Maximizing Yield Potential in Winter Wheat

Manni Singh

agronomy.msu.edu

msingh@msu.edu, 517-353-0226

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MICHIGAN WHEAT PROGRAM

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Cropping Systems Agronomy
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Wheat Yield Potential

- **Goal**: Design a canopy structure that maximizes:
  - Radiation interception
  - Radiation Use Efficiency
  - Harvest Index
- **Components**: (focused on planting strategies)

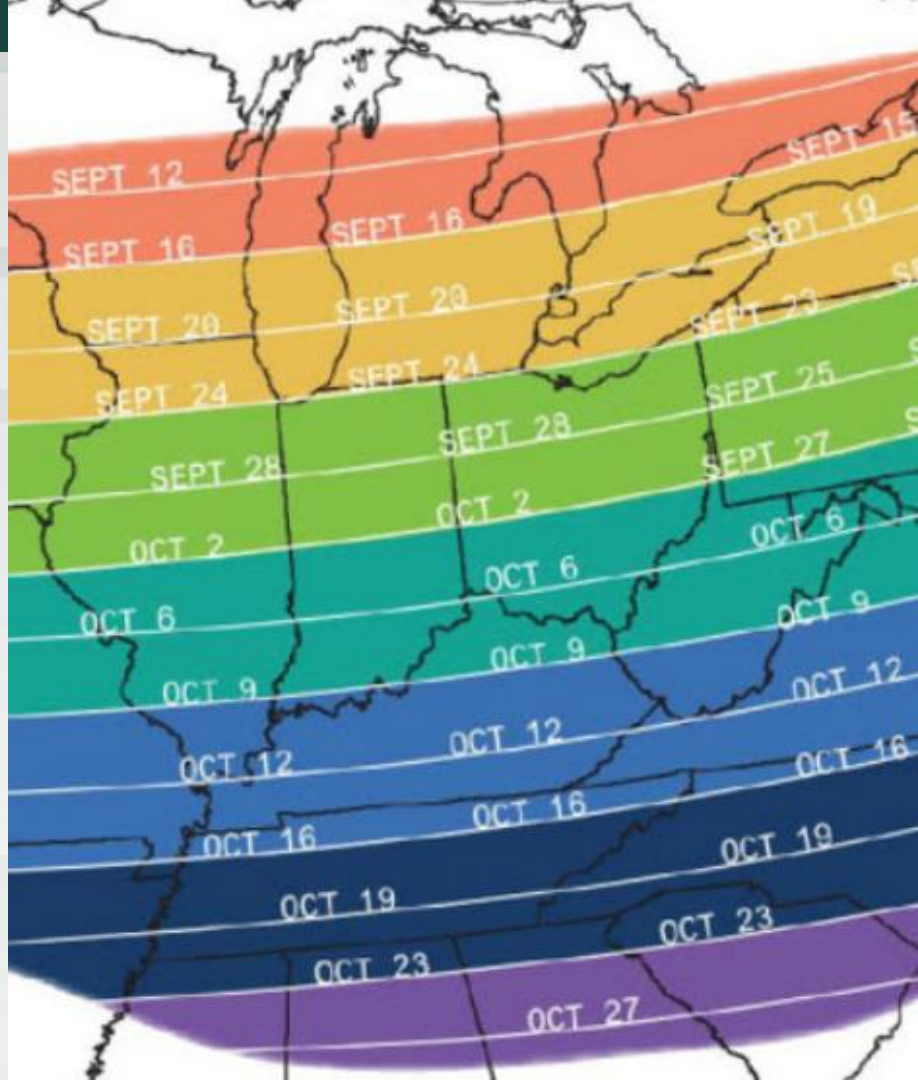
#1
- Planting time

#2
- Planting method (seed placement, planting speed)
  - Seeding depth
  - Seed-to-seed spacing
  - Row spacing

#3
- Variety selection (canopy type, leaf angle)
- Seeding rates

Wheat Planting time

- Start after **hessian fly free date**- still a good rule of thumb?
- Yield penalty with later planting- magnitude, need to change other management?



Plant dates (PD):

2019–20 growing season:
PD1: Sept 19 **(Mid-Sept.)**
PD2: Oct 7 **(Early-Oct.)**
PD3: Oct 18 **(Mid-Oct.)**
PD4: Oct 29 **(Late-Oct.)**
PD5: Nov 15 **(Mid-Nov.)**

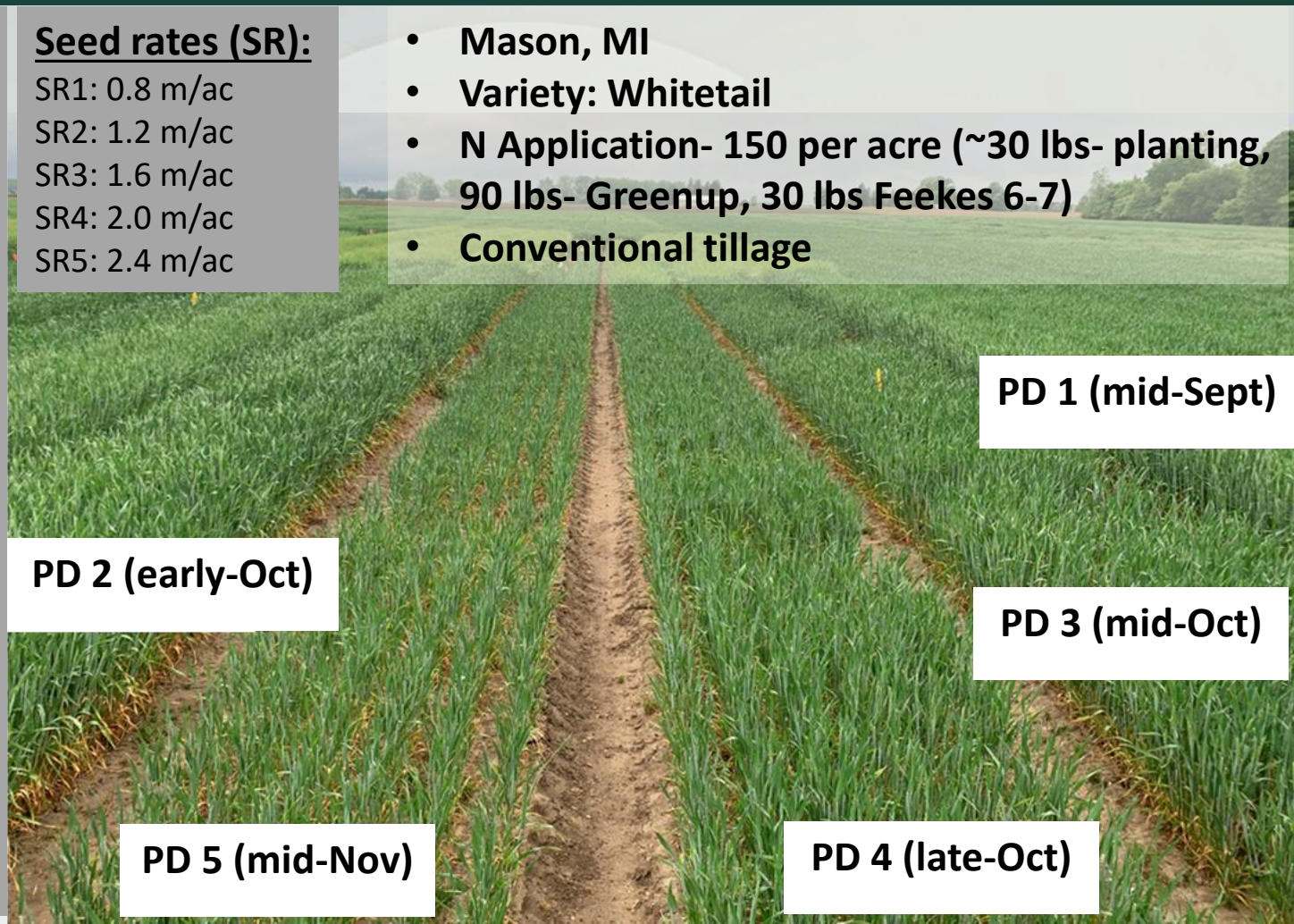
2020–21 growing season:
PD1: Sept 17
PD2: Sept. 29
PD3: Oct 14
PD4: Oct 29
PD5: Nov 12

2021–22 growing season:
PD1: Sept 19
PD2: Sept. 30
PD3: Oct 16
PD4: Oct 30
PD5: Nov 17

Seed rates (SR):

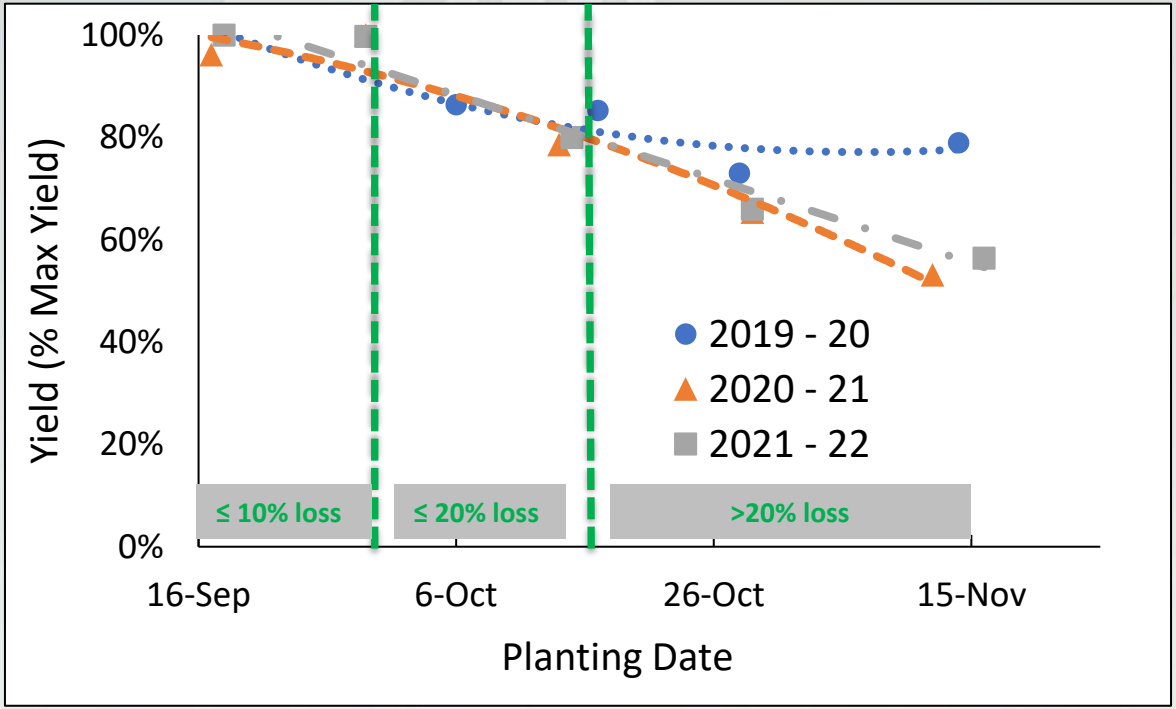
SR1: 0.8 m/ac
SR2: 1.2 m/ac
SR3: 1.6 m/ac
SR4: 2.0 m/ac
SR5: 2.4 m/ac

- **Mason, MI**
- **Variety: Whitetail**
- **N Application- 150 per acre (~30 lbs- planting, 90 lbs- Greenup, 30 lbs Feekes 6-7)**
- **Conventional tillage**



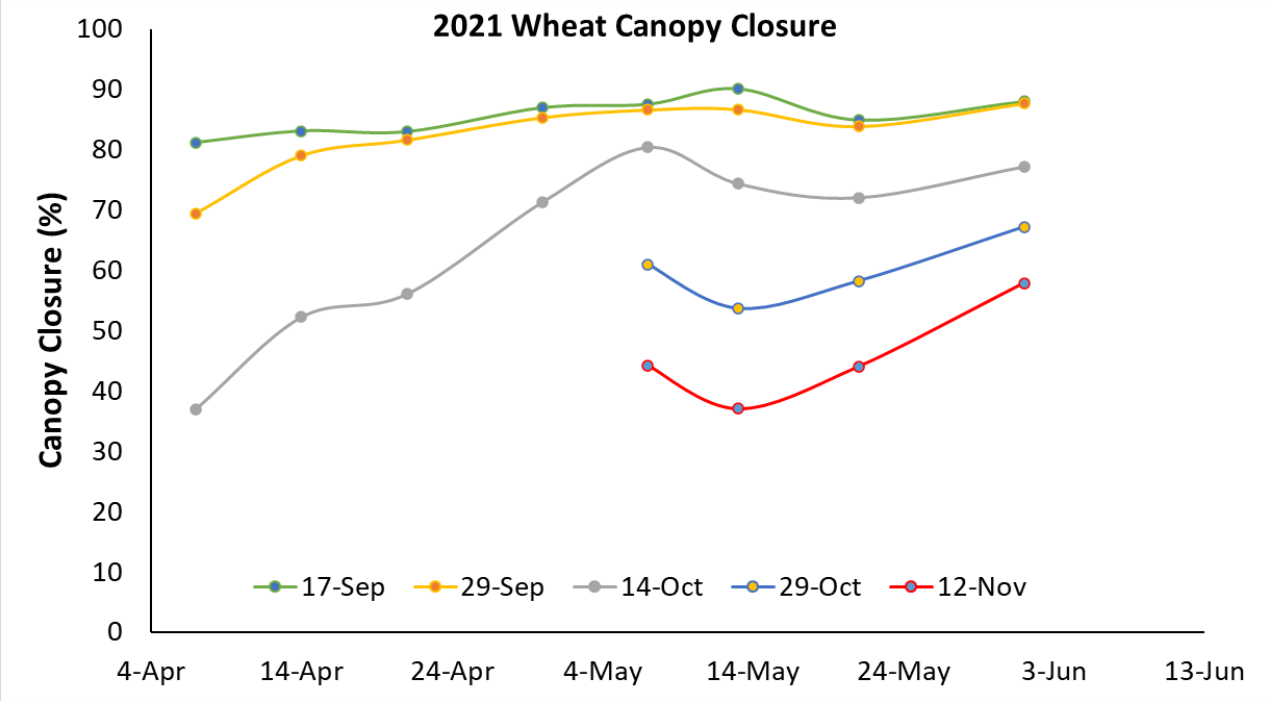
Planting Date Impacted Wheat Yield

- Yield declined with later planting, but rate of decline varied by year



Canopy Closure

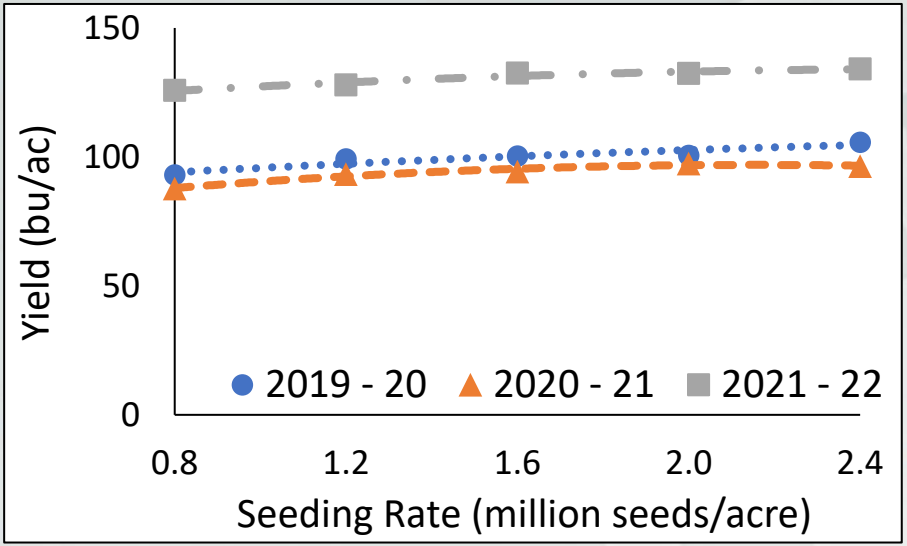
- First two planting dates reached canopy closure more quickly
- Later planting dates did not close canopy

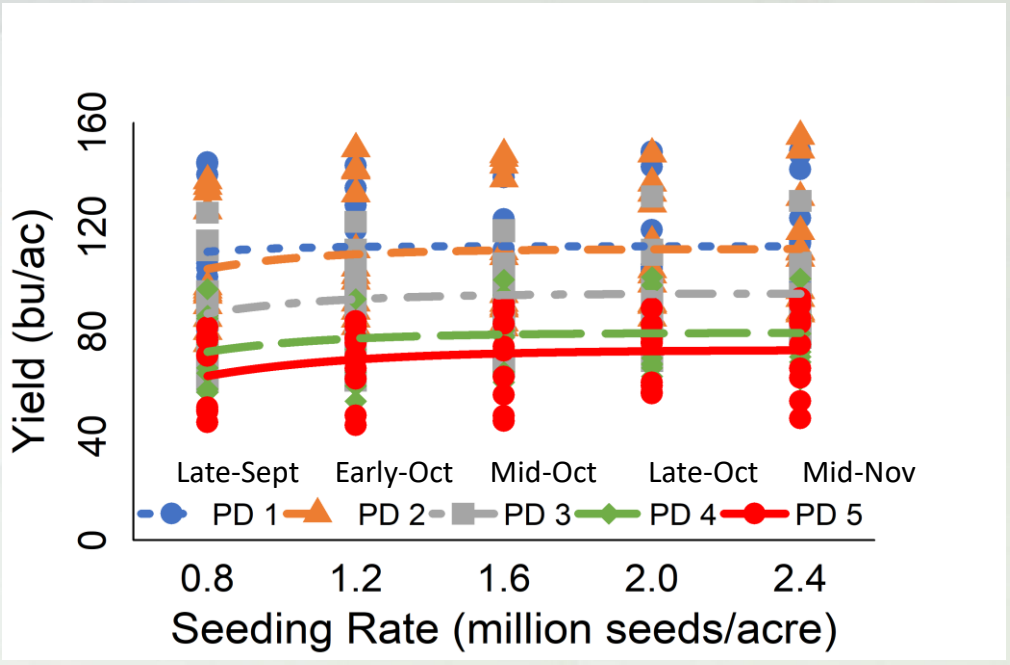


Fall Tillers

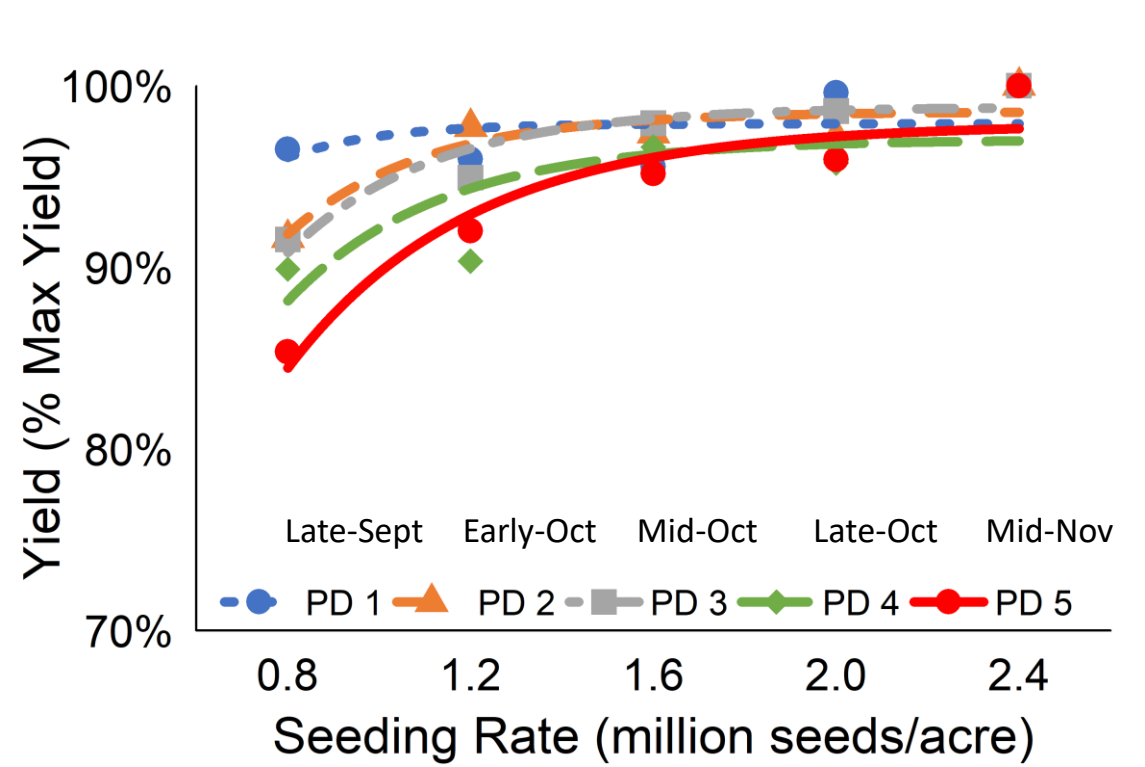
- Fall tillering influenced by planting date
- Sept to early-Oct plantings produced **2-4 tillers**
- Mid-Oct planting emerged but **did NOT produce tillers**
- End-Oct onwards: **not emerged**

Seeding Rate vs Yield





Seeding Rate vs Relative Yield



Optimal seeding rates:

Planting window	Seed Rate (million/acre)
Sept.	~0.8
Early-mid Oct	~1.2
After mid-Oct	~1.6

#2 Planting Method

Conventional “spill type” drill

Seed is metered out via a spinning gear and dropped down the seed tube to the ground.

Advantages: Conventional technology that is readily available and relatively cheap.

Disadvantages: Random, nonuniform seed placement within the row. Inconsistent seeding depth.

Precision Planter (PP)

Seed is metered out via a seed disc sized for crop with vacuum to pick one seed at a time.

Advantages: Allows for singulation. Greater flexibility in populations and crop types. Accurate seeding depth.

Disadvantages: Higher upfront cost (narrow rows require two gangs). Poor singulation accuracy with current technology. Slow speed of operation.

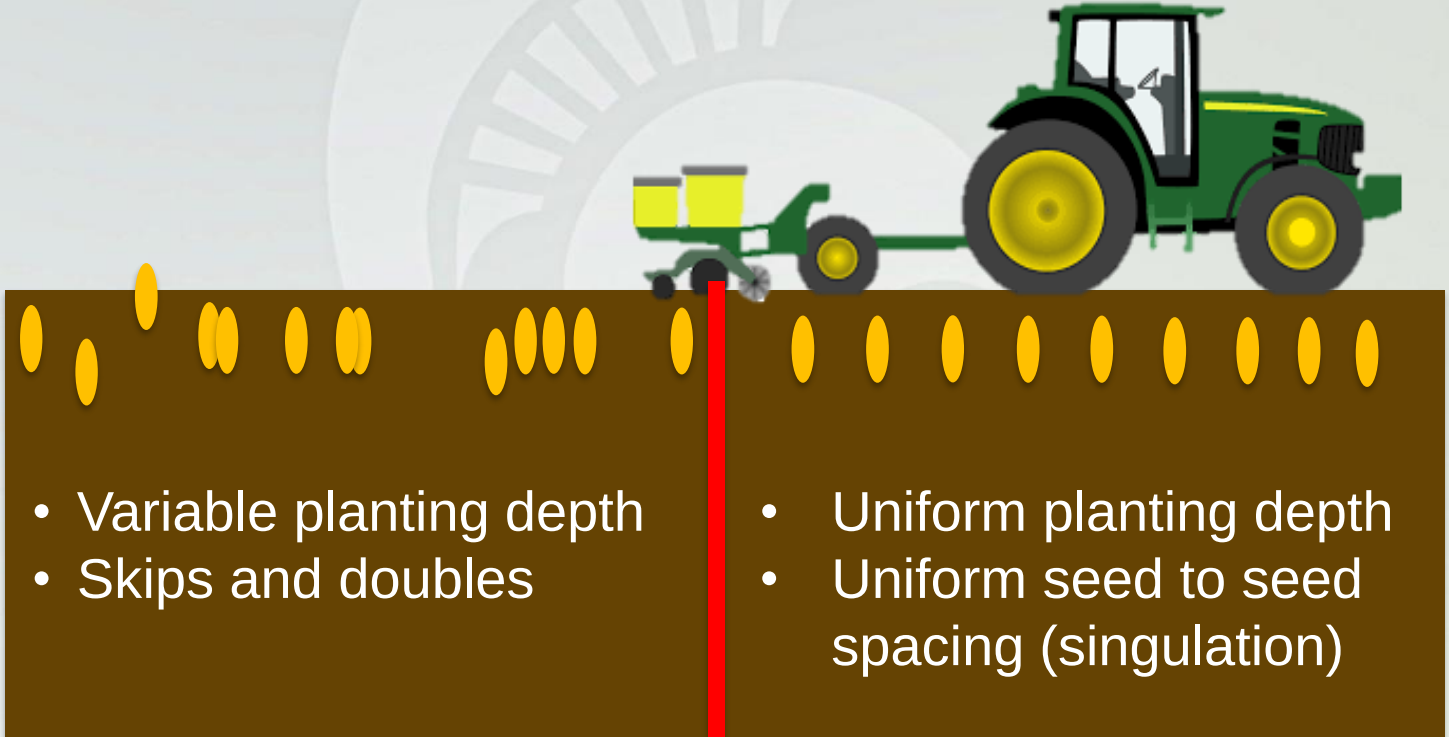
Broadcast Incorporation (BI)

Seed is broadcasted over soil surface, then incorporated with a shallow tillage implement.

Advantages: Enables faster planting. Random distribution of seeds may result in more uniform 2-dimensional distribution. More flexibility in crop types.

Disadvantages: Highly variable depth.

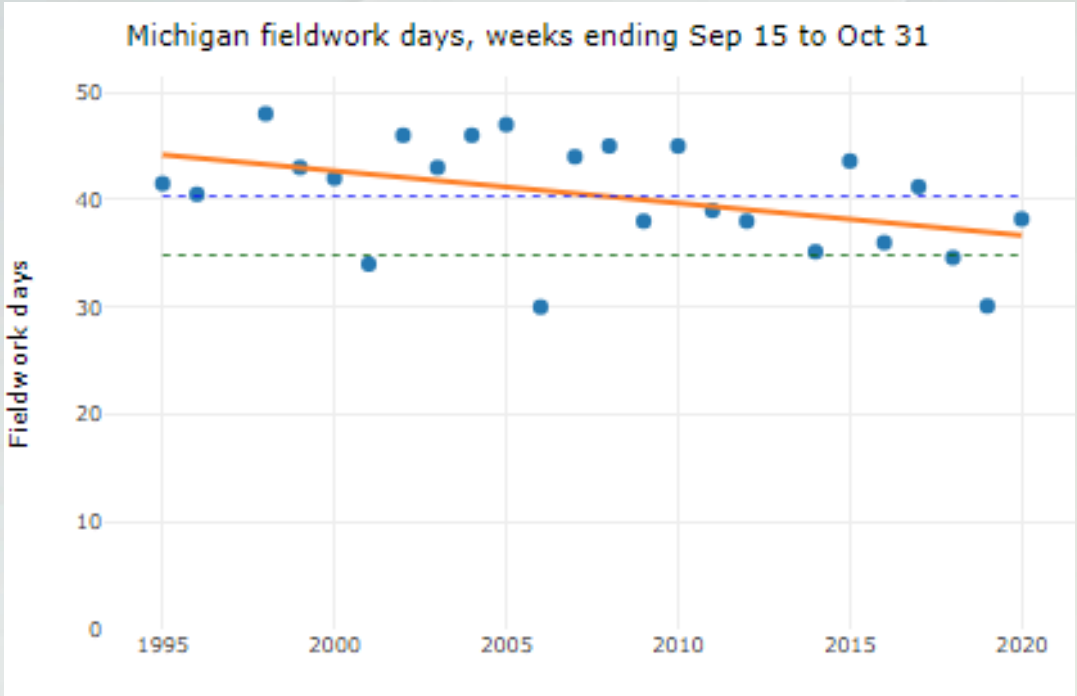
Importance of Seed Placement in Wheat?



- Variable planting depth
- Skips and doubles

- Uniform planting depth
- Uniform seed to seed spacing (singulation)

Decline in days for field work



- Days for field work (mid-Sept to end-Oct) decreased on average by 0.3 days per year
- Use faster planting technology to cover more area in less time (avoid late plant yield loss)?

Drill (7.5'' rows)

Planter (Monosem 4NG Planter)- 5''- 15'' rows

Broadcast Incorporation- BI: Gandy Air Seeder; Horsch Joker, Degelman Pro Till, Vertical Tillage Tool (no row spacing)

Drill- 7.5’’ row spacing

PP (Monosem)- 5’’ row spacing

BI (Broadcast Incorporation)- no row spacing

Variability in Seed Placement: Depth vs Seed Spacing

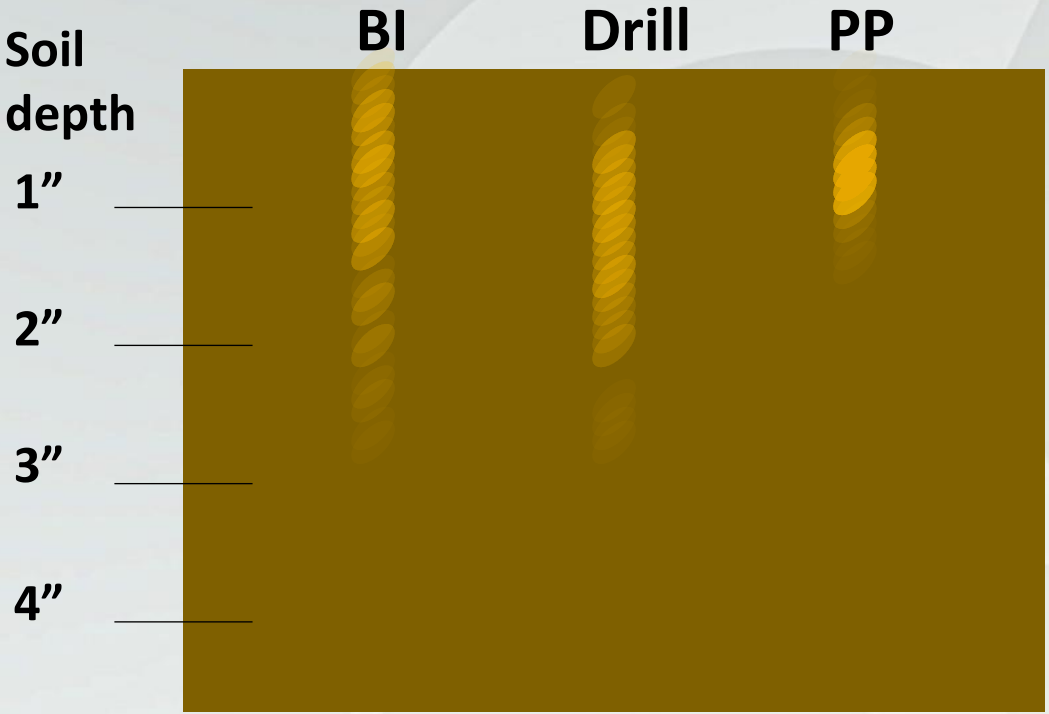
DRILL

PLANTER

Planter resulted in **lower variability in seeding depth**.

Variability in seed-to-seed spacing was lowered by using planter, but at lower level

What Seed Distribution Are We Achieving?

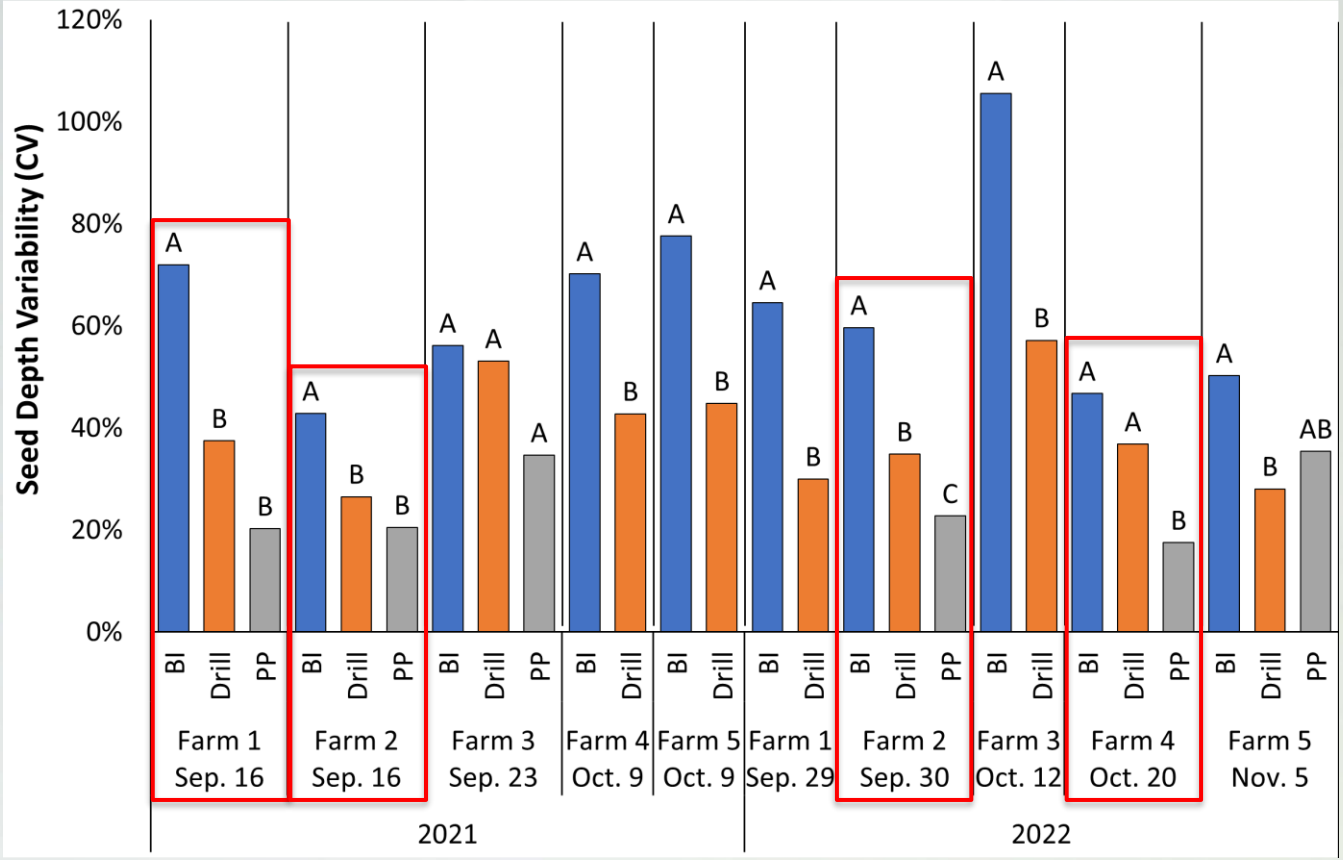


BI: Broadcast Incorporation
PP: Precision Planter

Actual seeding depths measured from 1 location in 2021–22 growing season

Depth Variability

Lowest in PP. 10–48% increase in BI than Drill



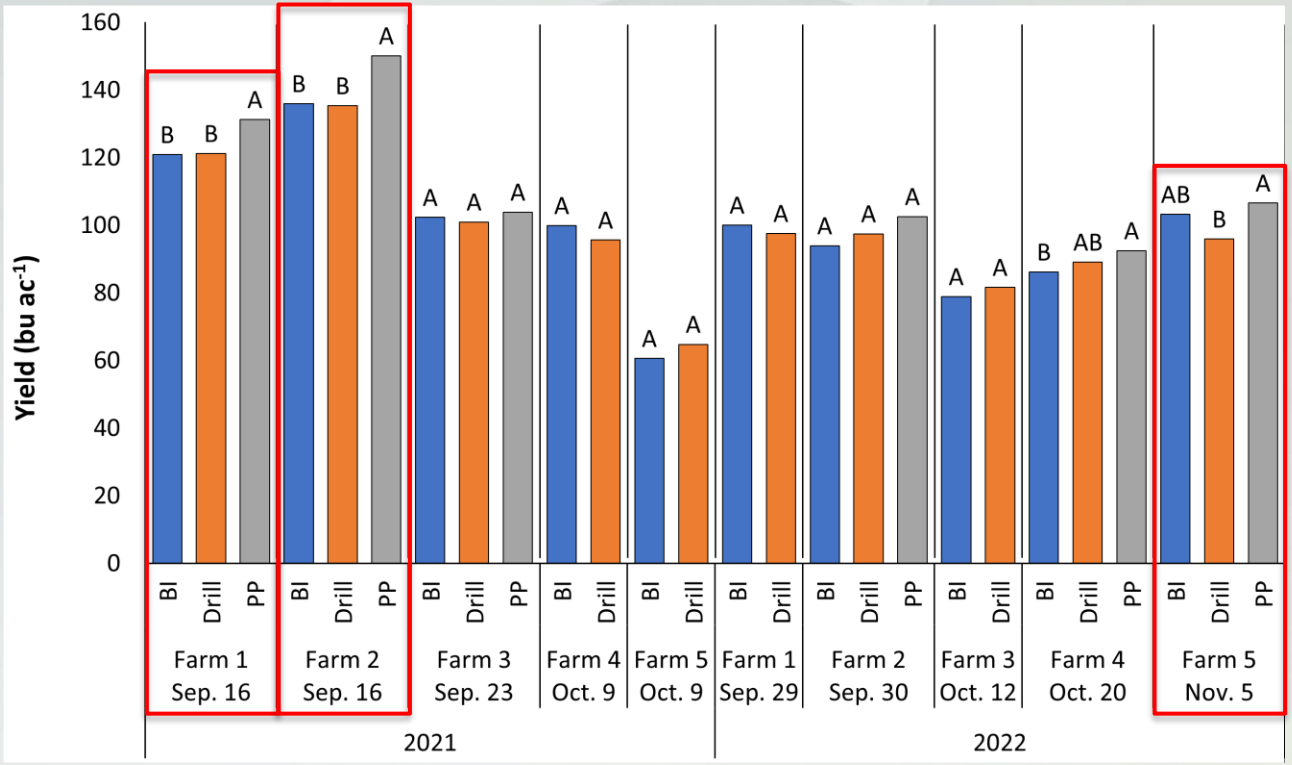
Bars with the same letter within a farm are not significantly different

BI: Broadcast Incorporation. **PP**: Precision Planter

Yield

8–11% Yield Increase in PP over Drill (3 out of 6 site years)

No difference between BI and drill



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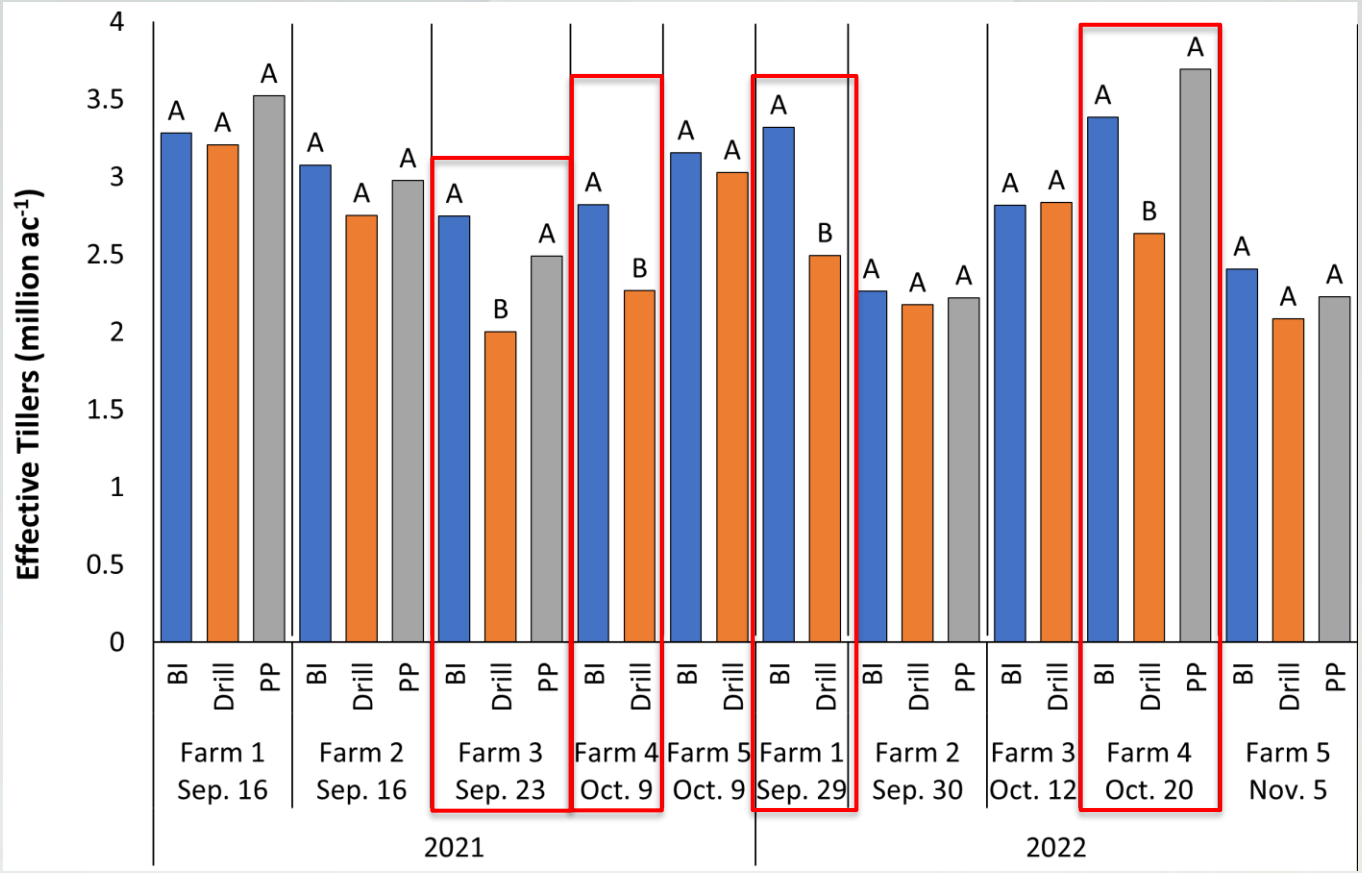
Effective Tillers

Max in PP/BI. 24–37% more Tillers in BI than Drill

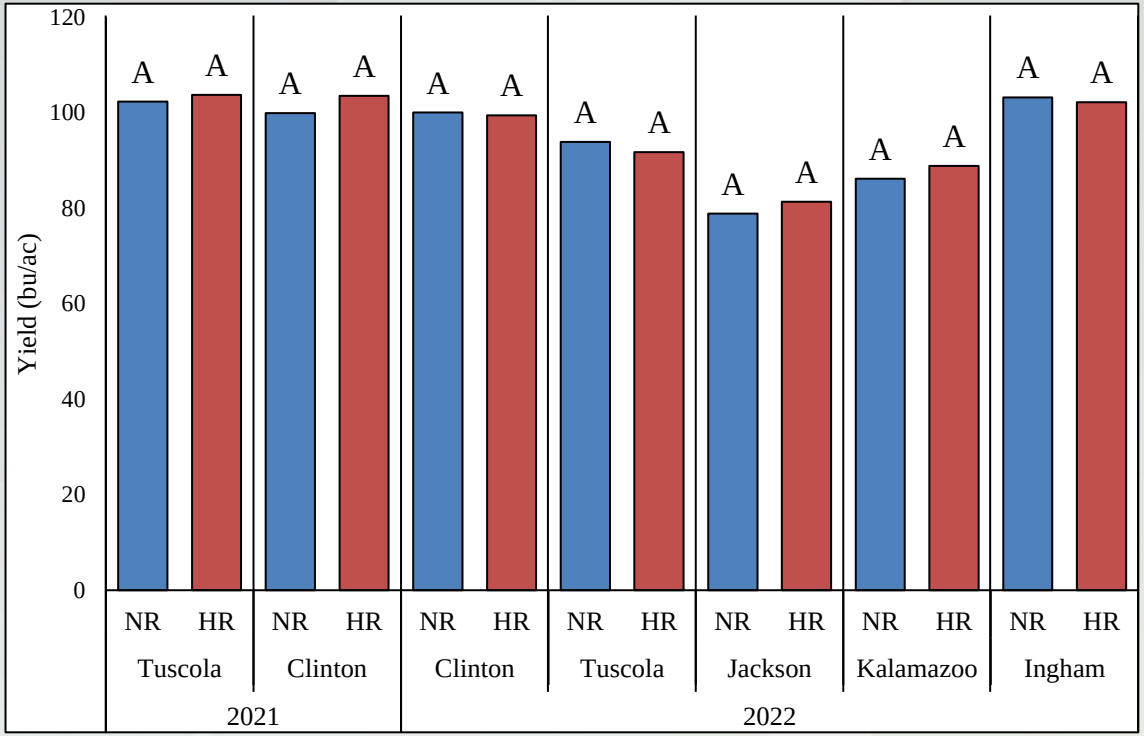


Bars with the same letter within a farm are not significantly different

BI: Broadcast Incorporation. **PP**: Precision Planter

Broadcast Incorporation

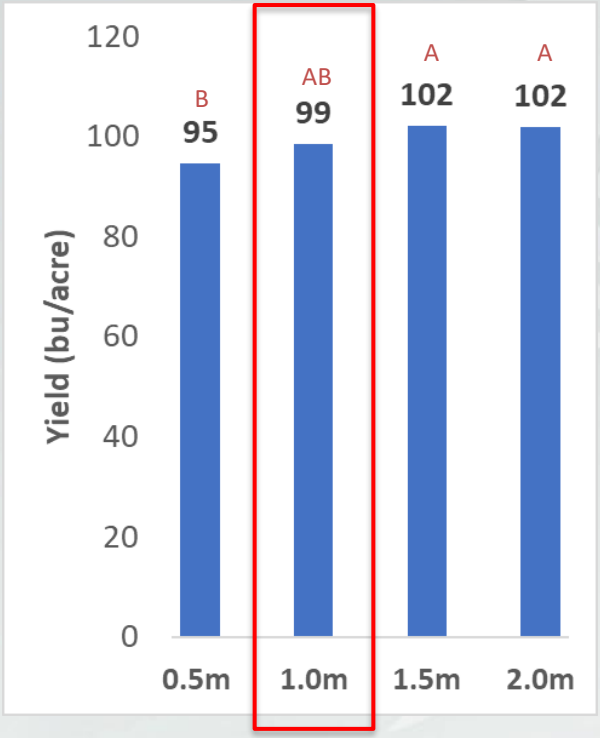
No difference in yield between seed rates

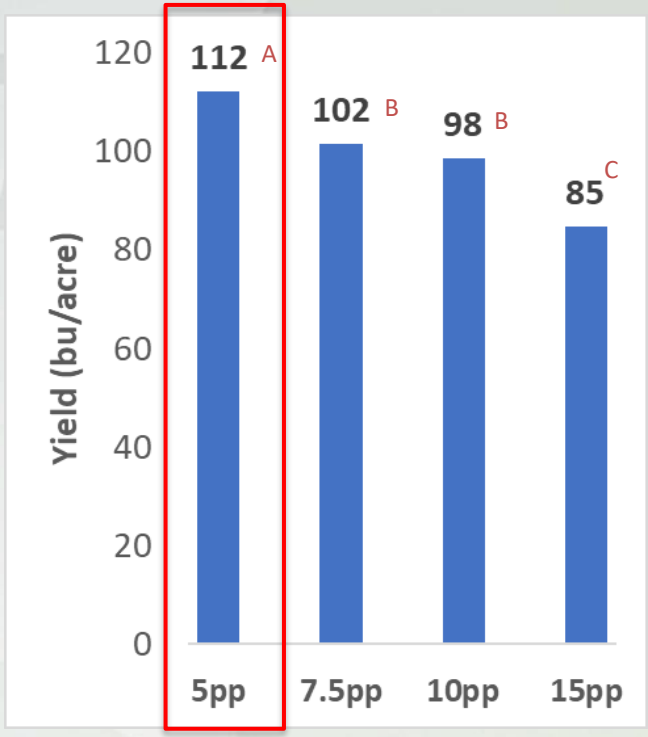


NR: Normal seed rate, **HR**: Higher (20-30%) seed rate

Bars with the same letter within a farm are not significantly different

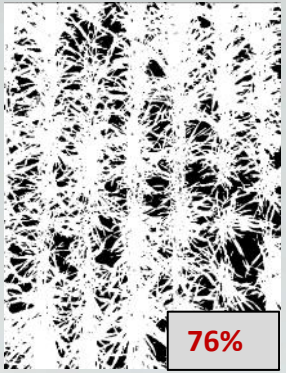
Precision Planter: Row spacing, Seeding rate





Data from 4 site years

May 8, 2020

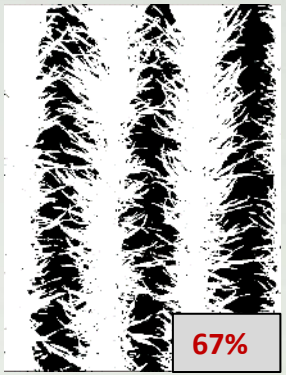


7.5'' spacing

5'' spacing

10'' spacing

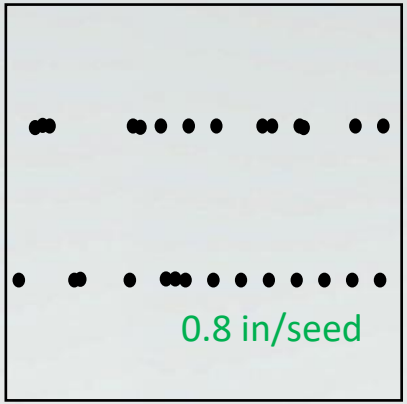
15'' spacing



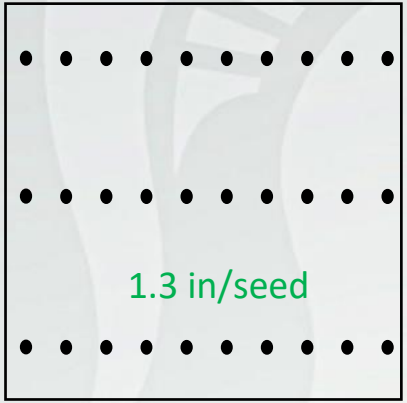
June 10- 77%
Others >95%

Comparing Wheat Planting Methods

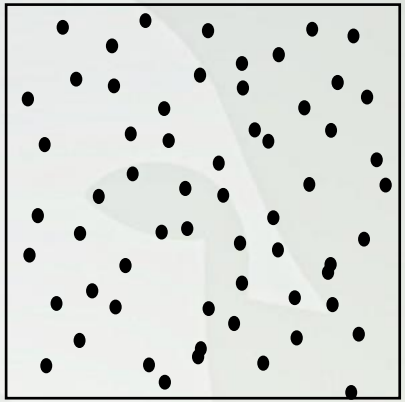
Seed Drill
7.5'' Row Spacing



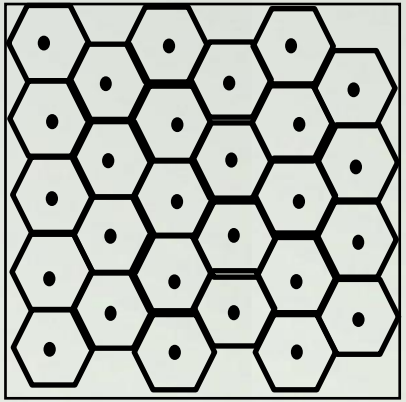
Precision Planter
5'' Row Spacing



Broadcast Incorporated
No Row Spacing

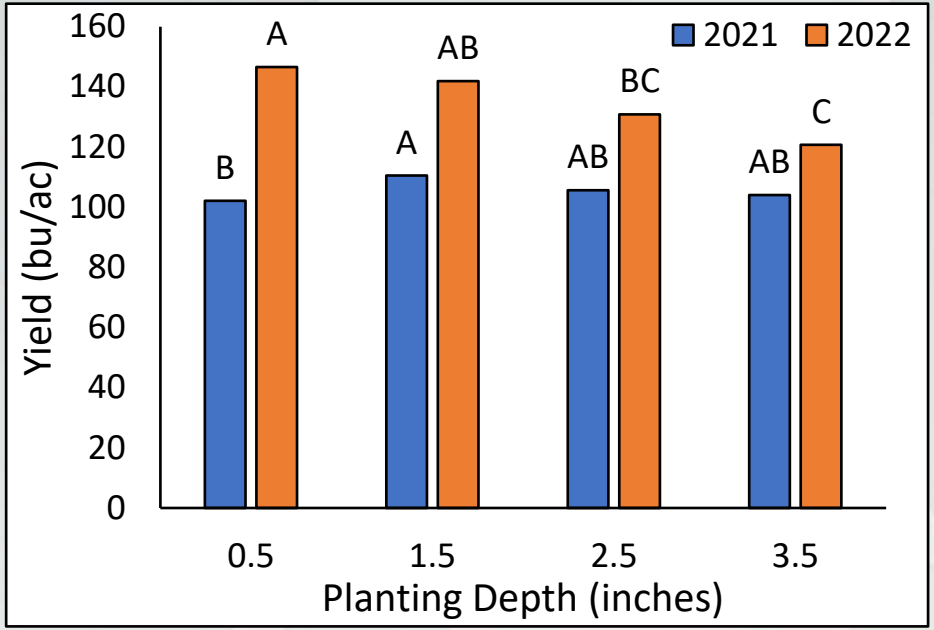


Ideal



2D vs 3D (seed depth) distribution?

Seeding depth vs Yield



- Highest yield with 1.5’’ seeding depth
- Narrow range in yield decline with shallow/deeper seeding

Take Home Messages

- Optimal planting strategies critical in setting up high yield potential.
- Early planting is crucial in achieving high yields and profits, faster planting technologies can help plant early.
- Narrow row spacing and/or improved seed placement can lead to increased crop uniformity, grain yield, and quality.
- Potential for reduction in seeding rate (≤1.2 m before mid-Oct, then ~1.6 m) without limiting yield. Test with strips (20-30% lower rate) in your field.
- Optimize current planter configuration vs invest in new planting technology to be used for multiple crops?

Variety canopy architecture

AgriMAXX 513 (**Droopy**)
Canopy Score- 1

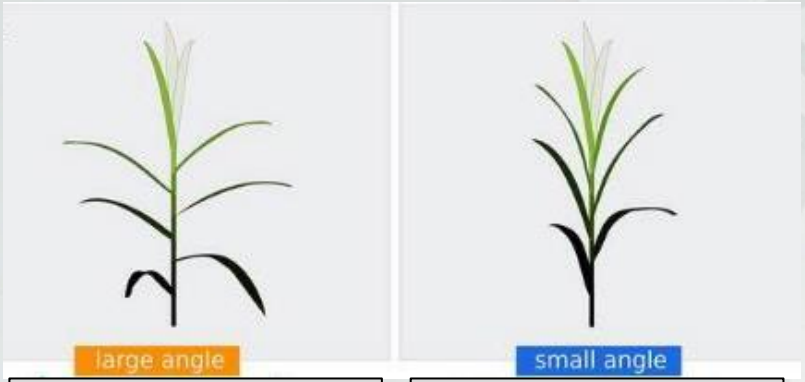
Hilliard (**Droopy**)
Canopy Score- 2

Branson (**Semi-erect**)
Canopy Score- 4

MCIA Wharf (**Erect**)
Canopy Score- 5

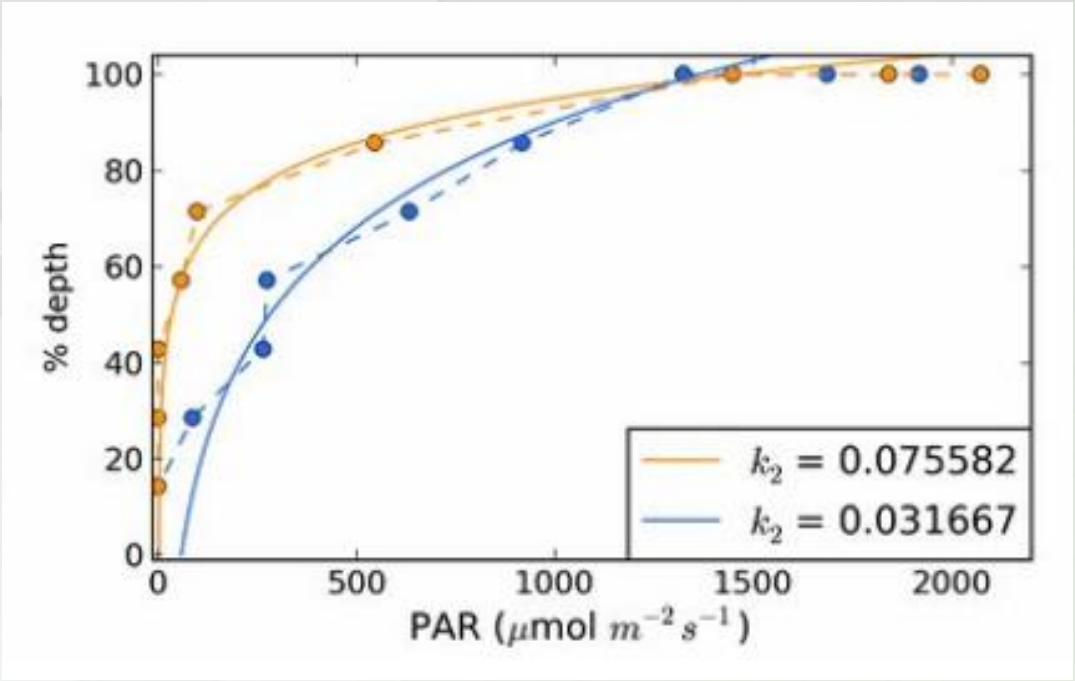
Canopy rating scale by **Eric Olson**
Collaboration with Eric Olson, Dennis Pennington, Ontario researchers

Canopy Light Interception



Droopy
Canopy Score- 1

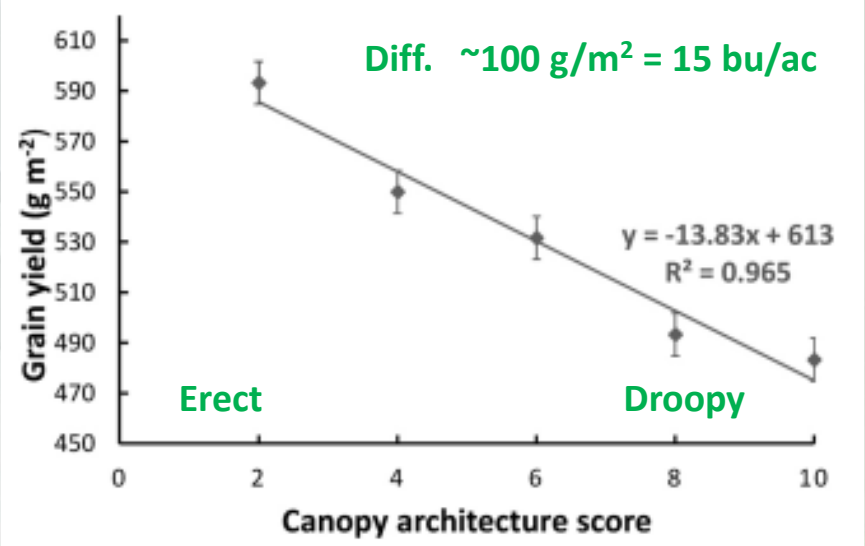
Erect
Canopy Score- 5



Truong et al. Genetics 2015;201:1229-1238

Previous Research

- Erect canopies had ~20% greater yield at early planting than floppy canopies
- Seeding rate response varied between erect and floppy varieties in Michigan

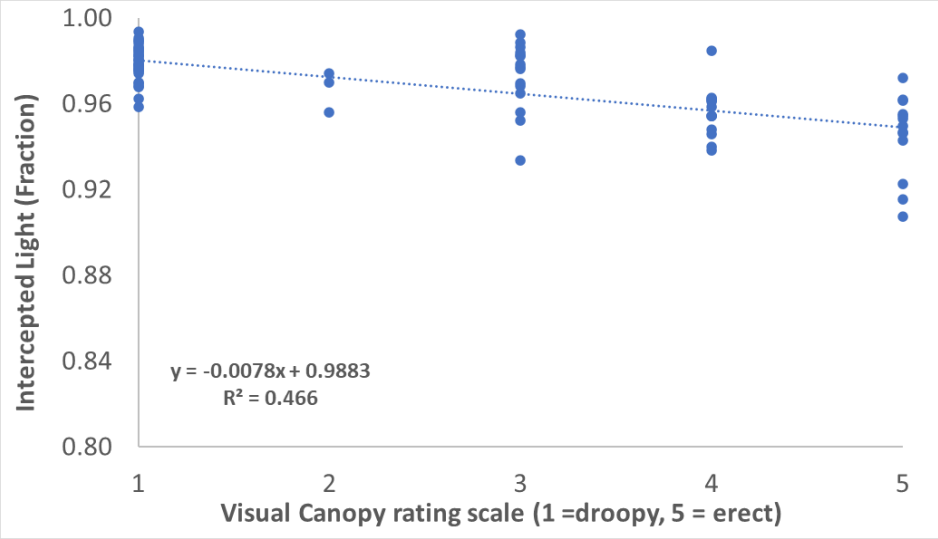


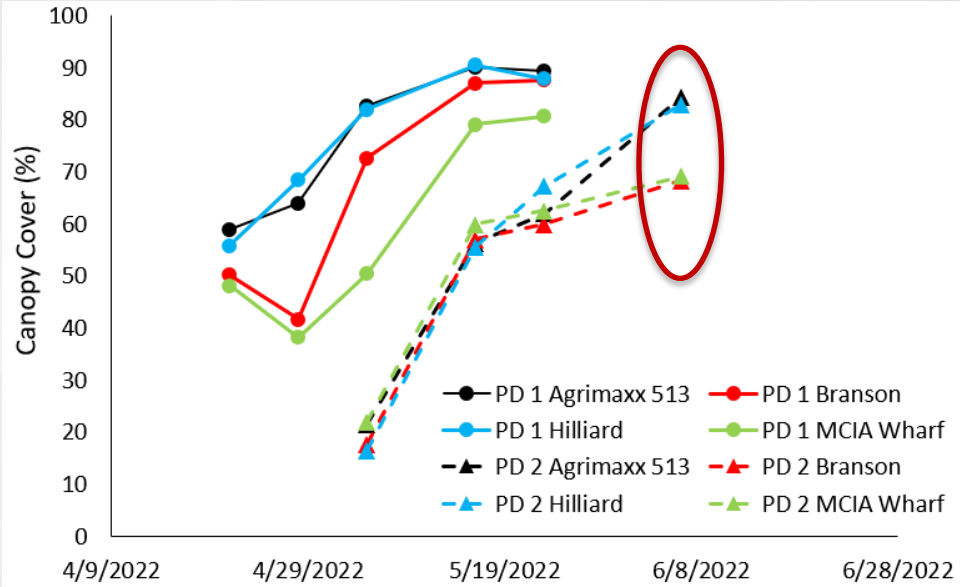
Spring wheat, Australia

Research Questions:

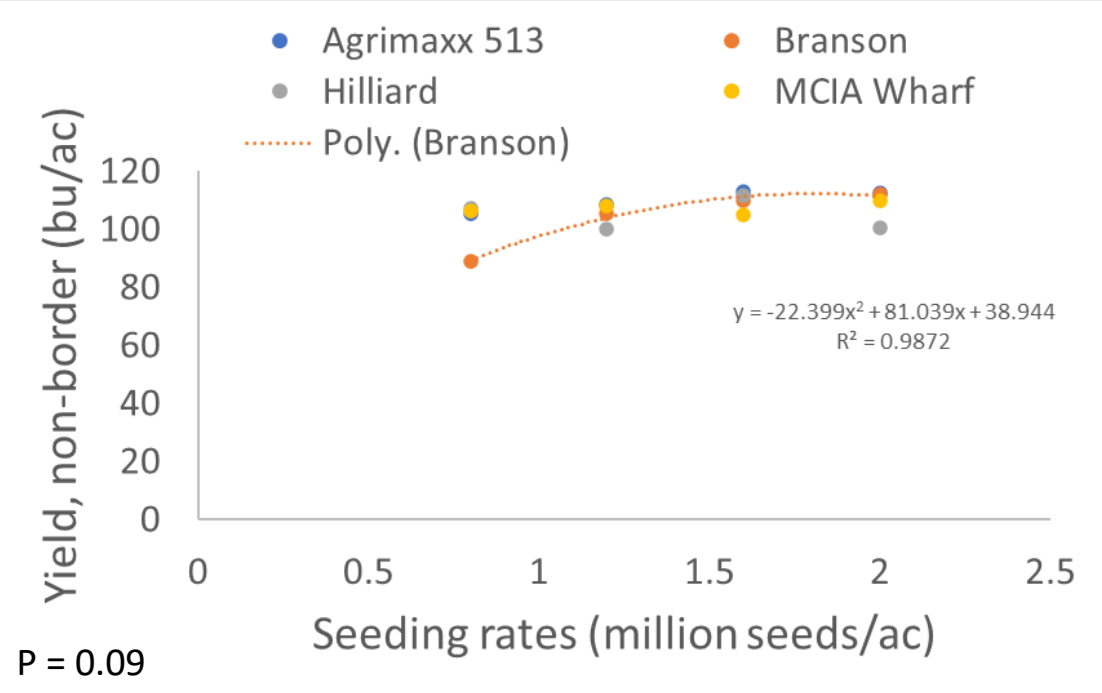
- Should wheat variety canopy architecture be part of grower's selection decision?
- Should wheat variety management strategy change dependent on its canopy architecture? E.g.-
  - Planting date, seeding rate, row spacing
  - Intensive management

Light Interception and Canopy cover





Seeding rate x Variety canopy



- Varieties with erect canopies (narrow leaf angles) showed a greater response to increase in seeding rate

Ideas on using variety canopy types

- Winter wheat varieties have differences in canopy architecture. However, most current varieties are droopy.

- Change management to maximize yield potential (OR minimize loss of yield)
  - Planting date: Droopy varieties under late planting?
  - Seeding rate: Lower seeding rate in droopy varieties?
  - Row spacing: Erect varieties in narrow rows, droopy in wide rows?
  - **Intensive management**: Use erect varieties?

- Continued research in breeding and agronomy can help develop system-level approach to maximize wheat yield potential and profits
  - Canopy rating on seed label?

- **Technicians**:
  - Patrick Copeland
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  - Tom Siler
- **Graduate Students**
  - Harkirat Kaur
  - Benjamin Agyei
  - Kalvin Canfield
- **Undergrad students**
- **Past students**

- **Dennis Pennington**
- **Dr. Eric Olson**
- **Farmer cooperators**
- Mike Particka
- Paul Horny
- Dr. Jeff Andresen
- Dr. Laura Lindsey (OSU)
- Dr. Ignacio Ciampitti (KSU)
- Dr. Chris Difonzo
- Dr. Christy Sprague

Manni Singh

msingh@msu.edu

517-353-0226

agronomy.msu.edu

Thanks!

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