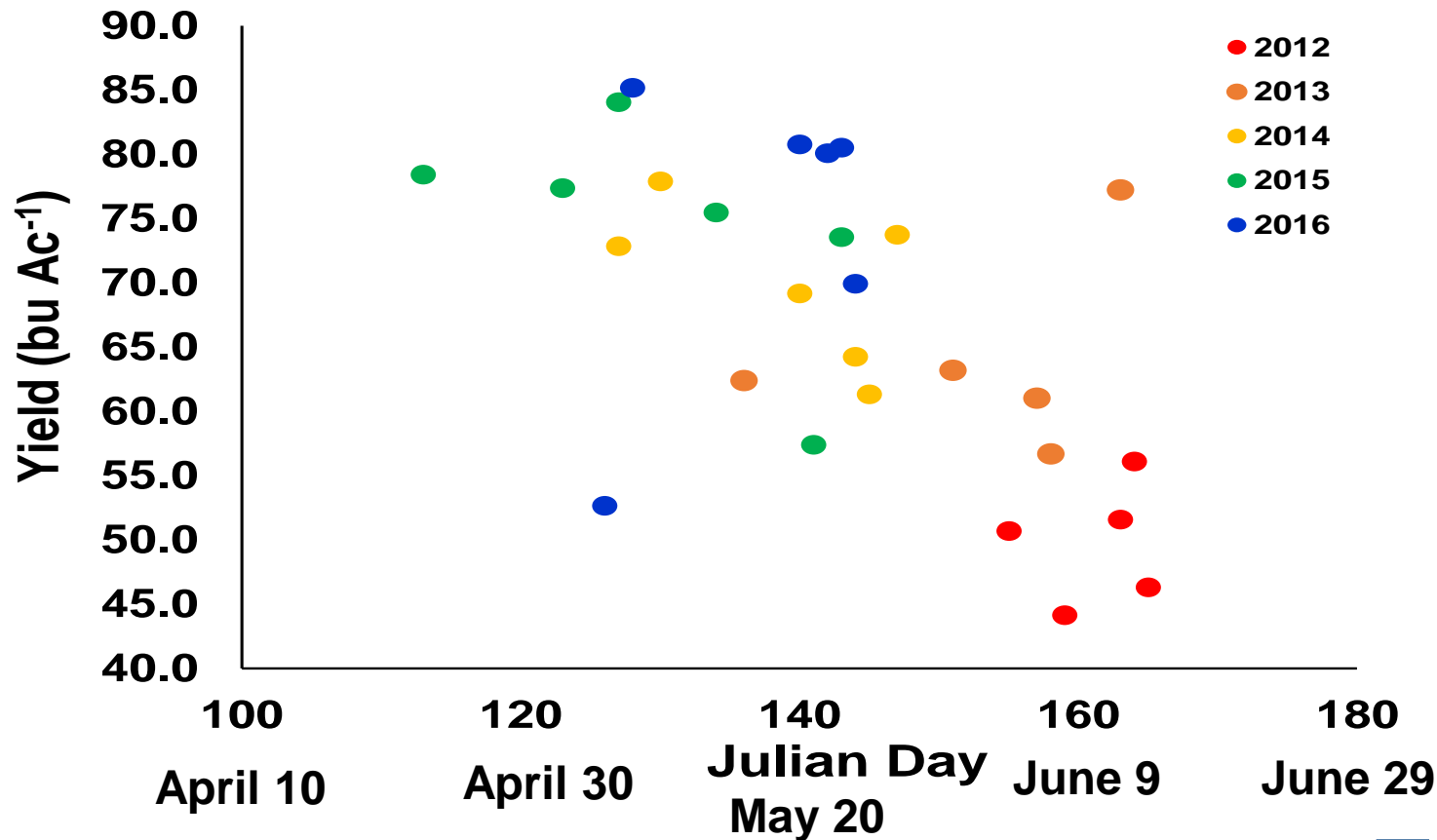
4

5

6

Given key prerequisites

Soybean Yield by Planting Date



Yield of control plots over five years

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Given key prerequisites

Average Soil Analysis at Crop Physiology Laboratory Research Sites

	Location		
	DeKalb/ Yorkville	Champaign	Harrisburg
OM (%)	4.5	3.6	2.2
pH	6.3	6.3	6.6
CEC	21.9	19.6	13.2
P (ppm)[†]	45	38	26
K (ppm)[†]	197	166	133



[†] Mehlich 3 extraction

All soils are silt loams or silty clay loams

Crop Physiology Laboratory Transport CONVOY







The Six Secrets of Soybean Success

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Given key prerequisites

Soybean Gets Some N from Fixation by Nodules



Test Your Knowledge of High Yield Soybean

- How much of soybean's N comes from the nodules?

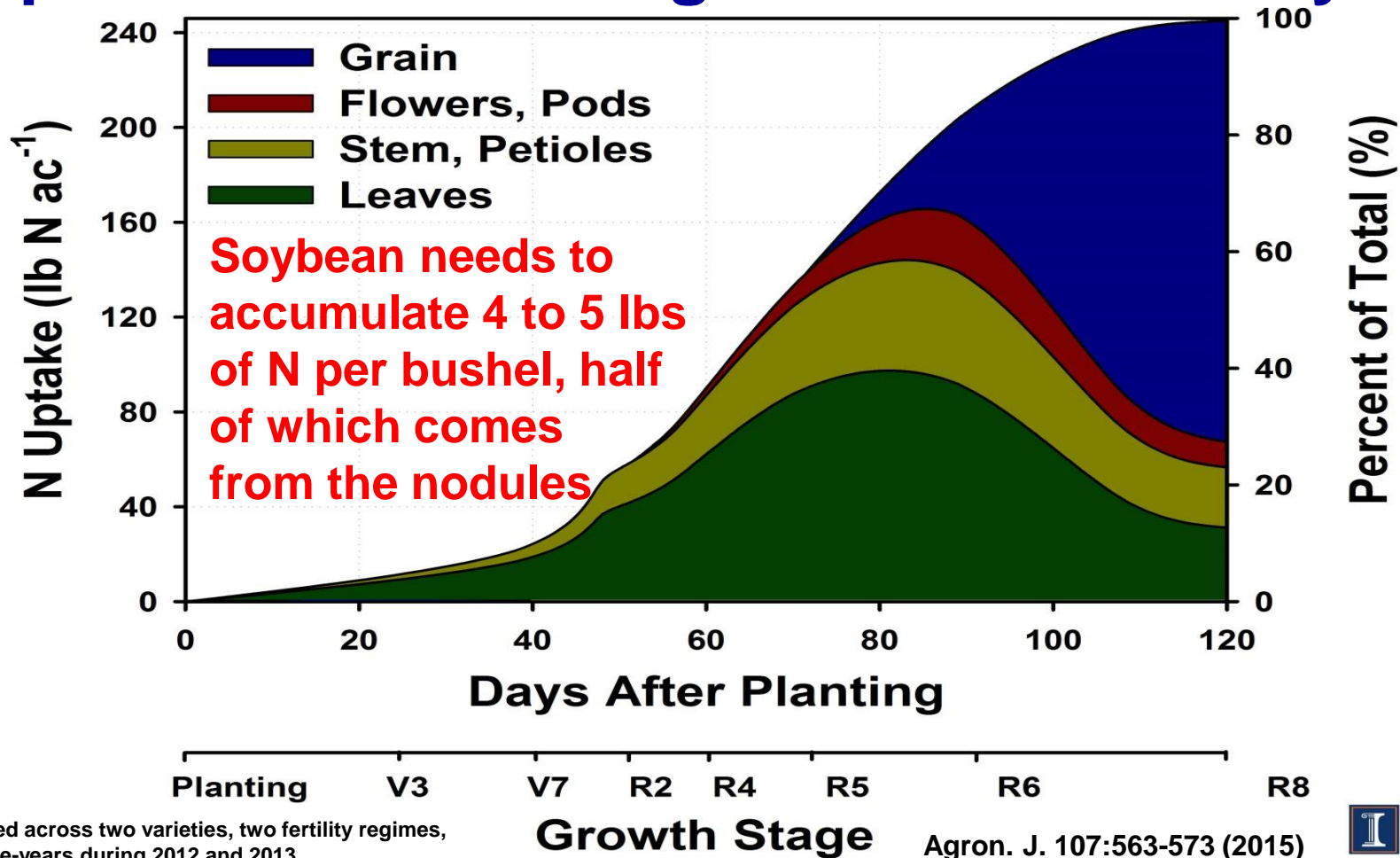
About half or 50%

Test Your Knowledge of High Yield Soybean

- How much N do soybean plants need to accumulate per each bushel of grain?

4 to 5 lbs of N per Bushel

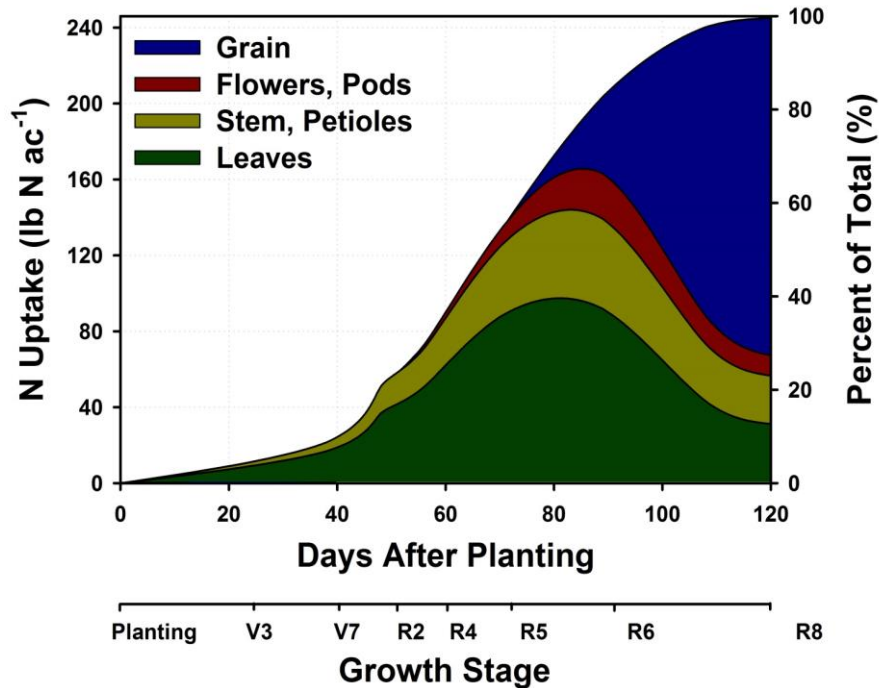
N Uptake & Partitioning for 60 Bushel Soybean



Data averaged across two varieties, two fertility regimes, and three site-years during 2012 and 2013.

Agron. J. 107:563-573 (2015)

Nitrogen Needs and Removal by 60 Bushel Soybean Crop



	Ibs N acre ⁻¹
Total N Uptake	245
N From Nodules	123
N Removed with Grain	179
Net Removal of N from Soil	56

*Assuming 50% of total N accumulation supplied by N fixation from nodules

Facts about Soybean and N

- **There is no such thing as a soybean N credit**
- **Soybean removes about a pound of N from the soil for each bushel that it produces**

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**Crop
Physiology**

Typical Fertilization for Corn and Soybean in Illinois

- 180 lbs N, 90 lbs P_2O_5 and 100 lbs K_2O per acre applied to corn. No S or micronutrients
- No fertilizer applied to soybean

Nutrient Uptake and Removal by 60 Bushel Soybean

Nutrient	Required to Produce	Removed with Grain	Harvest Index
	lbs per acre		%
N	245	179	73
P ₂ O ₅	43	35	81
K ₂ O	170	70	41
S	17	10	61
Zn (oz)	4.8	2.0	44
B (oz)	4.6	1.6	34

Data averaged across two varieties, two fertility regimes, and three site-years during 2012 and 2013.

Agron. J. 107:563-573 (2015)

Criteria For Important Soybean Nutrients

#2 Plant needs to accumulate a lot in a short amount of time

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Criteria For Important Soybean Nutrients

- #2 Plant needs to accumulate a lot in a short amount of time**
- #1 Nutrient has a high harvest index value**

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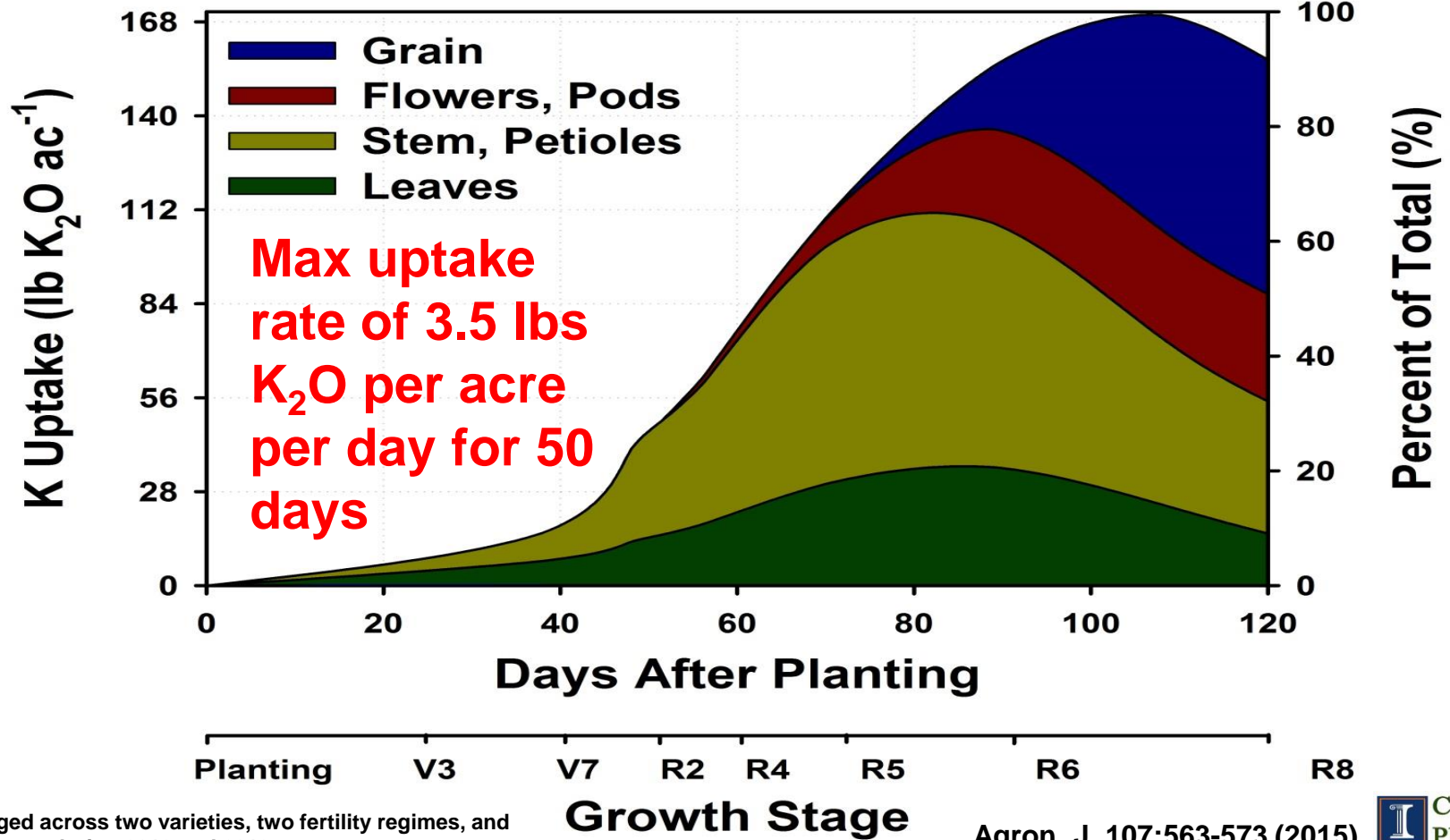
- 180 lbs N, 90 lbs P_2O_5 and 100 lbs K_2O per acre applied to corn. No S or micronutrients
- No fertilizer applied to soybean

P and K Uptake and Removal by 60 bushel Soybean vs 230 bushel Corn

Nutrient	Required to Produce		Removed with Grain		Remain in Stover	
	Corn	Soy	Corn	Soy	Corn	Soy
	lbs per acre					
P_2O_5	101	43	80	35	21	8
K_2O	180	170	56	70	124	100

Corn data from Agron J. 105:161-170 (2013)
 Soybean data from Agron. J. 107:563-573 (2015)

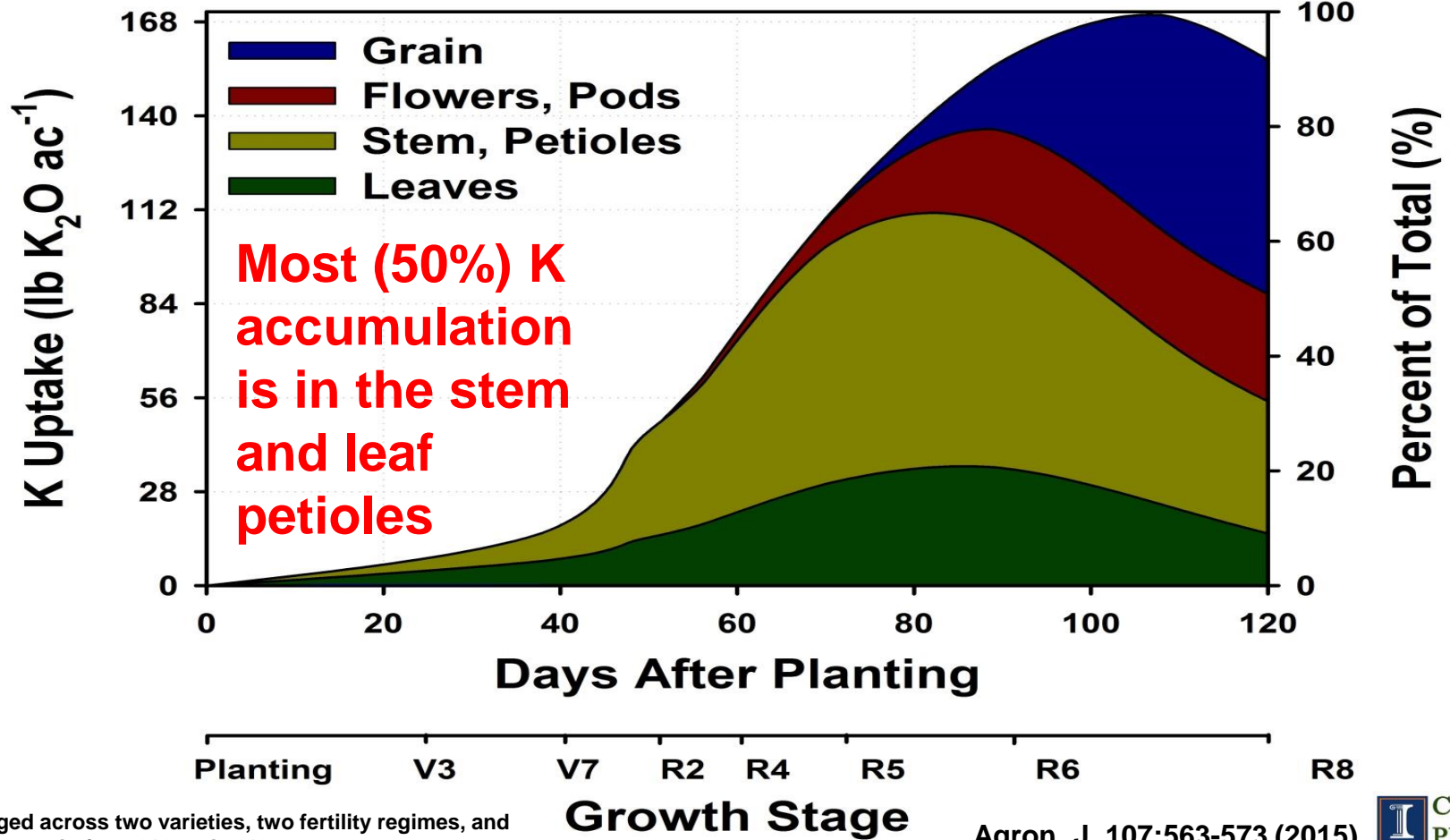
K Uptake & Partitioning for 60 Bushel Soybean



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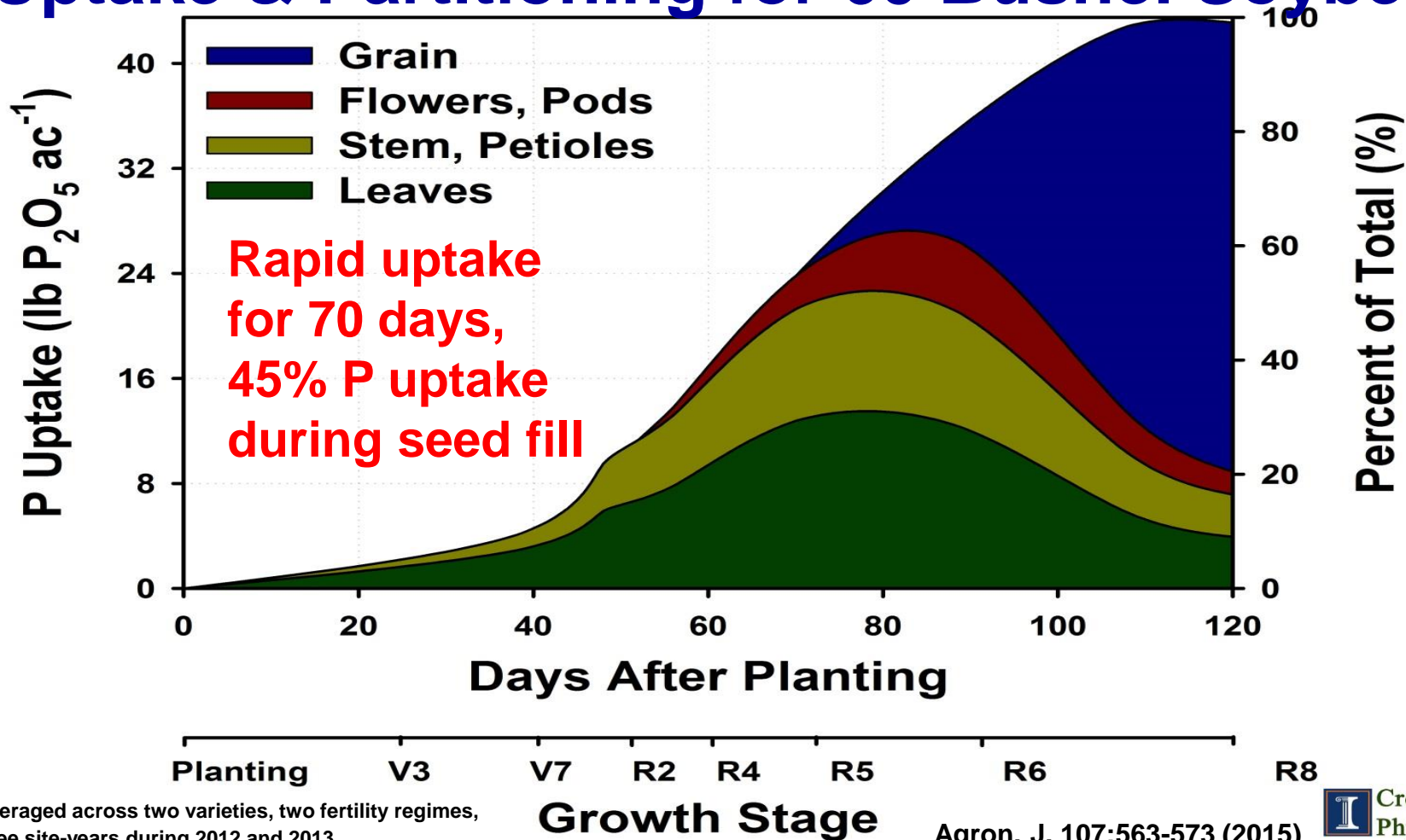
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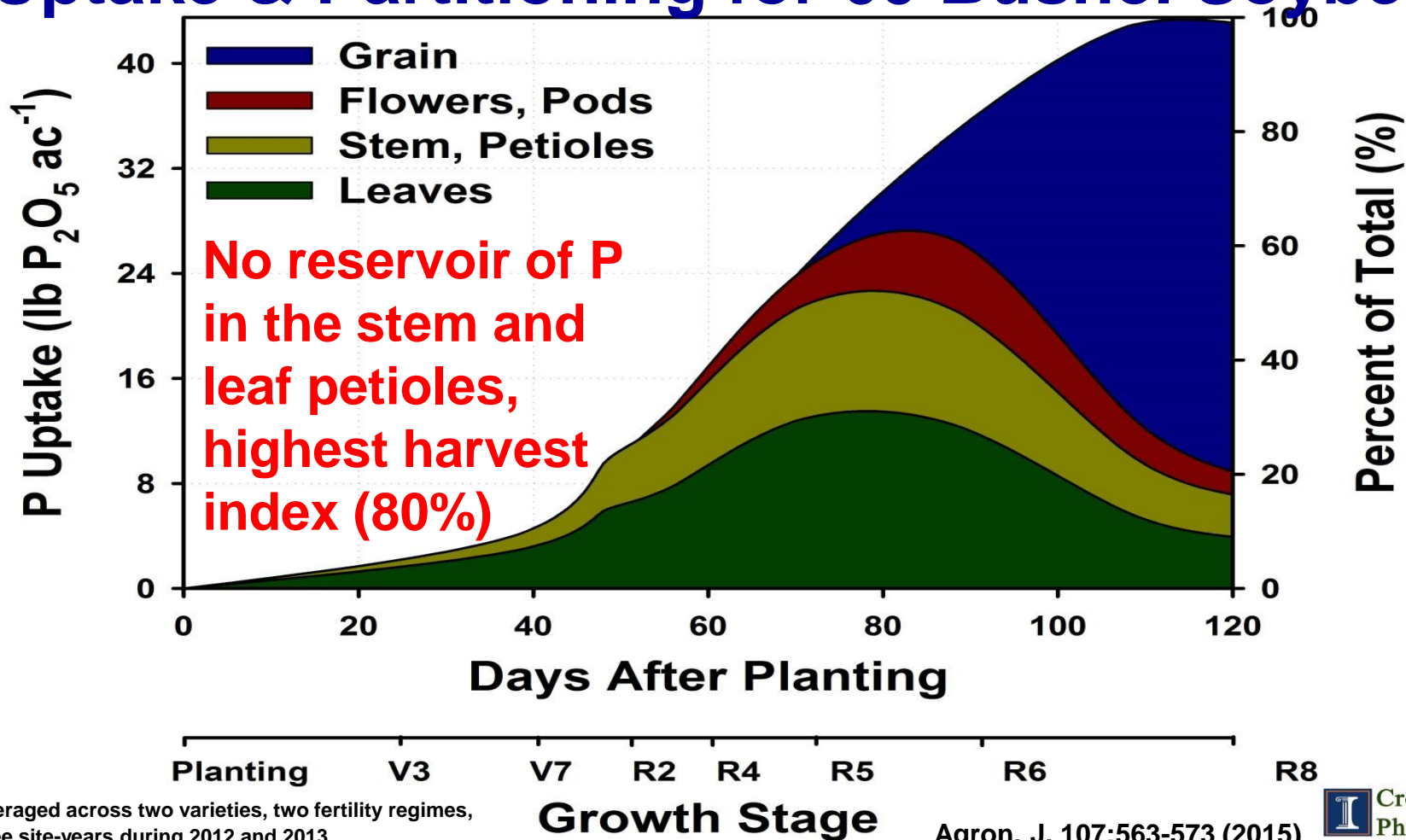
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The Six Secrets of Soybean Success

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Factor

1

Weather

2

Fertility

3

Genetics/Variety

4

5

6

Given key prerequisites



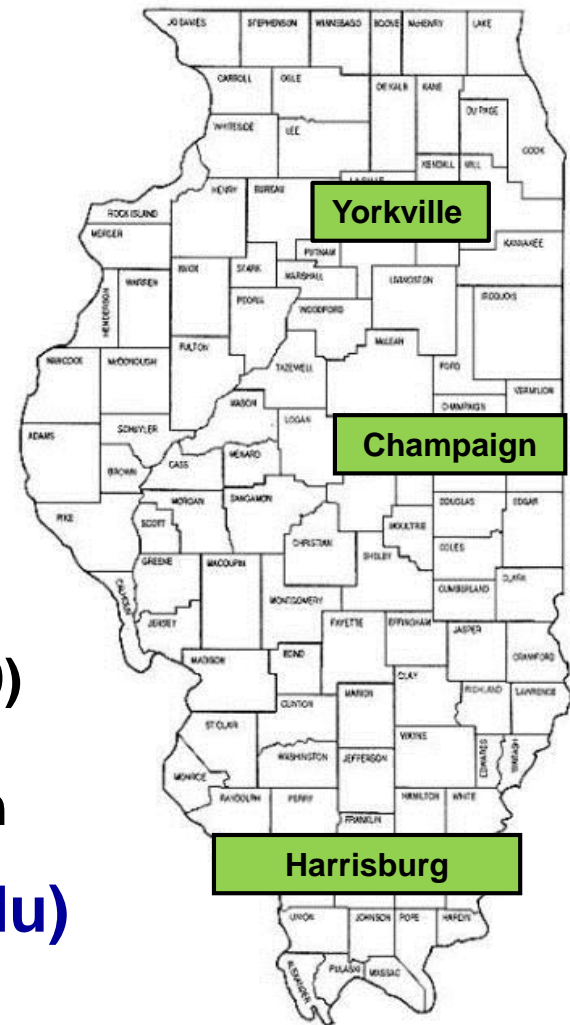
**Crop
Physiology**

Soybean Variety Testing - 2018

At Each Site:

- **36 Varieties @ each location (66 total)**
- **Maturity groups 2.1 - 4.8**
- **Five Seed Brands**
- **Management Yield Potential**
 1. Control (soil test P with no foliar protection)
 2. Fertility (75 lb P₂O₅, 23 lb N, 19 lb S as MES10)
 3. Foliar Protection (fungicide & insecticide)
 4. Response to both Fertility & Foliar Protection

(<http://cropphysiology.cropsci.illinois.edu>)



All Soybean Varieties are Not Created Equal

Variety	Yield	Variety	Yield	Variety	Yield	Variety	Yield
	bu acre ⁻¹		bu acre ⁻¹		bu acre ⁻¹		bu acre ⁻¹
1	86.3	10	82.2	19	76.5	28	74.0
2	86.0	11	82.0	20	76.3	29	73.4
3	84.9	12	81.8	21	76.3	30	72.7
4	84.7	13	81.7	22	76.1	31	71.3
5	84.7	14	81.2	23	75.9	32	70.9
6	84.3	15	78.0	24	75.5	33	70.9
7	83.8	16	77.9	25	74.5	34	70.4
8	83.4	17	77.0	26	74.1	35	69.3
9	82.4	18	76.6	27	74.0	36	66.1

LSD (0.10) = 8.3

RM range 3.5 to 4.8 at **Harrisburg (Southern IL)** in 2018



All Soybean Varieties are Not Created Equal

Variety	Yield	Variety	Yield	Variety	Yield	Variety	Yield
	bu acre ⁻¹		bu acre ⁻¹		bu acre ⁻¹		bu acre ⁻¹
1	93.8	10	88.5	19	84.2	28	80.7
2	91.0	11	88.1	20	83.3	29	80.4
3	90.9	12	87.9	21	82.4	30	79.4
4	90.8	13	87.0	22	82.1	31	77.1
5	89.9	14	86.7	23	82.1	32	77.0
6	89.6	15	86.5	24	81.8	33	74.7
7	89.5	16	86.1	25	81.6	34	73.5
8	89.2	17	85.2	26	81.1	35	72.5
9	88.5	18	84.4	27	80.8	36	66.0

LSD (0.10) = 9.3

RM range 2.7 to 4.2 at **Champaign (Central IL)** in 2018

All Soybean Varieties are Not Created Equal

Variety	Yield	Variety	Yield	Variety	Yield	Variety	Yield
	bu acre ⁻¹		bu acre ⁻¹		bu acre ⁻¹		bu acre ⁻¹
1	101.3	10	96.0	19	90.5	28	85.3
2	100.2	11	94.4	20	89.1	29	81.0
3	99.8	12	94.3	21	89.0	30	79.2
4	98.3	13	93.7	22	88.9	31	78.5
5	97.9	14	93.6	23	88.1	32	78.2
6	97.8	15	93.1	24	86.5	33	78.1
7	97.1	16	92.4	25	86.1	34	77.0
8	97.0	17	92.0	26	85.9	35	76.5
9	96.9	18	91.8	27	85.6	36	75.6

LSD (0.10) = 10.2

RM range 2.1 to 3.7 at **Yorkville (Northern IL)** in 2018



Crop
Physiology

All Soybean Varieties are Not Created Equal

Variety	Yield	Variety	Yield	Variety	Yield	Variety	Yield
	bu acre ⁻¹		bu acre ⁻¹		bu acre ⁻¹		bu acre ⁻¹
3.3	101.3	10	96.0	19	90.5	2.7	85.3
3.6	100.2	11	94.4	20	89.1	3.7	81.0
3.7	99.8	12	94.3	21	89.0	2.5	79.2
3.2	98.3	13	93.7	22	88.9	2.7	78.5
3.7	97.9	14	93.6	23	88.1	2.7	78.2
3.4	97.8	15	93.1	24	86.5	2.1	78.1
3.4	97.1	16	92.4	25	86.1	2.4	77.0
3.3	97.0	17	92.0	26	85.9	2.5	76.5
3.6	96.9	18	91.8	27	85.6	2.4	75.6

LSD (0.10) = 10.2

RM range 2.1 to 3.7 at **Yorkville (Northern IL)** in 2018



The Six Secrets of Soybean Success

Rank

Factor

1

Weather

2

Fertility

3

Genetics/Variety

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6

Given key prerequisites

Soybean is Indeterminate



- Flower and leaf development at the same time
- Closest leaf provides most of the energy for pods at that node
- Typical plant has 20 nodes

The Six Secrets of Soybean Success

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Foliar Protection

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Given key prerequisites

Soybean Yield Components

$$\text{Yield} = \text{Pod number/acre} \times \text{Seeds per pod} \times \text{Weight per seed}$$

The Legendary 5 Bean Pod



Champaign, 2013



Crop
Physiology

Soybean Yield Components

$$\text{Yield} = \text{Pod number/acre} \times \text{Seeds per pod} \times \text{Weight per seed}$$

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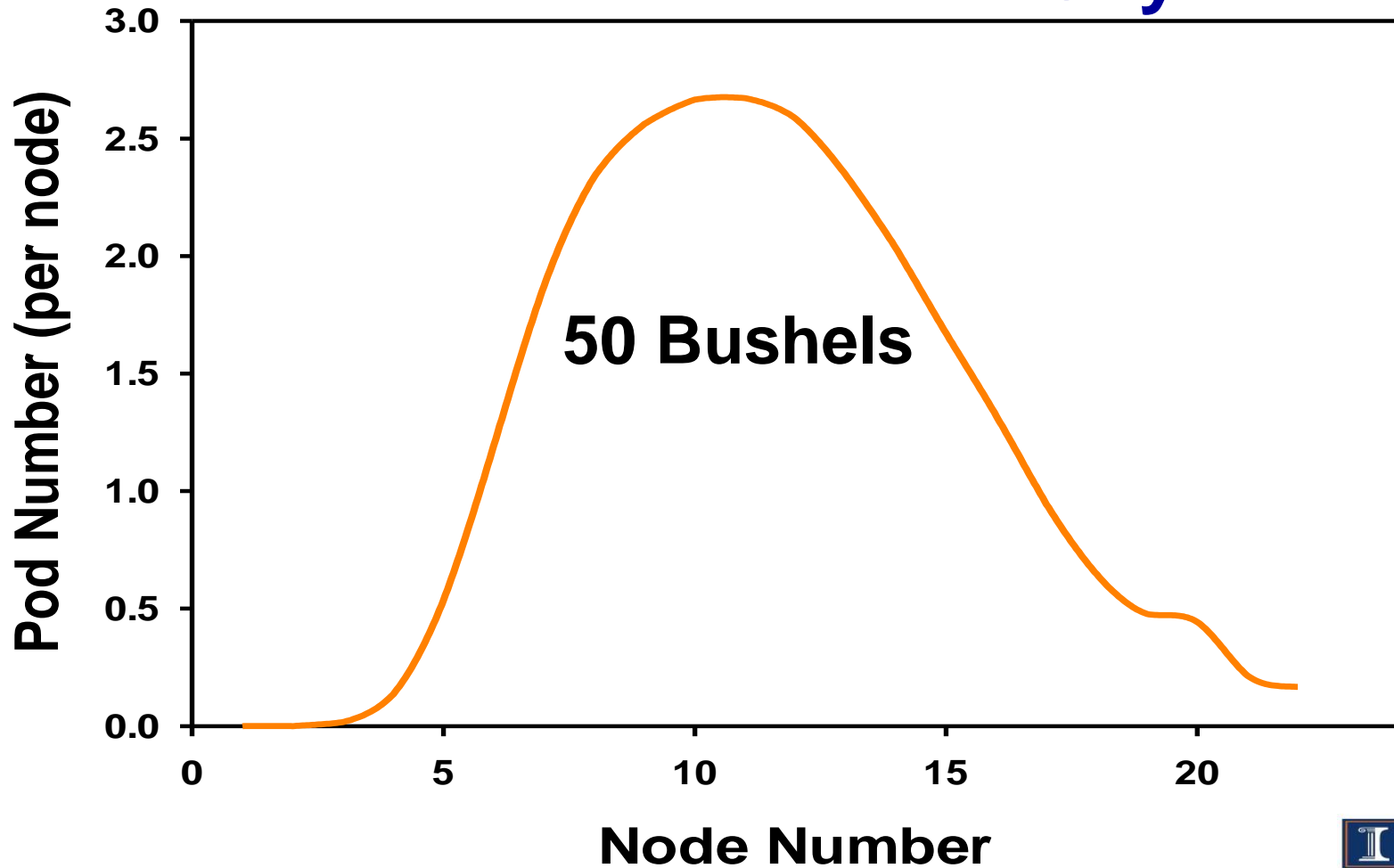
6

Given key prerequisites

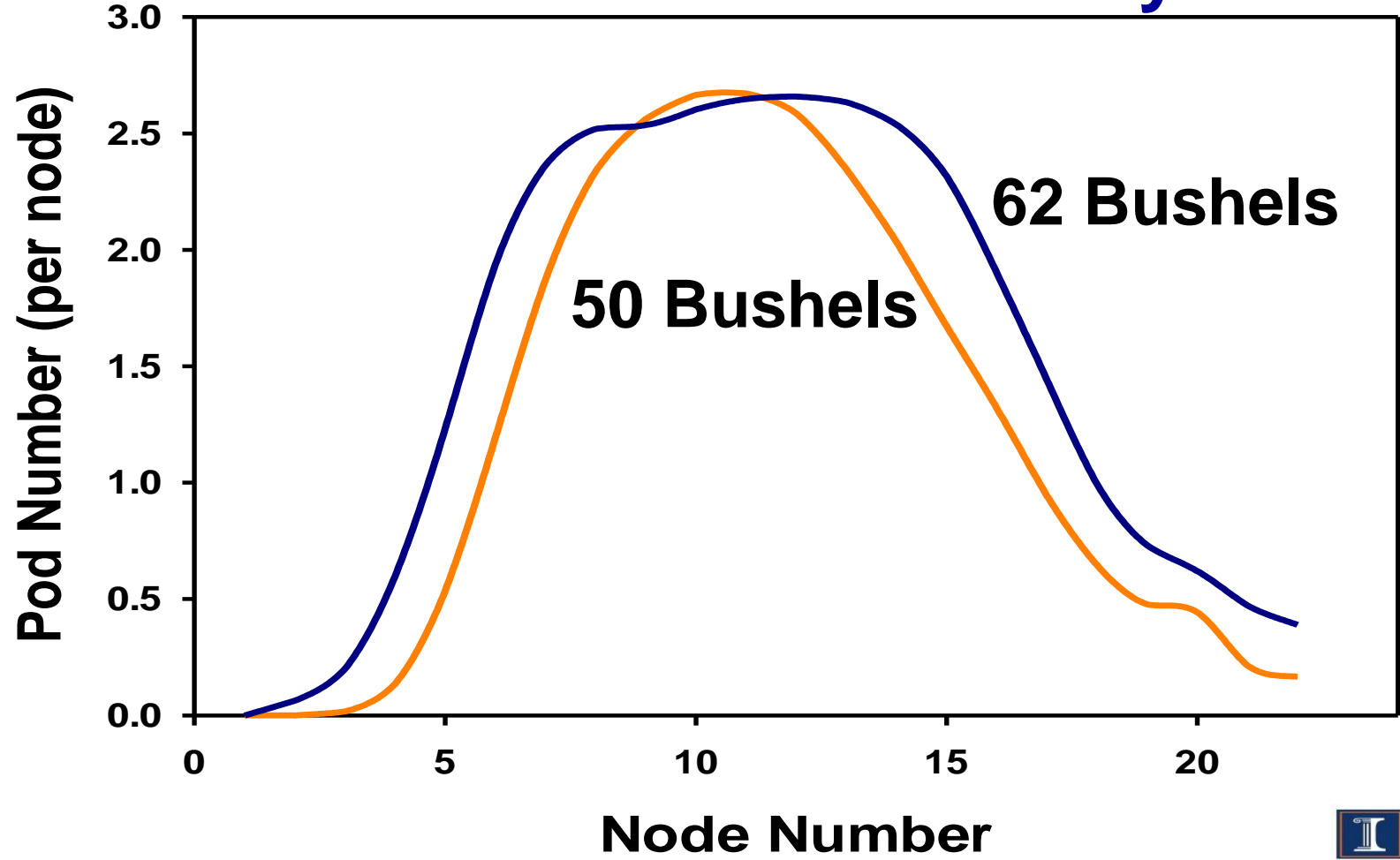
Soybean Yield Components

$$\text{Yield} = \text{Pod number/acre} \times \text{Seeds per pod} \times \text{Weight per seed}$$

How Does Pod Number Effect Soybean Yield



How Does Pod Number Effect Soybean Yield



- Foliar Protection



+ Foliar Protection



Fungicide and Insecticide August 2018, Champaign, IL

The Six Secrets of Soybean Success

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Foliar Protection

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Seed Treatment

6

Given key prerequisites

Fifty Shades of Seed Treatment

Clariva Complete +
Mertect 350-F

Naked

Equity VIP +
Clariva



Accelaron +
B-200 SAT +
Poncho/VOTiVO+iLeVO

PPST + DuPont
Lumisena

Impact of Seed Treatment on Emergence



Untreated



**Fungicide, Insecticide,
Nematicide**

Impact of Seed Treatment on Soybean Growth



Fungicide only

R2 growth stage, Champaign, IL

**Fungicide, Insecticide,
Nematicide**



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Physiology**

Impact of Seed Treatment on Soybean Growth



Plants at growth stage R2 at Champaign, IL

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Seed Treatment

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Row Spacing

Given key prerequisites



Crop
Physiology

Row Spacing Affects Light Interception And Canopy Air Movement



30" Rows



20" Rows

Grower Standard vs High Tech System 2014-18

Fertility

P applied the year before to corn

75 lbs P_2O_5 as MicroEssentials-S10 (also 23 N and 19 S) Banded 4-6" under row at planting

Variety

Normal and Full RM for the area

Normal and Full RM for the area

Foliar Protection

No foliar protection

Fungicide and Insecticide applied at R3

Seed Treatment

Untreated or Fungicide only

Fungicide, Insecticide, Nematicide

Row Spacing

30 inch row spacing

20 inch row spacing

Conclusions

- **Soybean yield can be increased with better crop management**
- **Soil fertility, particularly phosphorus is one of the most overlooked management factors for increasing soybean yields**

Conclusions

- **Variety makes a big difference and usually the fullest maturity gives the highest yield**
- **No such thing as a soybean N credit as soybean removes more N from the soil than it gets from the nodules**

Conclusions

- **60% of soybean yield comes from nodes 7-13, so it is important to protect leaves at those nodes, with an R3 spray**
- **Adding one more pod to each soybean plant increases yield by two bushels per acre**

Conclusions

- **Each of the six secrets can increase yield and when combined into a system they can act synergistically**

Crop Physiology 2018 Research Team



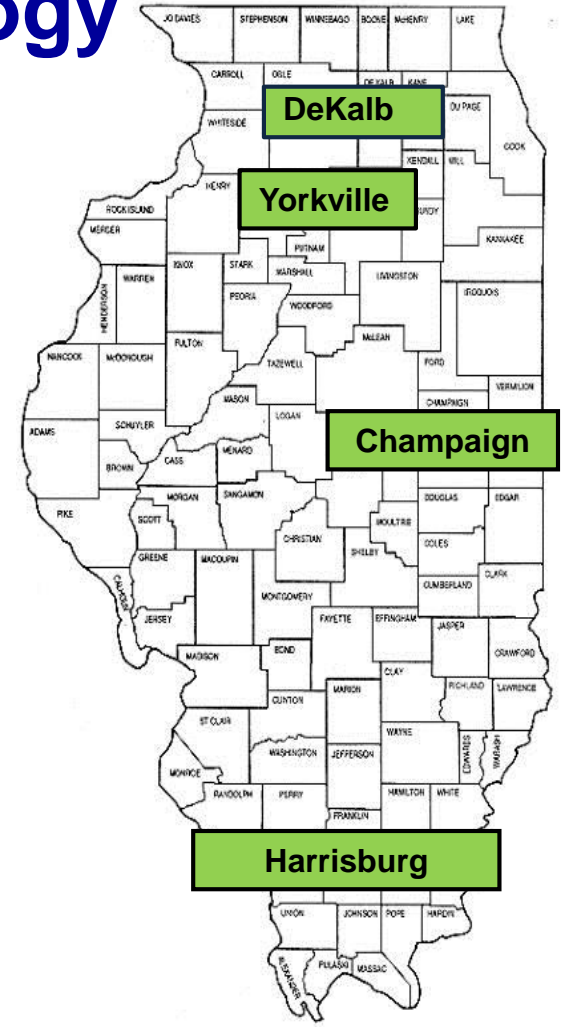
Past and Current Crop Physiology Lab Sites & Farm Cooperators

**DeKalb - Eric Lawler
H.B. Babson Farms**

**Yorkville - Bob and Brad Stewart
Stewart Farms LLC**

Champaign - UI Research Farm

**Harrisburg - Scott Berry
Berry Farms**



The Crop Physiology Laboratory

Financial and Product Support for 2018

- **AdvanSix**
- **Agrinos**
- **Agricen**
- **Agrocete**
- **Asilomar**
- **Avunia**
- **Balchem**
- **BASF**
- **Bayer**
- **Calmer Corn Heads**
- **Compass Minerals**
- **Crystal Green Fertilizer**
- **Fluid Fertilizer Foundation**
- **Helena**
- **ISA**
- **Illini FS**
- **Italpollina**
- **John Deere**
- **Mosaic**
- **Montag Mfg**
- **Netafim**
- **Nutrien**
- **Sipcam Agro**
- **Sirius Minerals**
- **Solvay**
- **Syngenta**
- **Tessengerlo Kerley**
- **United Prairie**
- **United Soybean Board**
- **Valent**
- **Verdesian**
- **West Central**
- **WinField United**

The Crop Physiology Laboratory

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- Sipcam Agro
- Sirius Minerals
- Solvay
- Syngenta
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- United Prairie
- United Soybean Board
- Valent
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- West Central
- WinField United

**Very Special Thanks to the Ehler Bros.
Company & Illinois Soybean Association**

For More Information:

Crop Physiology Laboratory

University of Illinois

<http://cropphysiology.cropsci.illinois.edu>

