Optimizing Soybean Yields With Innovative Agronomic Management

Dr. Connor Sible

Crop Physiology Laboratory

Department of Crop Sciences
University of Illinois at Urbana-Champaign

Illinois Soybean Association Virtual Webinar
August 9th, 2022

Crop Physiology

Is Soybean Currently Managed Adequately?

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 yield of 190 bushels per acre in 2019
- US average record yield of 53 bushels per acre in 2016

  (Illinois record is 64 in 2018 and 2021)
- Yield Gap = Record Yield – Average Yield = 137 bushels

The Six Secrets of Soybean Success

What Factors Have the Biggest Impact on Soybean Yield?

Crop Physiology

The Six Secrets of Soybean Success

Rank	Factor
1	Weather
2	Fertility
3	Genetics/Variety
4	Foliar Protection
5	Seed Treatment
6	Row Spacing

First Developed in 2012

Given key prerequisites

Crop Physiology

Has Soybean Yield Changed in the Past 10 Years?

The Soybean Yield Gap

- World Record yield of 190 bushels per acre in 2019
- US average record yield of 53 bushels per acre in 2016

  (Illinois record is 64 in 2018 and 2021)
- Yield Gap = Record Yield – Average Yield = 137 bushels

2022 - Six Secrets of Soybean Success

Rank	Factor	Value bu/acre
1	Weather	
2	Genetics/Variety	
3	Row Spacing	
4	Foliar Protection	
5	Fertility	
6	Seed Treatment	
	TOTAL	???

Given key prerequisites

Crop Physiology

2022 - Six Secrets of Soybean Success

Rank	Factor	Value bu/acre
1	Weather	35+
2	Genetics/Variety	
3	Row Spacing	
4	Foliar Protection	
5	Fertility	
6	Seed Treatment	

Given key prerequisites

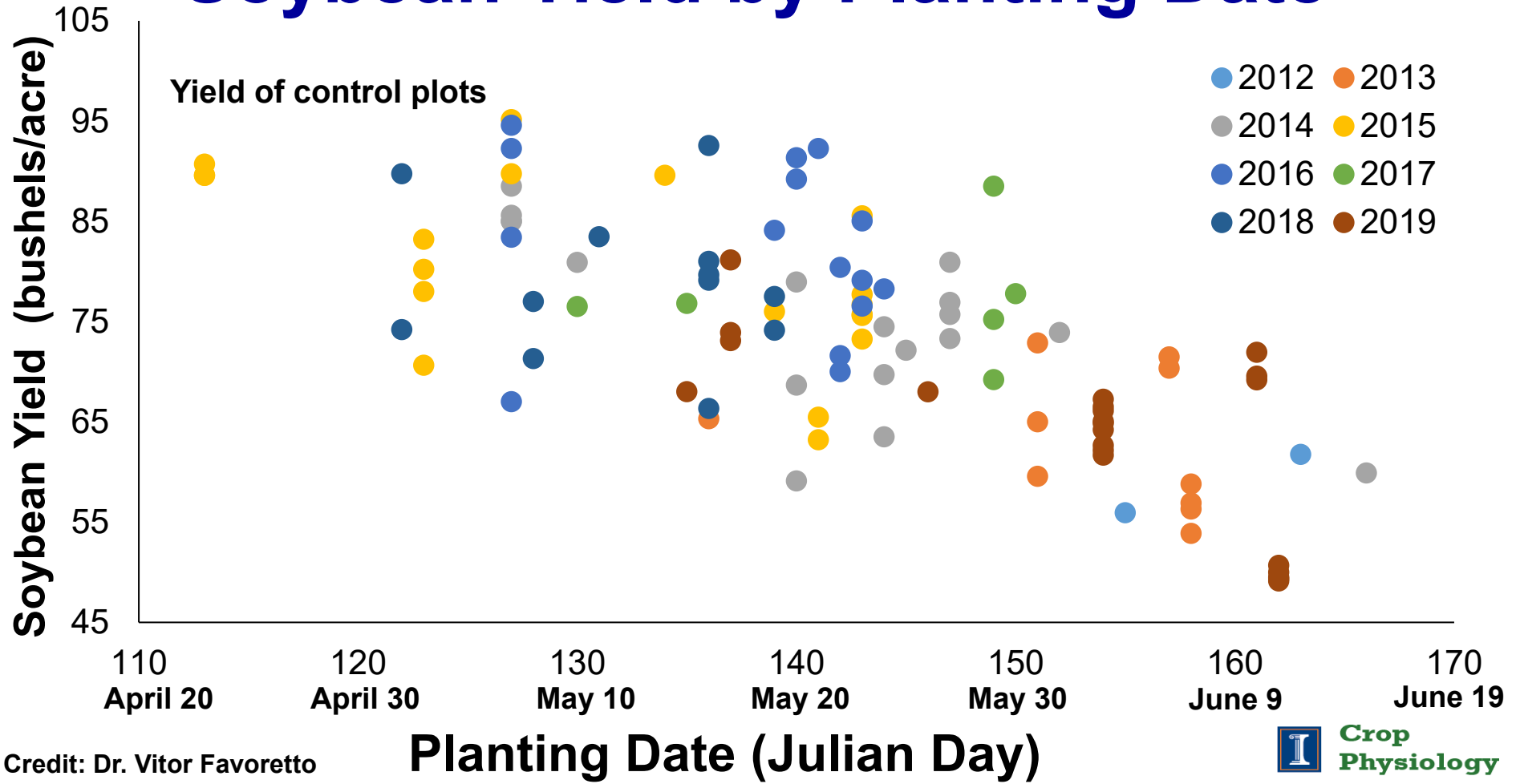
Crop Physiology

Planting Date is Determined by Weather

May 15th, 2019 in Champaign, IL

Crop Physiology

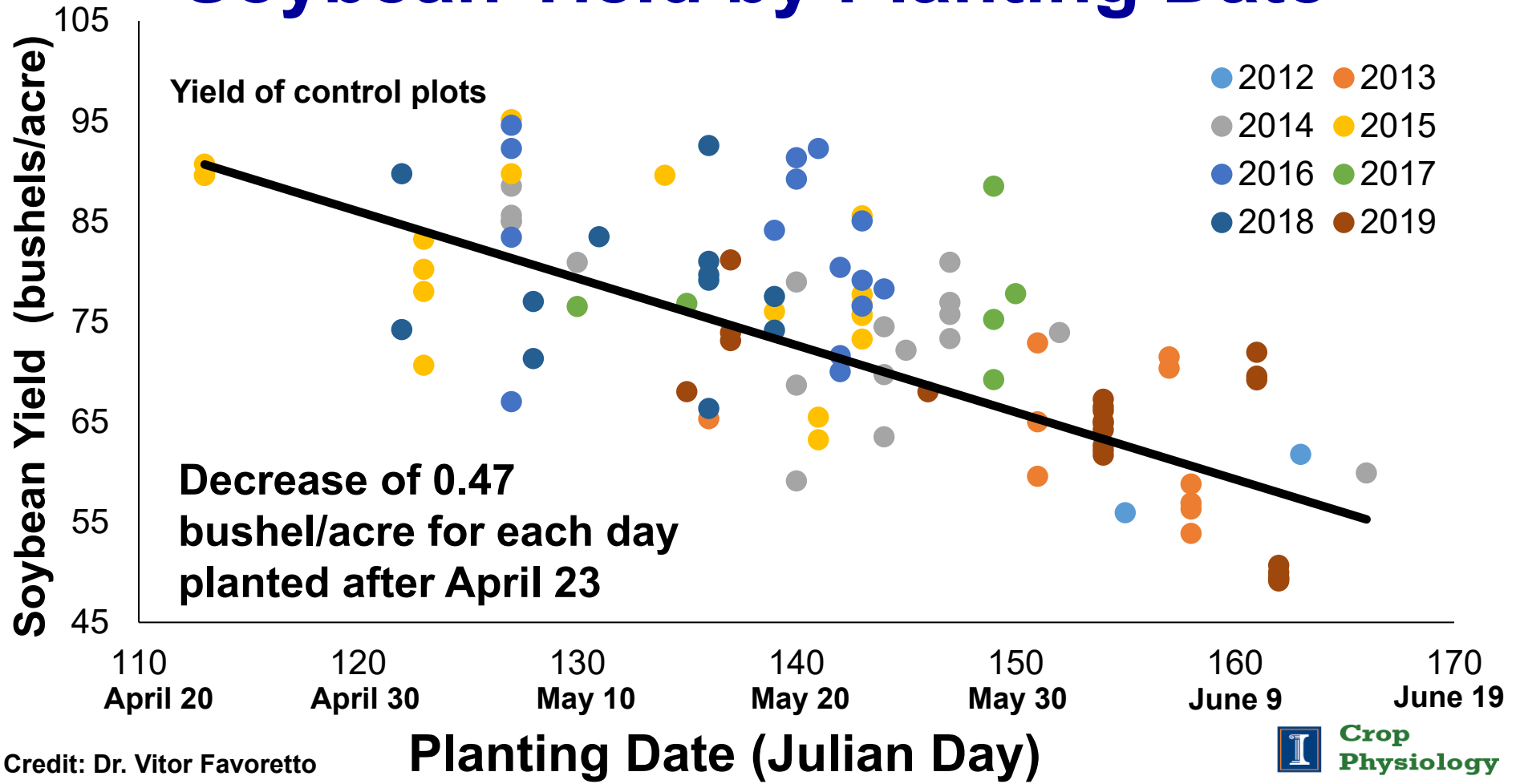
Soybean Yield by Planting Date



Credit: Dr. Vitor Favoretto

Crop Physiology

Soybean Yield by Planting Date



Credit: Dr. Vitor Favoretto

Crop Physiology

Planting Date and Management Interact

April 23rd vs May 9th

May 9th vs May 31st

May 31st vs June 15th

Photos taken on June 15th, 2022

Champaign, IL

Crop Physiology

Planting Date and Management Interact

April 23rd vs May 9th

May 9th vs May 31st

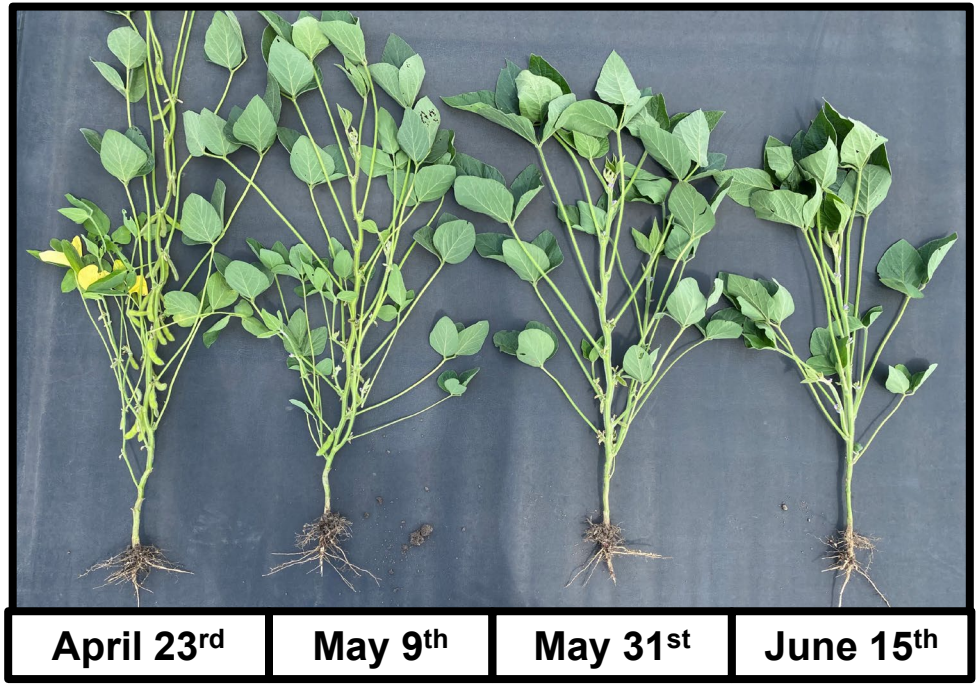
May 31st vs June 15th

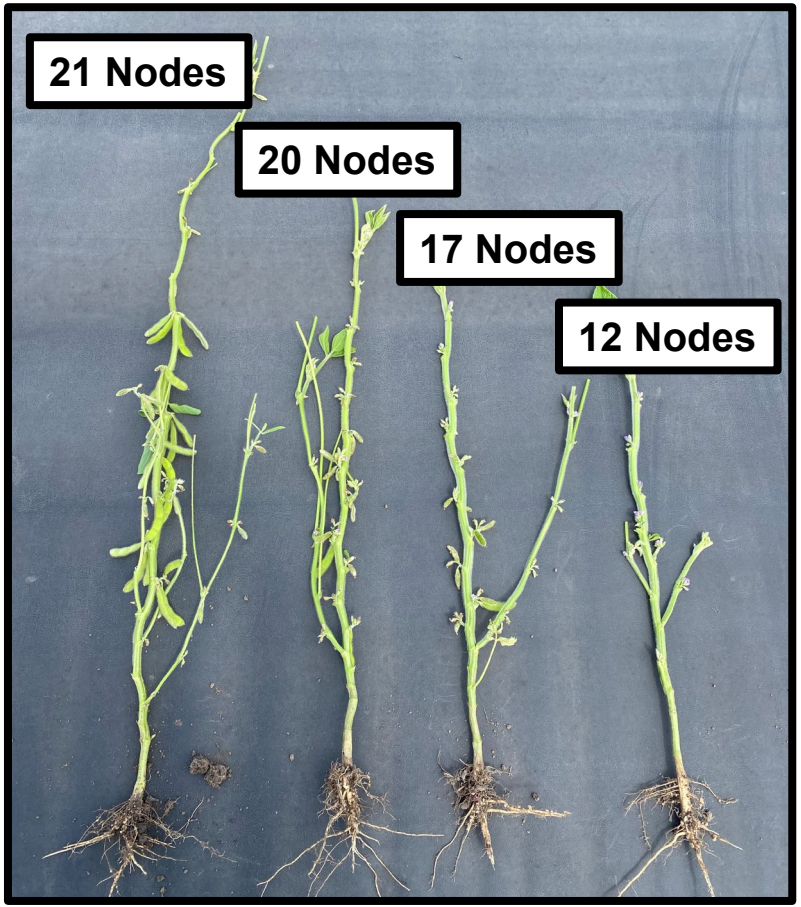
Photos taken on July 31st, 2022

Champaign, IL

Crop Physiology

Planting Date and Node Number





Champaign, IL – July 31st, 2022

Crop Physiology

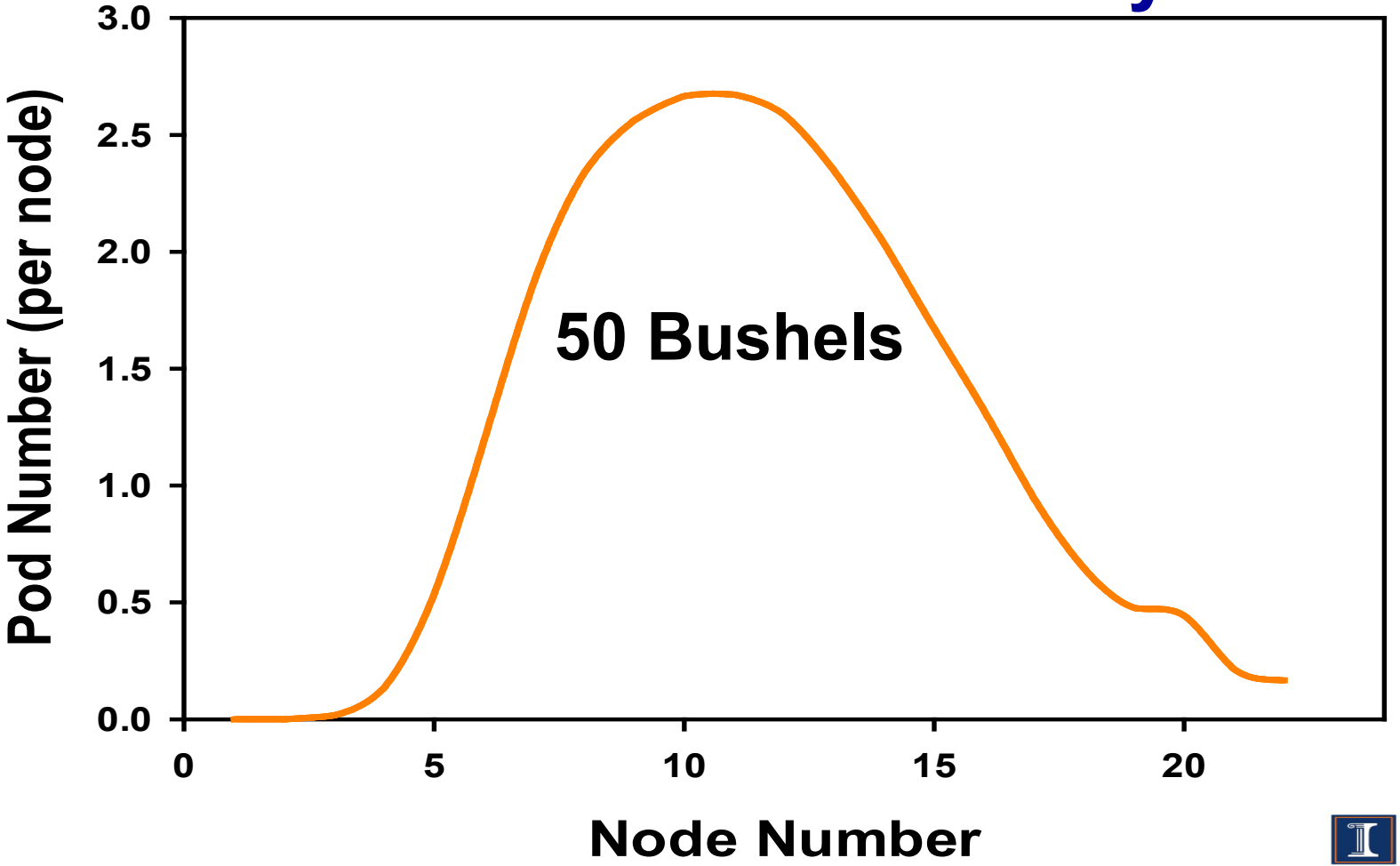
Soybean Yield Algorithm

Yield = Pod number/acre x

Seeds per pod x

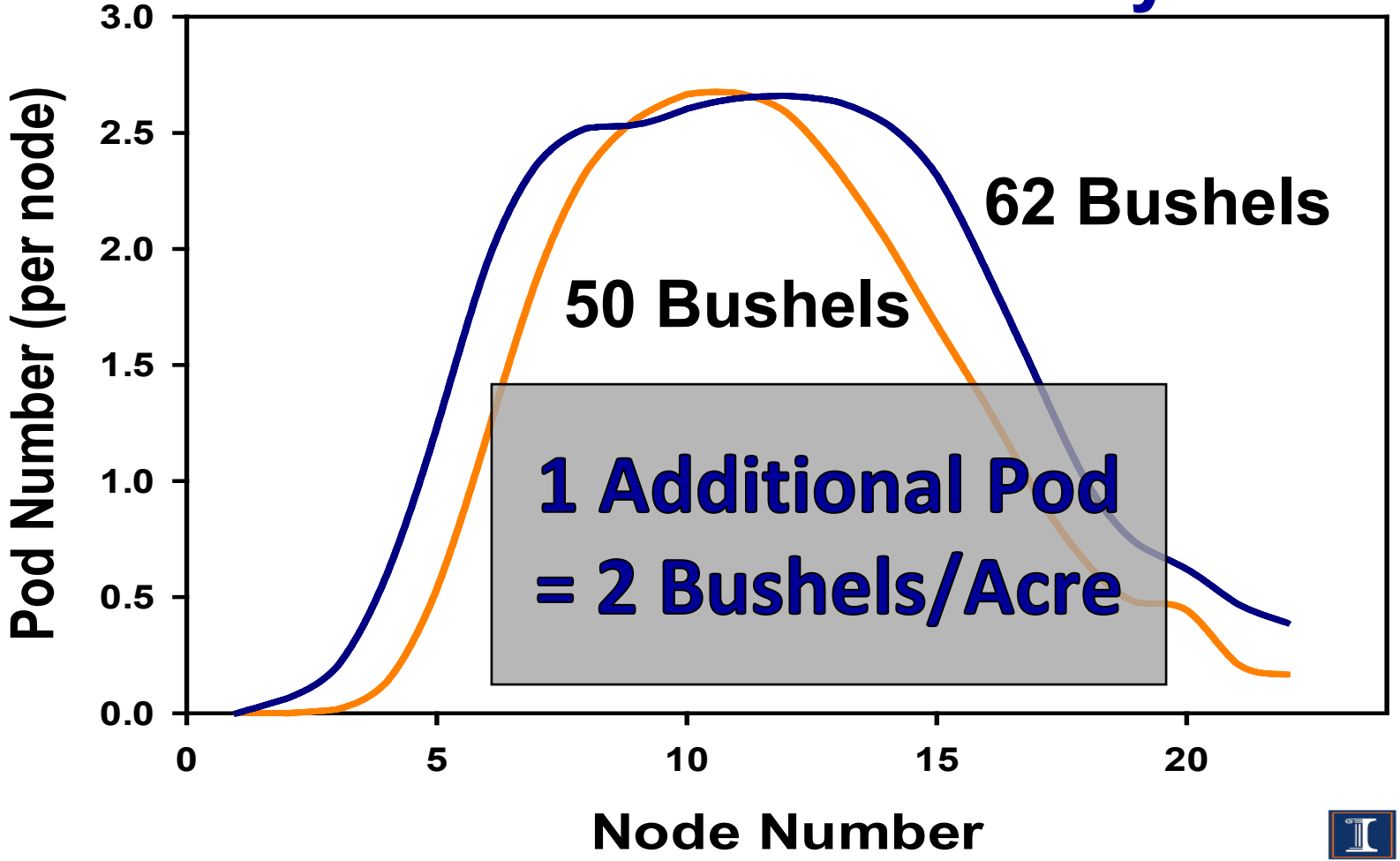
Weight per seed

How Does Pod Number Effect Soybean Yield



Crop Physiology

How Does Pod Number Effect Soybean Yield



Crop Physiology

2022 - Six Secrets of Soybean Success

Rank	Factor	Value
		bu/acre
1	Weather	35+
2	Genetics/Variety	25
3	Row Spacing	
4	Foliar Protection	
5	Fertility	
6	Seed Treatment	

Given key prerequisites

Crop Physiology

All Soybean Varieties are Not Created Equal

Variety	Yield	Variety	Yield	Variety	Yield
	bushels/acre		bushels/acre		bushels/acre
1	100.6	10	86.7	19	79.2
2					
3					
4					
5					
6					
7					
8	87.7	17	81.7	26	73.0
9	87.2	18	79.7		

27.6 bushel yield range in variety

LSD (0.10) = 6.7

RM range 2.5 to 4.4

Standard Management Champaign (Central IL) in 2021

Crop Physiology

All Soybean Varieties are Not Created Equal

Variety	Yield	Variety	Yield	Variety	Yield
	bushels/acre		bushels/acre		bushels/acre
1	100.6	10	86.7	19	79.2
2	96.0	11	86.6	20	78.2
3	93.8	12	86.1	21	77.8
4	91.9	13	85.8	22	76.1
5	91.3	14	85.3	23	75.8
6	88.9	15	83.3	24	74.6
7	87.7	16	81.8	25	73.5
8	87.7	17	81.7	26	73.0
9	87.2	18	79.7		

LSD (0.10) = 6.7

RM range 2.5 to 4.4

Standard Management Champaign (Central IL) in 2021

Crop Physiology

All Soybean Varieties are Not Created Equal

Variety	Yield	Variety	Yield	Variety	Yield
	bushels/acre		bushels/acre		bushels/acre
3.7	100.6	10	86.7	2.9	79.2
4.3	96.0	11	86.6	2.8	78.2
3.1	93.8	12	86.1	3.5	77.8
3.8	91.9	13	85.8	3.3	76.1
3.9	91.3	14	85.3	3.1	75.8
4.4	88.9	15	83.3	2.7	74.6
4.2	87.7	16	81.8	2.5	73.5
3.5	87.7	17	81.7	2.9	73.0
3.9	87.2	18	79.7		

LSD (0.10) = 6.7 RM range 2.5 to 4.4

Standard Management Champaign (Central IL) in 2021

Crop Physiology

2022 - Six Secrets of Soybean Success

Rank	Factor	Value
		bu/acre
1	Weather	35+
2	Genetics/Variety	25
3	Row Spacing	9
4	Foliar Protection	
5	Fertility	
6	Seed Treatment	

Given key prerequisites

Crop Physiology

Row Spacing Affects Light Interception
And Canopy Air Movement

30” Rows

20” Rows

Champaign, IL

Crop Physiology

Narrow Row Spacing Increases Yield

Row Spacing	Grain Yield	Seed Number
inches	— bushels per acre —	— seeds per m^2 —
30	74.1	3194
20	80.5	3524
Increase from 20 inch rows	+6.4*	+330*

* Significantly different at $P \leq 0.0001$.

Data averaged across 11 trials during 2014 and 2015.

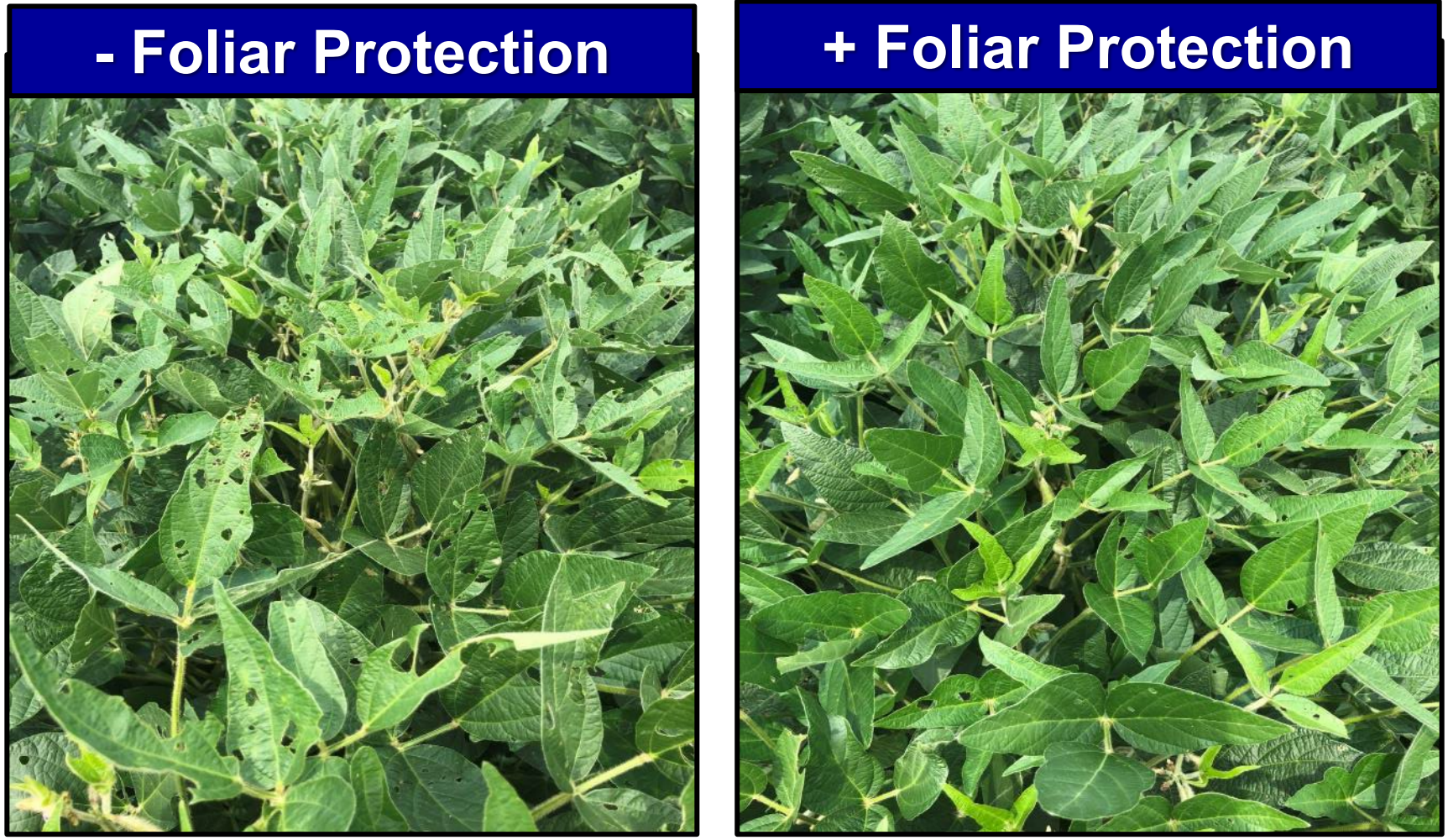
Crop Physiology

2022 - Six Secrets of Soybean Success

Rank	Factor	Value
		bu/acre
1	Weather	35+
2	Genetics/Variety	25
3	Row Spacing	9
4	Foliar Protection	5
5	Fertility	
6	Seed Treatment	

Given key prerequisites

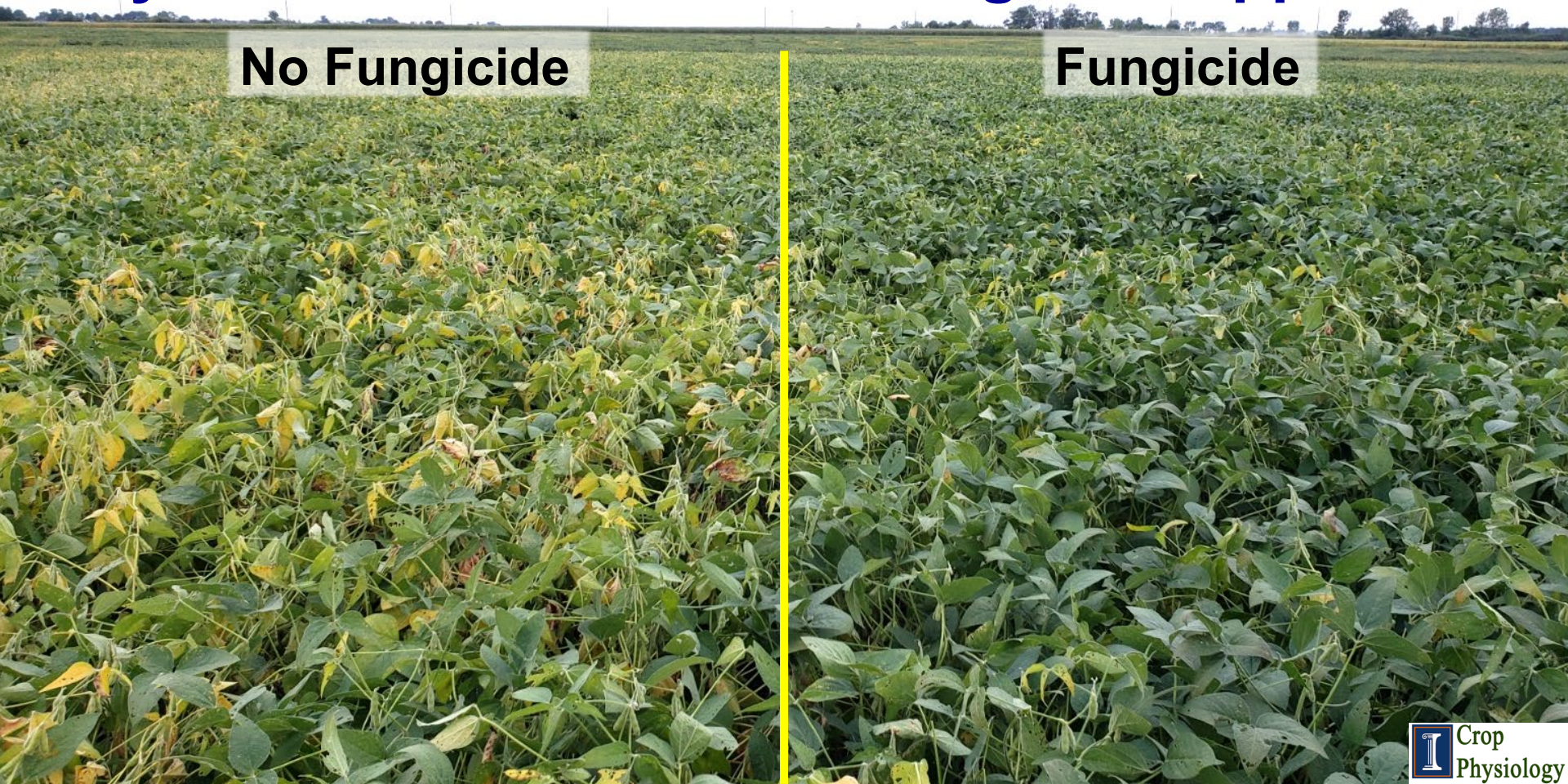
Crop Physiology



Fungicide and Insecticide August 2021, Champaign, IL

Crop Physiology

Stay-Green Effect from R3 Fungicide Application



How Can Foliar Protection Play a Role in Increasing Soybean Yields?

- Average soybean seed weighs 150 mg
- If increase seed weight 2 mg (from 150 to 152 mg) = 1 bushel

Foliar Protection Increases Yield

Foliar Protection	Grain Yield	Seed Weight
Application	— bushels per acre —	— mg per seed —
None	72.5	131.8
Fungicide/Insecticide	75.8	135.6
Increase from foliar protection	3.3	+3.8*

* Significantly different at $P \leq 0.0001$.

Data averaged across 11 trials during 2014 and 2015.

Crop Physiology

2022 - Six Secrets of Soybean Success

Rank	Factor	Value
		bu/acre
1	Weather	35+
2	Genetics/Variety	25
3	Row Spacing	9
4	Foliar Protection	5
5	Fertility	4
6	Seed Treatment	

Given key prerequisites

Crop Physiology

Nutrient Uptake and Removal by 80 Bushel Soybean

Nutrient	Required to Produce	Removed with Grain	Harvest Index
	lbs per acre		%
N	327	239	73
P_2O_5	57	47	81
K_2O	227	93	41
S	23	13	61
Zn (oz)	6.4	2.7	44
B (oz)	6.1	2.1	34

Nutrient Uptake and Removal by 80 Bushel Soybean

Nutrient	Required to Produce	Removed with Grain	Harvest Index
	lbs per acre		%
N	327	239	73
P_2O_5	57	47	81
K_2O	227	93	41
S	23	13	61
Zn (oz)	6.4	2.7	44
B (oz)	6.1	2.1	34

Nutrient Uptake and Removal by 80 Bushel Soybean

Nutrient	Required to Produce	Removed with Grain	Harvest Index
	lbs per acre		%
N	327	239	73
P_2O_5	57	47	81
K_2O	227	93	41
S	23	13	61
Zn (oz)	6.4	2.7	44
B (oz)	6.1	2.1	34

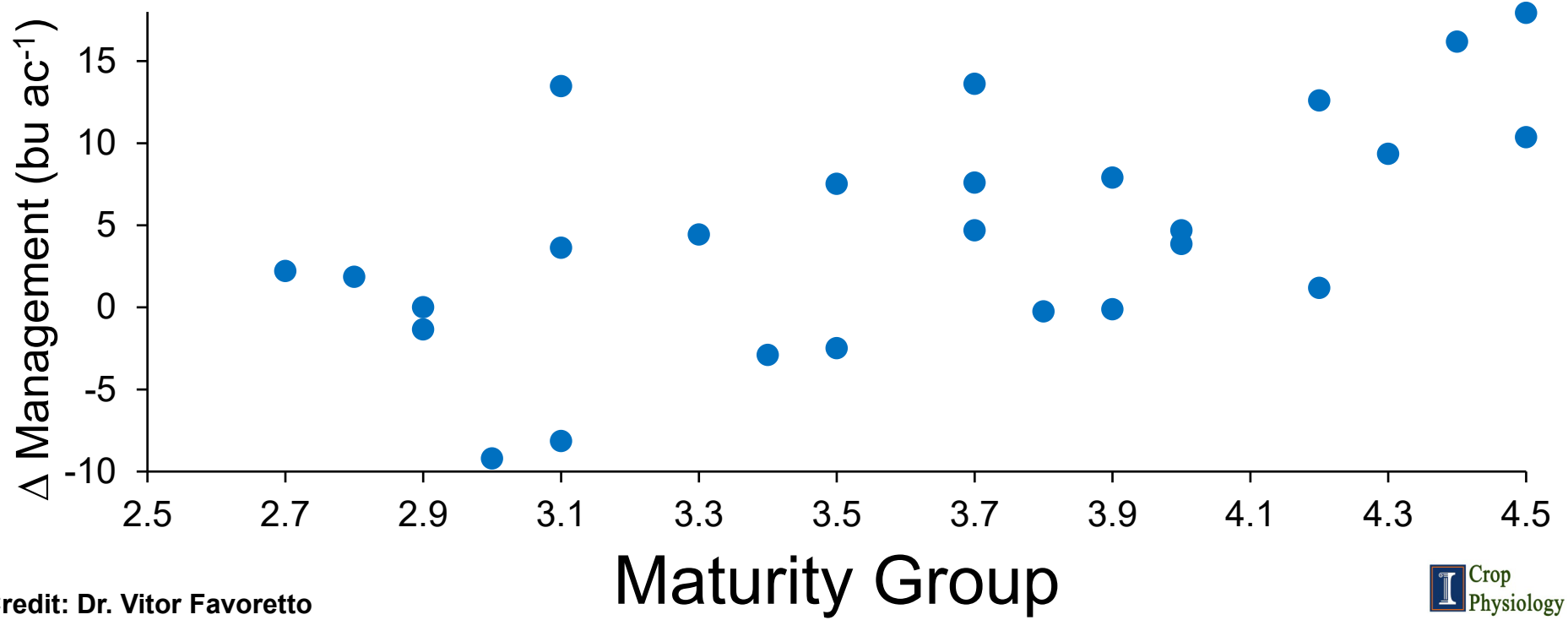
Strong Start From Banded Fertility

Crop Physiology


What makes a variety more responsive to fertility?
Crop Physiology

Soybean Yield Response to Management Relative to Maturity Group - Nashville

Δ Management = Progressive – Standard Management

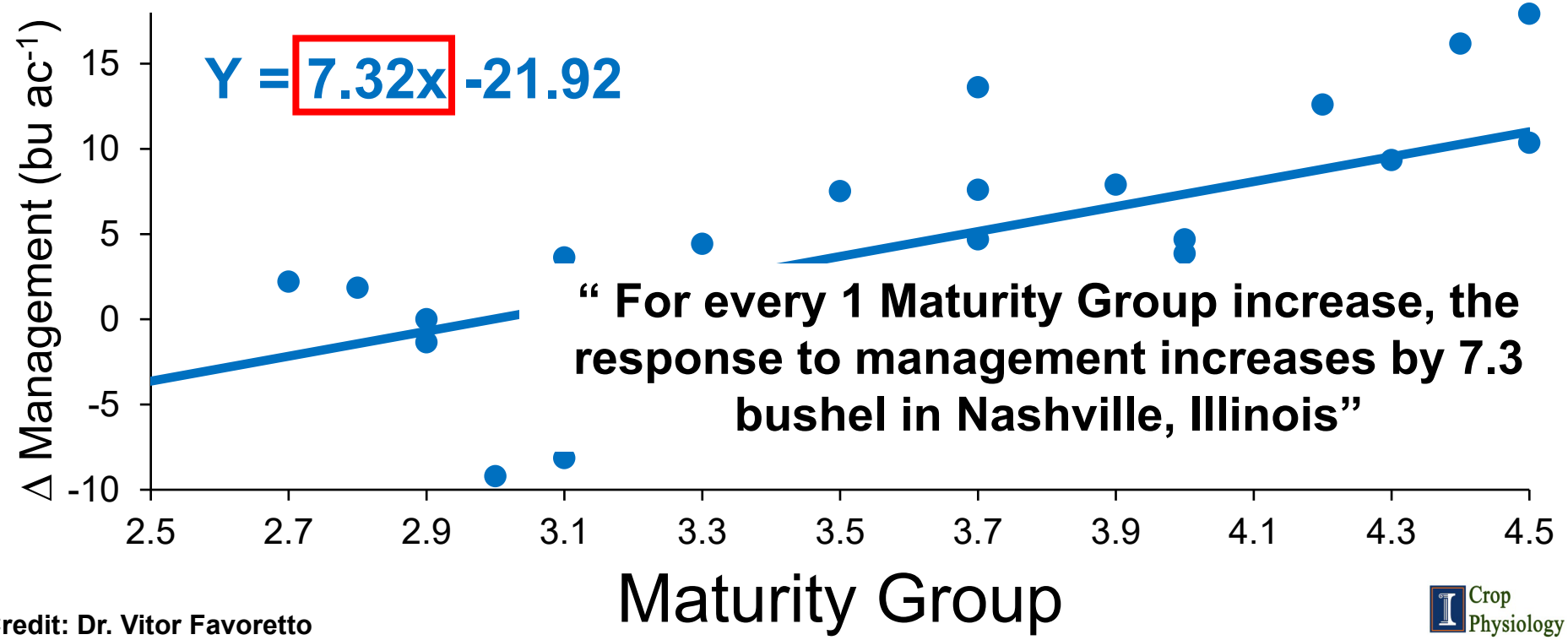


Credit: Dr. Vitor Favoretto

Crop Physiology

Soybean Yield Response to Management Relative to Maturity Group - Nashville

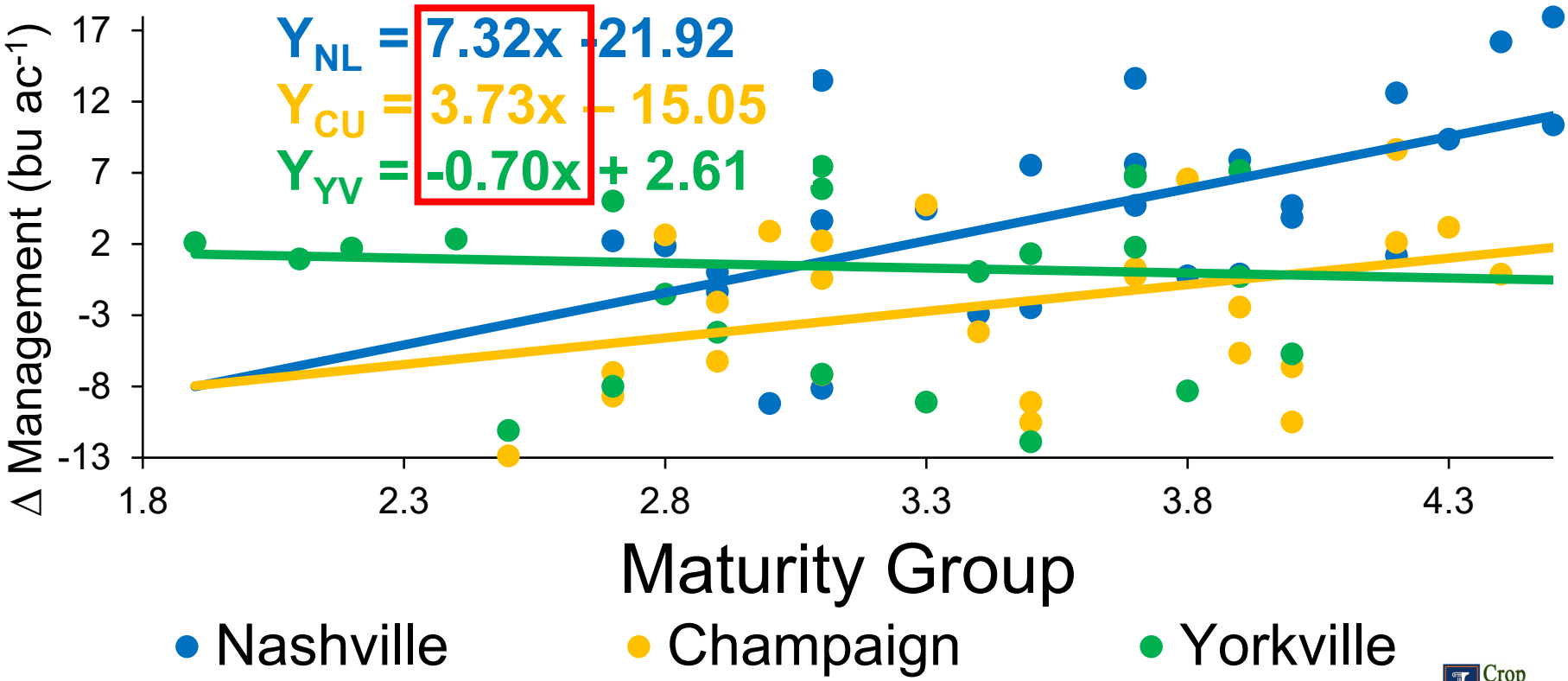
Δ Management = Progressive – Standard Management



Credit: Dr. Vitor Favoretto

Crop Physiology

Soybean Yield Response to Management Relative to Maturity Group - Illinois

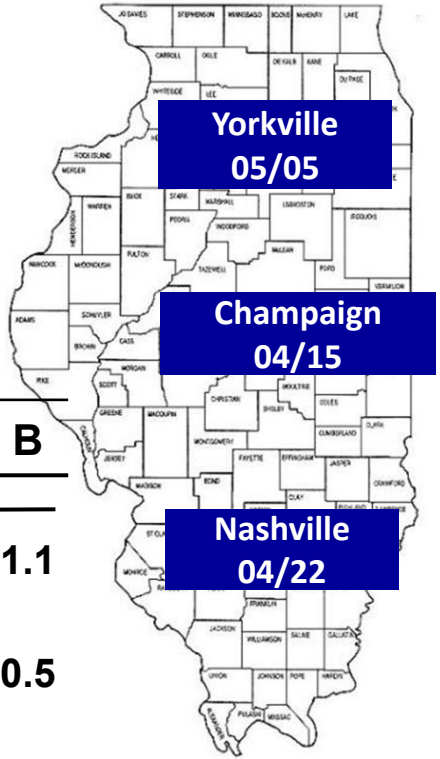


Credit: Dr. Vitor Favoretto

Crop Physiology

Trial and Soil Information

- 33 varieties total
- 26 varieties per location, 3 locations
- Maturity ranging from 1.9 - 4.5 across the state
- Four replications



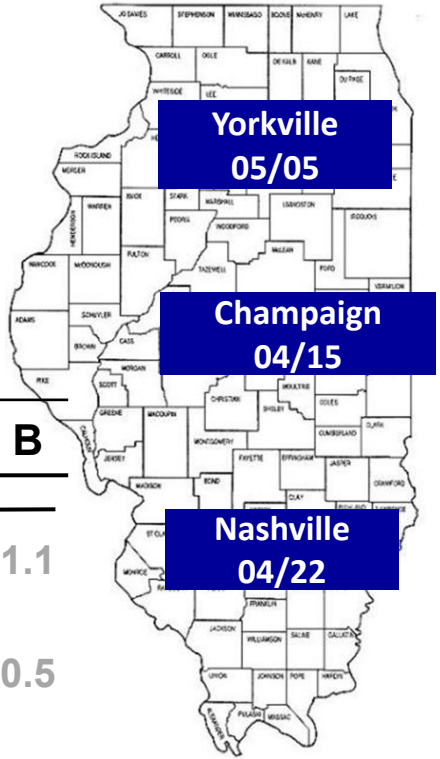
Location	O.M.	pH	CEC	P†	K	Ca	Mg	S	Zn	Mn	Fe	Cu	B
	%		Meg.100g^{-1}	ppm									
Yorkville	6.4	6.6	22.8	58	185	2914	677	8	5.7	34	139	2.7	1.1
Champaign	3.7	6.9	16.7	34	123	2390	422	8	1.5	39	118	1.5	0.5
Nashville	2.7	7.1	9.9	47	113	1713	123	12	2.1	134	265	1.9	0.5

Depth = 0”- 6”
†Mehlich III extraction

Crop Physiology

Trial and Soil Information

- 33 varieties total
- 26 varieties per location, 3 locations
- Maturity ranging from 1.9 - 4.5 across the state
- Four replications

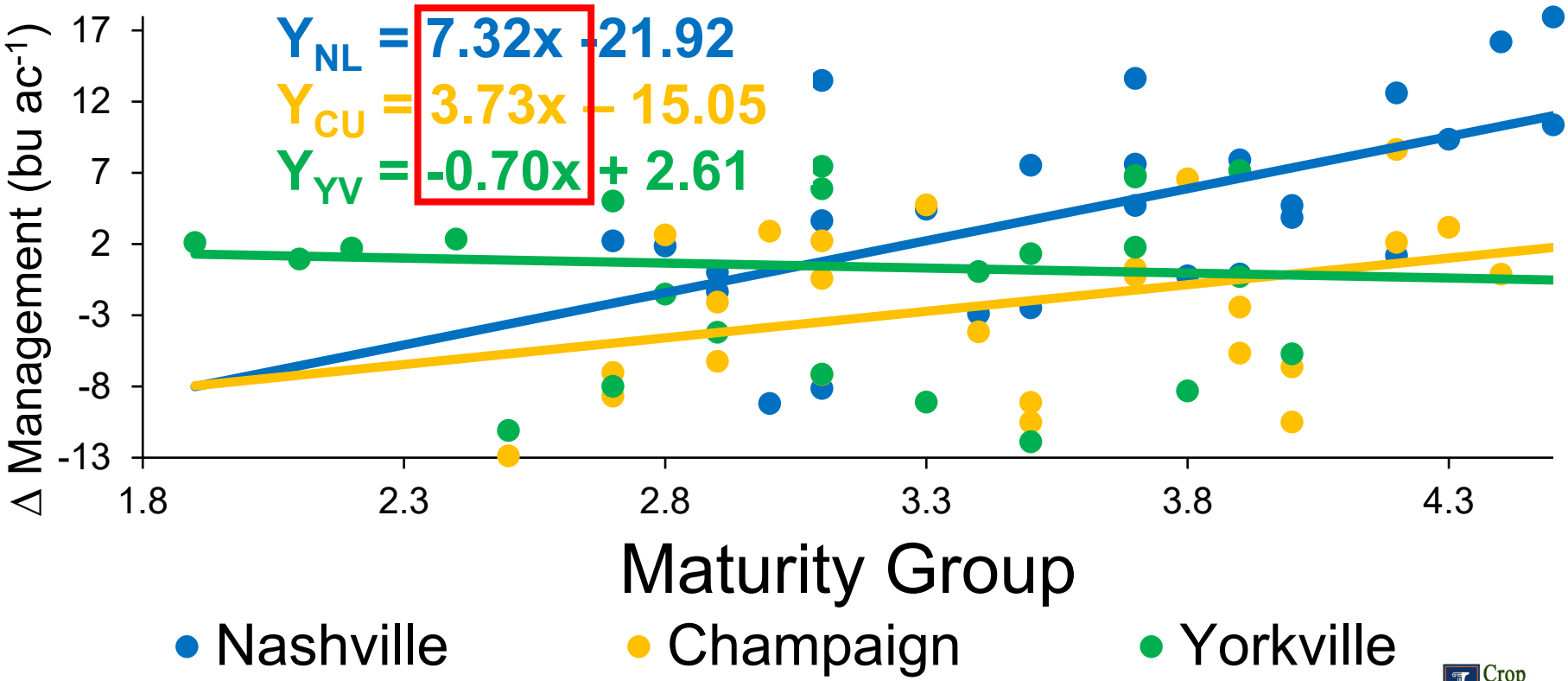


Location	O.M.	pH	CEC	P†	K	Ca	Mg	S	Zn	Mn	Fe	Cu	B
	%		Meg.100g^{-1}	ppm									
Yorkville	6.4	6.6	22.8	58	185	2914	677	8	5.7	34	139	2.7	1.1
Champaign	3.7	6.9	16.7	34	123	2390	422	8	1.5	39	118	1.5	0.5
Nashville	2.7	7.1	9.9	47	113	1713	123	12	2.1	134	265	1.9	0.5

Depth = 0”- 6”
†Mehlich III extraction

Crop Physiology

Soybean Yield Response to Management Relative to Maturity Group - Illinois



Credit: Dr. Vitor Favoretto

Crop Physiology

Key Takeaways

- Soybean needs fertility and foliar protection to obtain higher yields in progressive systems

- Fuller maturity soybean variety for a given location tends to be more responsive to the addition of preplant P and K applications

2022 - Six Secrets of Soybean Success

Rank	Factor	Value
		bu/acre
1	Weather	35+
2	Genetics/Variety	25
3	Row Spacing	9
4	Foliar Protection	5
5	Fertility	4
6	Seed Treatment	2

Given key prerequisites

Crop Physiology

Impact of Seed Treatment on Emergence

Untreated

Fungicide, Insecticide, Nematicide

Photos courtesy of AJ Woodyard

Crop Physiology

2022 - Six Secrets of Soybean Success

Rank	Factor	Value
		bu/acre
1	Weather	35+
2	Genetics/Variety	25
3	Row Spacing	9
4	Foliar Protection	5
5	Fertility	4
6	Seed Treatment	2
	TOTAL	???

Given key prerequisites

Crop Physiology

2022 - Six Secrets of 80 Bushel Soybean

Rank	Factor	Value
		bu/acre
1	Weather	35+
2	Genetics/Variety	25
3	Row Spacing	9
4	Foliar Protection	5
5	Fertility	4
6	Seed Treatment	2
	TOTAL	80 bu

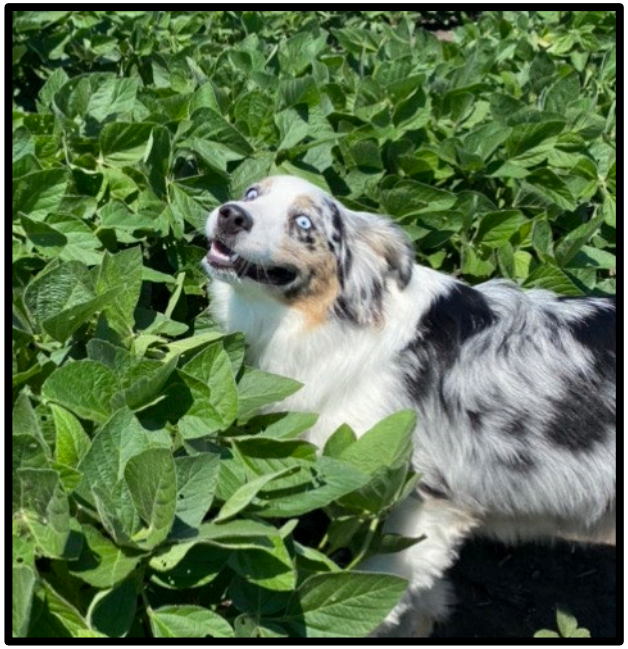
Given key prerequisites

Crop Physiology

Six Secrets of Soybean Success

2012

60 bushels/acre



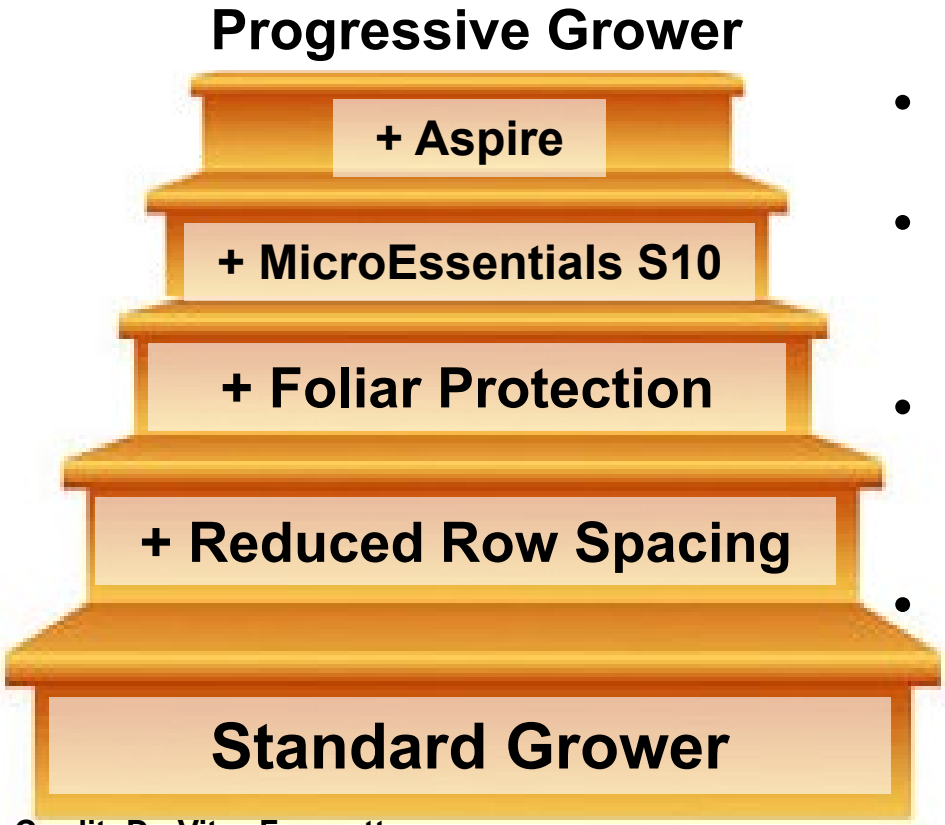
2022

80 bushels/acre!!

Crop Physiology


Can we achieve greater than 80 bushels per acre?
Crop Physiology

Soybean Yield Study - 2021



- Aspire broadcasted (102 lbs ac^{-1})
- MicroEssentials S10 broadcasted (100 lbs ac^{-1})
- Foliar protection
  - MiravisTop and Endigo at R3
- Row spacing reduced from 30 to 20 inches

Credit: Dr. Vitor Favoretto

Crop Physiology

Effect of Management on Soybean Yield in Illinois

Management	Location		
	Yorkville (5/5)	Champaign (4/15)	Nashville (4/20)
	bushels acre^{-1}		
Untreated Control			
+Reduced Row Spacing			
+Foliar Protection			
+MicroEssentials S10			
+Aspire			
LSD (p<0.1)	2.4	1.8	2.1
p-value	0.09	0.19	<0.01

Credit: Dr. Vitor Favoretto

Effect of Management on Soybean Yield in Illinois

Management	Location		
	Yorkville (5/5)	Champaign (4/15)	Nashville (4/20)
	bushels acre^{-1}		
Untreated Control	84.3	88.9	81.8
+Reduced Row Spacing			
+Foliar Protection			
+MicroEssentials S10			
+Aspire			
LSD ($p<0.1$)	2.4	1.8	2.1
p-value	0.09	0.19	<0.01

Credit: Dr. Vitor Favoretto

Effect of Management on Soybean Yield in Illinois

Management	Location		
	Yorkville (5/5)	Champaign (4/15)	Nashville (4/20)
	bushels acre^{-1}		
Untreated Control	84.3	88.9	81.8
+Reduced Row Spacing	82.0	83.6	82.5
+Foliar Protection			
+MicroEssentials S10			
+Aspire			
LSD ($p<0.1$)	2.4	1.8	2.1
p-value	0.09	0.19	<0.01

Does Early Planting Need Narrow Rows?

Credit: Dr. Vitor Favoretto

Fertility is One Management Needed for Higher Soybean Yields

Management	Location		
	Yorkville (5/5)	Champaign (4/15)	Nashville (4/20)
	bushels acre^{-1}		
Reduced Row Spacing	82.0	83.6	82.5
+Foliar Protection			
+MicroEssentials S10			
+Aspire			
LSD ($p<0.1$)	2.4	1.8	2.1
p-value	0.09	0.19	<0.01

Fertility is One Management Needed for Higher Soybean Yields

Management	Location		
	Yorkville (5/5)	Champaign (4/15)	Nashville (4/20)
	bushels acre^{-1}		
Reduced Row Spacing	82.0	83.6	82.5
+Foliar Protection	85.9	85.9	84.1
+MicroEssentials S10	85.0	86.6	86.3
+Aspire	84.7	88.8	86.2

When planting in narrow rows, management is needed for higher yields

How else can we manage soybean?

Biologicals?

What are Biologicals?

- Plant Growth Regulators (PGRs)
- Beneficial Microbes
- Biostimulants

What are Biologicals?

- Beneficial Microbes

"The Living"

- Biostimulants

"The Dead"

Crop Physiology

What are Biologicals?

- Beneficial Microbes

"The Microbes"

- Biostimulants

"The Products They Produce"

Biological Sub-Categories

- Nitrogen-Fixing Bacteria
- P-Solubilizing Bacteria
- Mycorrhizal Fungi

Beneficial Microbes

- Enzymes (Phosphatases)
- Humic/Fulvic Acids
- Marine Extracts
- Sugars

Biostimulants

Crop Physiology

Biological Sub-Categories

- Nitrogen-Fixing Bacteria – Increase Plant Available N
- Soybean – Rhizobium Relationship

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

Crop Physiology

Test Your Knowledge of High Yield Soybean

World Yield Record of 190 Bushels Requires 855 lbs N/acre!

4 to 5 lbs of N per Bushel

Crop Physiology

Alternate Biologicals for Soybean Management?

Are there other opportunities beyond microbes for nitrogen fixation?

Biological Sub-Categories

- Nitrogen-Fixing Bacteria – Increase Plant Available N
- P-Solubilizing Bacteria – Increase Availability of Mineral P
- Mycorrhizal Fungi
- Enzymes (Phosphatases)
- Humic/Fulvic Acids
- Marine Extracts
- Sugars

Biological Sub-Categories

- Nitrogen-Fixing Bacteria – Increase Plant Available N
- P-Solubilizing Bacteria – Increase Availability of Mineral P
- **Mycorrhizal Fungi – Extension of the Root System**
- **Enzymes (Phosphatases)**
- **Humic/Fulvic Acids**
- **Marine Extracts**
- **Sugars**

Biological Sub-Categories

- Nitrogen-Fixing Bacteria – Increase Plant Available N
- P-Solubilizing Bacteria – Increase Availability of Mineral P
- Mycorrhizal Fungi – Extension of the Root System
- **Enzymes (Phosphatases) – Increase Availability of Organic P**
- **Humic/Fulvic Acids**
- **Marine Extracts**
- **Sugars**

Biological Sub-Categories

- Nitrogen-Fixing Bacteria – Increase Plant Available N
- P-Solubilizing Bacteria – Increase Availability of Mineral P
- Mycorrhizal Fungi – Extension of the Root System
- Enzymes (Phosphatases) – Increase Availability of Organic P
- **Humic/Fulvic Acids – Chelate Soil Cations and Feed Microbes**
- **Marine Extracts**
- **Sugars**

Biological Sub-Categories

- Nitrogen-Fixing Bacteria – Increase Plant Available N
- P-Solubilizing Bacteria – Increase Availability of Mineral P
- Mycorrhizal Fungi – Extension of the Root System
- Enzymes (Phosphatases) – Increase Availability of Organic P
- Humic/Fulvic Acids – Chelate Soil Cations and Feed Microbes
- **Marine Extracts** } Soil Applied Stimulates Microbes and Roots
- **Sugars** } Foliar Applied Mitigates Stresses (Drought)

Crop Physiology

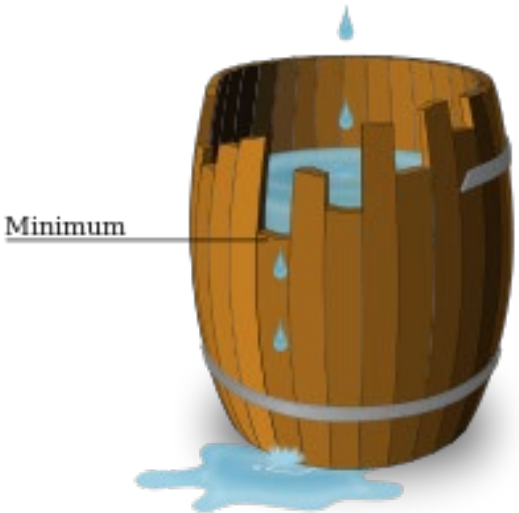
When Using Biologicals…

Phosphorus

Seed Treatment

Weather

Potassium



Nitrogen

Plant Population

Foliar Protection

Micronutrients

Biologicals

Crop Physiology

ILSOY ADVISOR

Learn Webinars Events Programs Tools/Resources Contact Us

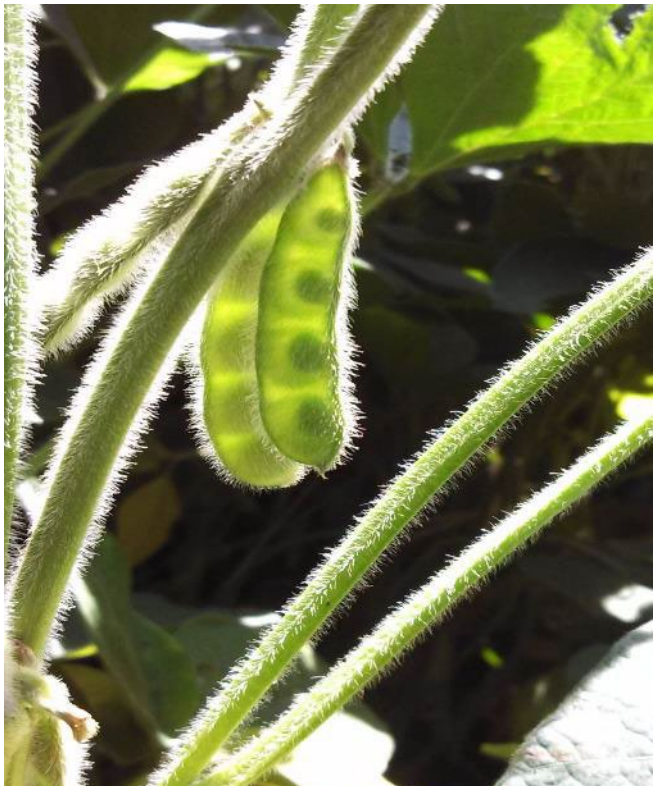
FUNDED BY THE ILLINOIS SOYBEAN ASSOCIATION CHECKOFF PROGRAM.

WEBINAR: Understanding Biologicals For Improved Soybean Management

Published On: July 7, 2021 | By Illinois Soybean Association | Categories: 4R-Nutrient Management, CONSERVATION PRACTICES

Crop Physiology

Strategy for Producing High Soybean Yields



- Early and rapid leaf area development
- Prolonged leaf area duration, pod set, and seed growth
- Prevent crop stress

Crop Physiology

Special Thanks to Illinois Soybean Association

For More Information:

Crop Physiology Laboratory

University of Illinois

http://cropphysiology.cropsci.illinois.edu

CEU CREDITS

Crop Physiology