Planting Strategies for Optimizing Wheat Canopy and Yield

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Cropping Systems Agronomy
MICHIGAN STATE UNIVERSITY

Michigan Wheat Program

Project GREEEN

Michigan Crop improvement association

Improve Wheat Yield Potential

- **Goal**: Design a canopy structure that optimizes:
  - Radiation Interception, Radiation Use Efficiency, Harvest Index
  - Yield components (grain number, grain weight)

- **Components**: (focused on planting strategies)

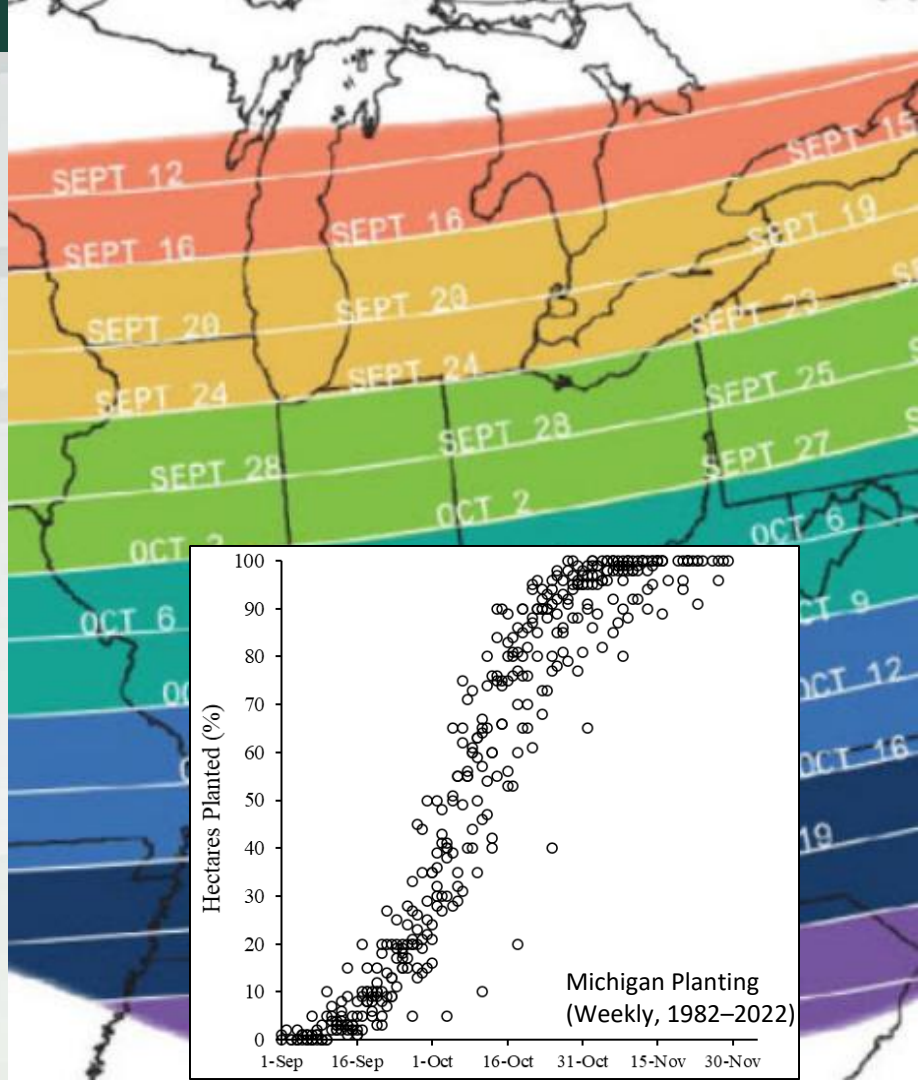
#1
- Planting time
- Seeding rate
- Planting method (seed placement, planting speed)

#2
  - Row spacing
  - Seeding depth
  - Seed-to-seed spacing

#3
- Variety selection (canopy type, tiller angle)
- Others (e.g., intensive management)

Winter Wheat Planting time

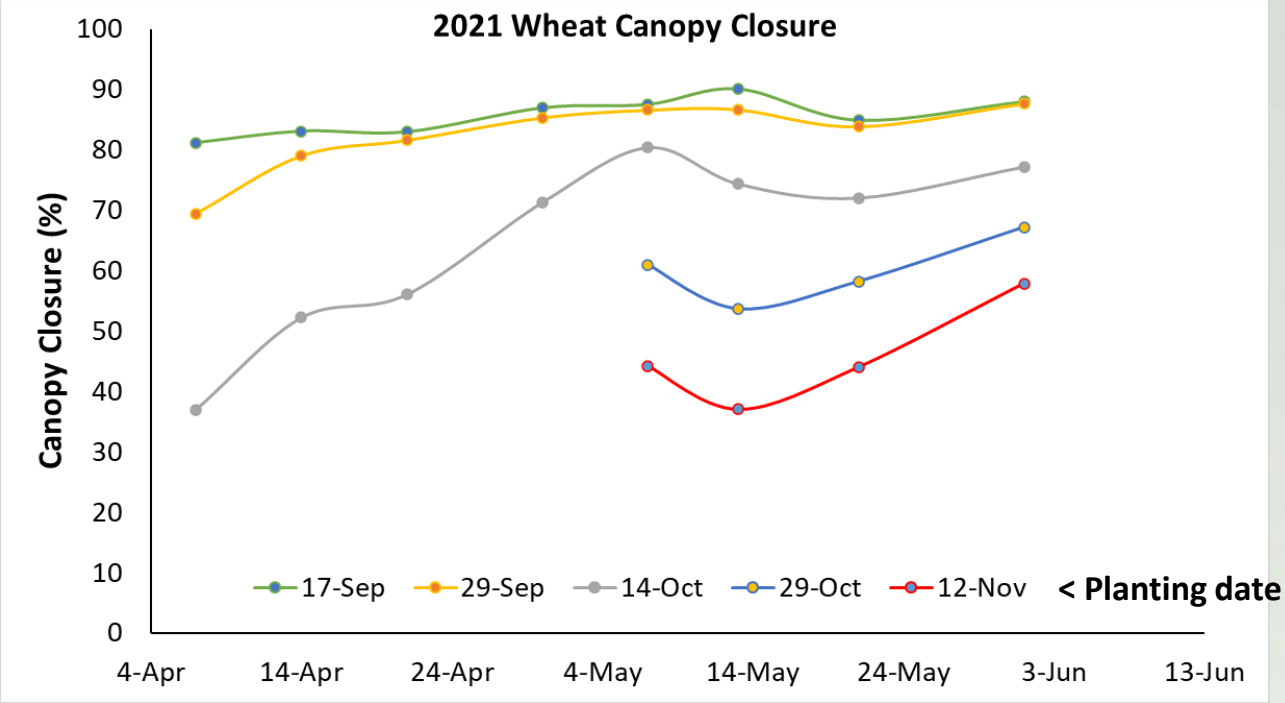
- Start after **hessian fly-free date:** still a good rule of thumb?
- Yield penalty with later planting-magnitude, need to change other management?



Planting Time Impacts Wheat **Growth** in Michigan

- **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

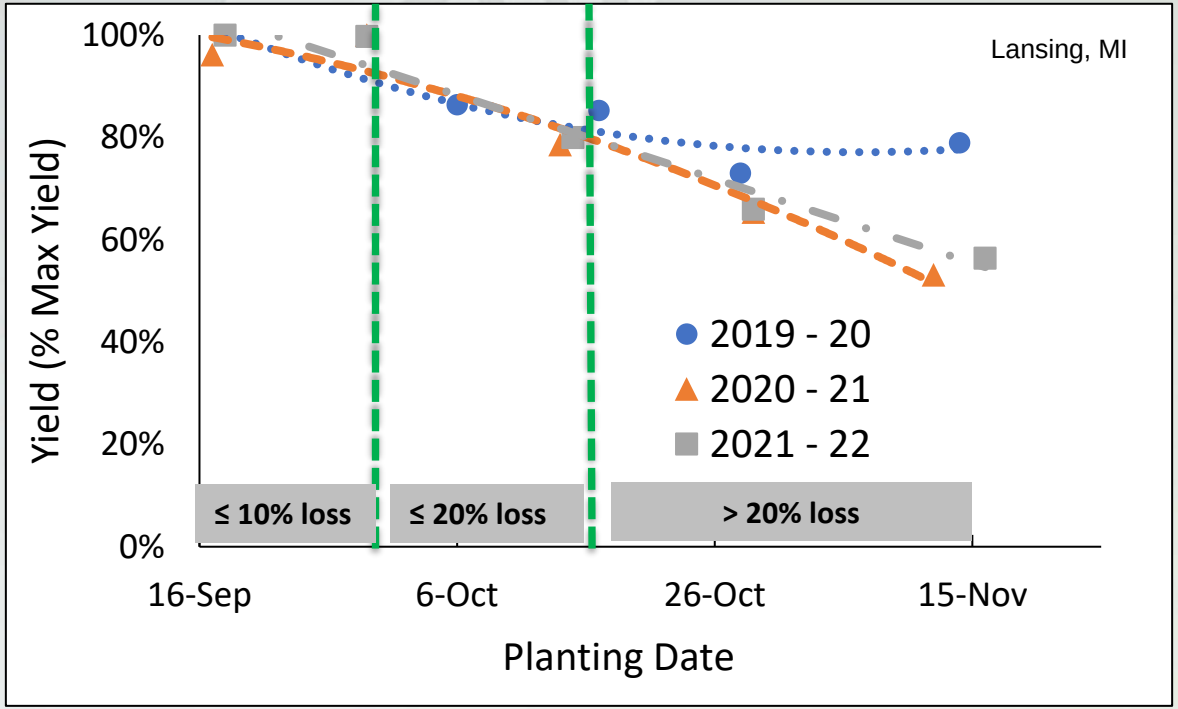
Planting Time Impacts Wheat **Growth** in Michigan



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

Planting Time Impacts Wheat **Yield** in Michigan

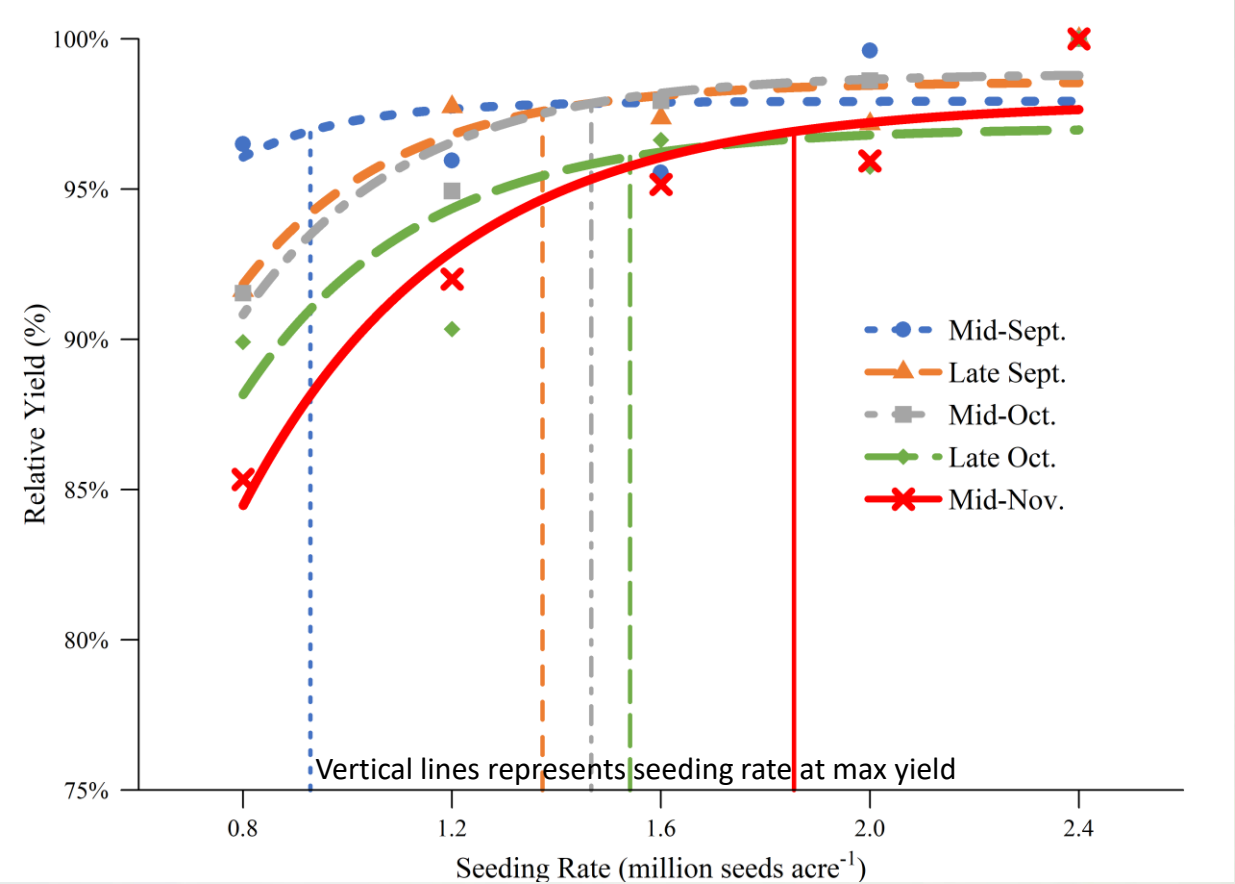
- Yield declined with later planting, but rate of decline varied by year



Crop insurance eligibility: by **Oct 25**

Copeland et al., 2023

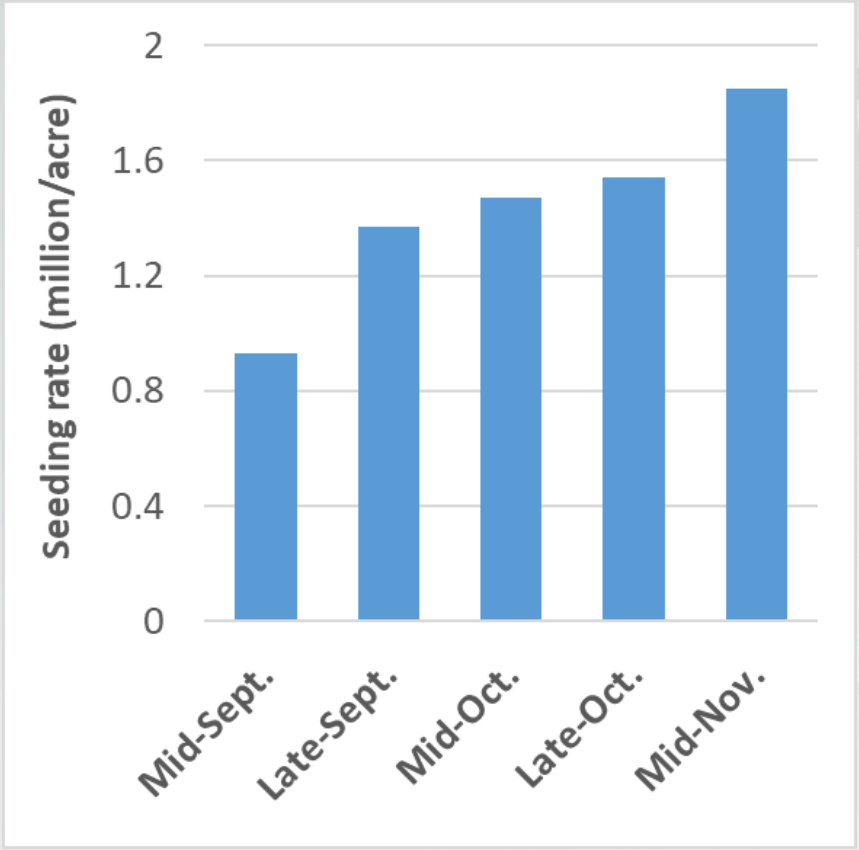
Optimal Seeding Rate vs Planting Date



3 years (2020-2022)
Mason, MI
Tilled Fields (7.5" drill)
Variety: Whitetail

Copeland et al., 2023

Optimal Seeding Rate vs Planting Date



Optimal seeding rates:

Planting window	Seed Rate (million/acre)
Sept.	≤ 1.0
Early-mid Oct	1.2 – 1.4
After mid-Oct	≥ 1.6

3 years (2020-2022)
Mason, MI
Tilled Fields (7.5" drill)
Variety: Whitetail

Copeland et al., 2023

Importance of Seed Placement?

- Variable planting depth
- Skips and doubles

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

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.

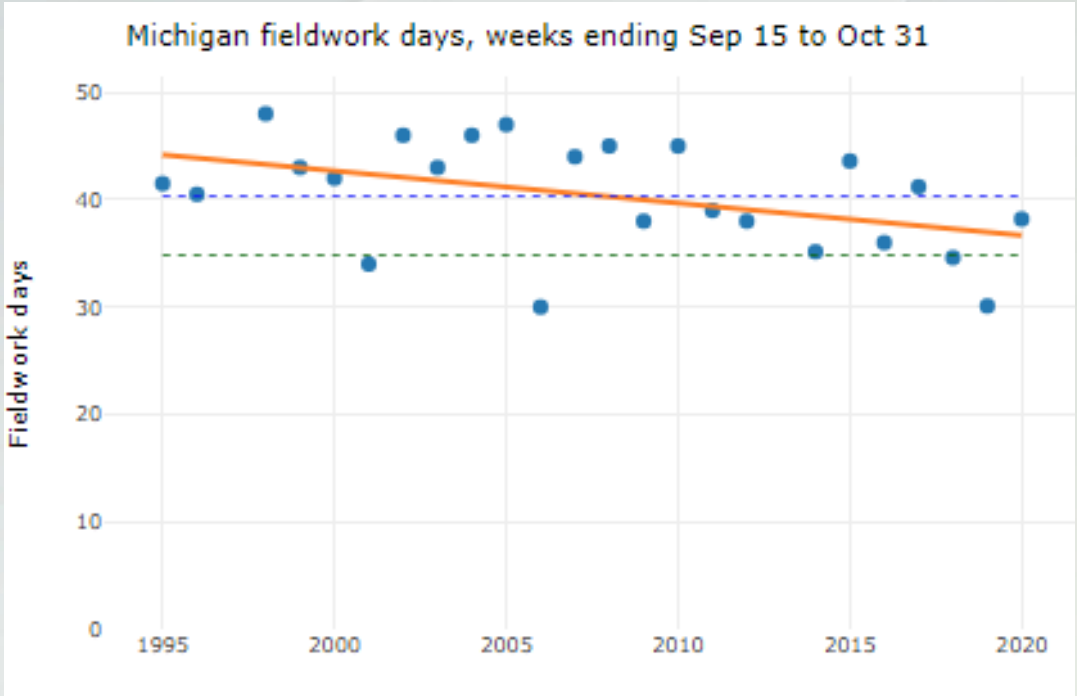
Broadcast Incorporation (BI)

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.

Decline in days for Fall 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)?

Wheat planting method trials

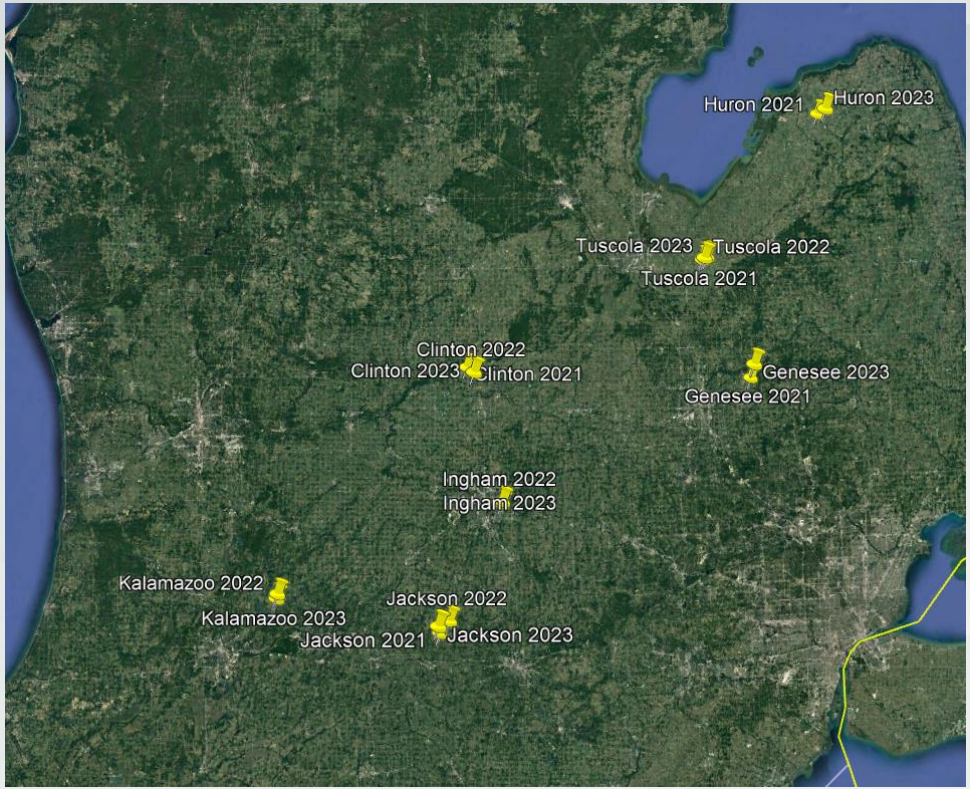
Drill (7.5-in rows)

Air Seeder (4.8, 5, or 7.5-in rows)

Planter (5, 10, or 15-in rows)

Broadcast Incorporation (no row spacing)

On-Farm Planting method trials



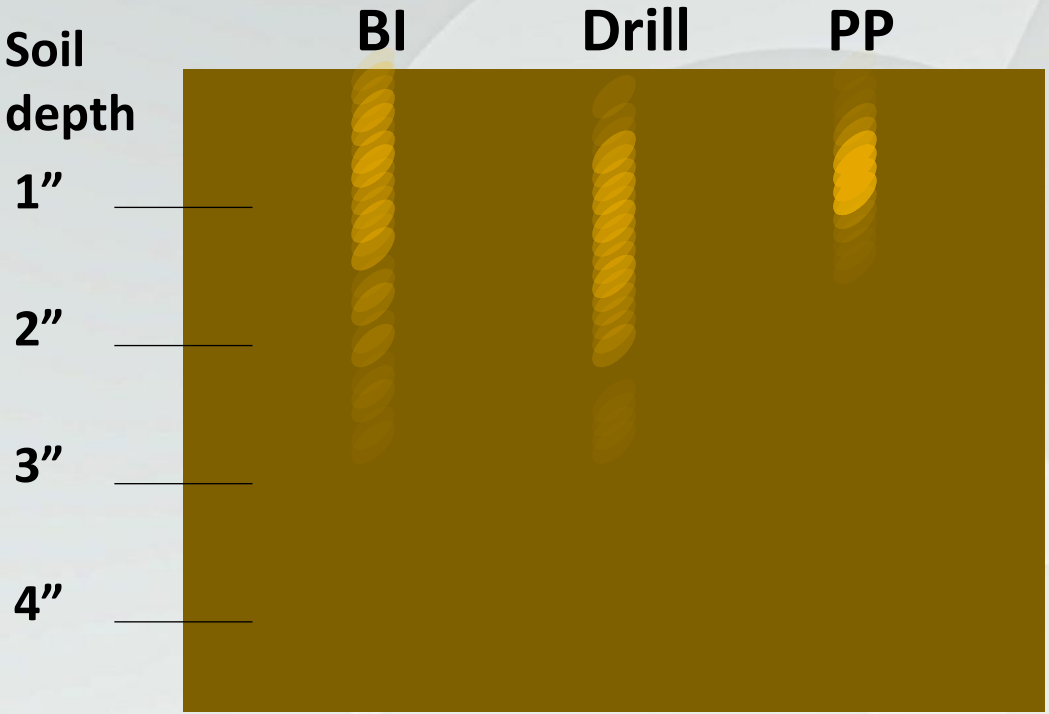
- 17 site-years across Michigan over 3 years (2021-2003)
- Field scale (30–3,000 ft x 10–110 ft)
- RCBD, 4 reps
- Treatments (min. 3 per site-year):
  - Traditional grain drill or air seeder
  - Precision planter (5-in rows)
  - Broadcast incorporation
  - Broadcast incorporation with 30% higher seeding rate

Drill- 7.5’’ row spacing

PP (Monosem)- 5’’ row spacing

BI (Broadcast Incorporation)- no row spacing

Wheat: what seed distribution did we achieve?



BI: Broadcast Incorporation
PP: Precision Planter

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

Variability in Seed Placement: Depth vs Seed Spacing

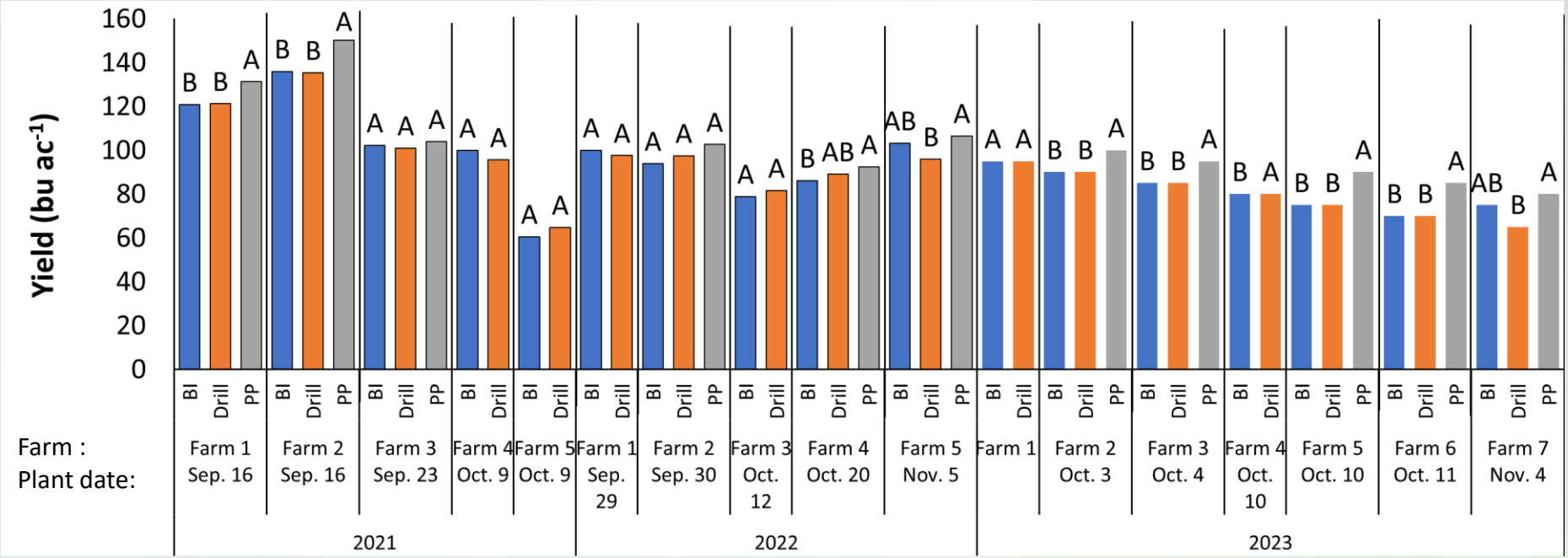
DRILL

PLANTER

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

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

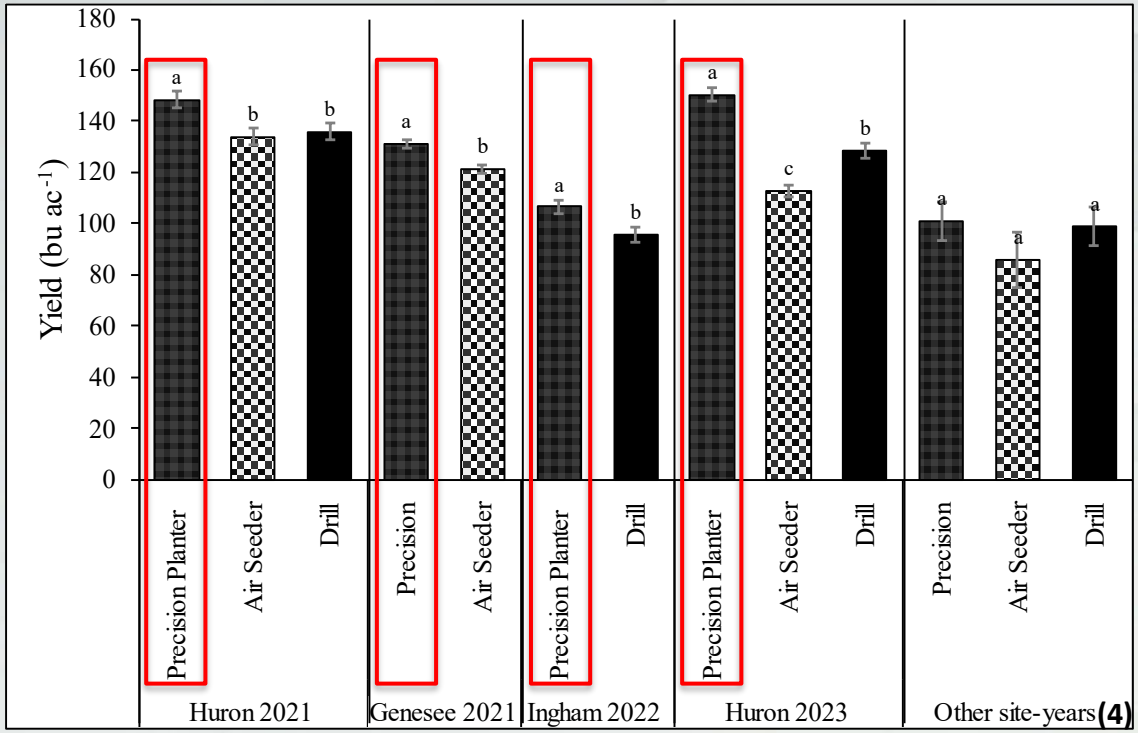
Yield: All treatments and site-years



BI: Broadcast Incorporation

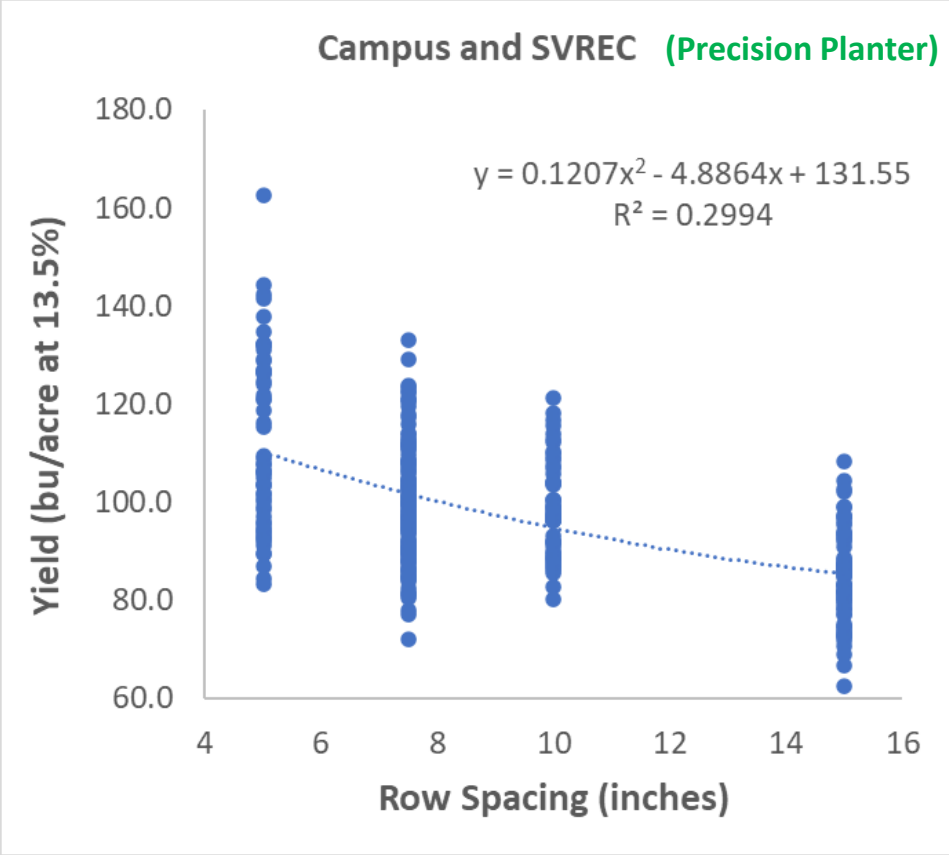
PP: Precision Planter

Yield: Precision Planter vs Drill or Air Seeder



- Precision planting yield **8–33% higher** than drill at 4 of 8 sites
- 46% lower depth variability
- 30–98% higher emergence
- 10–36% more heads per ac
- **Lower DON? (at 1 site-year from other study)**

Wheat yield vs Row Spacing (small-plot research)



Michigan Data. 2018-2019 over 2 locations

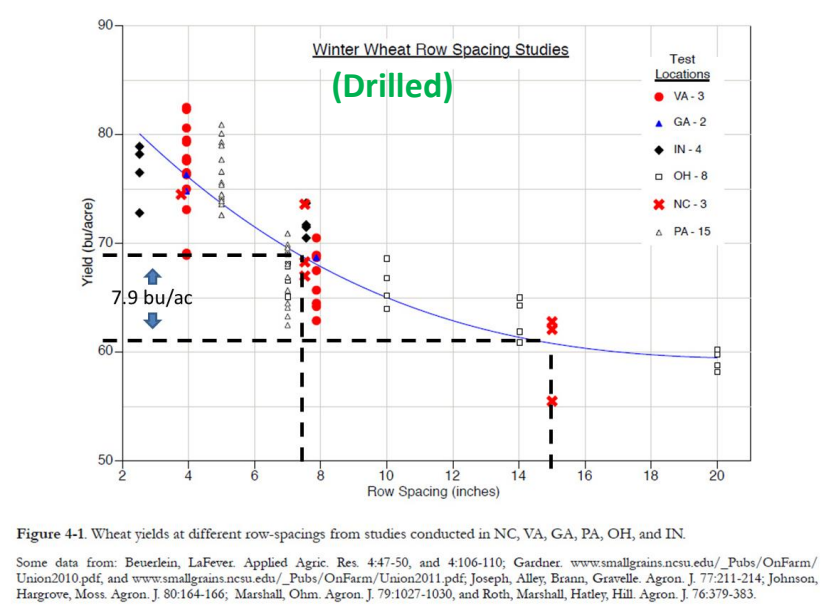
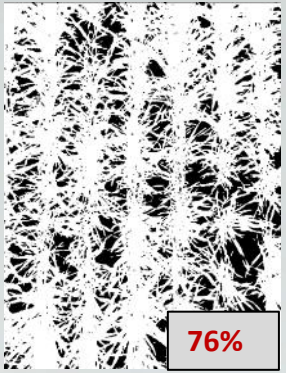


Figure 4-1. Wheat yields at different row-spacings from studies conducted in NC, VA, GA, PA, OH, and IN.

Some data from: Beuerlein, LaFever. Applied Agric. Res. 4:47-50, and 4:106-110; Gardner. www.smallgrains.ncsu.edu/_Pubs/OnFarm/Union2010.pdf, and www.smallgrains.ncsu.edu/_Pubs/OnFarm/Union2011.pdf; Joseph, Alley, Brann, Gravelle. Agron. J. 77:211-214; Johnson, Hargrove, Moss. Agron. J. 80:164-166; Marshall, Ohm. Agron. J. 79:1027-1030, and Roth, Marshall, Hatley, Hill. Agron. J. 76:379-383.

Data from literature

May 8, 2020

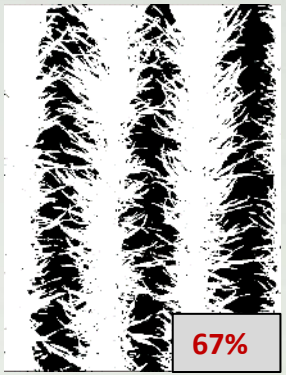


7.5’’ spacing

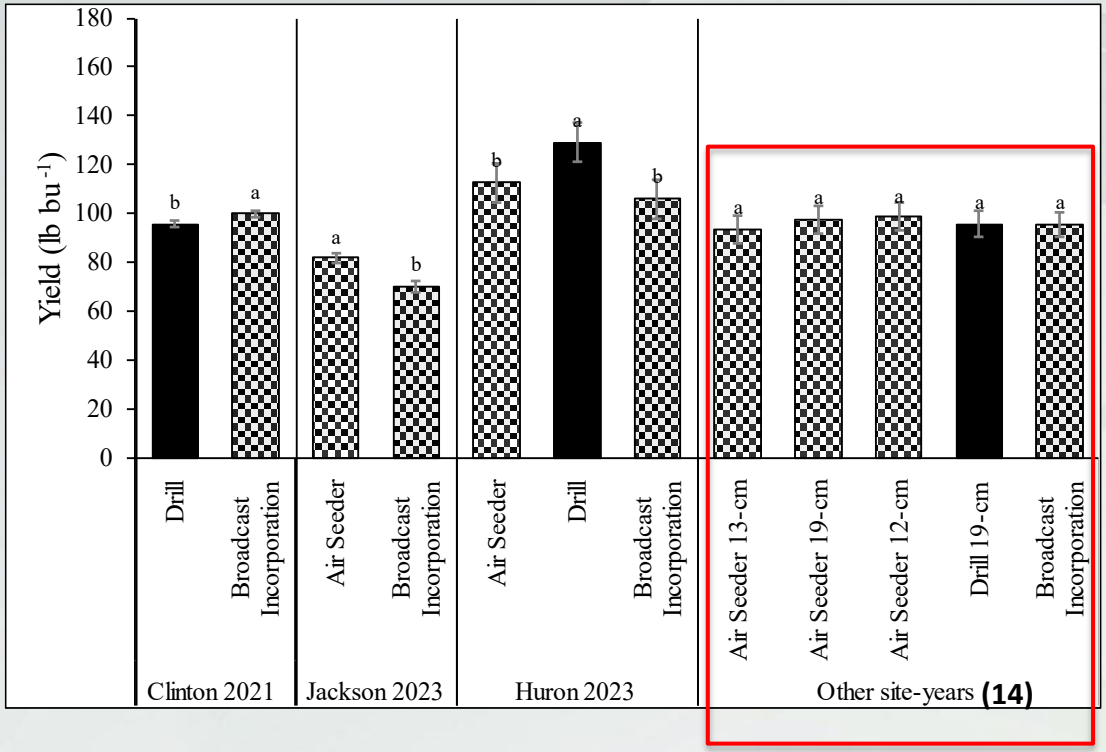
5’’ spacing

10’’ spacing

15’’ spacing

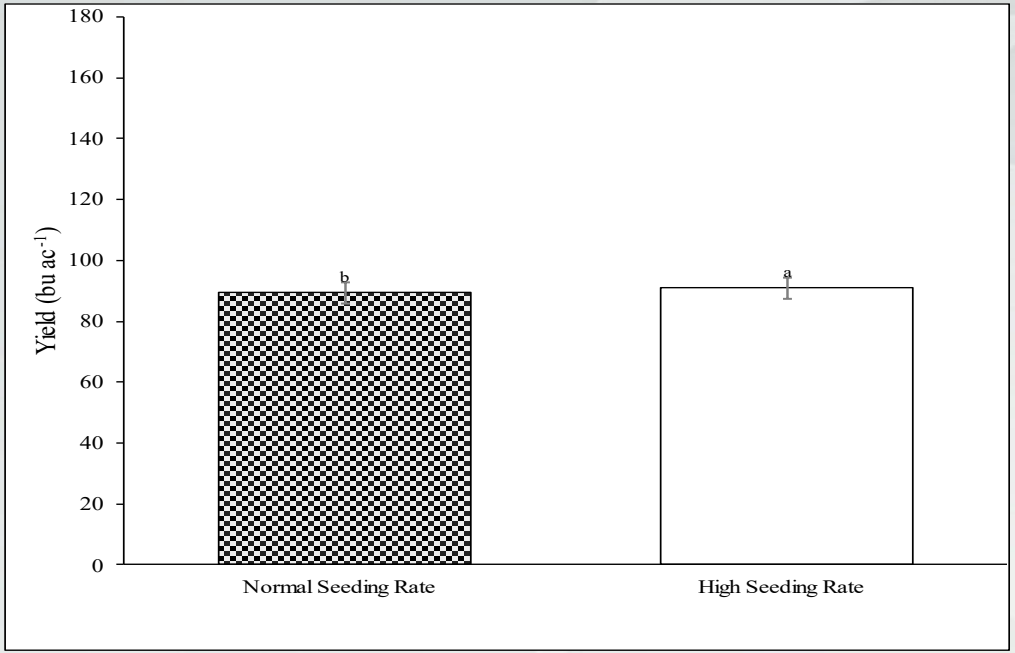


Yield: Broadcast Incorporation vs Drill



- **Similar yield** between broadcast incorp. and Drill
- 103–133% higher depth variability in broadcast
- 28–30% lower emergence
- 56–169% more heads per plant

Yield: Broadcast High vs Low Seeding Rate

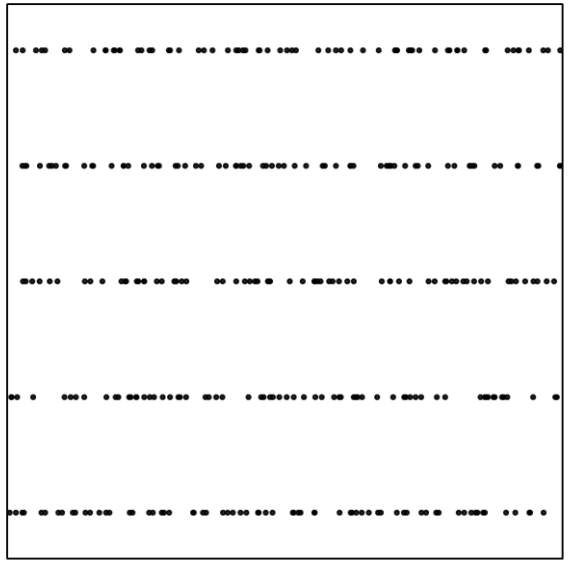


- 2% higher yield under higher seeding rate
- 16% fewer heads plant^{-1} under higher seeding rate
- 6% lower emergence under higher seeding rate

Wheat Seed Distributions

Seed Drill

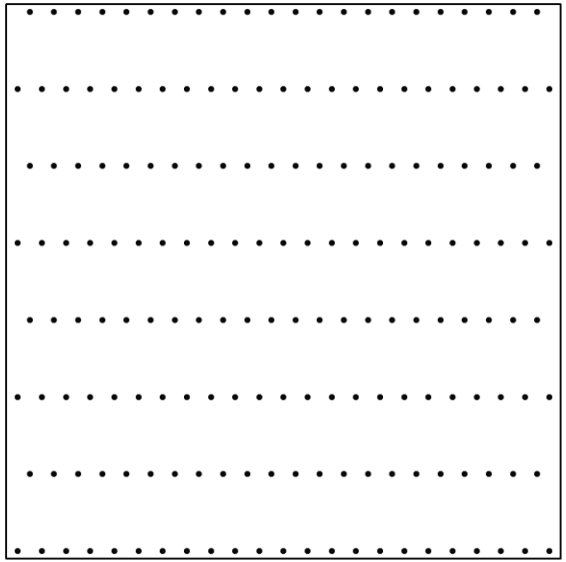
7.5’’ Row Spacing, 1.6m s/a



0.5” seed spacing
(variable depth, spacing)

Precision Planter

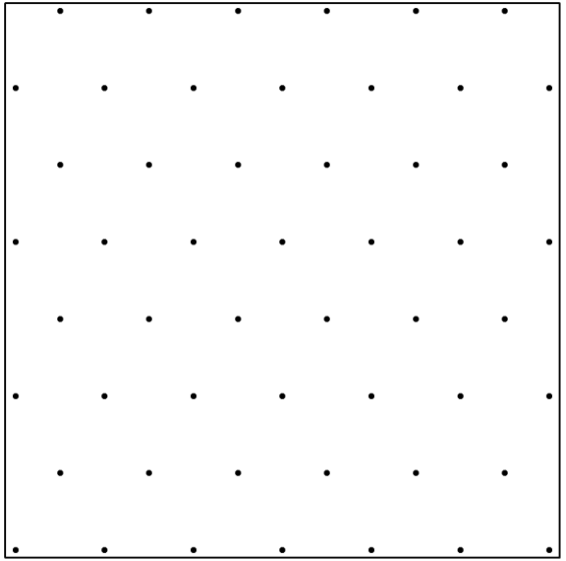
5’’ Row Spacing, 0.8m s/a



1.6” seed spacing

Precision Planter

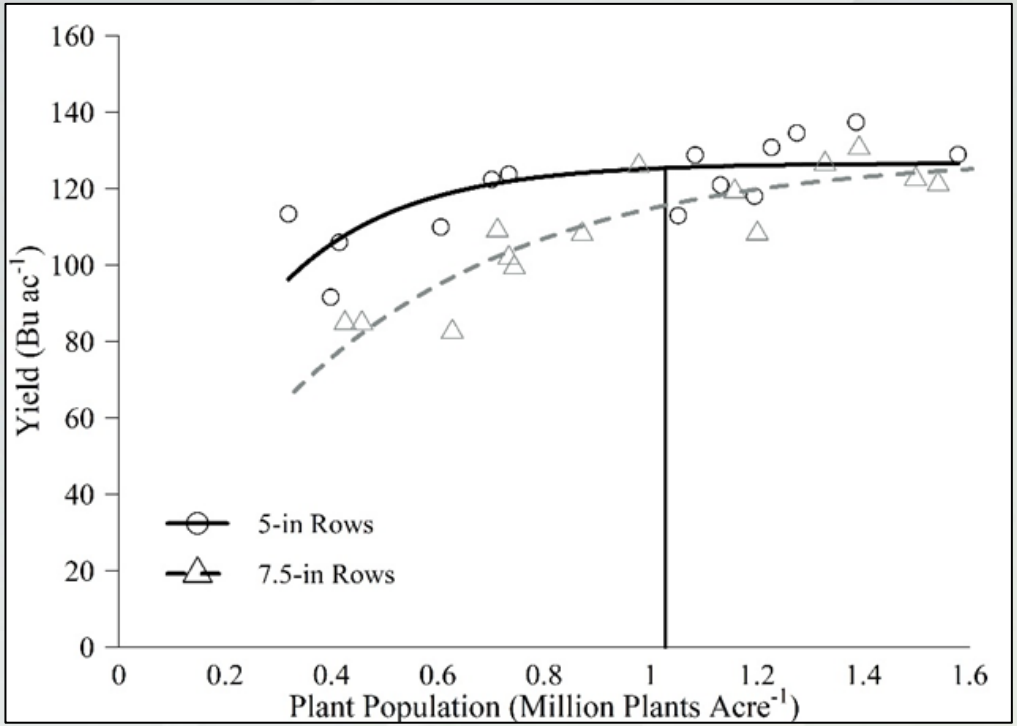
5’’ Row Spacing, ~0.25m s/a



5.8” seed spacing
(Equi-distant)

Ongoing research: New custom-build planter with capacity to plant in **5” row spacing** (using 2 toolbars, with row units spaced 10” apart on each)

Preliminary data (2024): seeding rates

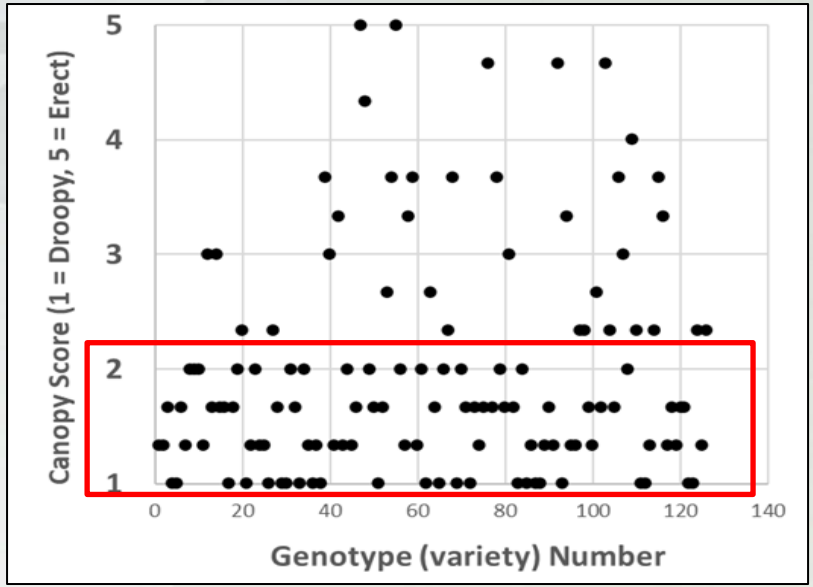


- Optimal seeding rate was lower in planter (5” rows) than drill (7.5” rows)
- Optimal for planter (5” rows): 1.03 m plants/acre

Variety canopy architecture

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

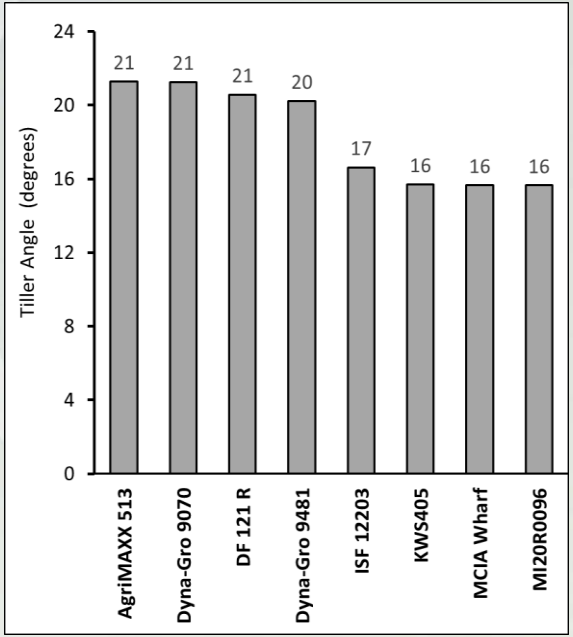
MCIA Wharf
(Erectophile, **Erect**)
Canopy Score- 5



2022 Michigan wheat variety trials

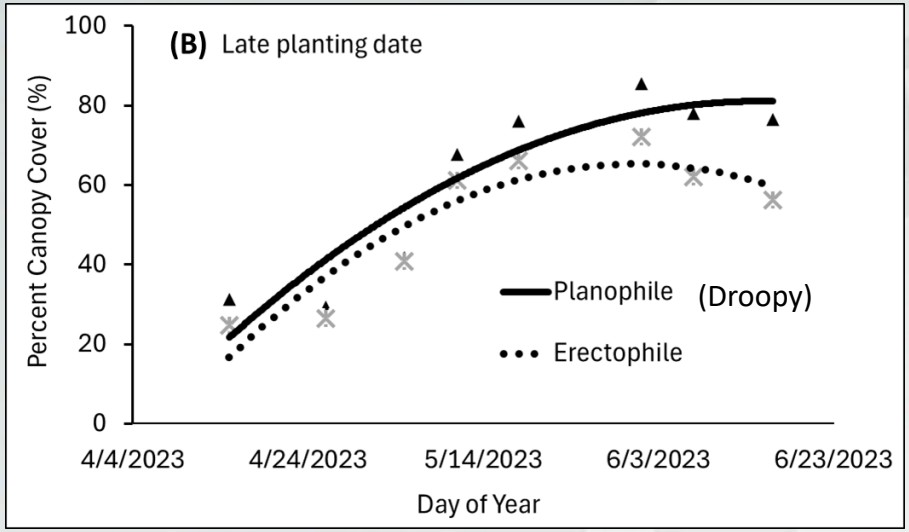
- Wheat varieties differ in their canopy, but most current varieties are droopy
- Research from Australia has shown increased yield with erect varieties

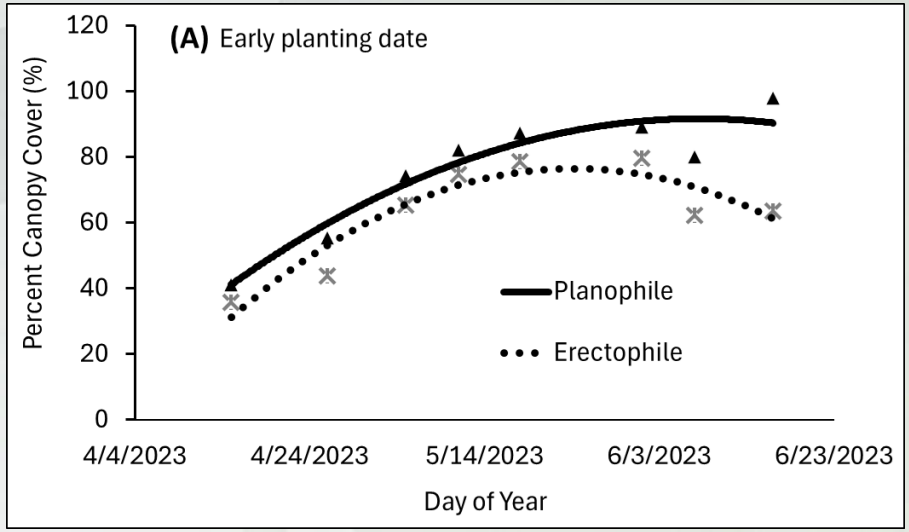
Variety canopy architecture



- Tiller angle was the best measure to quantify varietal canopies
- Evaluate interaction with other factors (e.g., Planting date, Row spacing)

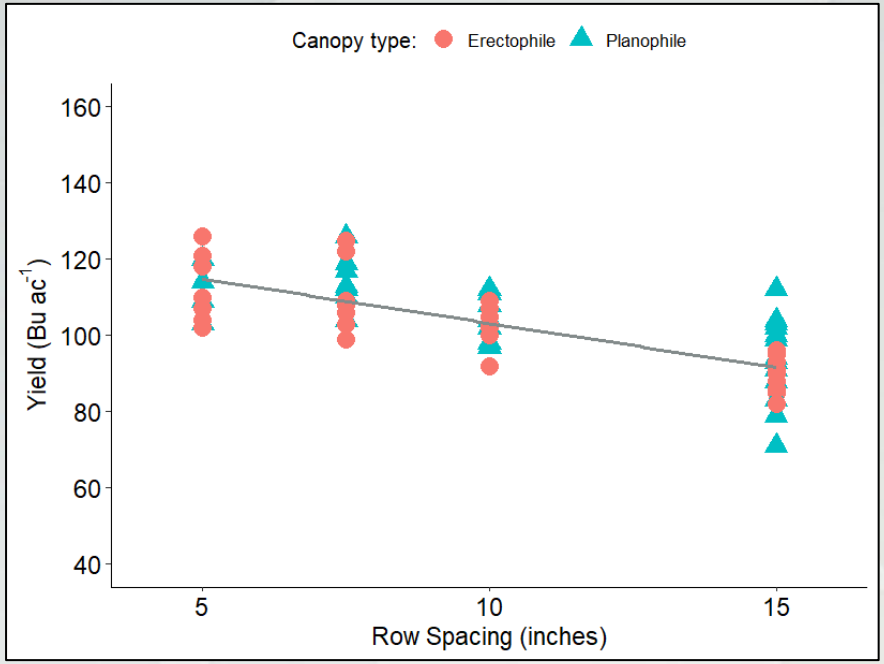
Variety canopy architecture (x Planting date)





- Earlier and grater canopy cover with droopy (planophile) varieties compared to erect types
- Minimal differences in yield (**planting date** was the main factor)

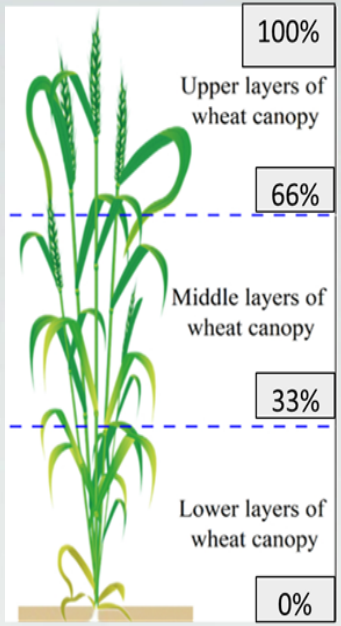
Preliminary data (2024): row spacing x variety canopy

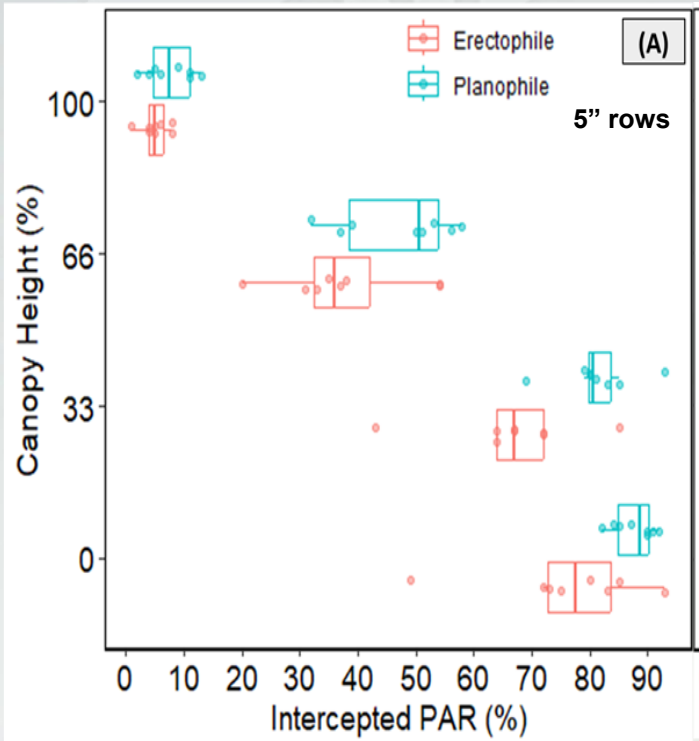


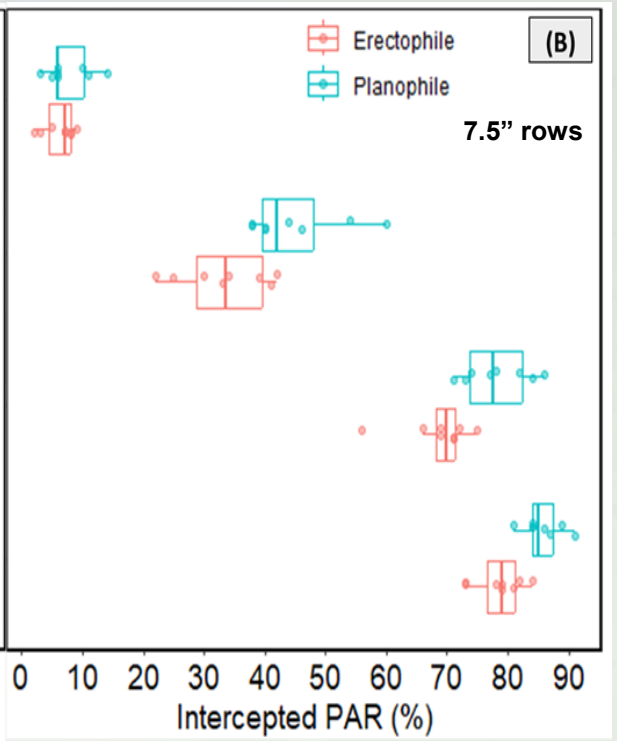
- Narrower rows resulted in yield improvements
- Erect varieties did well in 5” spacing, but NOT in wider (15”) rows
- Droopy varieties did well in wider rows

Preliminary data (2024): row spacing x variety canopy

- Differences in light interception between varieties & row spacings







Take Home Messages

- Timely planting is crucial in achieving high yields and profits, faster planting technologies can help plant early. Timely soybean harvest is important.
- Potential for reduction in seeding rate under timely planting without limiting yield. Test with strips (20-30% lower rate) in your field.
- Narrow row spacing and improved seed placement can lead to increased crop uniformity, grain yield, and quality.
- Match canopy type of wheat variety to your production system? E.g., High yield environments (narrow rows, early planting, high input): use erect varieties.
- Invest in new multi-crop planting system or optimize current planting equipment?

- **Technicians**:
  - Patrick Copeland
  - Lorato Wood
- **Graduate Students**
  - Paulo Arias
  - Wallas Mendes da Silva
  - Benjamin Agyei
  - Kalvin Canfield
- **Undergrad students**
- **Past students**

- **Dennis Pennington**
- **Eric Olson**
- **Amanda Noble**
- Mike Particka
- Paul Horny
- Joao Pereira
- Natalie Michelson

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Thanks!

Cropping Systems Agronomy
MICHIGAN STATE UNIVERSITY

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MICHIGAN WHEAT PROGRAM

Project GREEEN

Seed companies

How to increase Wheat Yields

- Increase # kernels per acre, while maintaining kernel weight