ROI and Soybean Production

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Cropping Systems Agronomy
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NORTH CENTRAL SARE
Sustainable Agriculture Research & Education

MICHIGAN SOYBEAN COMMITTEE

NCSRP NORTH CENTRAL SOYBEAN RESEARCH PROGRAM

Project GREEEN

USDA NIFA

Soybean Yield Components

- Establish uniform plant stand (plants/acre)
- Set and retain more pods (pods/plant)
- Increase number of seeds/pod

Seeds/acre

- Maximize seed weight (seeds/lb.)

Seed weight

What can be done to **POSITIVELY** influence these yield components and **minimize Yield Limiting Factors at field-scale**

SCIENCE FOR SUCCESS

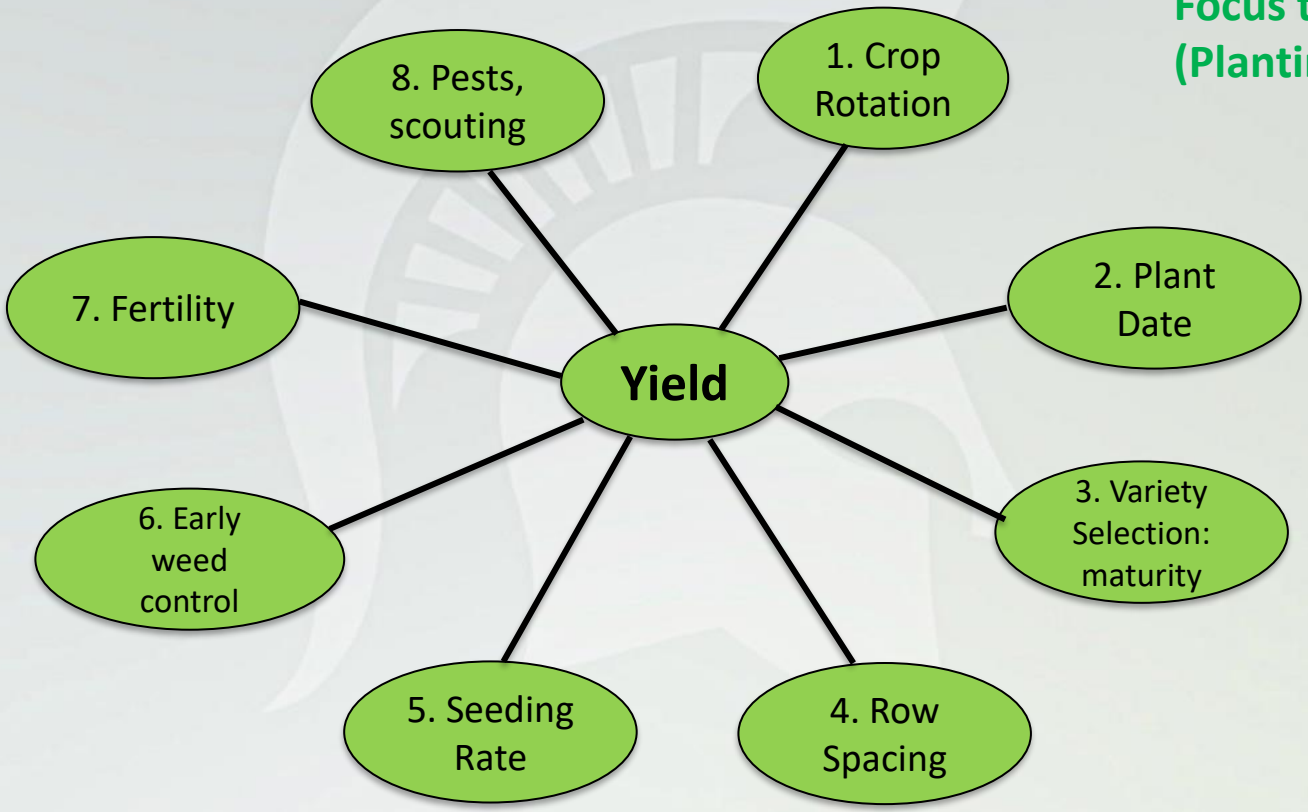
FUNDED BY THE SOYBEAN CHECKOFF

The Soybean Growth Cycle: Important Risks, Management and Misconceptions

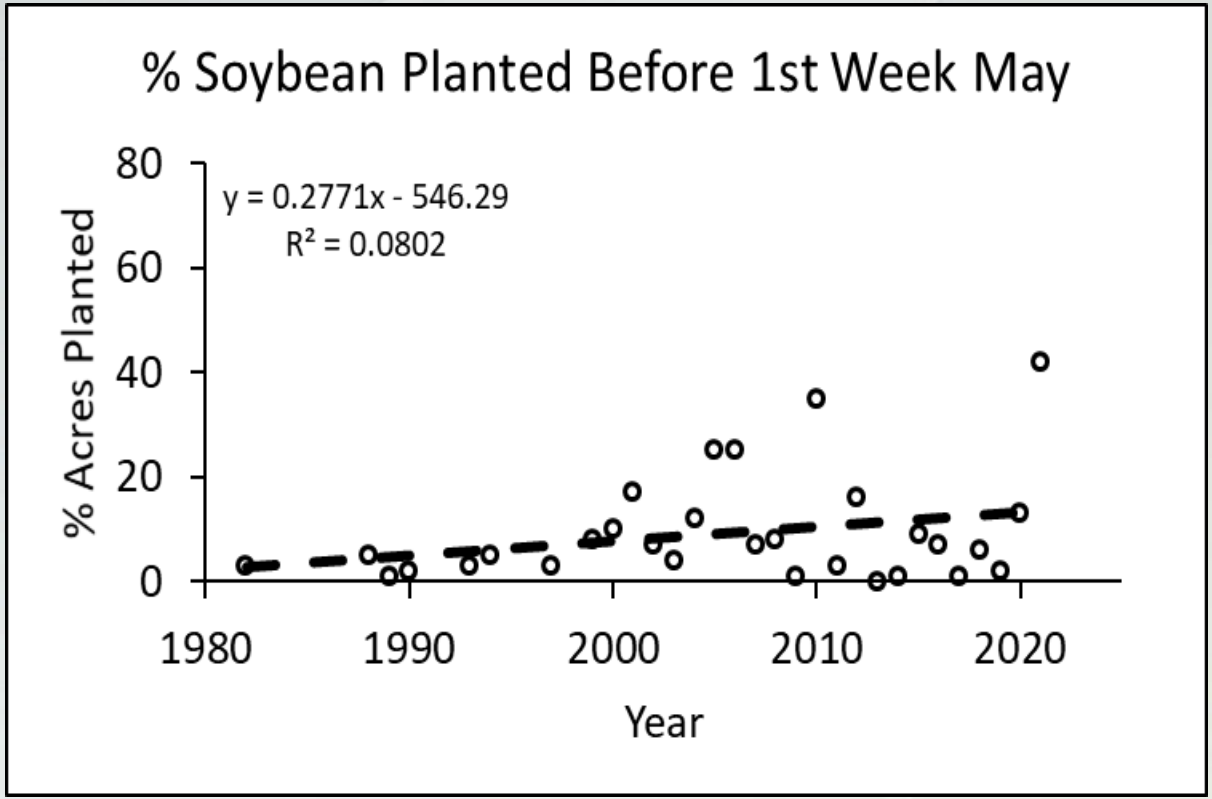
Publication will be available on our website soon

Managing Soybean for higher Yield/Profit

Focus today on #2-5 (Planting decisions)

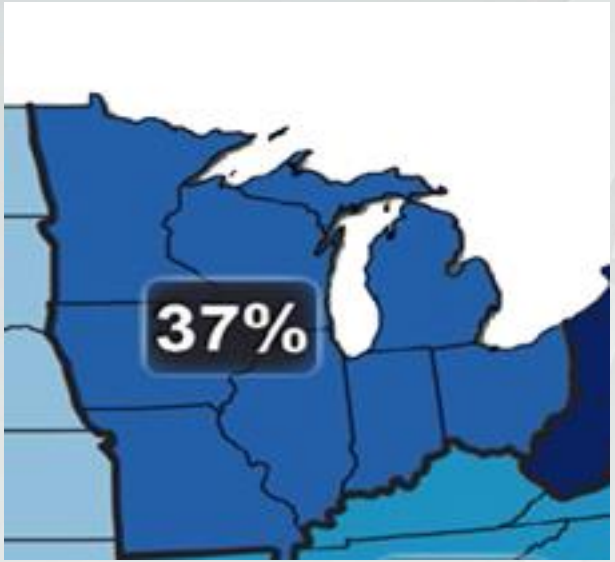


Planting Progress- Variability over years



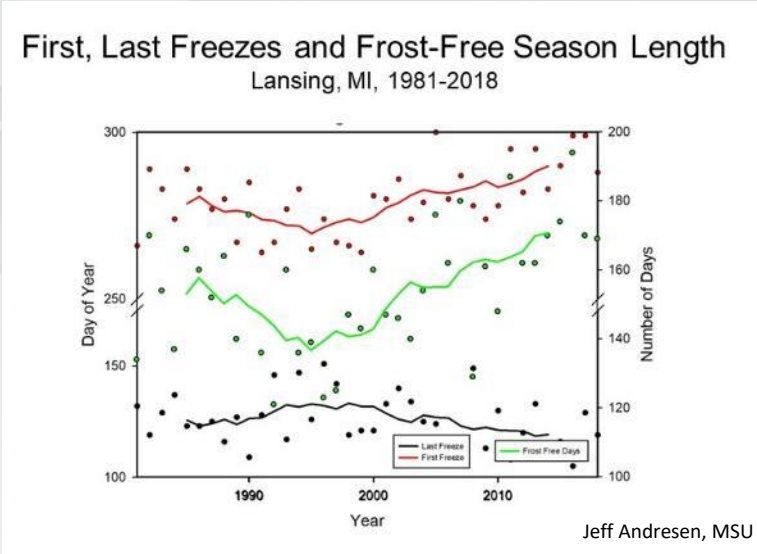
USDA NASS Date from 1982 – 2021, Week 18

Weather Trends: Wetter and Warmer



Increase in extreme precipitation
(during top 1% of severe storms)

GLISA, 2019

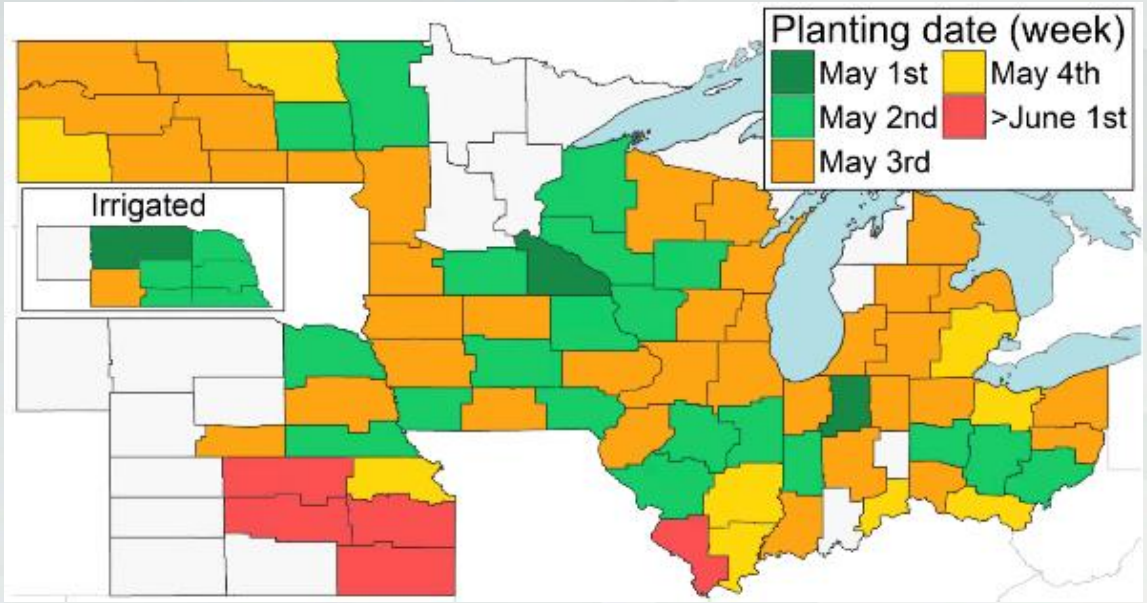


Jeff Andresen, MSU

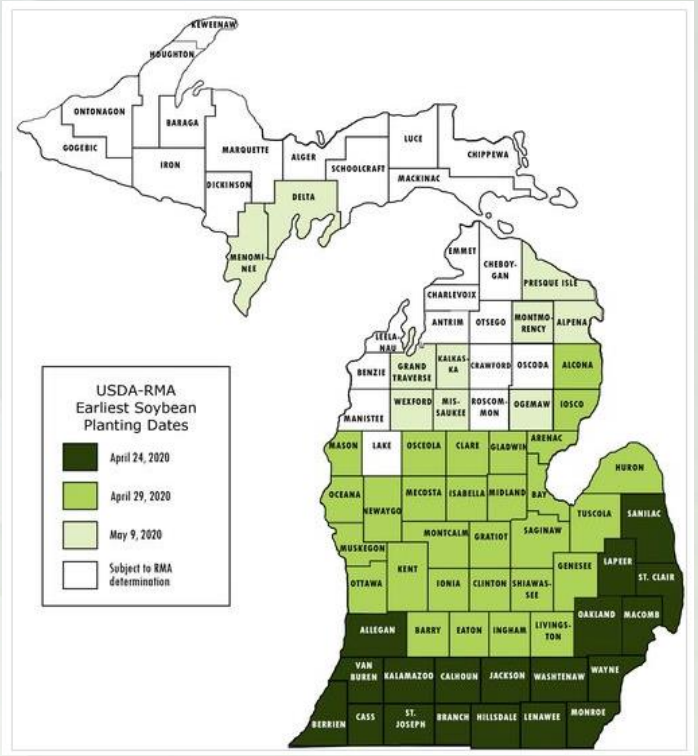
GLISA, 2019

Planting Time	Conditions
➢ **Early Season** (before early-May)	• Cool, wet soil- can lead to uneven stands • **Extended Growing Season**
➢ **Mid Season**	• Typically, adequate soil temp. and moisture
➢ **Late Season** (June)	• Lack of soil moisture • **Restricted Growing Season**

Soybean Planting Date

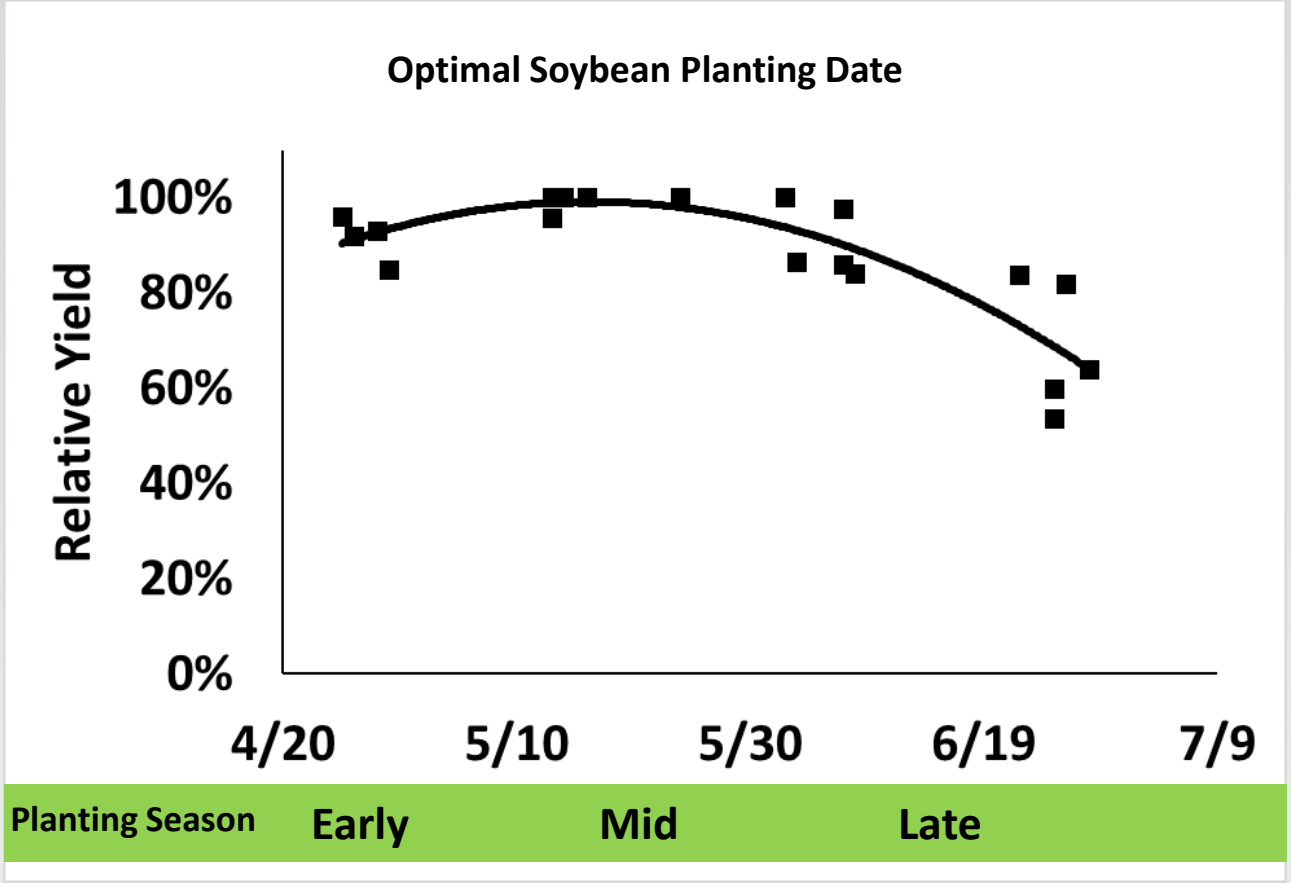


Grassini, P., & Conley, S. (2019). Benchmarking Soybean Production Systems in the North-Central USA. **2014-2017 data**



Risk Management Agency's (RMA) earliest planting dates for soybeans in Michigan

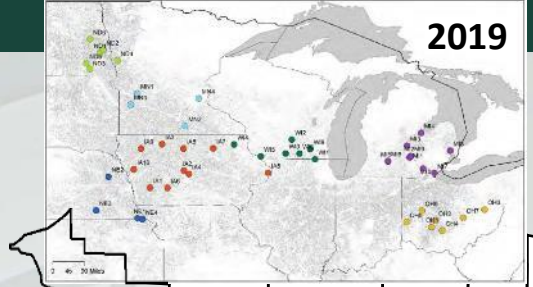
Planting Time Impacts Yield in Michigan

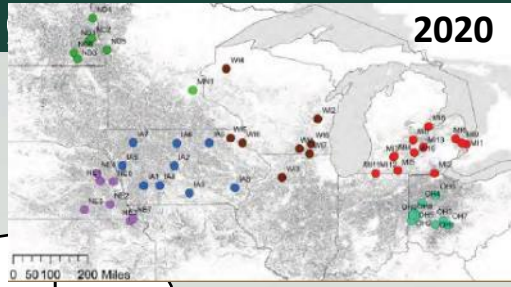


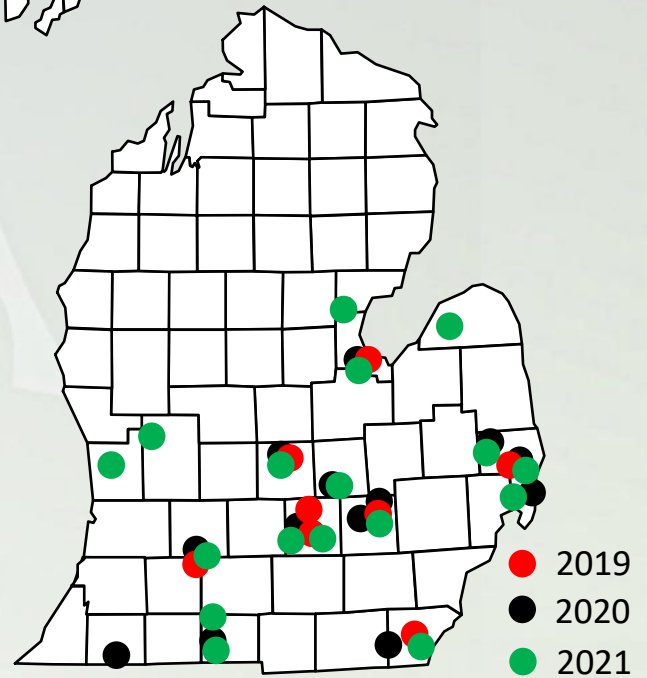
Data from 2018-2021 across multiple trials

On-farm Soybean Trials

- Conducted 2019 - 2021
- 2 plant dates (**early, typical**), ~3 weeks apart, in strips
  - Fungicide/insecticide at R3 in few fields in 2019 in early planting
- Yield from each strip
- Seed quality samples

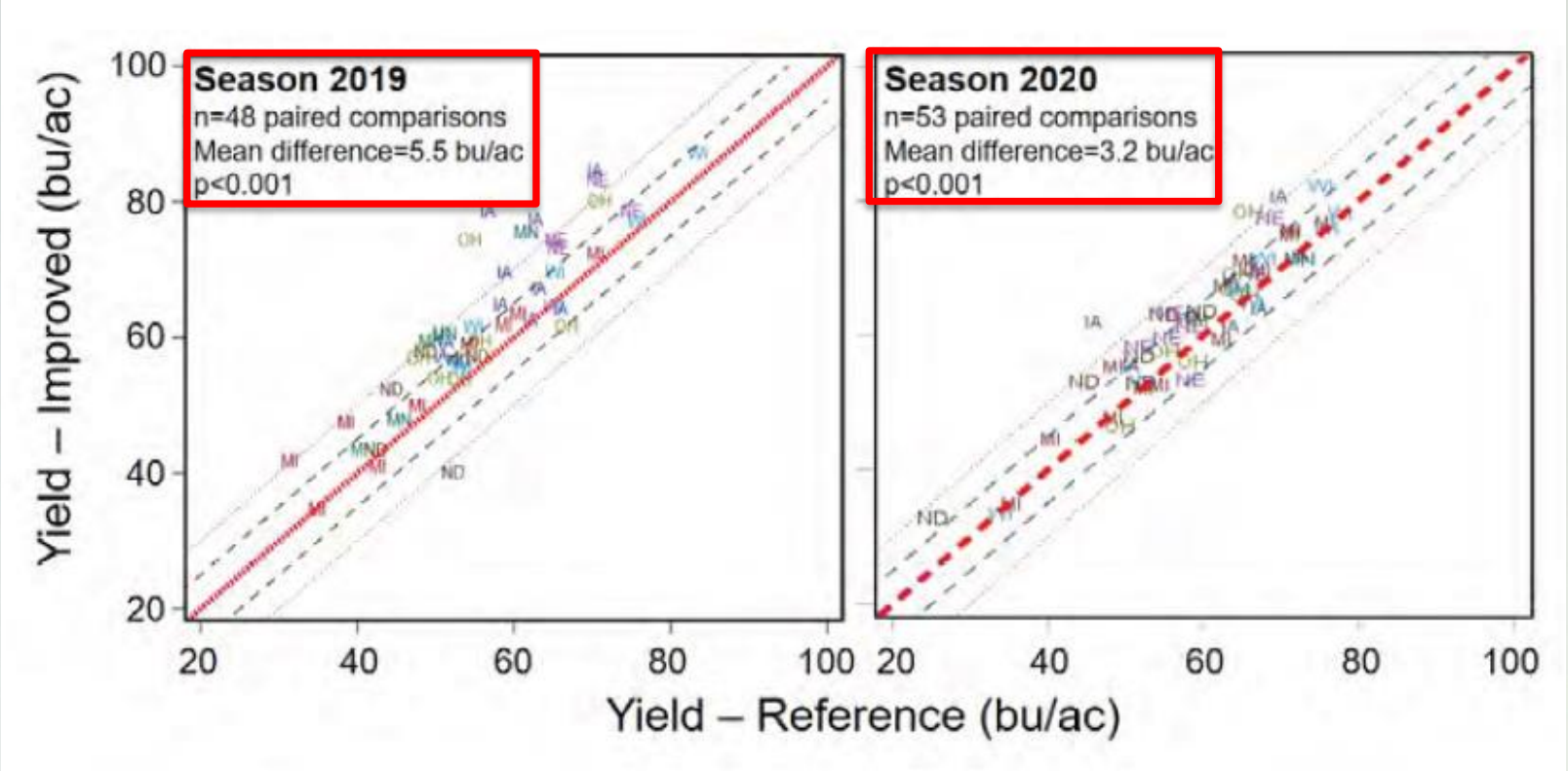






NCSRP NORTH CENTRAL SOYBEAN RESEARCH PROGRAM

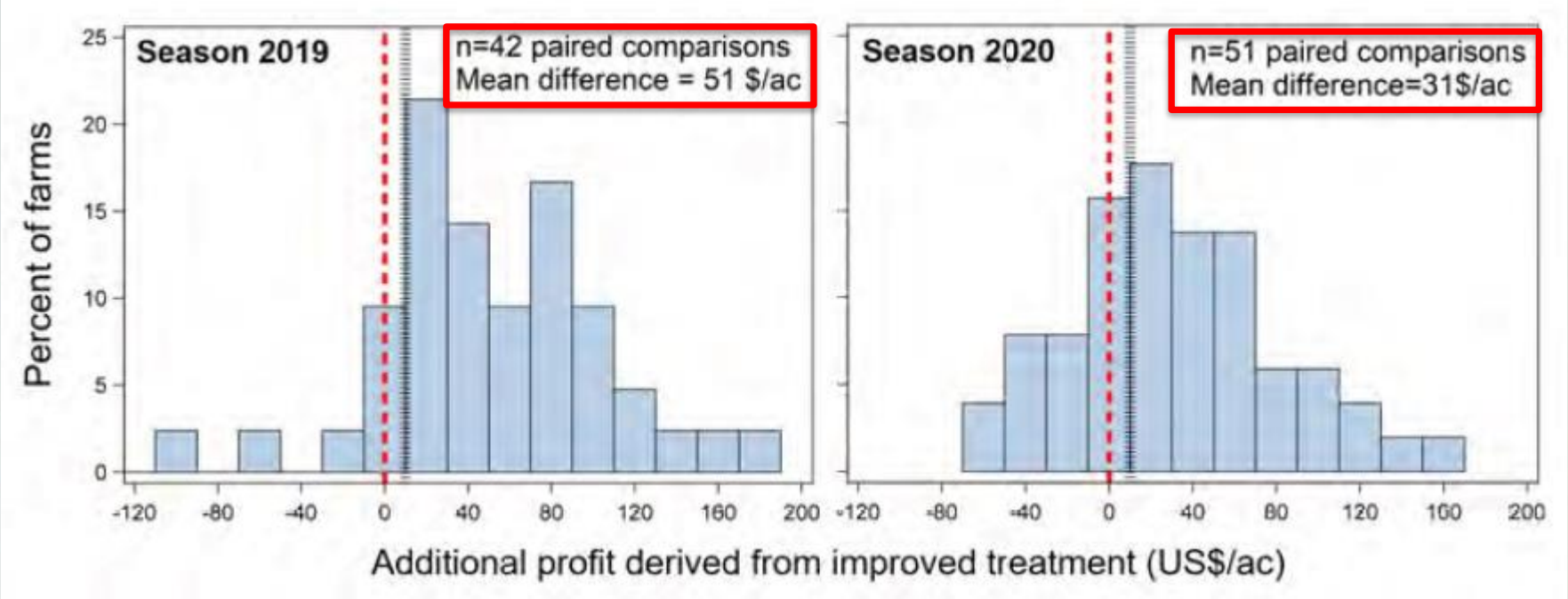
Yield: 2019-20 data across states



Reference is Typical planting time

Improved is Early Planting + other management (e.g., fung./insect. spray, late-MG, lower seed rate)

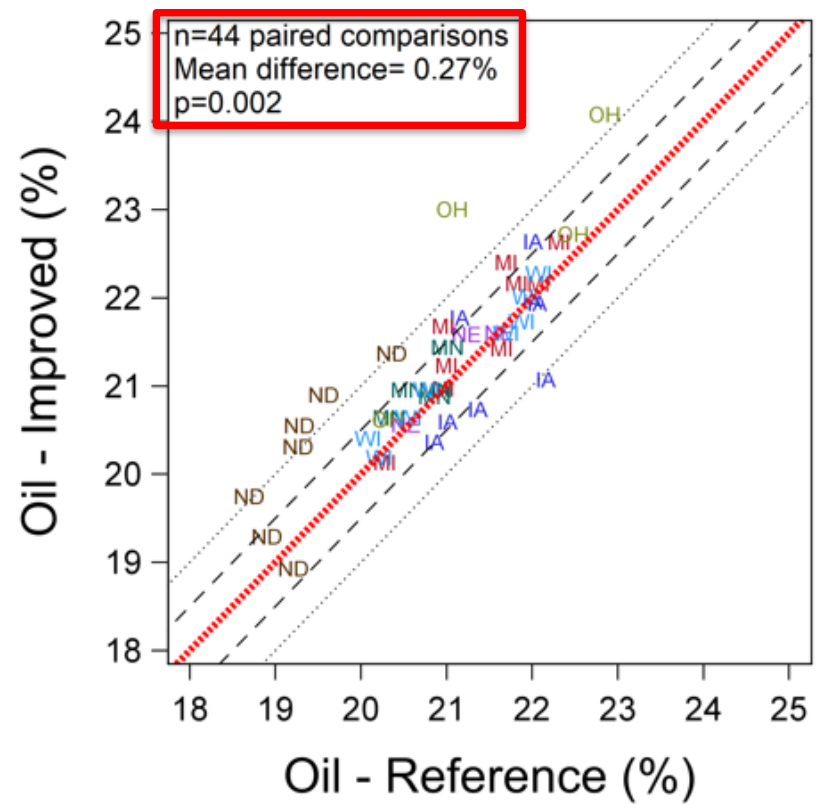
Yield: 2019-20 data across states

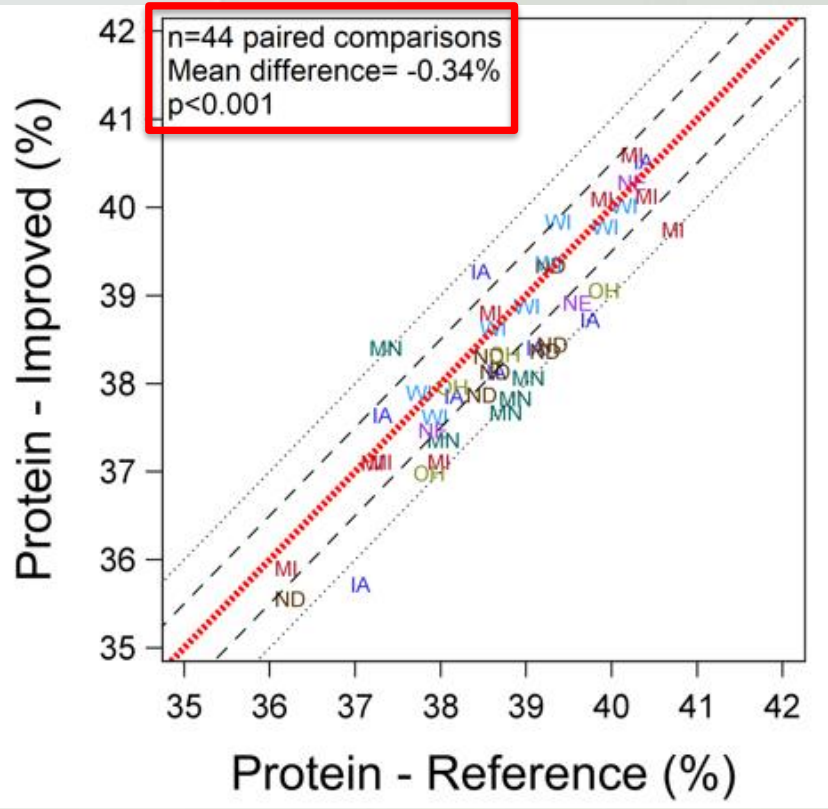


Improved is Early Planting (+ fung./insect. spray in few fields)
Reference is Typical planting

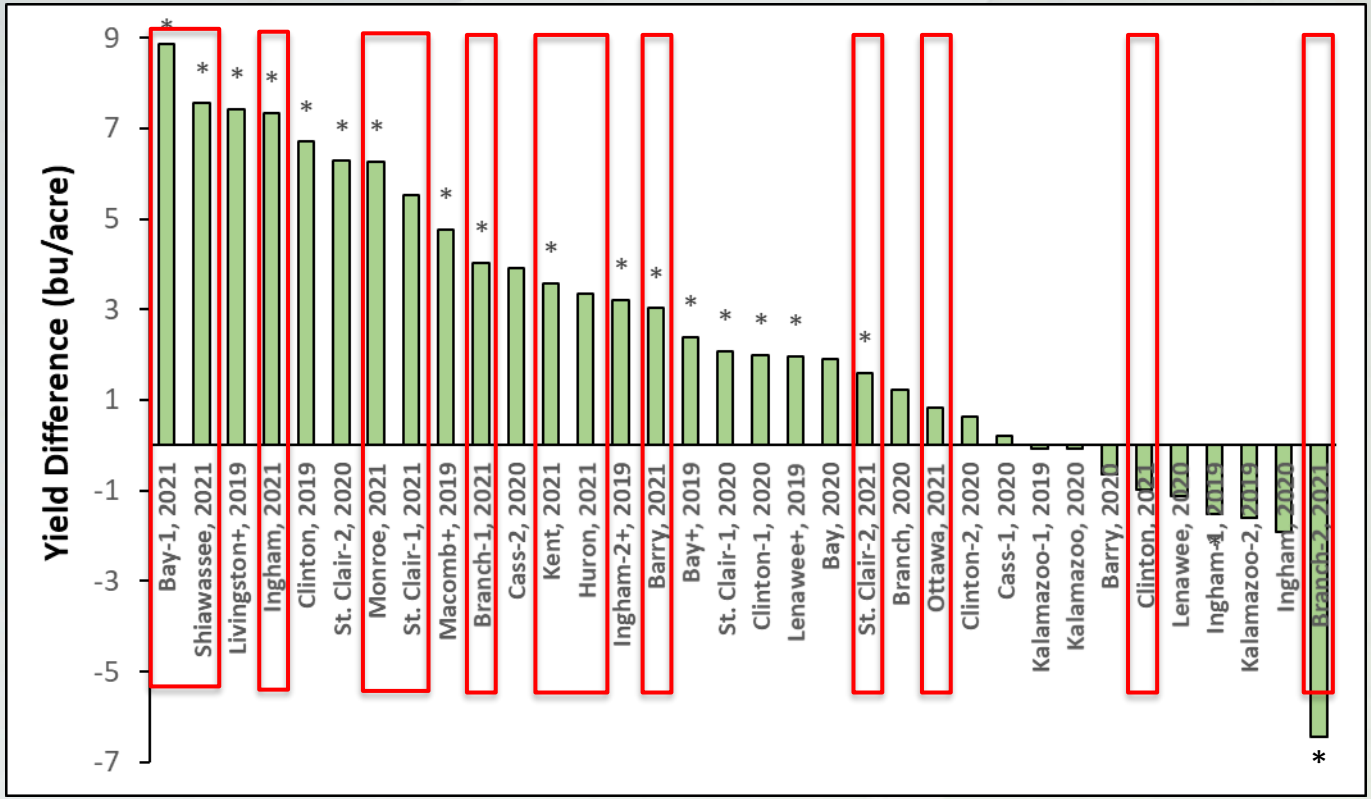
- Soybean price: $11/bu in 2020 ($9/bu in 2019)
- Treated seed cost: $60/140k seeds
- Non-treated seed cost: $54/140k seeds
- Foliar insecticide (product only) = $3/ac
- Foliar fungicide (product only) = $10/ac
- Foliar fungicide and/or insecticide application (excluding product cost): $6.50/ac

Seed Quality- 2019





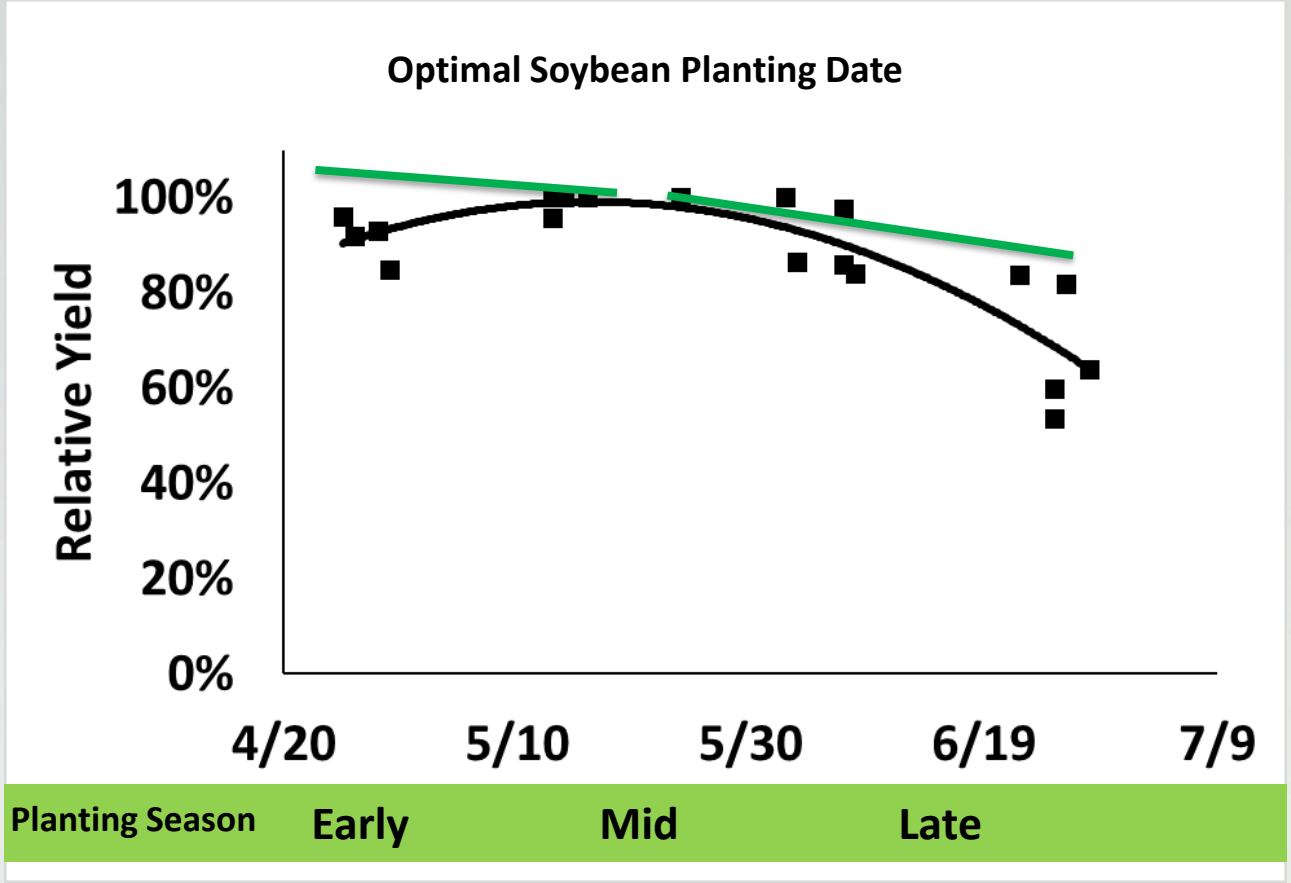
Yield: 2019 - 2021 Michigan Data



Yield diff. = Early planting- Normal planting time

* Denotes significant differences at P <0.10
\+ denotes fung./insect. spray at R3 in early planting in 2019

Planting Time: change other management?

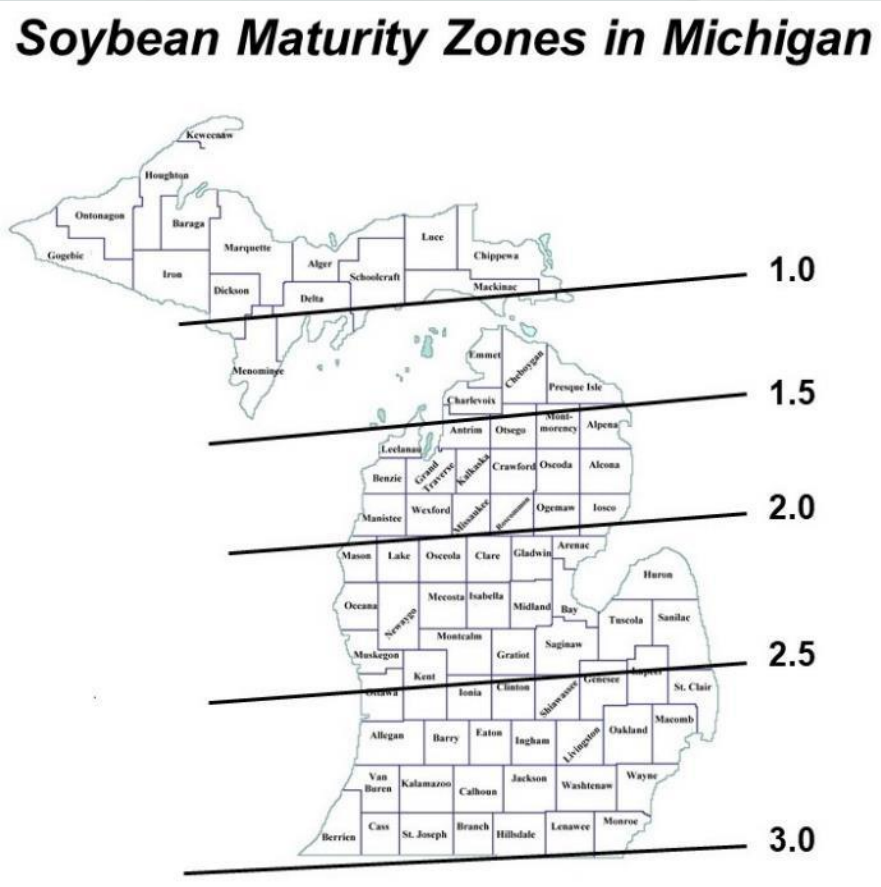


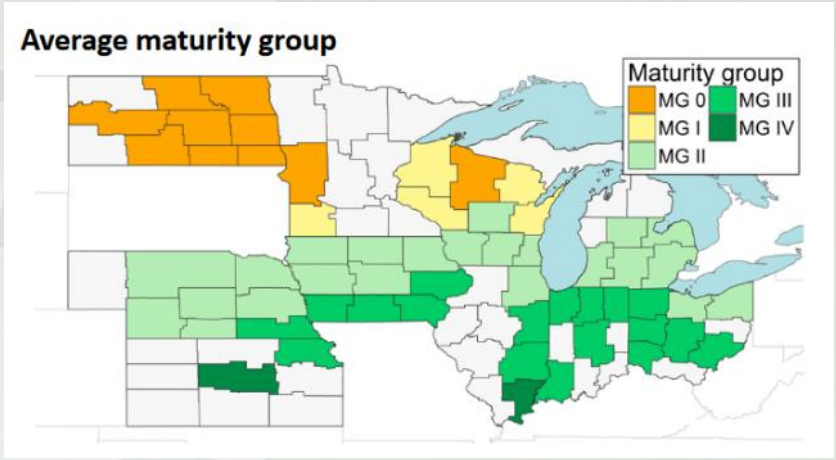
How to Improve Yield Potential

OR Minimize Input Cost

=Increased Profit

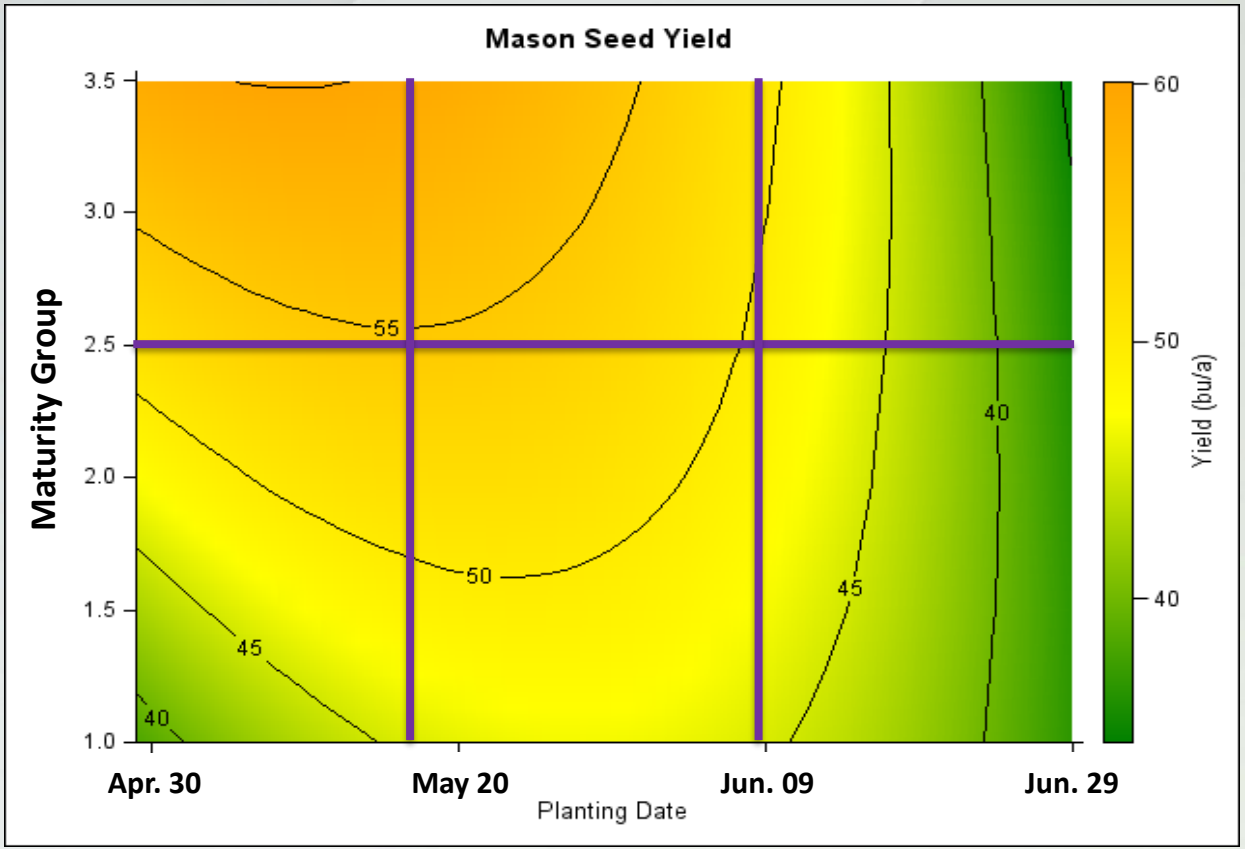
Optimal Maturity Selection: Role of planting date?



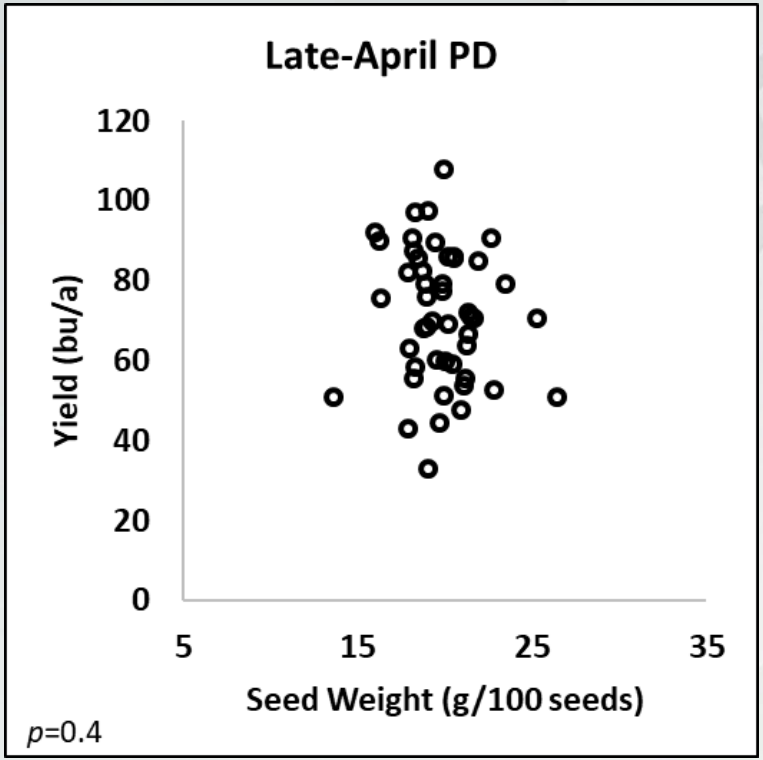


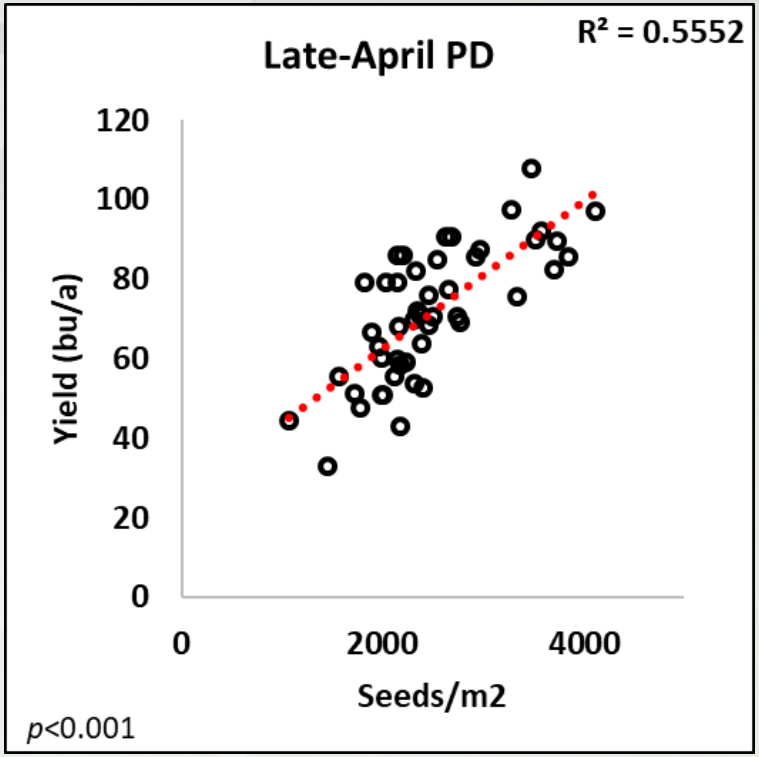
- **Based on one planting date (mid-season)**
- **Does NOT account for early/late planting**

Optimal Maturity Selection: by planting date

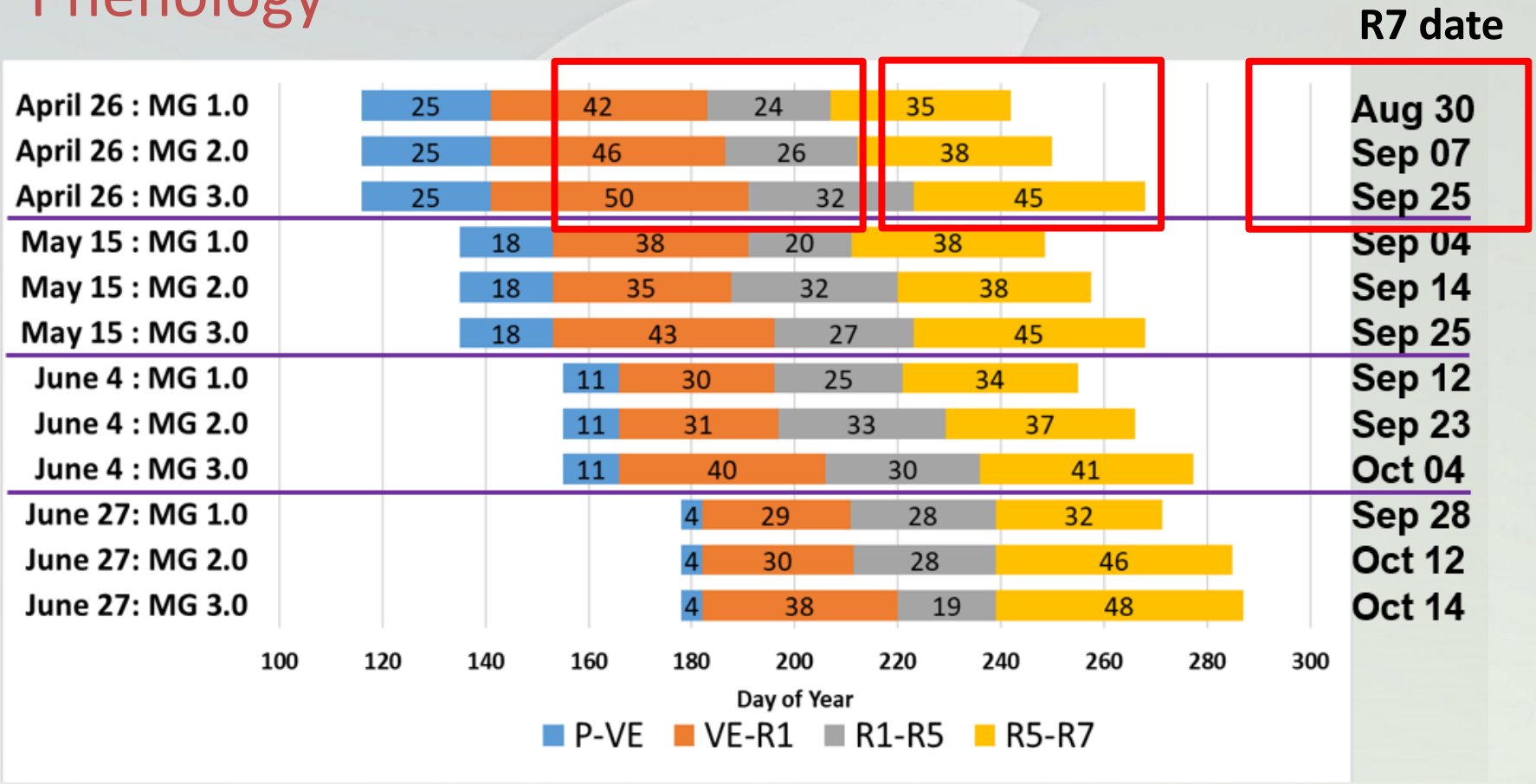


Yield Components





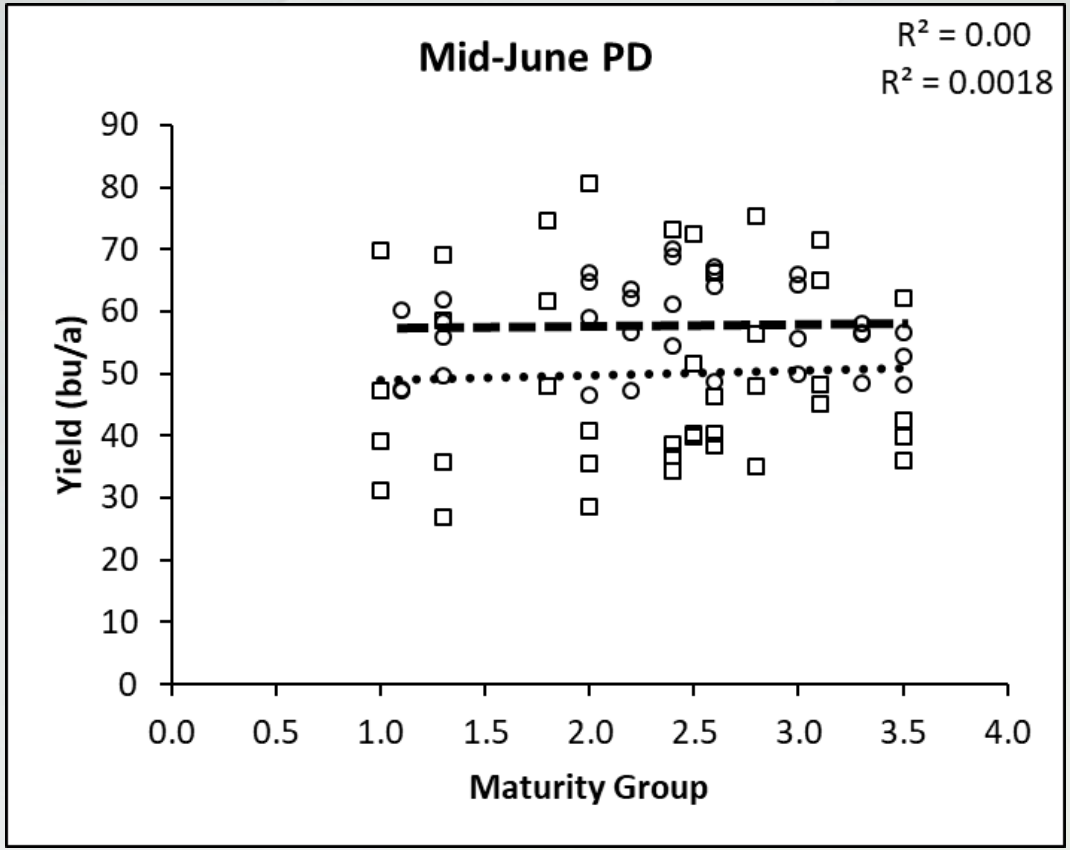
Phenology


R7 date
April 26 : MG 1.0
25
42
24
35
Aug 30
April 26 : MG 2.0
25
46
26
38
Sep 07
April 26 : MG 3.0
25
50
32
45
Sep 25
May 15 : MG 1.0
18
38
20
38
Sep 04
May 15 : MG 2.0
18
35
32
38
Sep 14
May 15 : MG 3.0
18
43
27
45
Sep 25
June 4 : MG 1.0
11
30
25
34
Sep 12
June 4 : MG 2.0
11
31
33
37
Sep 23
June 4 : MG 3.0
11
40
30
41
Oct 04
June 27: MG 1.0
4
29
28
32
Sep 28
June 27: MG 2.0
4
30
28
46
Oct 12
June 27: MG 3.0
4
38
19
48
Oct 14
100
120
140
160
180
200
220
240
260
280
300
Day of Year
P-VE
VE-R1
R1-R5
R5-R7

Physiology of Yield Increase

- Adjust planting date and soybean maturity in order to:
  - Harvest more light prior to the onset of reproductive development
  - Maximize number of nodes/pods/seed per acre, longer reproductive phase
  - Minimize the impact of periods of extreme heat and/or moisture stress during flowering and pod set

2020 & 2021 Results- late planted soybean



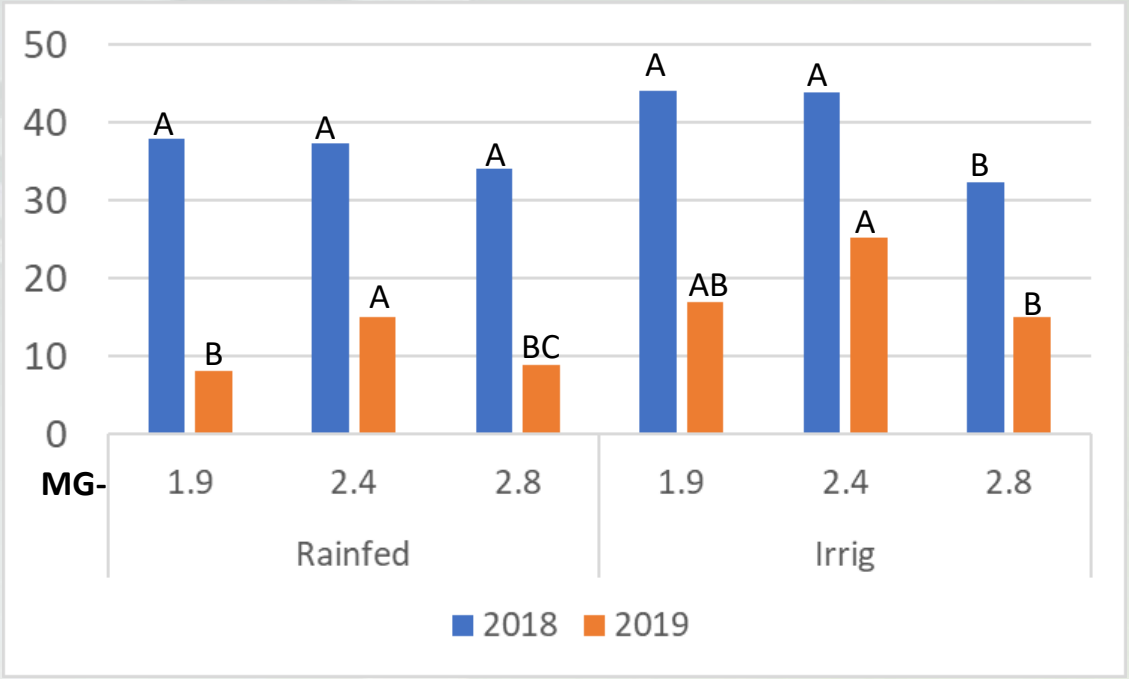
Maturity/Quality concerns

2020- 1st killing Frost on Oct. 16

2021- 1st killing Frost on Nov. 3

Optimal Maturity Selection: Double Crop systems

- Location: KBS, 2018-19
- Planted 1st week of July after winter barley harvest
- Seed rate- 140 k and 200k per acre



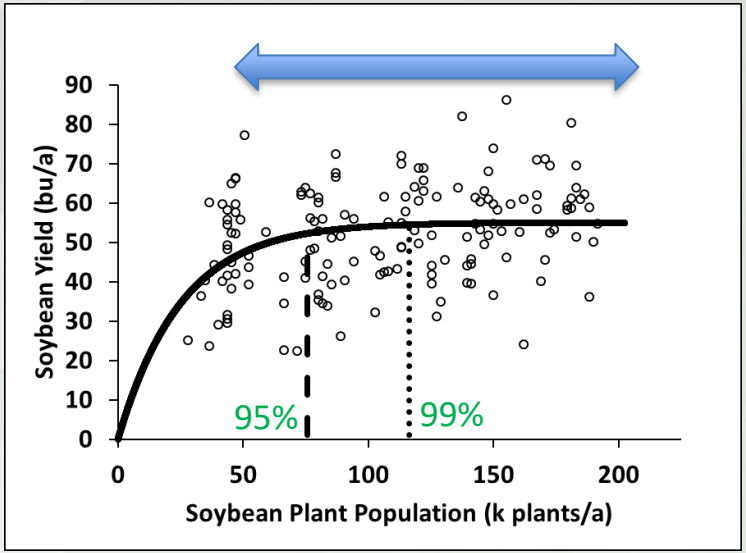
Letters show comparison among 3 variety maturities within each year and water level

Plant date/ Maturity selection Summary

- Combine early planting with other management for higher yields
- Optimal maturity varies with time of planting
- For mid-season planting, mid- and early- maturity varieties have competitive yield, and low moisture
- Benefits of early-season planting can be expanded upon with the use of late-maturity variety
- Select early-maturity variety to minimize yield loss/ moisture issues in delayed/replant situations
- **Portfolio approach** in maturity selection
  - Plant late-maturity variety first (30-40% acres)
  - Plant mid- and early-maturity varieties in sequence to “stack” flowering/pod set/fill
  - Plant ~20-30% acres to each of mid- and early-maturity variety

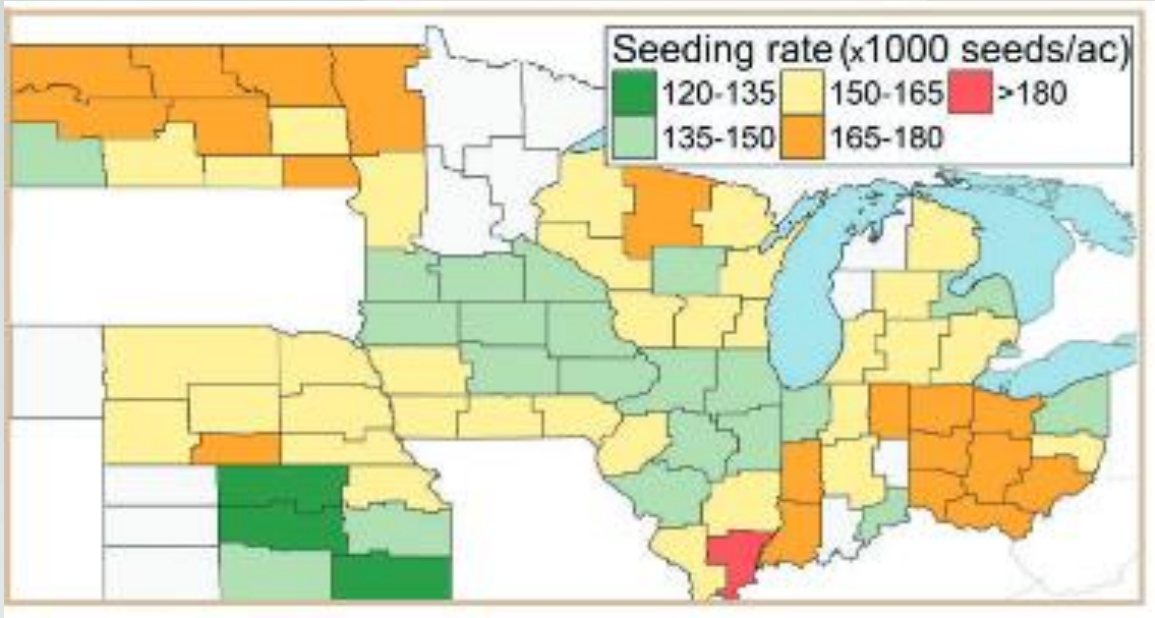
Soybean Seeding Rate

50,000 Seeds/A	90,000 Seeds/A	130,000 Seeds/A	170,000 Seeds/A	210,000 Seeds/A



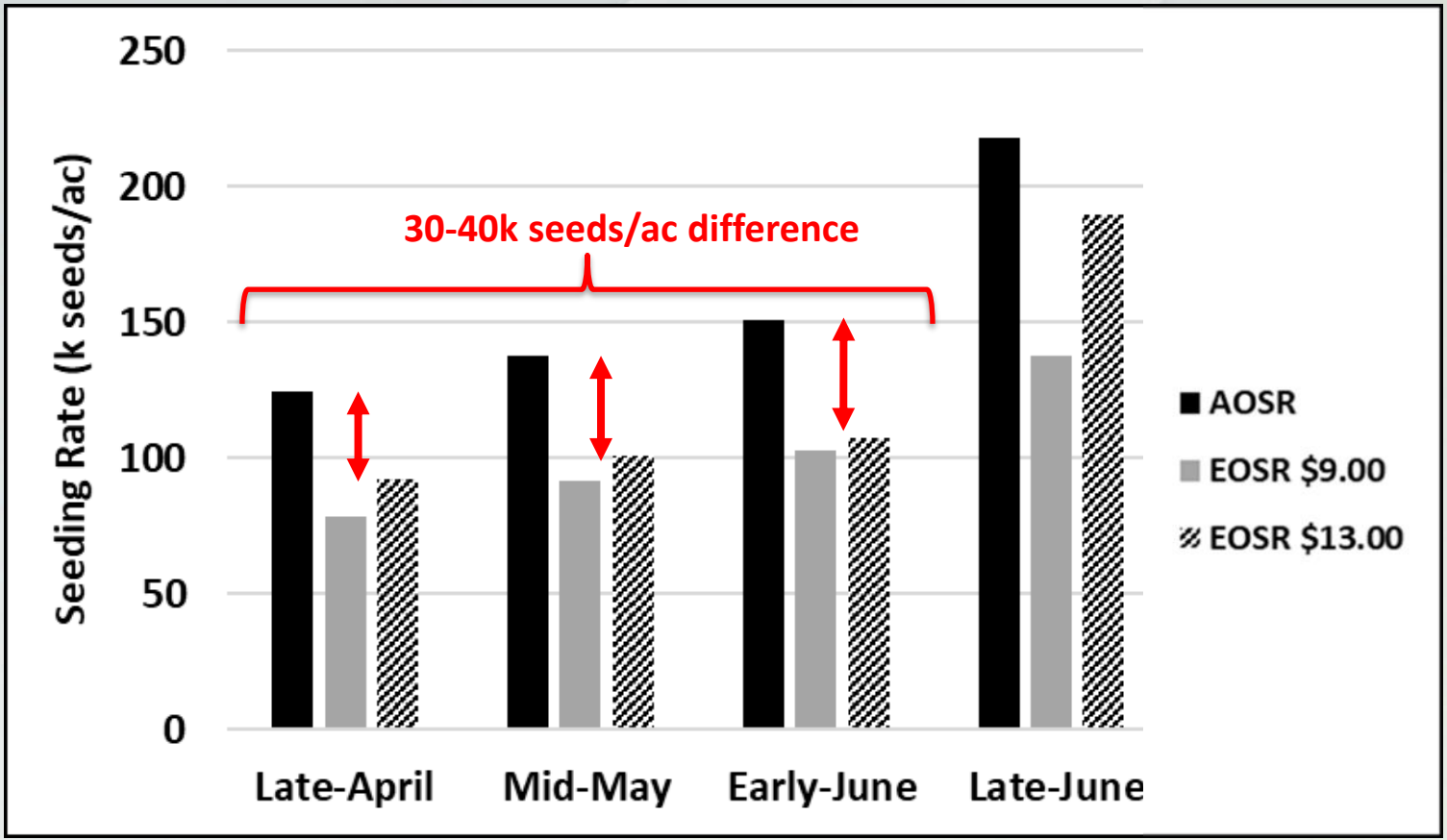
Seed rate: ~20% higher

Seeding Rate



Grassini, P., & Conley, S. (2019), based on 2014-17 farmer survey

Soybean Seeding Rate- Agronomic vs Economic Optimal

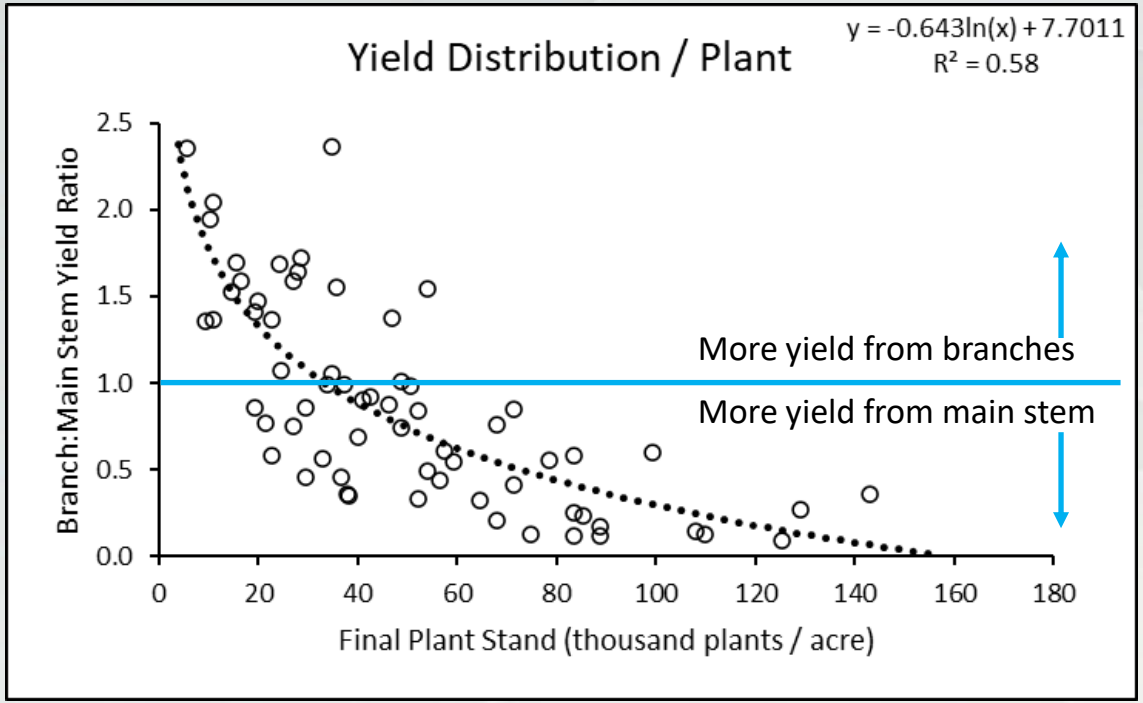


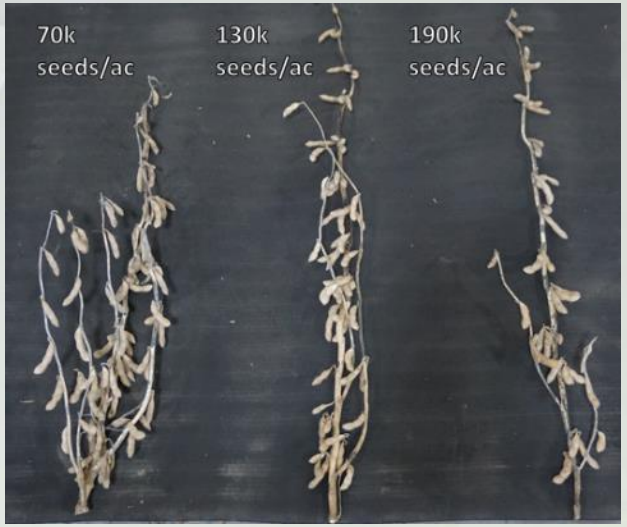
Agronomic Optimal Seed Rate

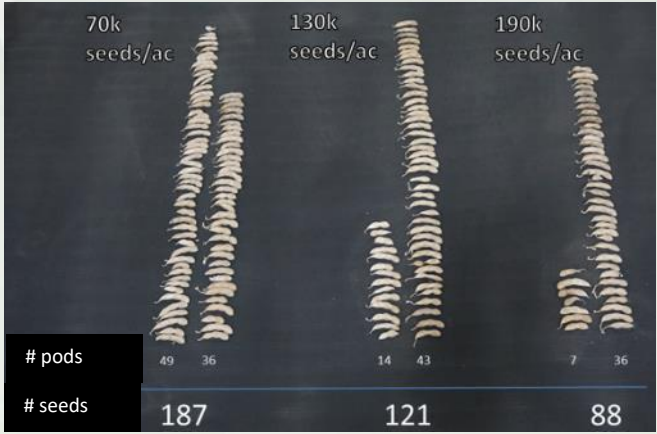
Economic Optimal Seed Rate

15-inch rows
4 site-years data

Seeding Rate- Plant architecture



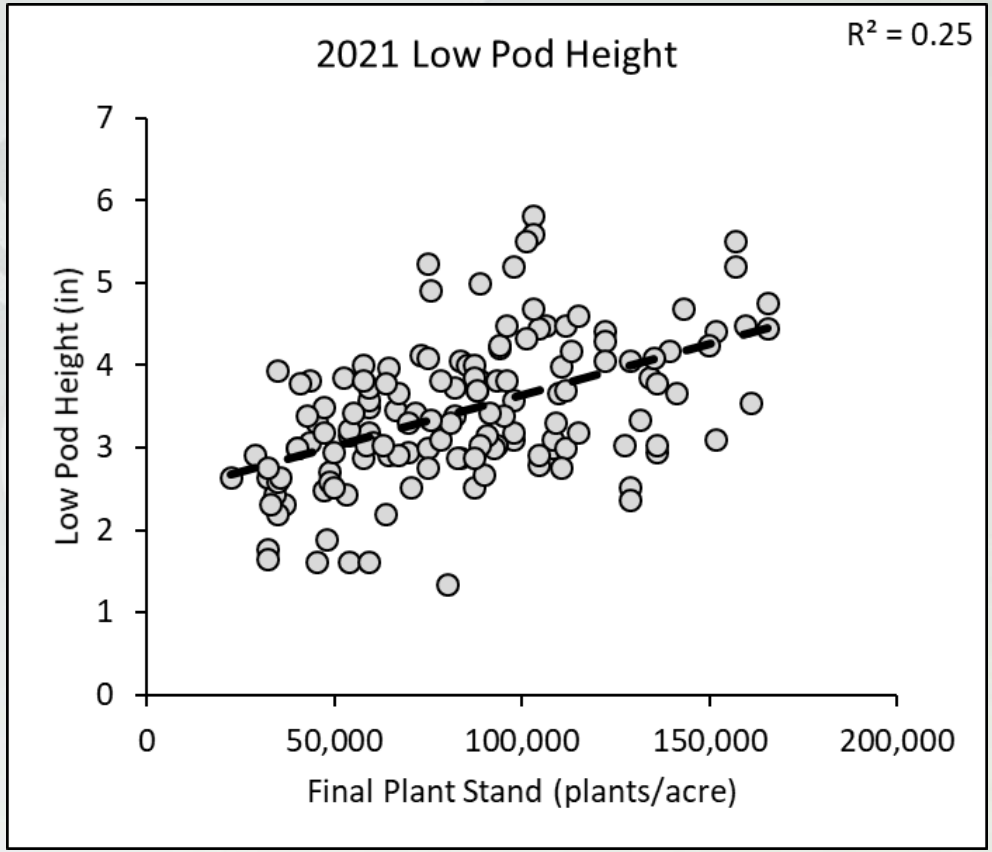




Seeding Rate- Plant architecture

Low Seed Rate

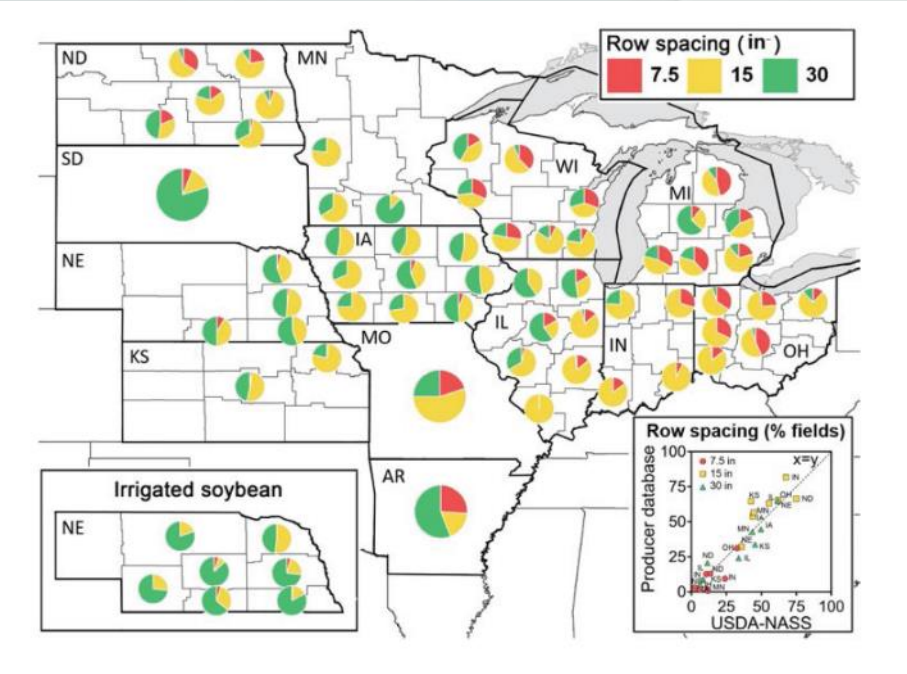
High Seed Rate



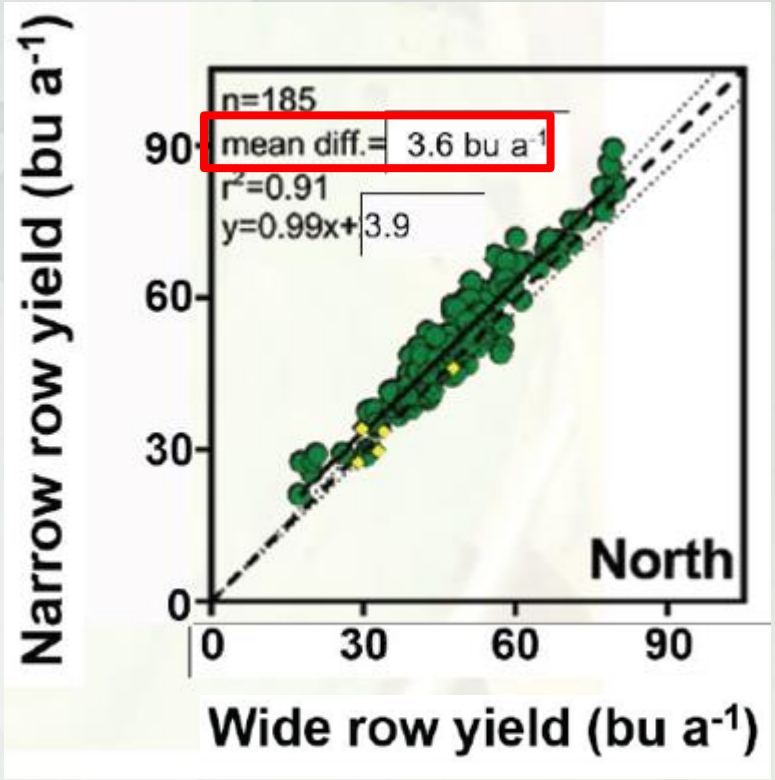
Seeding Rate Summary

- For max yield: final plant stand of 100-120,000/ac for May planting, 120-150,000 plants/ac for June planting (~20% higher for seeding rate)
- Economic optimum rates are lower (30-40k) than agronomic optimum rates
- Lower seeding rate in high yielding areas/fields, higher rate in low yielding areas
- Higher seeding rate for northern locations, early-maturity varieties
- Early planted uniform stand of >50k/ac can produce high yield, plant into existing stand below that stand rather than replanting
- Stand count is important for evaluating yield potential

Row Spacing



2014-17 farmer survey data

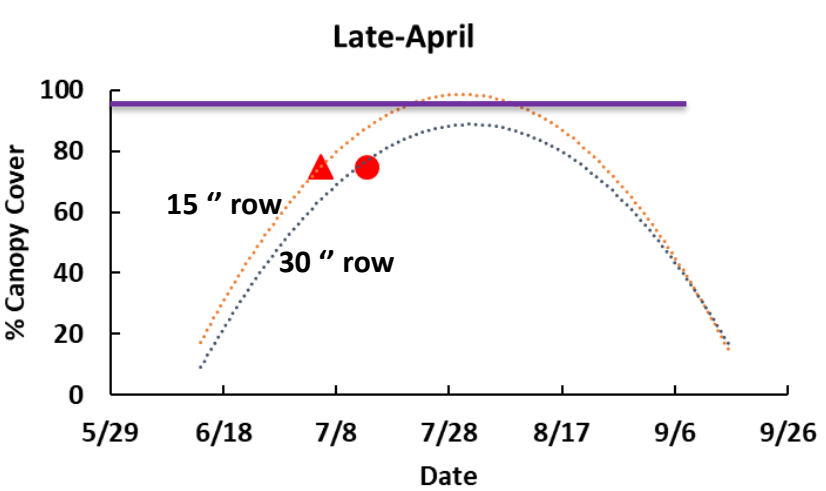


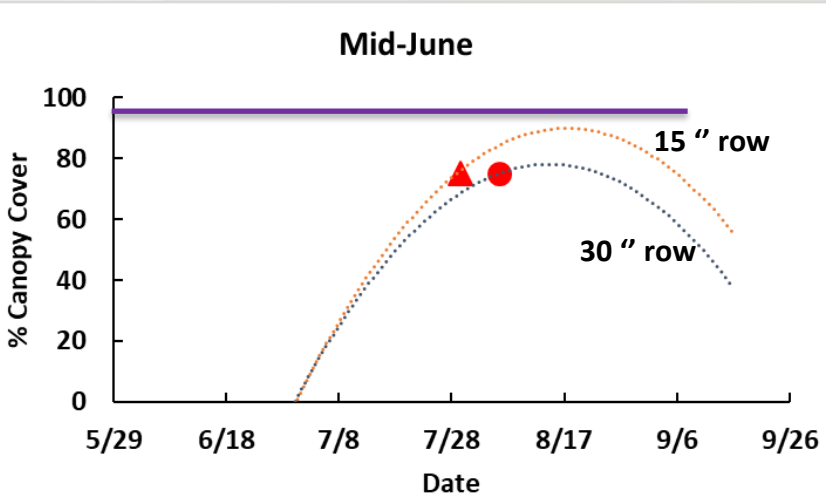
Andrade et al., 2019

Soybean Row Spacing

30’’ spacing

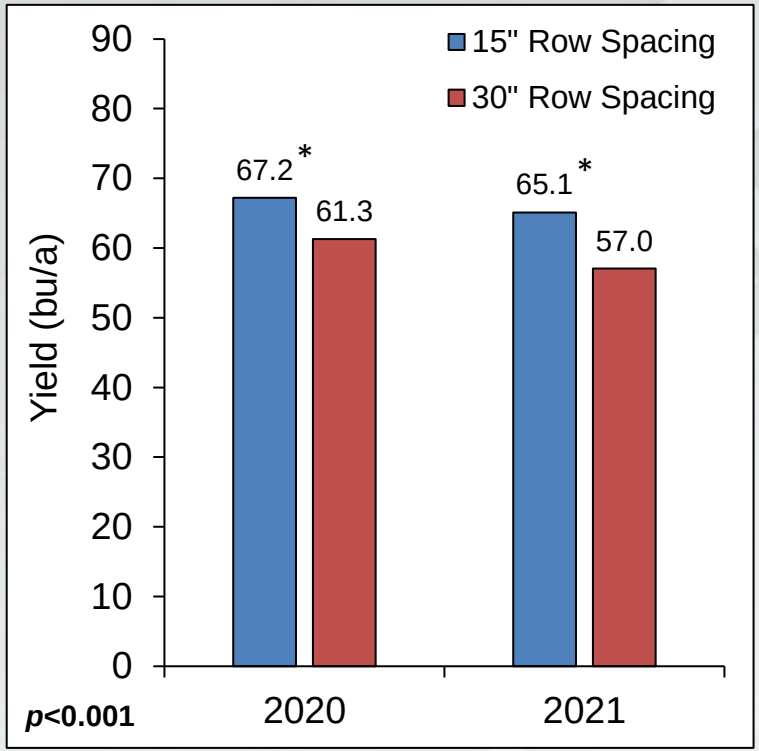
15’’ spacing

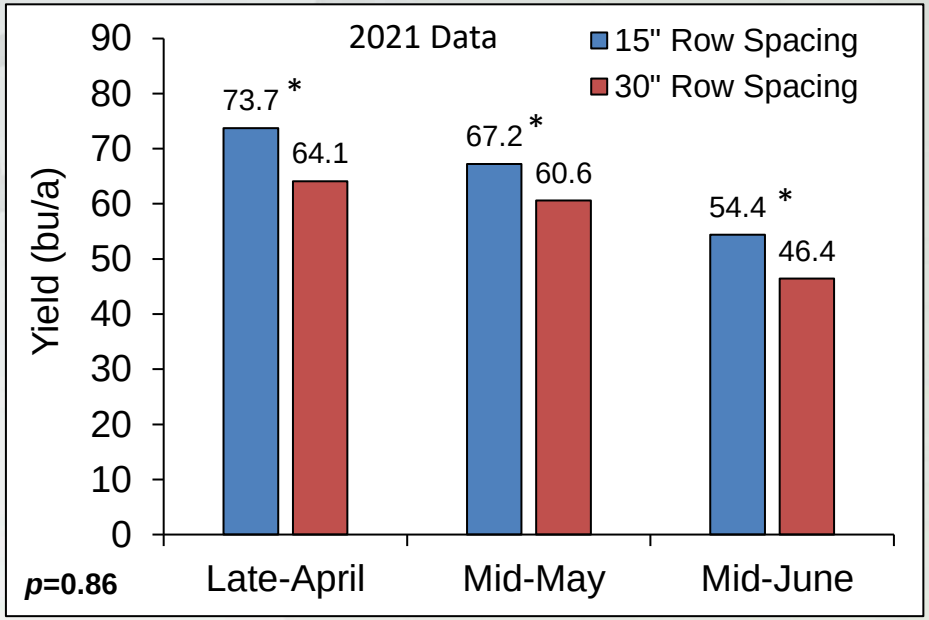




* Denotes significant differences at P <0.10

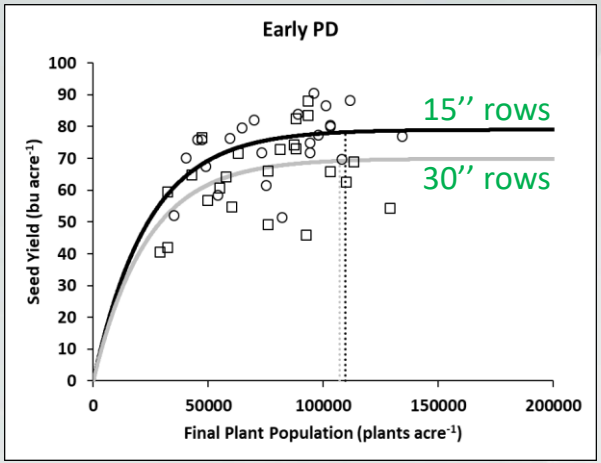
Soybean Row Spacing

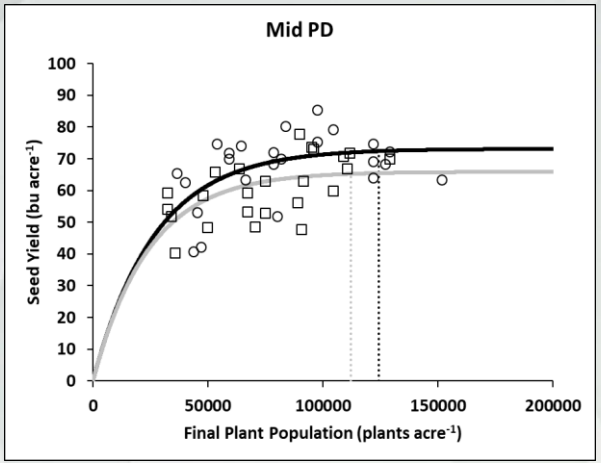


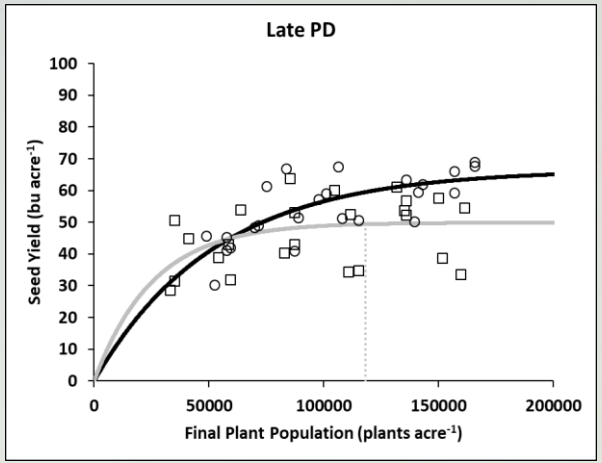


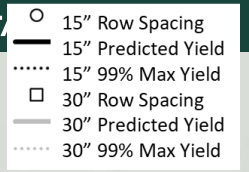
- Optimal Seeding rate did not differ between the two row spacings

Soybean Row Spacing: seeding rate responses









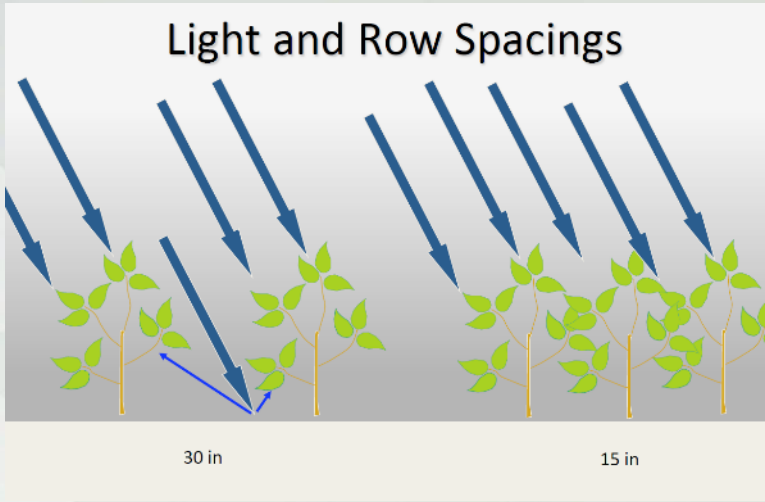
- Optimal Seeding rate did not differ between the two row spacings
- Economic optimal seeding rate, across both row spacings
  - Early PD – 86,890 plants/acre
  - Mid PD – 85,281 plants/acre
  - Late PD – 118,081 plants/acre

Row Spacing Summary

- **Narrow rows**: faster canopy closure, >95% light interception, moisture conservation, weed control

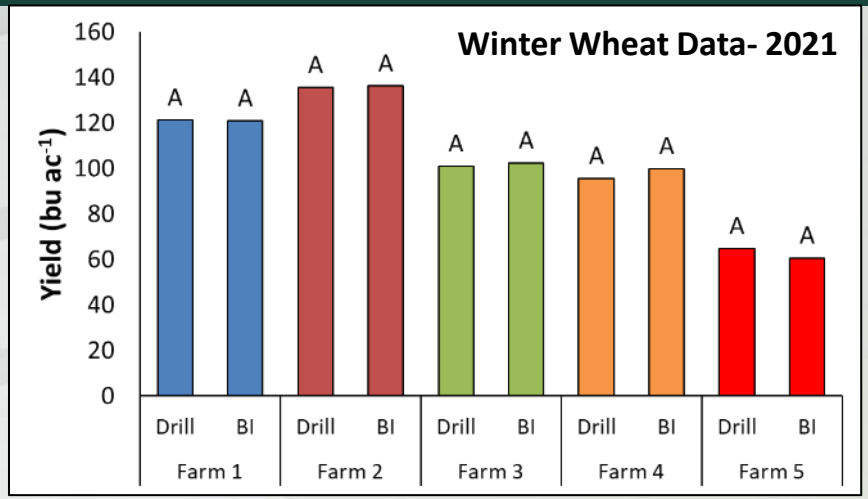
- **Yield benefit** under narrow rows: Limited time for vegetative growth before flowering
  - Northern production regions
  - Delayed planting/ Double crop
  - Early-maturing varieties

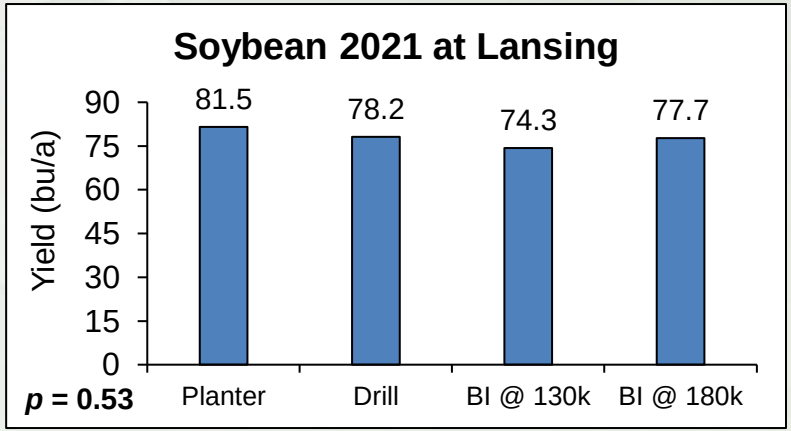
- **Yield loss**: Disease pressure- white mold



Planting Method

Broadcast Incorporation (BI)

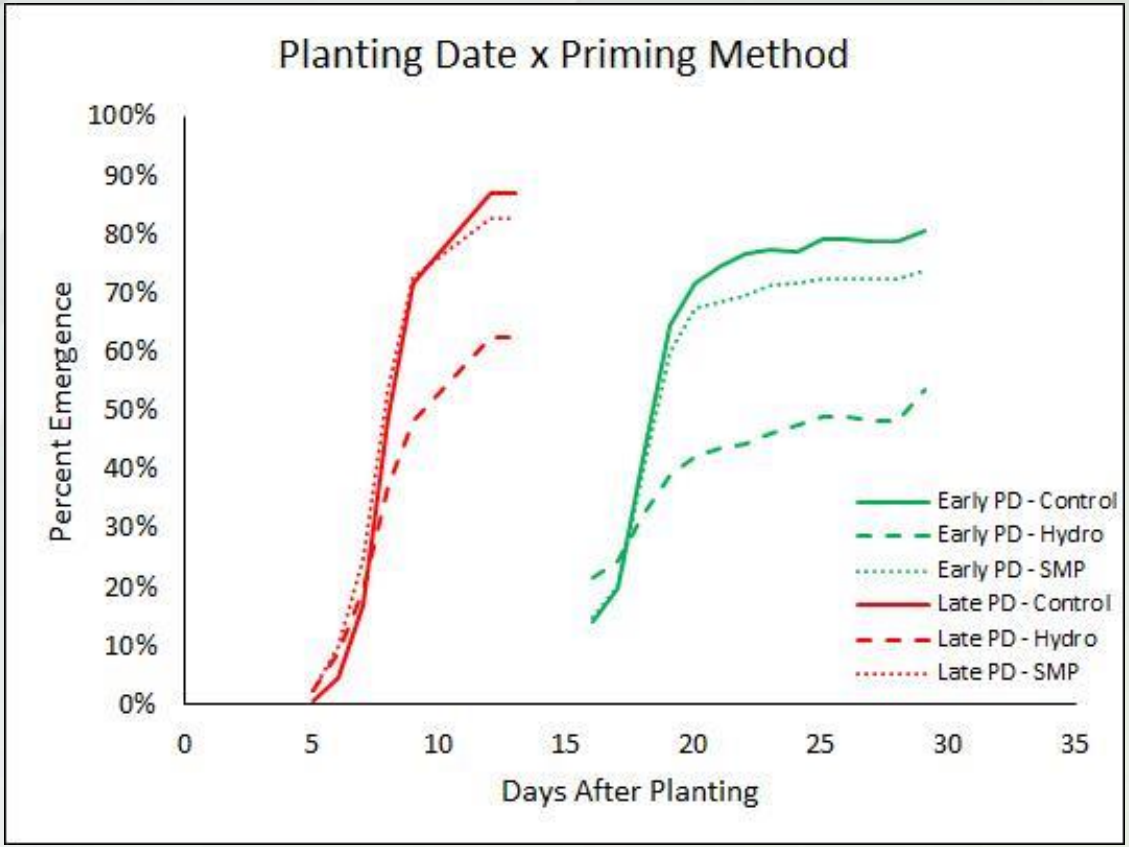




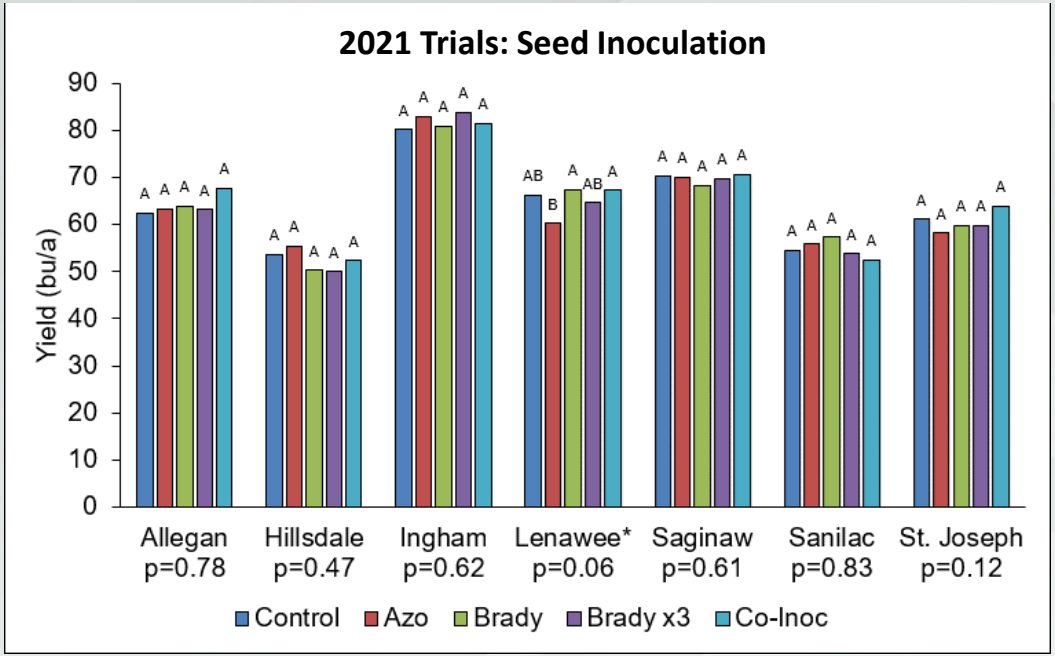
Soybean Seed Priming

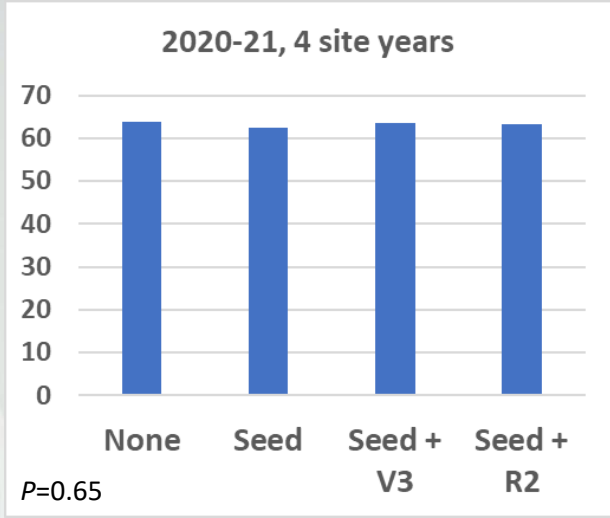
Hydropriming

Solid Matrix Priming



Inoculation

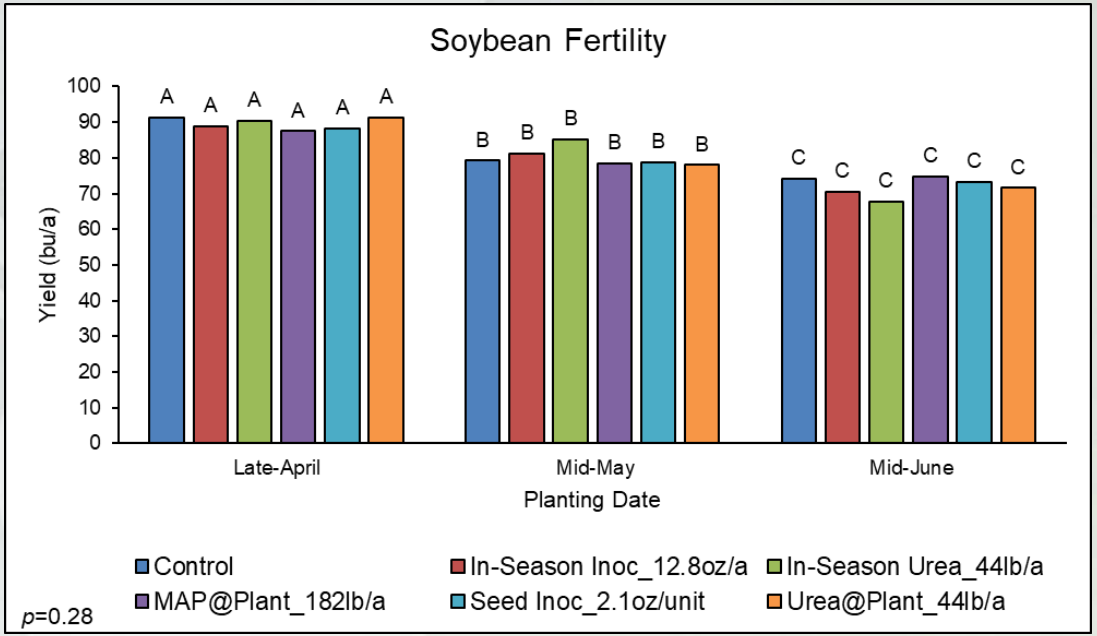




- No response to rhizobia inoculation in fields with soybean history
- Co-inoculation with Azospirillum didn't improve yield
- In-season application (V3 or R2) had no impact on yield

Fertility- 2021 data

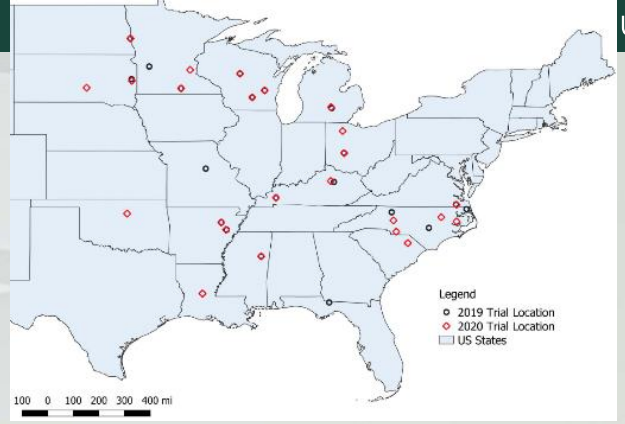
- Adequate P and K soil test levels at study site
- No interaction between plant date and fertility treatments
- Fertility (at-plant or in-season) and inoculation had no impact on yield
- Effect of plant date was significant

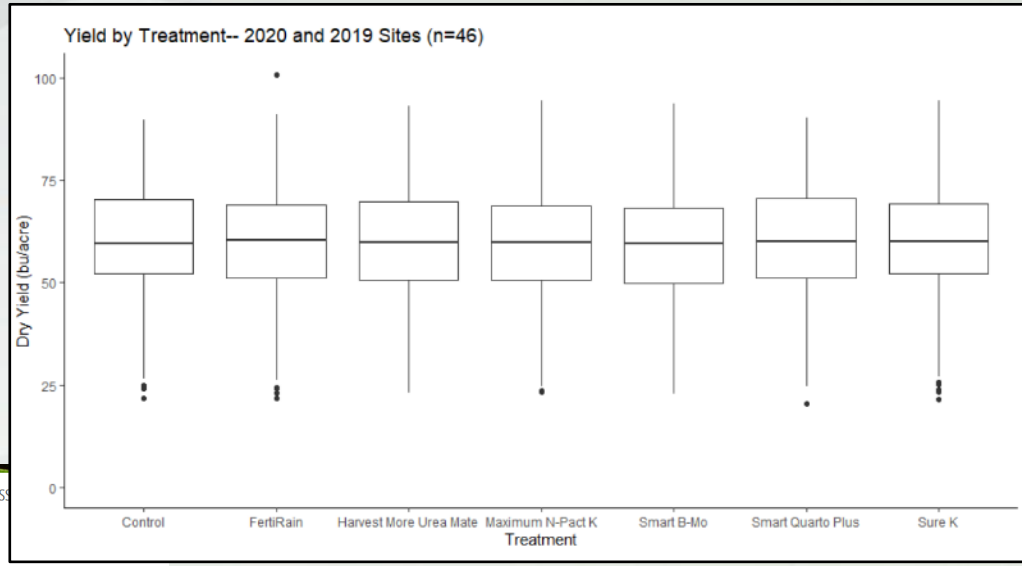


Field	Soil pH	P	K	Mg	Ca	CEC
PP3	6.3	63	140	235	1050	8.8

Fertility: in-season foliar

- 46 site years, 2019-20
- Products applied at R3, prophylactic
- There were no significant diff. in yield among treatments (p=0.998)
- No difference in grain composition
- No difference in N, P, K, Ca, Mg, Fe concentrations
- Difference in Mn, Cu, and B conc,





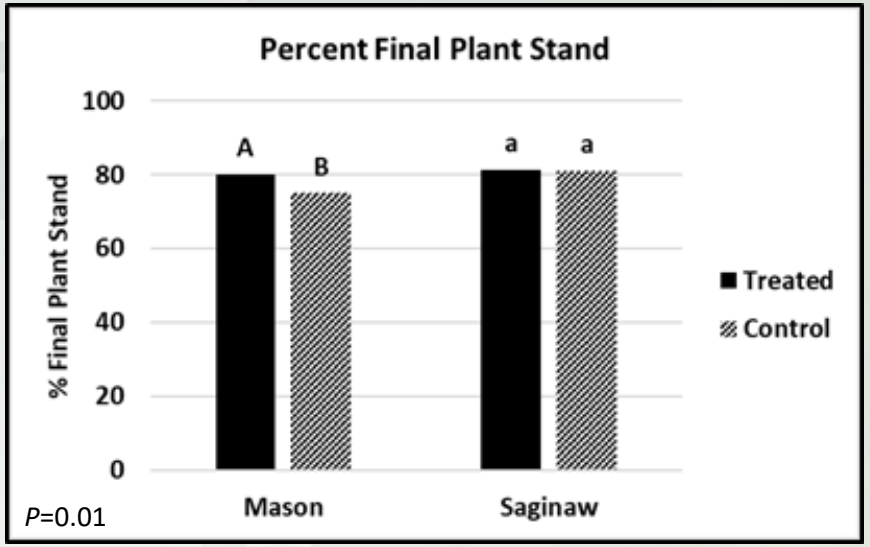
The best soybean management practices by Extension researchers from across

Foliar Fertilizers Rarely Increase Yield in U.S. Soybean

Foliar Fertilizer Overview

Seed Treatment

- **No yield improvement** from using a seed treatment at any plant date, across 4 site-years (minimal pest pressure)
- Using a seed treatment **reduced net returns** (-$11/acre)
  - Treated: $322/acre
  - Control: $333/acre

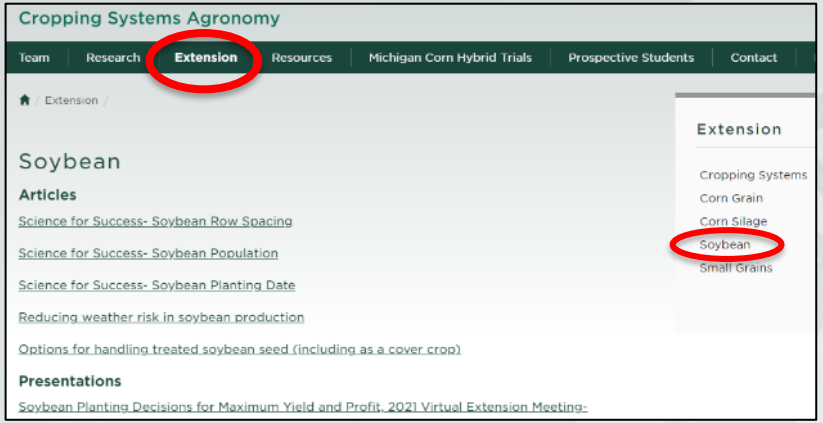


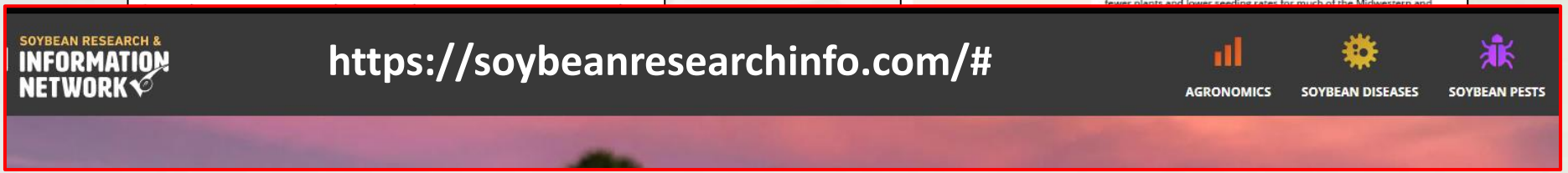
2018-19 data, 4 site years

Take Home Messages

- Combining improved genetics (variety selection) with management can increase yield (reduce on-farm yield gap), quality, and profits
- Specific practices dependent on field specific conditions:
  - **Plant date**: early planting in optimal moisture, change other management
  - **Maturity selection**: later-maturity variety with early planting
  - **Seeding rate**: lower seeding rate with minimum yield penalty
  - **Row Spacing**: narrow row spacing
  - Others- planting method, fertility, crop rotation, pest management
- Not every practice will affect yield in a given field or year
  - Minimize field-specific yield limiting factors (**light, water**, nutrition, pests) to best utilize the growing season

Resources: agronomy.msu.edu





NCSRP NORTH CENTRAL SOYBEAN RESEARCH PROGRAM

Do you grow soybeans?

Will you help us develop specific recommendations by sharing your field data?

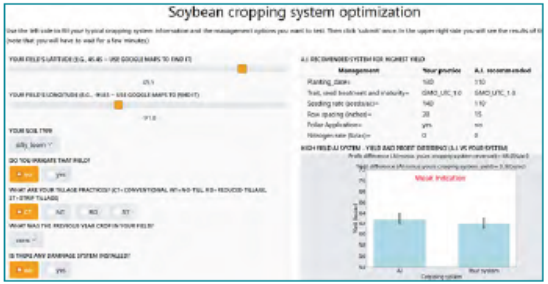
We are seeking info from your Soybean Fields!

USING DATA-DRIVEN KNOWLEDGE FOR PROFITABLE SOYBEAN MANAGEMENT SYSTEMS

- We would like to get historic yield and management data from a field or two on your farm
- We're looking for over 1000 fields overall to make the survey robust
- We'd like information about your field management, costs, and yields
- We'll add soil data, weather data, and satellite image data to your yield data
- It's completely confidential!

Here's our goal!

To develop a new **online cropping system optimization decision tool** that uses the data collected in the survey.



Ready to go?

- Participate in our survey!
- The survey is online and will take about 10-20 minutes to complete
- We can come to your farm office and will help you complete the survey

We Need Your Help!!

For more information:

Manni Singh
Cropping Systems Agronomist
msingh@msu.edu
517-353-0226

Tom Siler
Research Assistant II
silertho@msu.edu
989-817-8570

Cropping system optimization

Use the left and middle columns to fill your typical cropping system information and the management options you want to test. Then press 'submit' one time. In the left column you will see the results of the algorithm (AI) and how it compares with your system

YOUR FIELD'S LATITUDE (E.G., 45.45 - USE GOOGLE MAPS TO FIND IT)
45.5

YOUR FIELD'S LONGITUDE (E.G., -91.85 - USE GOOGLE MAPS TO FIND IT)
-91.8

YOUR SOIL TYPE
silty_loam

DO YOU IRRIGATE THAT FIELD?
yes / no

WHAT ARE YOUR TILLAGE PRACTICES? (CT=CONVENTIONAL, NT=NO-TILL, RD=REDUCED TILLAGE)
CT / NT / RD

WHAT WAS THE PREVIOUS YEAR CROP IN YOUR FIELD?
corn

IS THERE ANY DRAINAGE SYSTEM INSTALLED?
yes / no

YOUR TYPICAL PLANTING DATE AS DAY OF YEAR(E.G., MAY 10=130)
130

WHAT IS THE EARLIEST POSSIBLE DAY YOU CAN PLANT (DAY OF YEAR)
110

WHAT IS THE LATEST POSSIBLE DAY YOU CAN PLANT (DAY OF YEAR)
180

YOUR TYPICAL SEEDING RATE (X1000 SEEDS/AC)
140

WHAT IS THE LOWEST SEEDING RATE YOU WANT TO TEST?
70

WHAT IS THE HIGHEST SEEDING RATE YOU WANT TO TEST?
250

YOUR TYPICAL ROW SPACING (INCHES)
30

WHAT IS THE NARROWEST ROW SPACING YOU WANT TO TEST?
15

WHAT IS THE WIDER ROW SPACING YOU WANT TO TEST?
40

DO YOU TYPICALLY APPLY FOLIAR FUNGICIDE?
yes / no

DO YOU WANT TO TEST THE EFFECT OF FOLIAR FUNGICIDE?
yes / no

HOW MUCH NITROGEN (LB/AC) DO YOU NORMALLY APPLY?
0

WHAT IS THE MAXIMUM AMOUNT OF NITROGEN FERTILIZER YOU WANT TO TEST? (HINT: PUT ZERO IF YOU DON'T WANT TO TEST IT)

TRAIT OF YOUR TYPICAL SEED
GMO / Conv

SEED TREATMENT OF YOUR TYPICAL SEED (UTC=NO TREATMENT, F=FUNGICIDE, I=INSECTICIDE, N=NEMATICIDE)
UTC / FI / FIN

MATURITY GROUP OF YOUR TYPICAL SEED
1

HOW MUCH THAT SEED COSTS PER 140,000 SEEDS
50

OPTION 1 SEED TRAIT (HINT: CHOOSE NA IF YOU DON'T WANT TO TEST ANOTHER SEED)
GMO / Conv / NA

OPTION 1 SEED TREATMENT (HINT: CHOOSE NA IF YOU CHOSE NA ABOVE)
UTC / FI / FIN / NA

OPTION 1 MATURITY GROUP (HINT: IF YOU CHOSE NA ABOVE, DON'T WORRY ABOUT THIS)
2.5

HOW MUCH OPTION 1 SEED COST PER 140,000 SEEDS (HINT: IF YOU CHOSE NA ABOVE, DON'T WORRY ABOUT THIS)
43.5

OPTION 2 SEED TRAIT (HINT: CHOOSE NA IF YOU DON'T WANT TO TEST ANOTHER SEED)
GMO / Conv / NA

OPTION 2 SEED TREATMENT (HINT: CHOOSE NA IF YOU CHOSE NA ABOVE)
UTC / FI / FIN / NA

OPTION 2 MATURITY GROUP (HINT: IF YOU CHOSE NA ABOVE, DON'T WORRY ABOUT THIS)
1.3

HOW MUCH OPTION 2 SEED COST PER 140,000 SEEDS (HINT: IF YOU CHOSE NA ABOVE, DON'T WORRY ABOUT THIS)
58.5

SOYBEAN SELLING PRICE ($/BU)
12.5

HOW MUCH DOES NITROGEN FERTLIZER COSTS ($/LB)
0.35

HOW MUCH DOES NITROGEN APPLICATION COST ($/AC)
10

HOW MUCH DOES FOLIAR FUNGICIDE APPLICATION+PRODUCT COSTS ($/AC)
25

CLEAR SUBMIT

YOUR CROPPING SYSTEM

```
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AI RECOMENDED FOR HIGHEST YIELD SYSTEM

```
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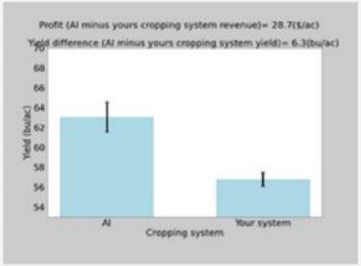
HIGH YIELD AI SYSTEM - YIELD AND PROFIT DIFFERENCE (AI VS YOUR SYSTEM)



AI RECOMENDED FOR HIGHEST PROFIT SYSTEM

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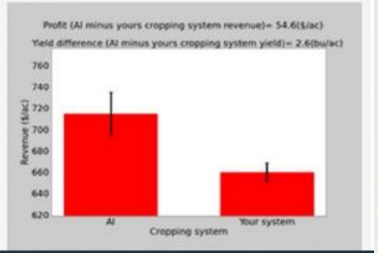
HIGH PROFIT AI SYSTEM - YIELD AND PROFIT DIFFERENCE (AI VS YOUR SYSTEM)



New NCSRP project 2022-24: Farmer Survey

- **2 drawings for cash prize of $1,000 and $500**
- Each field will be one entry in the drawings (e.g., 4 fields = 4 entries)
- Provide your contact information in the sign-up sheet
- We will contact you based on your selected preference

Name	Email	Phone	Street	City	State	ZIP	How would you like to receive survey?	
							Email	Mailed
John Doe	*doejohn@gmail.com*	*(999)123-4567*	*123 Farm Ln*	*East Lansing*	*MI*	*48823*	*x*	

- **Technicians**:
  - **Tom Siler**
  - **Micalah Blohm**
- **Graduate Students**
  - Harkirat Kaur
  - Patrick Copeland
  - Benjamin Agyei
- **Undergrad students**
- **Past students**
- Mike Particka
- Paul Horny
- Charles Scovill (Syngenta)
- **Farmer cooperators**

- Mike Staton
- Dr. Laura Lindsey (OSU)
- Dr. I. Ciampitti (KSU)
- Dr. Shawn Conley (UW)
- Dr. Marty Chilvers
- Dr. Chris Difonzo
- Dr. Dechun Wang
- Dr. Christy Sprague
- Dr. Kurt Steinke

Manni Singh

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agronomy.msu.edu

MICHIGAN SOYBEAN COMMITTEE

NORTH CENTRAL SARE Sustainable Agriculture Research & Education

Project GREEEN

NCSRP NORTH CENTRAL SOYBEAN RESEARCH PROGRAM

Cropping Systems Agronomy MICHIGAN STATE UNIVERSITY

MICHIGAN STATE UNIVERSITY | Extension

Seed companies

USDA NIFA