Maximizing Wheat Yield with Precision Planting and Agronomic Management

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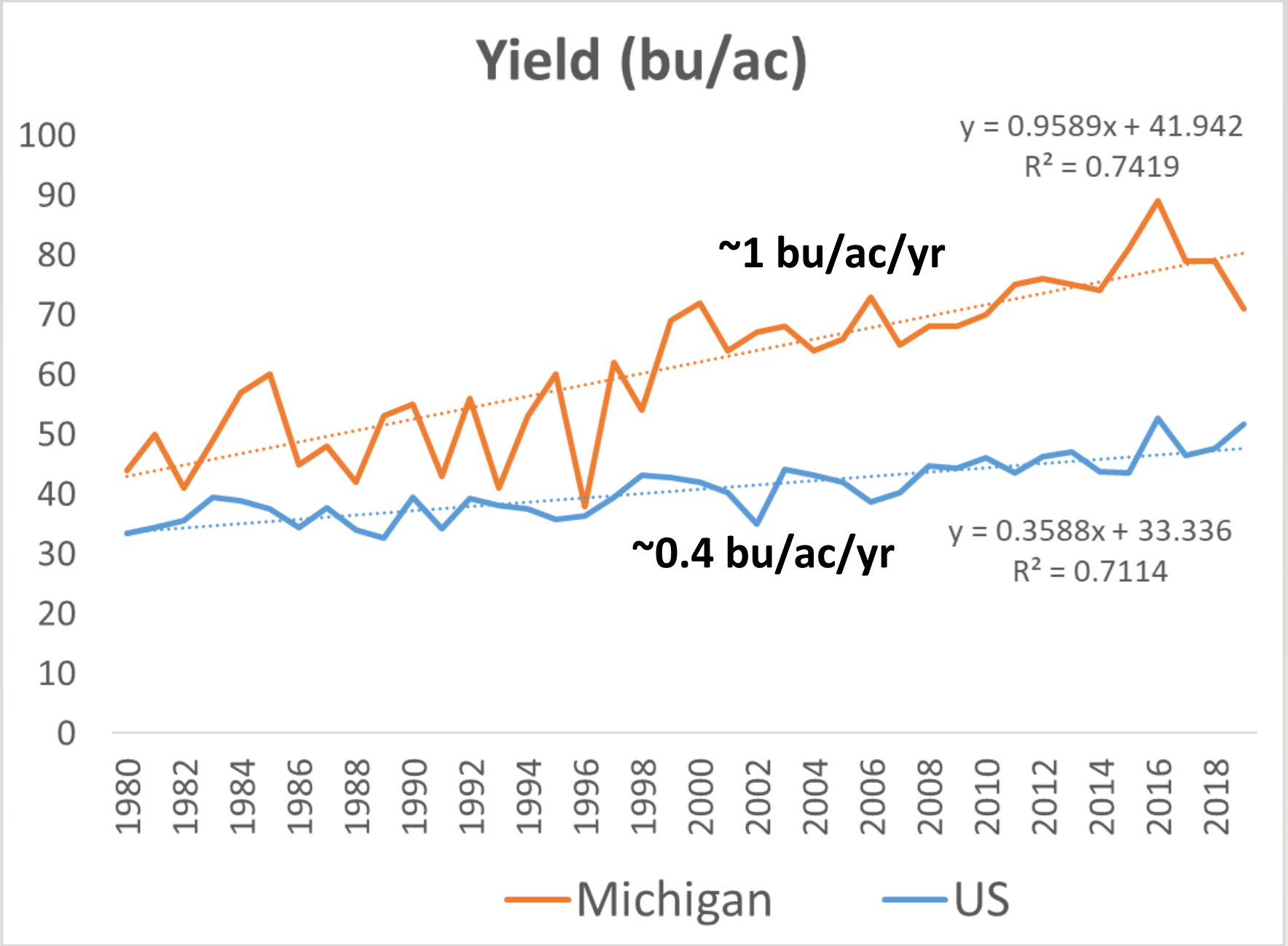
Project GREEEN

Cropping Systems Agronomy
MICHIGAN STATE UNIVERSITY

MICHIGAN STATE UNIVERSITY Extension

MICHIGAN WHEAT PROGRAM

Michigan Crop improvement association


Yield (bu/ac)
y = 0.9589x + 41.942
R² = 0.7419
~1 bu/ac/yr
~0.4 bu/ac/yr
y = 0.3588x + 33.336
R² = 0.7114
100
90
80
70
60
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Michigan
US

Wheat Yield Potential

YP = LI x RUE x HI

YP = Yield potential

LI = Light Interception

RUE = Radiation Use Efficiency

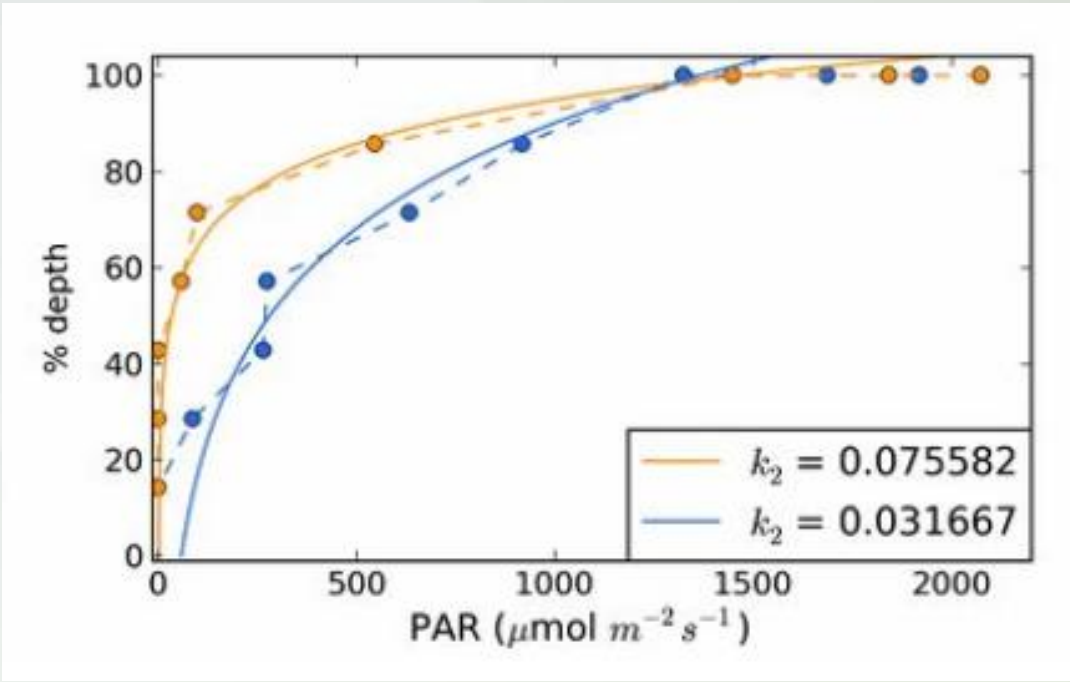
HI = Harvest Index

Wheat Yield Potential

- **Goal**: Design a canopy structure that maximizes:
  - Light interception
  - Radiation Use Efficiency
- **Components**:
  - Stand establishment (seed placement)
    - Seed spacing
    - Seeding depth
  - Row spacing
  - Seed-seed spacing (seeding rates)
  - Variety selection (leaf angle/tillering)
  - Planting time

Canopy Light Interception

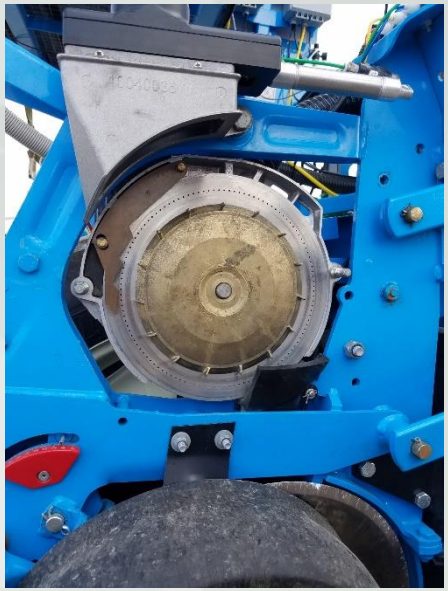
Truong et al. Genetics 2015;201:1229-1238

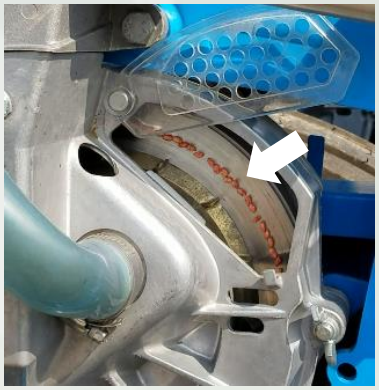


Why Look at Planting Technology???

Wheat Seed Placement

Conventional drill with rotating gear that “spills” seed into the drop tube.





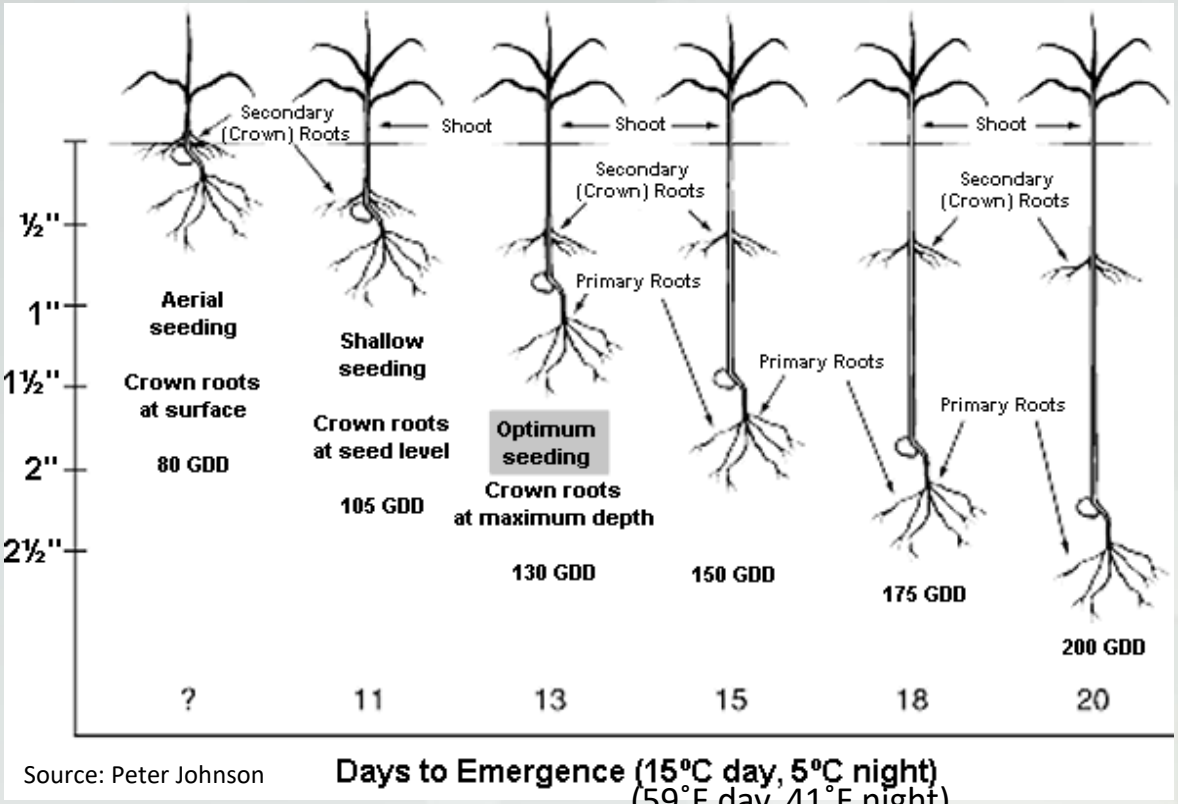
Precision planter with vacuum that picks up individual seeds and drops one seed at a time down the drop tube.

Uniform Seed Placement

- Variable planting depth
- Skips and doubles

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

Target: Uniform Emergence

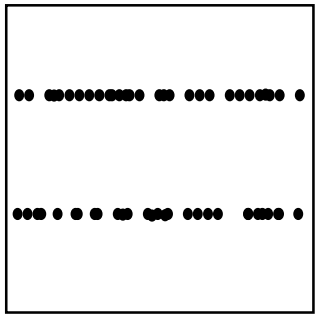
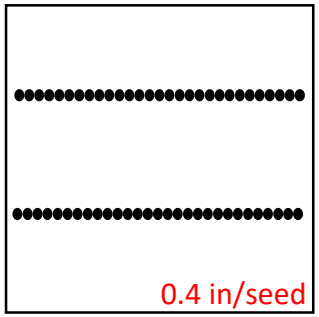
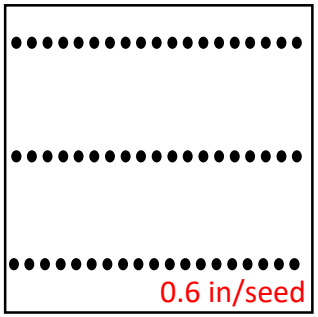
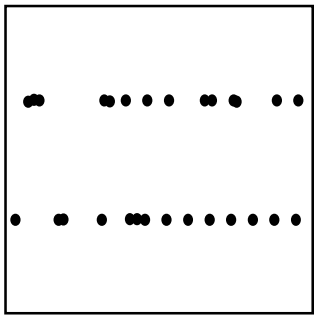
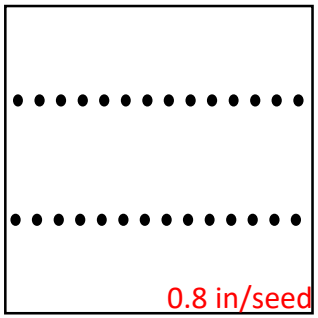
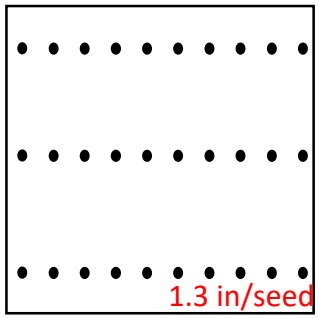


Source: Peter Johnson

Target: Seed to Seed spacing (Singulation)

- More uniform placing of plants within row (less gaps)
- More uniform number of tillers/plant (4-5)
- More uniform planting = more uniform head emergence (better head scab control?)
- Are we there yet??

Seed to Seed Spacing (Singulation)

	Seed drill **7.5'' Row Spacing**	**Precision Planter** **7.5'' Row Spacing**	**Precision Planter** **5'' Row Spacing**
2 million seeds/acre			
1 million seeds/acre			

Uniform Seed Placement

- Uniform spatial distribution can lead to increased resources use efficiency and improved plant health (above and below ground)

- Less variability in crop phenological development- ideal for management decisions

In addition to higher yields, Wallace says he uses less seed since he started planting wheat with a corn planter fitted with inter-plant row units.

Wheat is planted in 15-in. rows. Consistent seed depth and spacing leads to uniform growth and better quality grain, says Wallace.

By Janis Schole, Contributing Editor

He Plants Wheat With His Corn Planter

An Ontario farmer says his wheat yields went up 12 bu. per acre when he started planting with a corn planter instead of a drill.

Morley Wallace of North Gower, Ontario, says that in addition to yield boosts, he uses 11 percent less seed because the crop is planted according to seed population rather than by grain weight. Although the rows were wider apart (15-in. rows versus 7-in. with grain drill), more plants grew per row.

"The corn planter is able to achieve a far more accurate and consistent seed depth than a grain drill, regardless of soil conditions."

Consistent seed depth and seed spacing leads to uniform growth and better quality grain, he points out. Because the row spacing is that much wider, it allows more air movement and more crop movement. Wallace says he plants 1.2 million seeds per acre.

He uses a Trimble EZ- Steer GPS system to ensure precision on-row planting with the corn planter, and the GPS is also used to analyze the field and yield data.

His White 6606 corn planter is fitted with inter-plant units. He changes the plates on

Other than blackening his ground before seeding corn the first year, Morley Wallace of North Gower, Ontario, operates zero till production of soybeans for two years, and one year of wheat, before cultivating again for corn the fifth year. Thanks to seeding with a corn planter using GPS, all crops are grown row on top of row so that they can take advantage of nutrients the previous crop left behind. This virtually eliminates the need for broadcast fertilizer on the wheat, according to Wallace.

"Corn produces its own phosphorus and

one planter and very little cultivation, so it keeps our expenses to a minimum."

He still applies liquid fertilizer with the planter when necessary (22 liters/acre on corn, 11 liters/acre on soybeans, and 11 liters/acre on wheat), but the major savings is from not having to broadcast nitrogen for the wheat.

Although a corn planter is worth between $75,000 and $100,000, Wallace says not needing any other types of planters makes this system worthwhile.

Contact: FARM SHOWFollowup, Morley

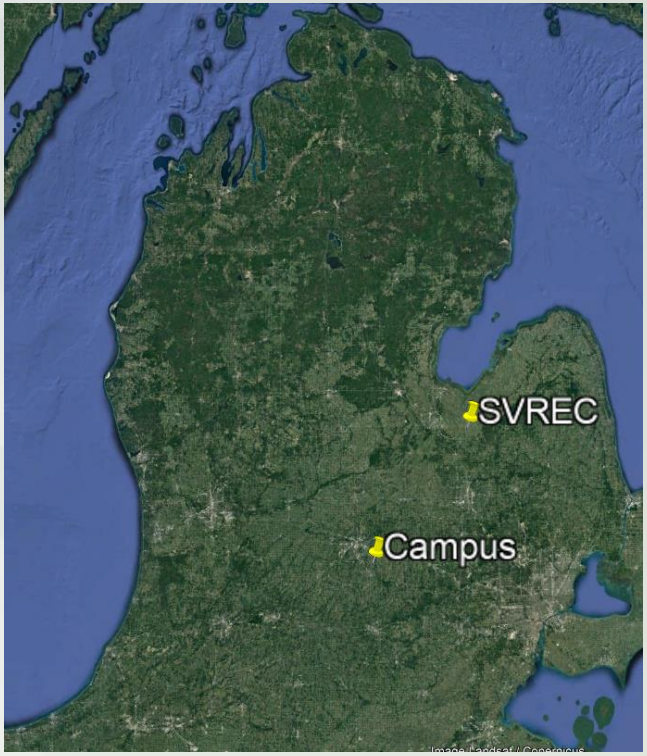
Farm Show Magazine (2007), 31 (5), pp17

Project Objectives

- Compare seed placement accuracy of conventional drill to available precision planting technology
- Determine the optimum row spacing and population in wheat planted with precision planter
- Quantify the response to seeding density in wheat varieties with differing growth habits
- Evaluate optimum seeding rate and variety selection under wide row wheat planting

Methods

- Trial locations:
  - Mason (MSU Mason farm, Lansing, MI)
  - SVREC (Frankenmuth, MI)
- 2017-18, 2018-19, 2019-20
- Split plot design, 4 replications
  - Main plots:
    - Row spacing using precision planter (5'', 7.5'', 10'', 15'')
    - Seed drill (7.5'')
  - Sub plots: Plant population (4)- 0.5, 1.0, 1.5, and 2.0 million seeds/acre
- N - 90 lbs/A at greenup; 30 lbs/A- F7; Herbicide (end April); Quilt Xcel- F9; Prosaro- F10.5.1



Variables Measured

- Stand count
- Seed placement
  - Seeding depth
  - Seed-to-seed spacing
- Canopy light interception
  - Canopy closure
  - Leaf area index (LAI)
- Harvest:
  - Grain yield (13.5% moisture)
  - Moisture content
  - Test weight
- Yield components:
  - Spikes per unit area
  - Kernels per spike
  - Thousand kernel weight (TKW)
  - Total biomass and harvest index

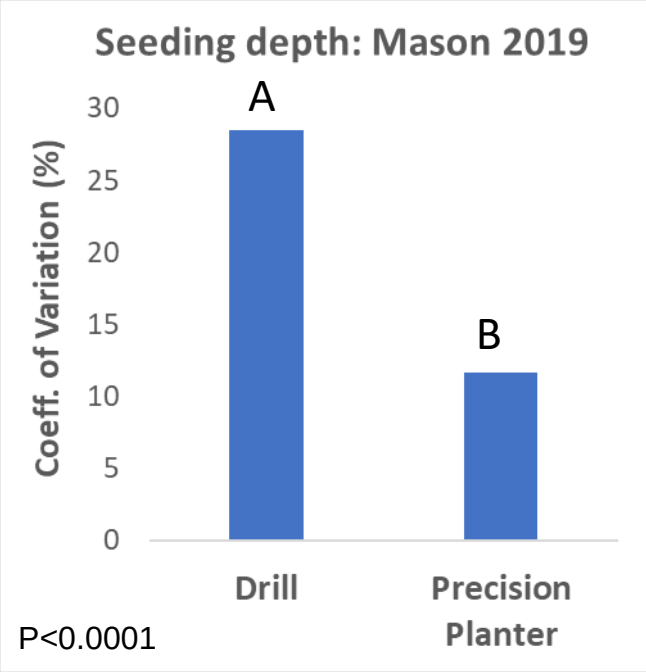
5” spacing

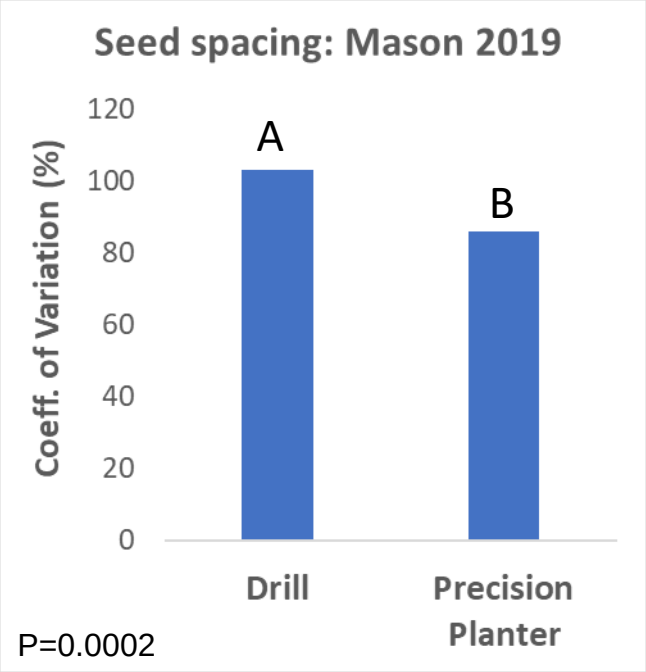
7.5” spacing

10” spacing

15” spacing

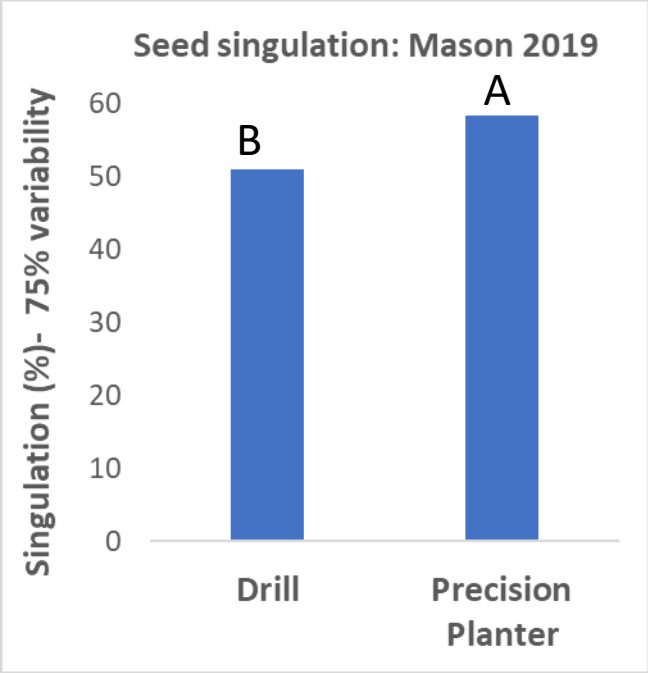
Variability in Seed Placement

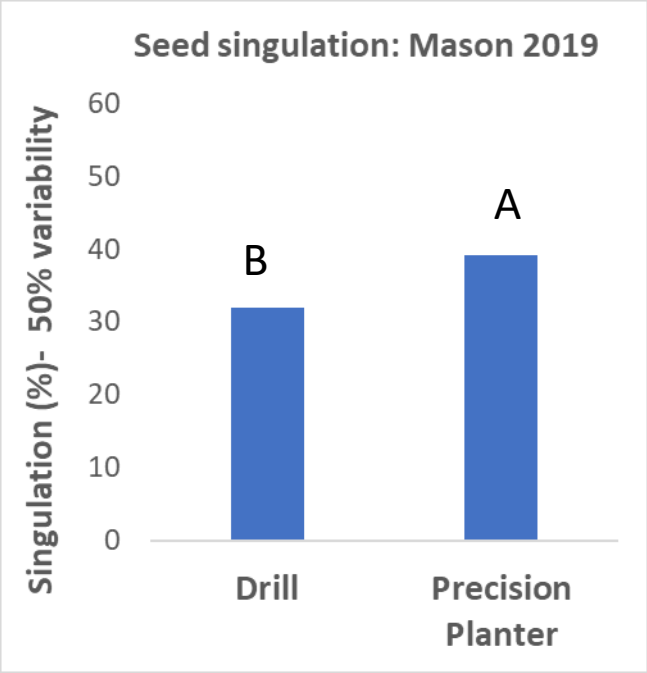


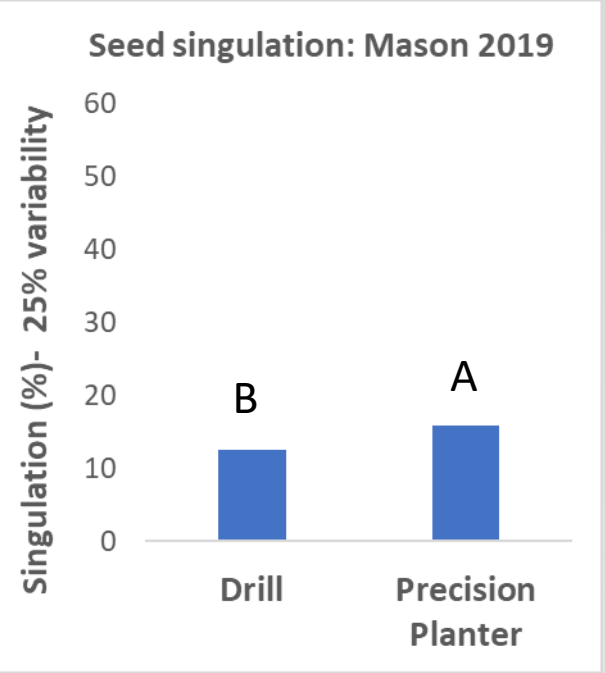


- Planter reduced Coeff. of Variation of seeding depth by an average of **59%** across all treatments
- Planter reduced Coeff. of Variation of seed to seed spacing by an average of **17%** across all treatments

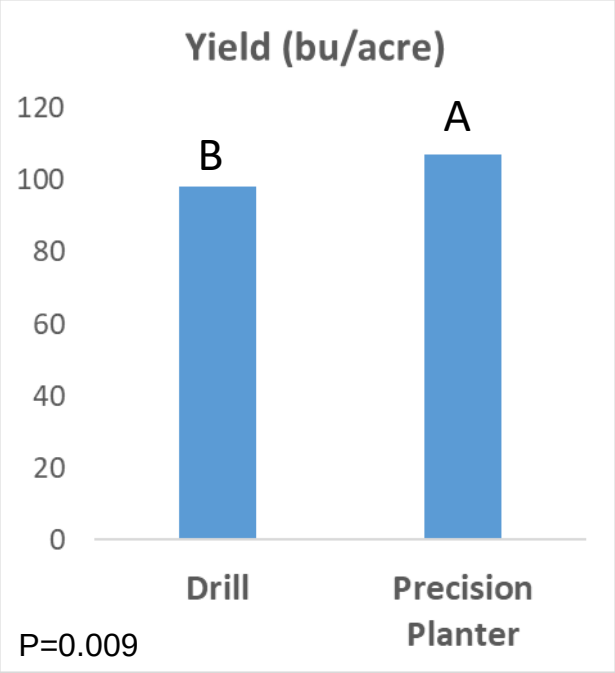
Seed Singulation

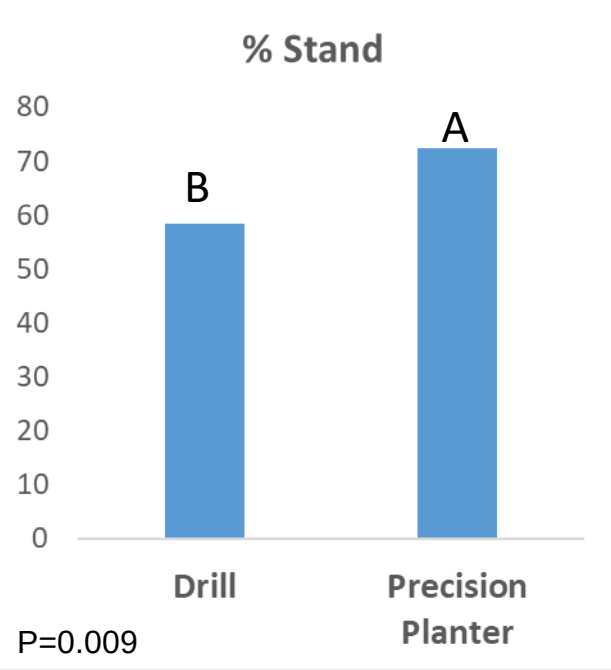






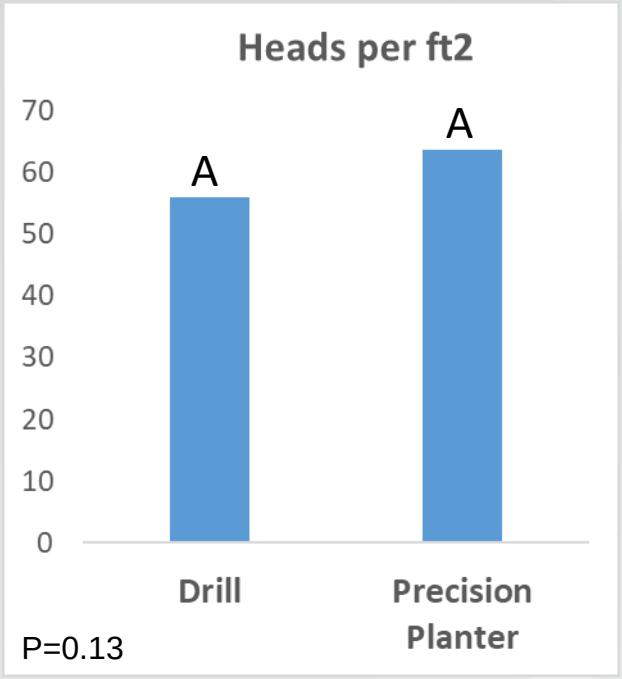
Yield- Drill vs Planter

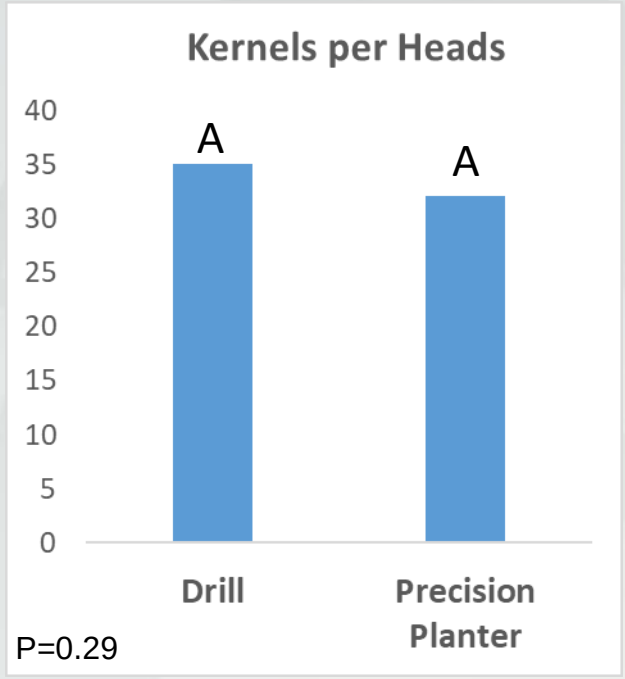


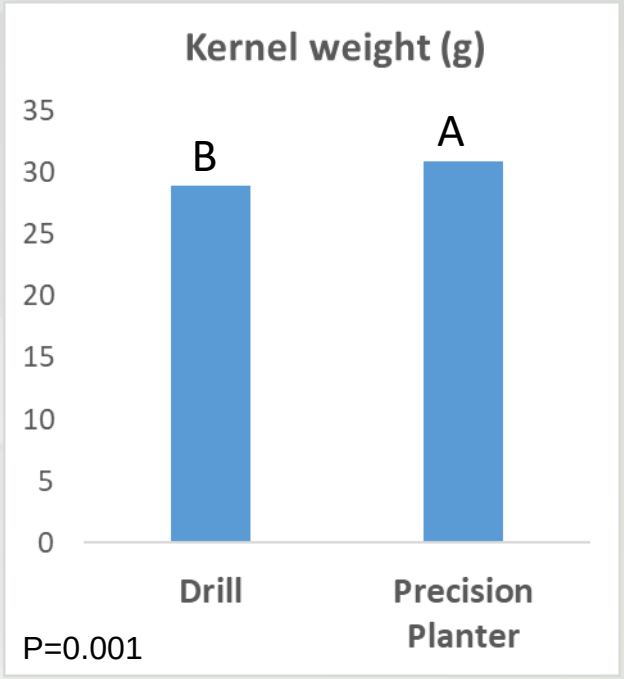


- Planter had 9 bu/ac (9%) greater yield than drill in 7.5’’ spacing
- Stand improved by 24% in planter vs drill

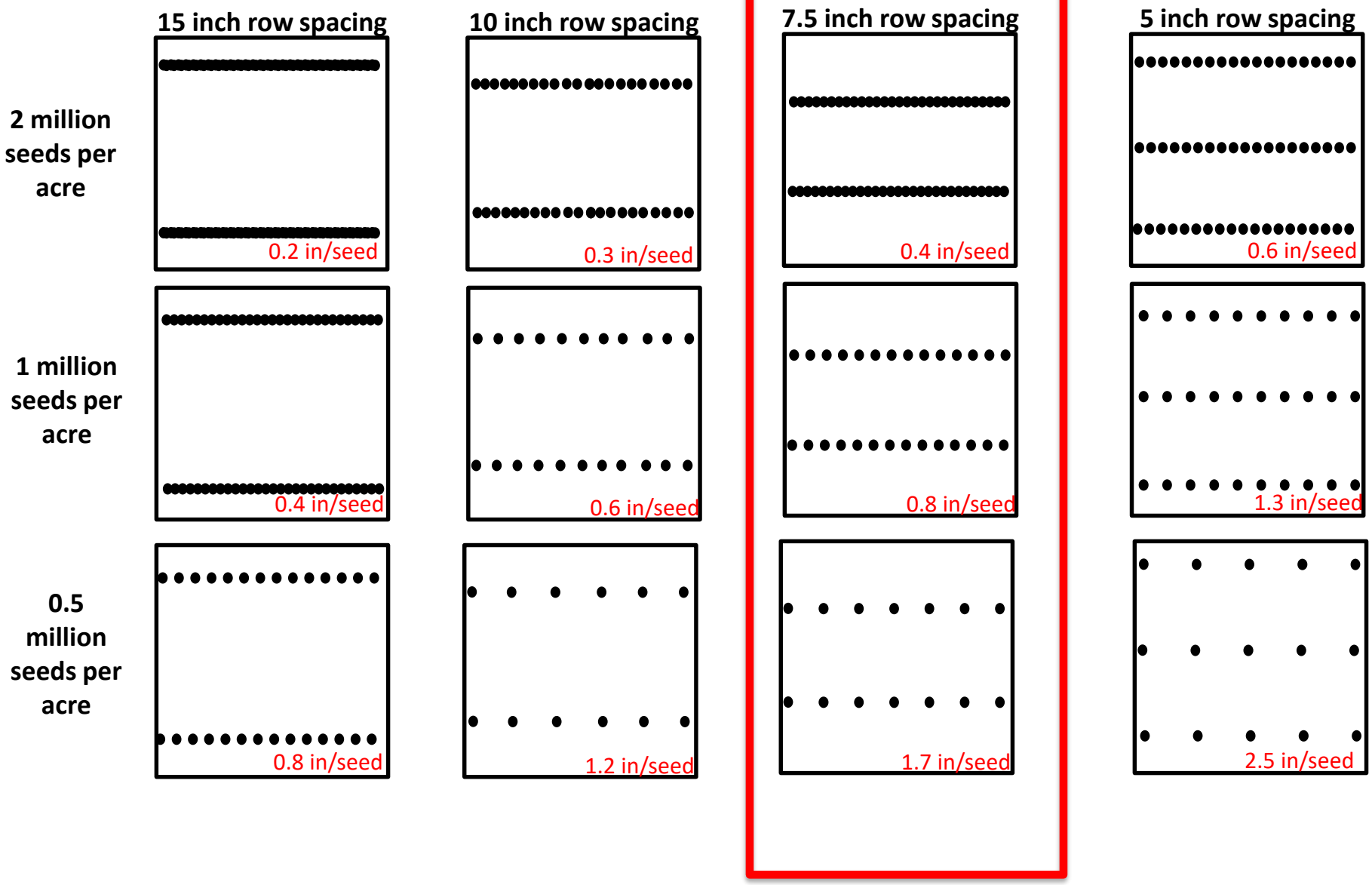
Yield Components



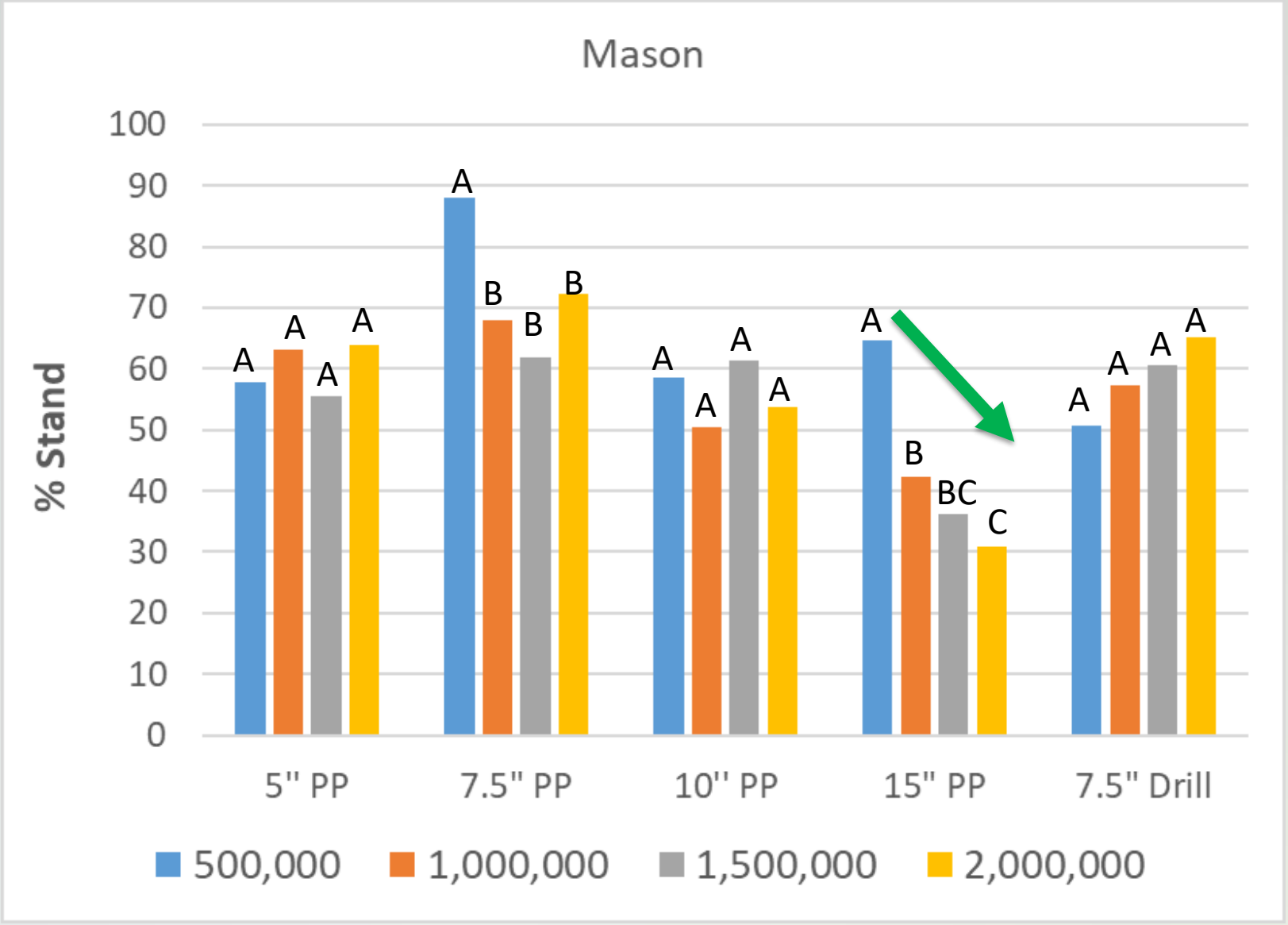




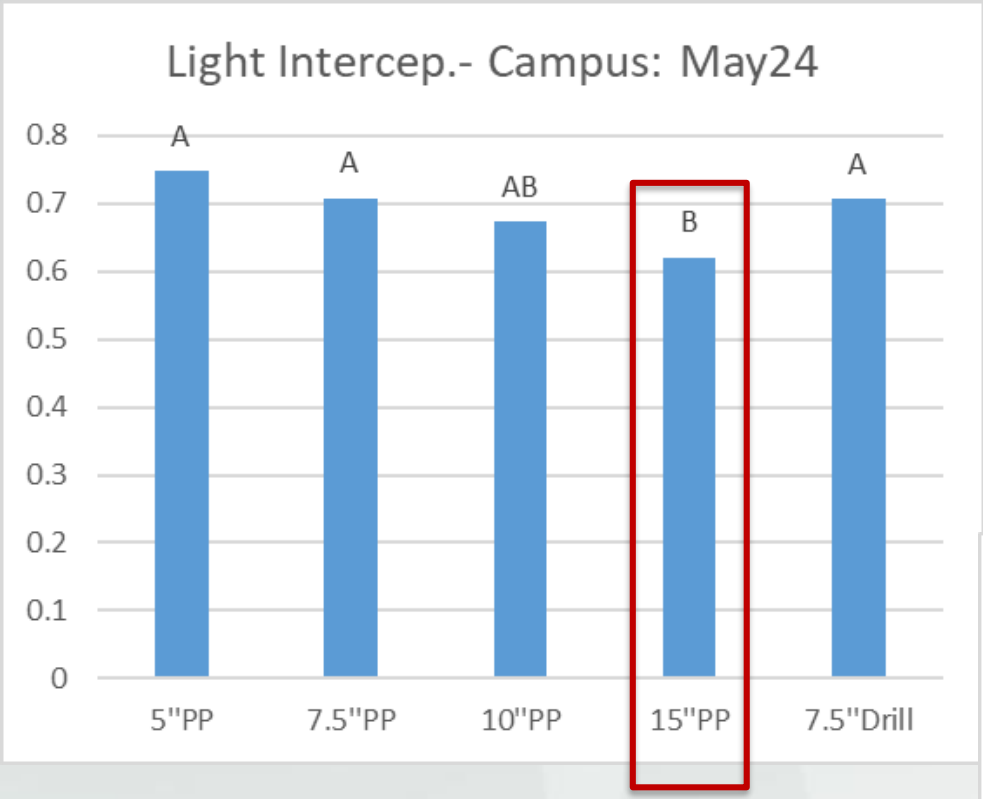
Seed to Seed spacing



Percent Stand



Light Interception



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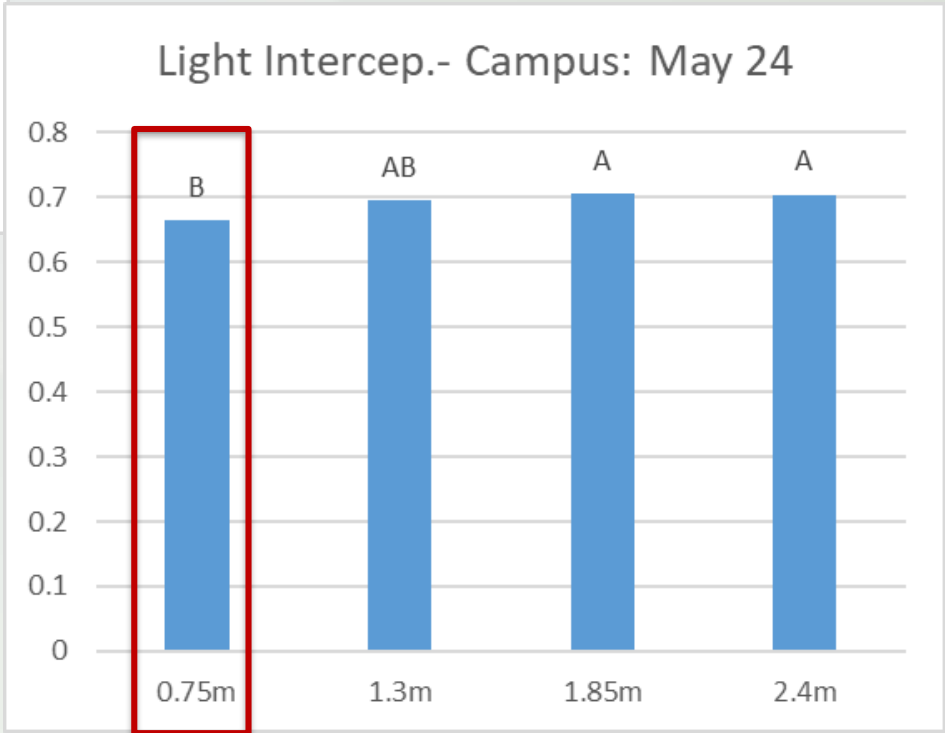

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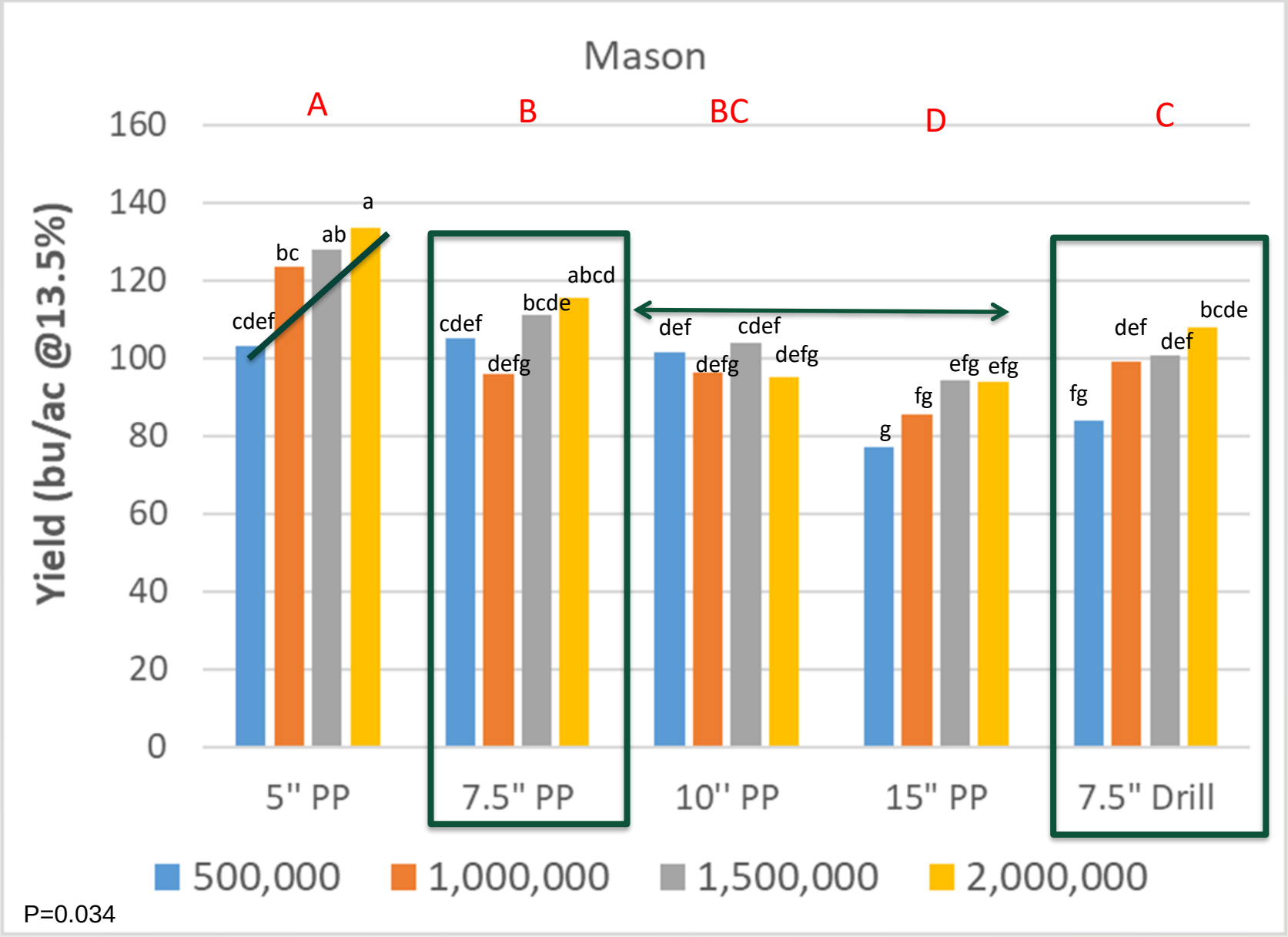
Yield (Mason 2019)

Planting: Oct 24

County average yield: 81 bu/a



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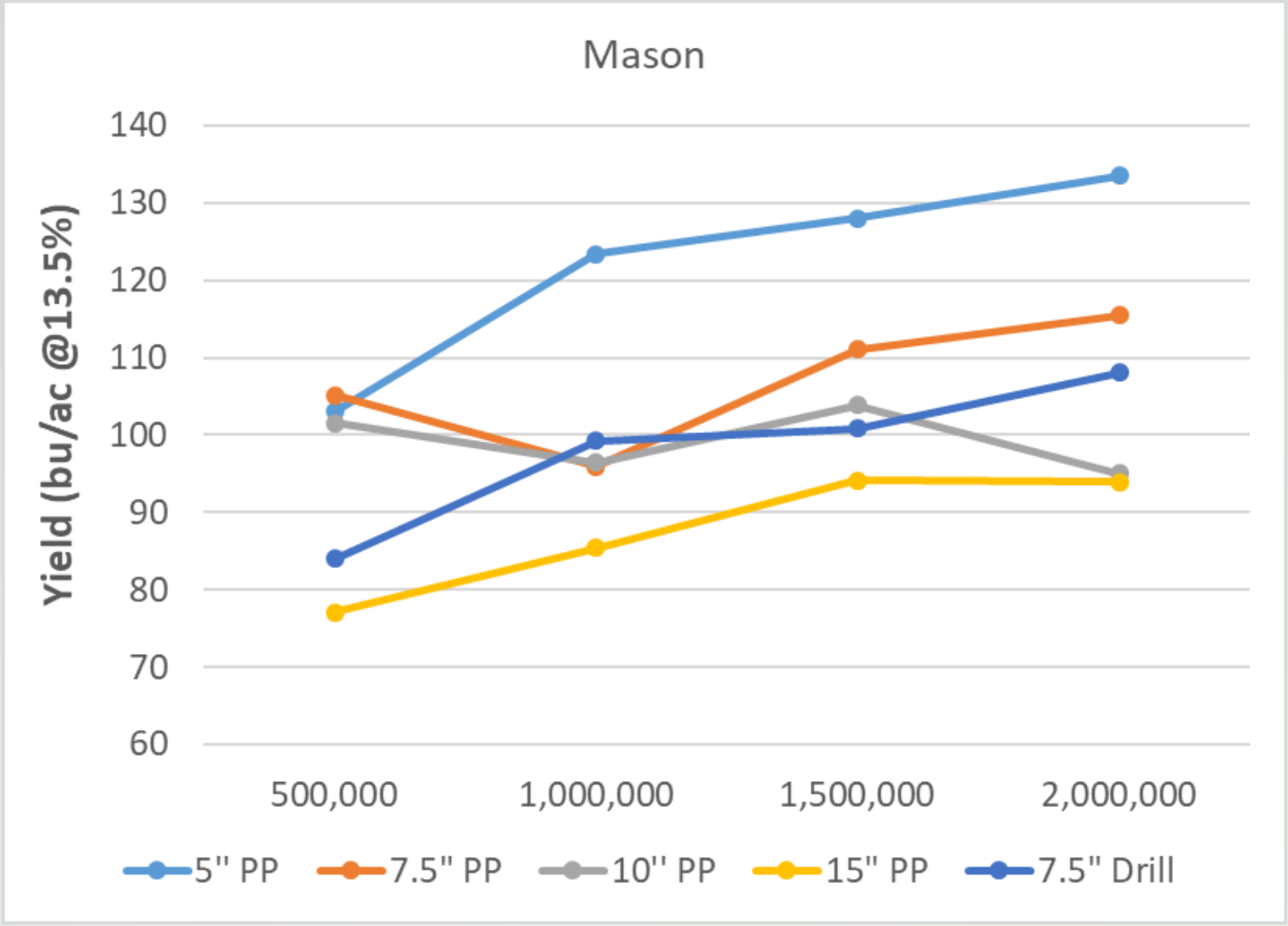
Yield (Mason 2019)

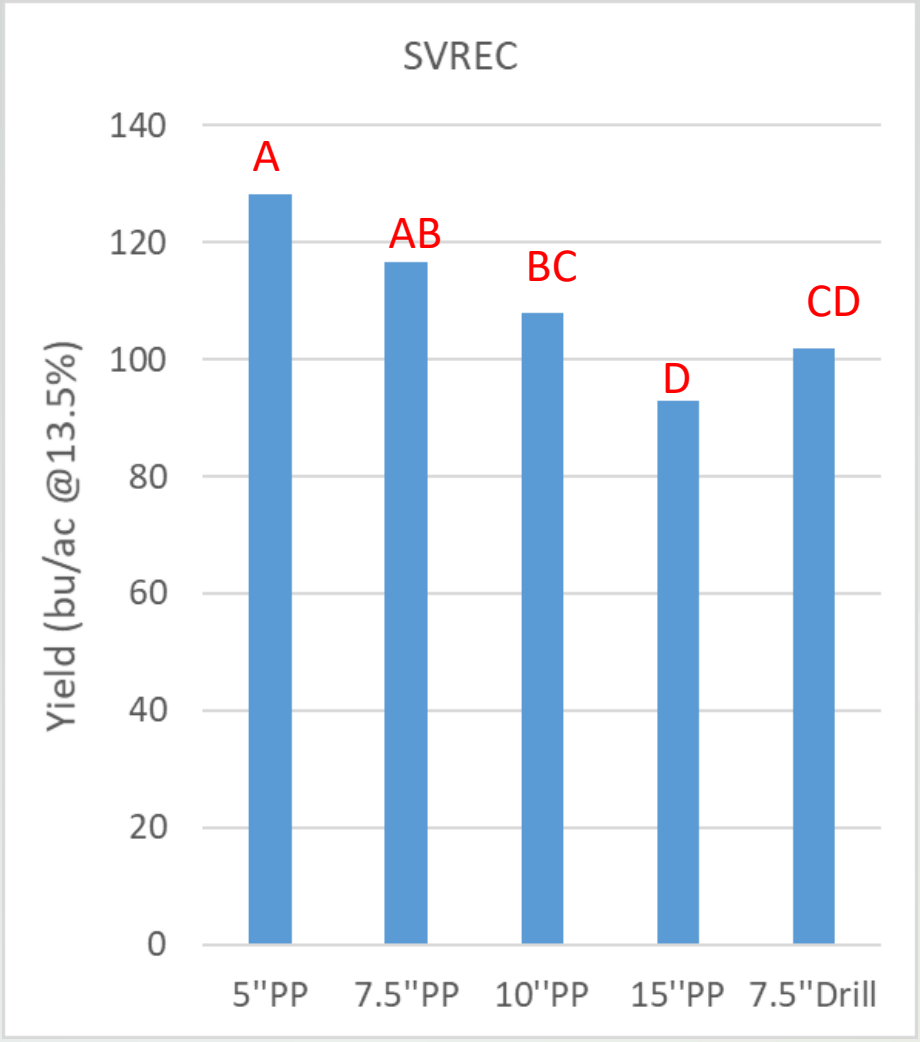
Planting: Oct 24

County average yield: 81 bu/a



Yield (SVREC 2019)

Planting: Oct 9



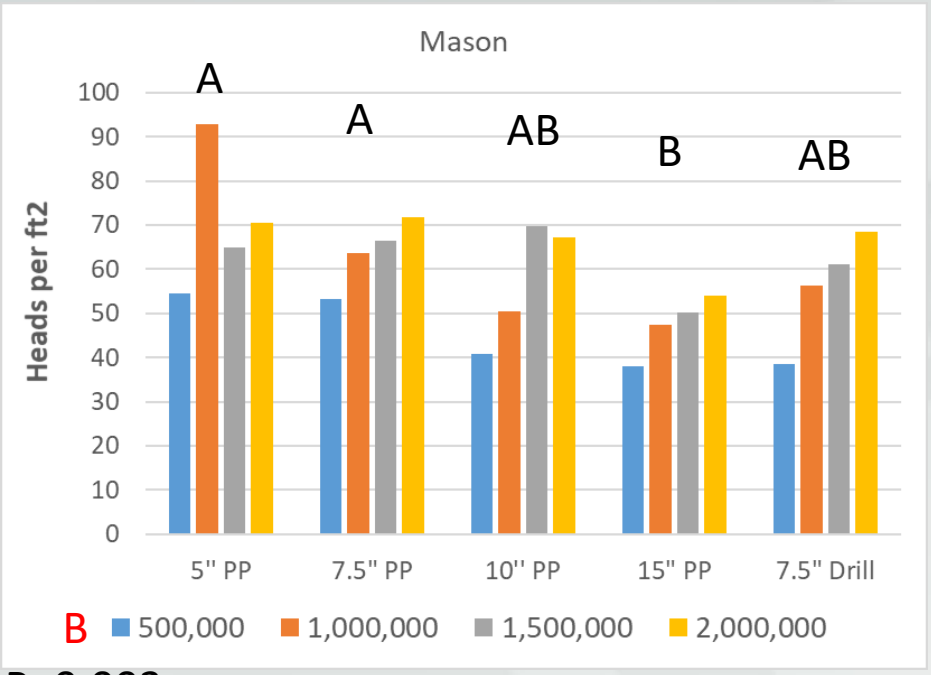
Yield Components

Location	Heads/ft2	Kernels/head	TKW (g)
UK (168 bu/a)	45	50	50
Ontario (119 bu/a)	65	35	35
Michigan (80 bu/a)	60	30	30

Source: Dennis Pennington, MSU

19.2” on 7.5” row spacing = 1 square foot

Yield Components



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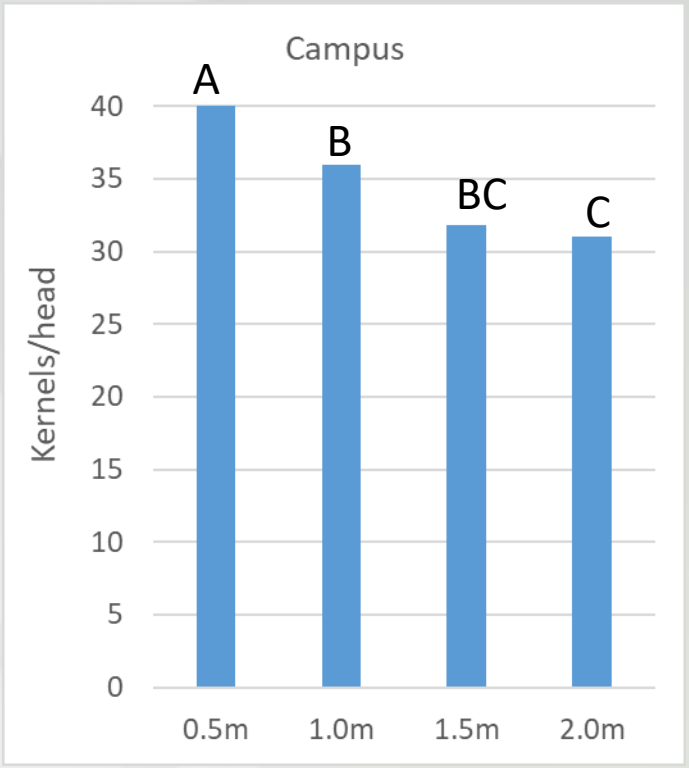

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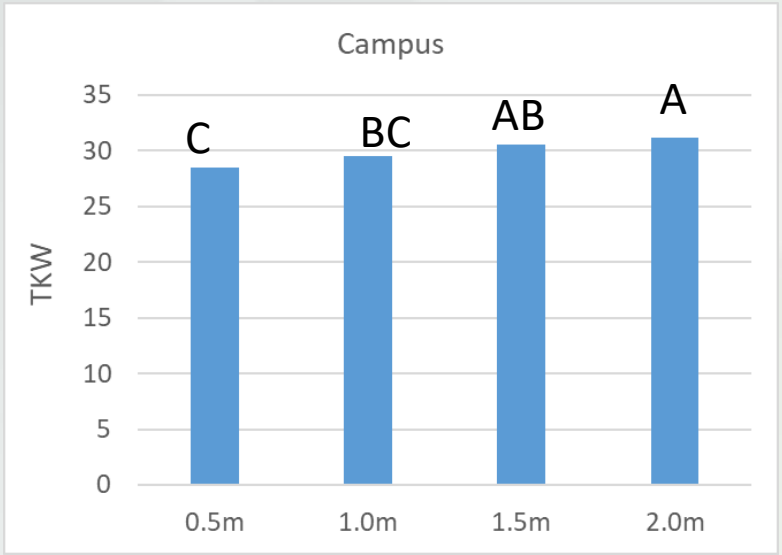

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UK (168 bu/a)	45	50	50
Ontario (119 bu/a)	65	35	35
Michigan (80 bu/a)	60	30	30
Target	60-70	35-40	35-40

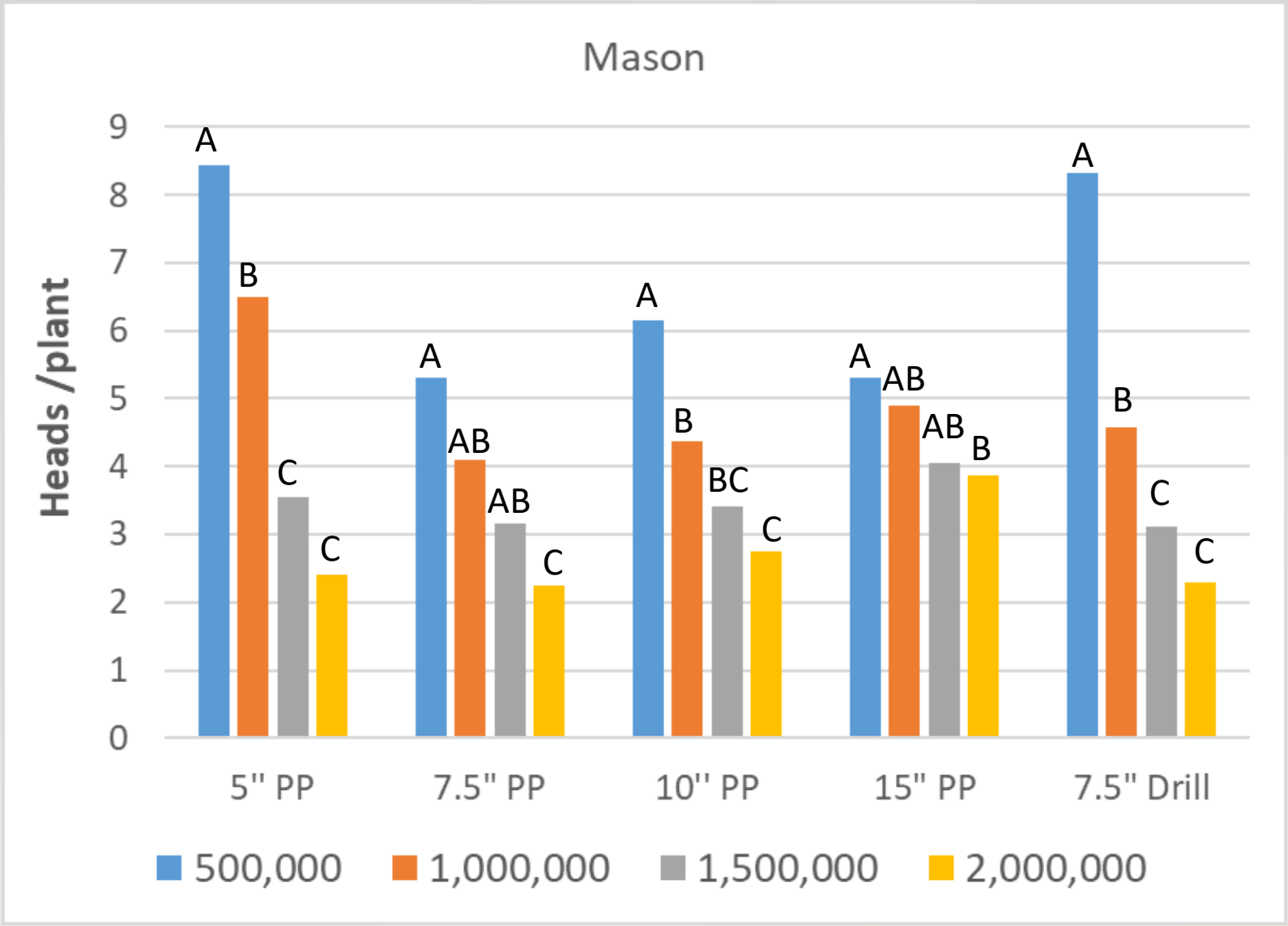
19.2” on 7.5” row spacing = 1 square foot

Tiller Management

- First order tillers (4-5)
- NO second order tillers
- Fall v Spring tillers
- Optimize seed-to-seed spacing
- Use of PGRs?

From Dr. George Schurnbager, N.U. Agrar University, Germany

Heads per plant



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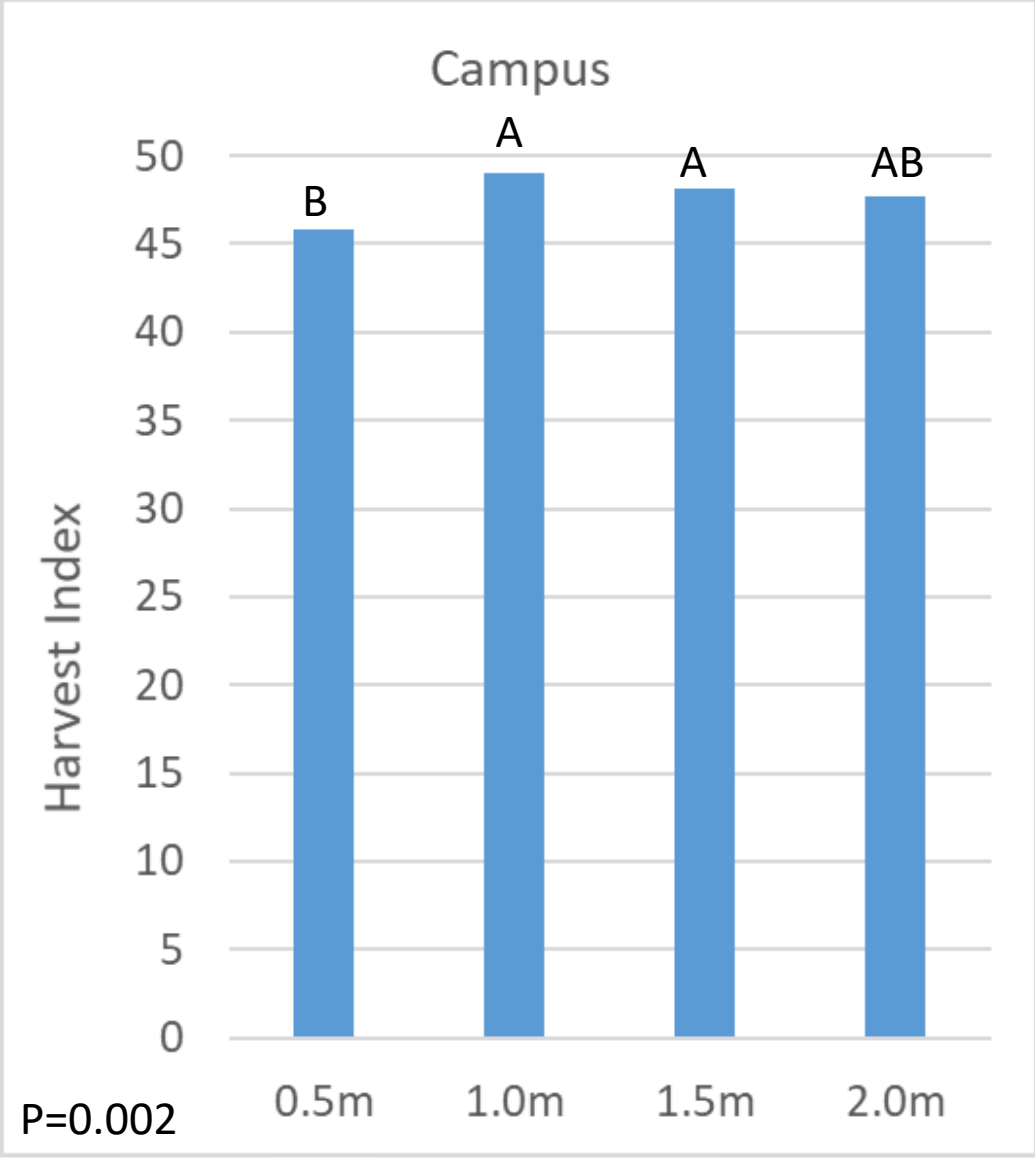
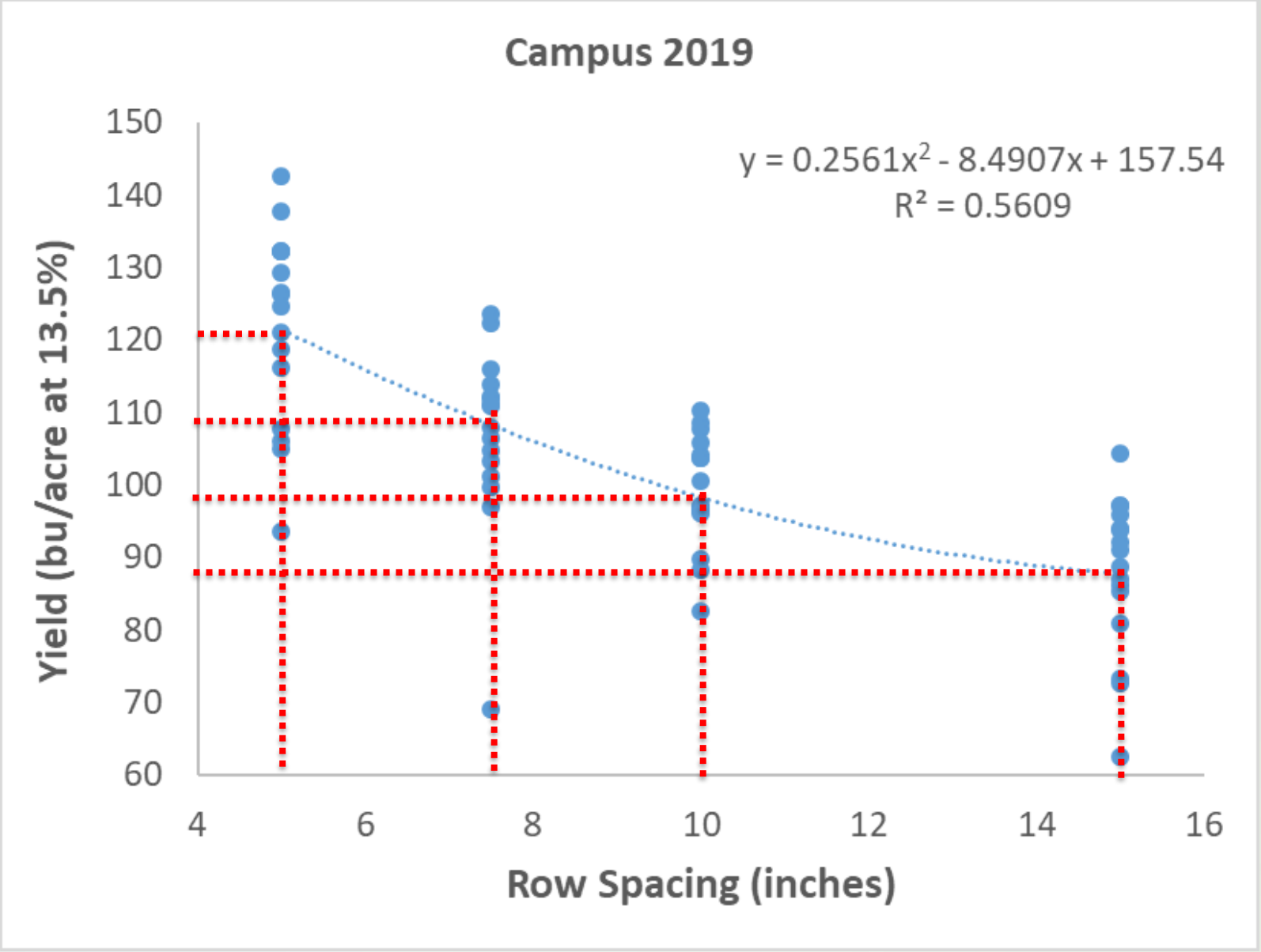
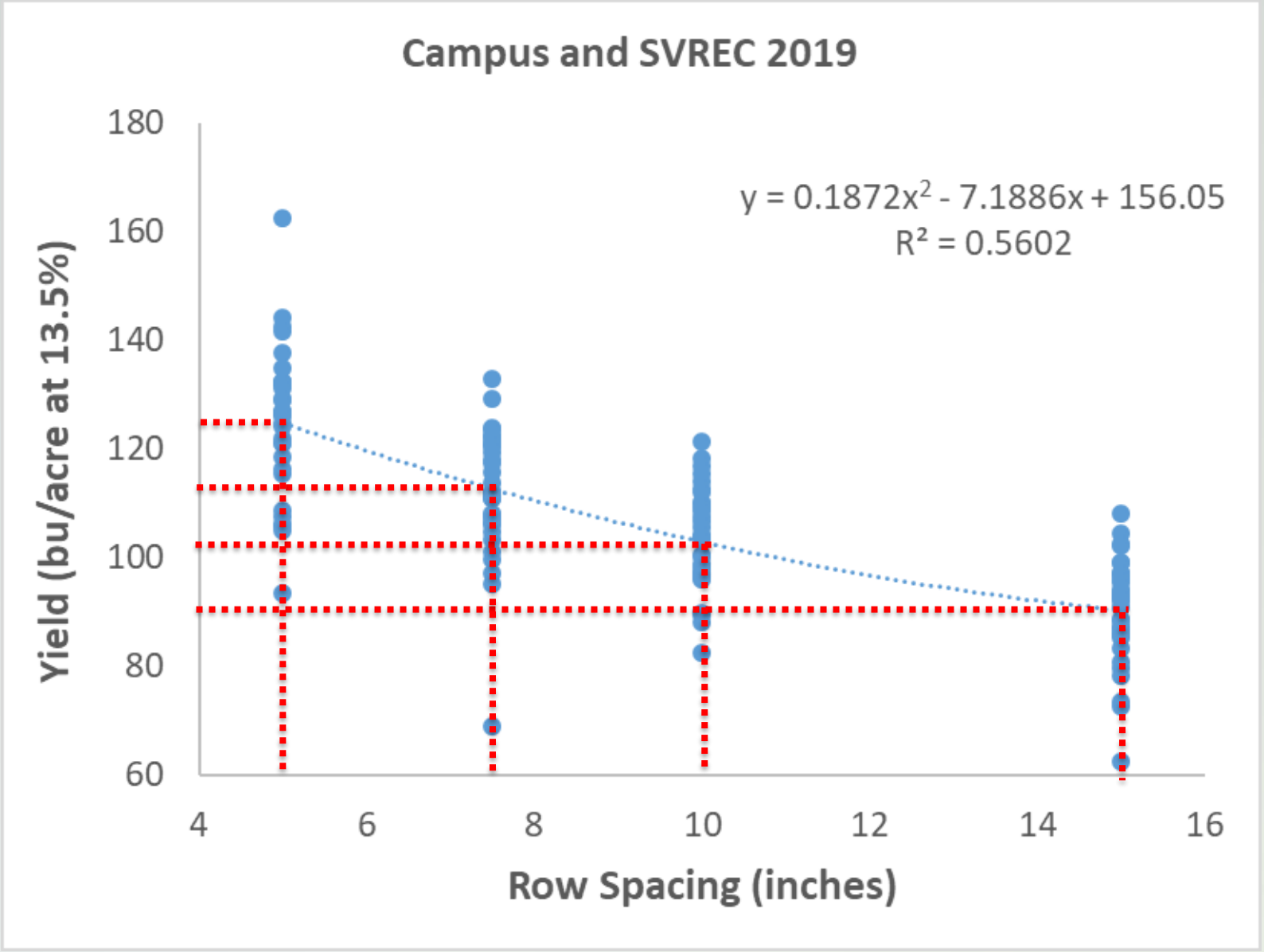
Harvest Index



Row Spacing vs Yield



Row Spacing vs Yield



Row Spacing vs Yield

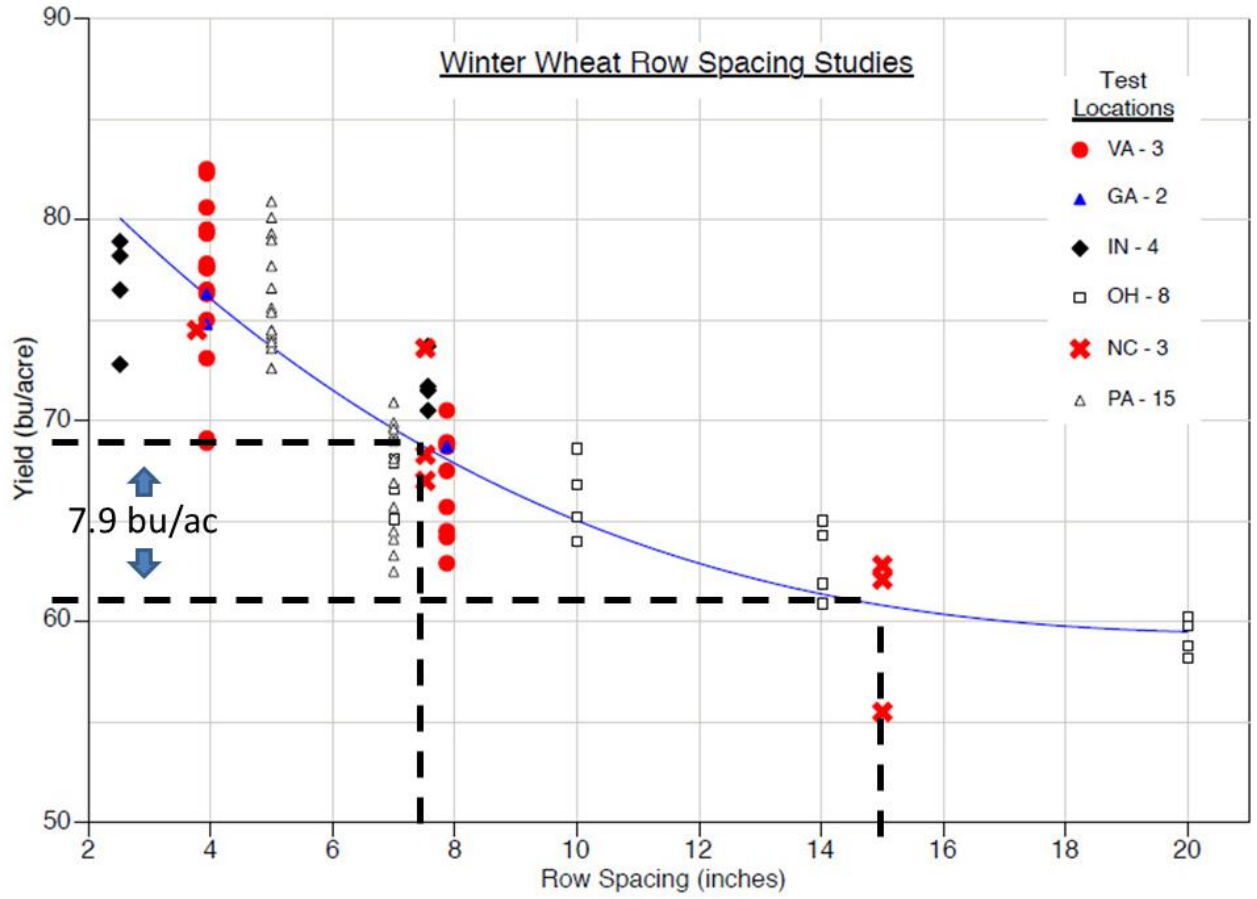


Figure 4-1. Wheat yields at different row-spacings from studies conducted in NC, VA, GA, PA, OH, and IN.

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.

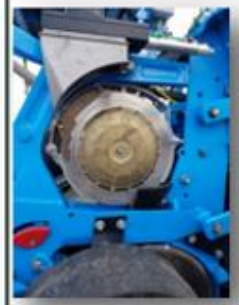
Ongoing/Future work?

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: While metering can be calibrated for a target rate, seed placement within the row is random and often results in skips and 2 or 3 seeds placed together. Seeding depth is also not consistent.



Vacuum plate planter

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

Advantages: Seed is dropped one at a time to singulate placement in the row. Planter is adjustable to plant a variety of crops in a variety of populations. Accurate and consistent seeding depth.

Disadvantages: Cost is higher, only way to plant narrow rows is with two gangs which increases cost, accuracy of singulation for wheat populations is poor with current technology.

Air drill with seed singulation

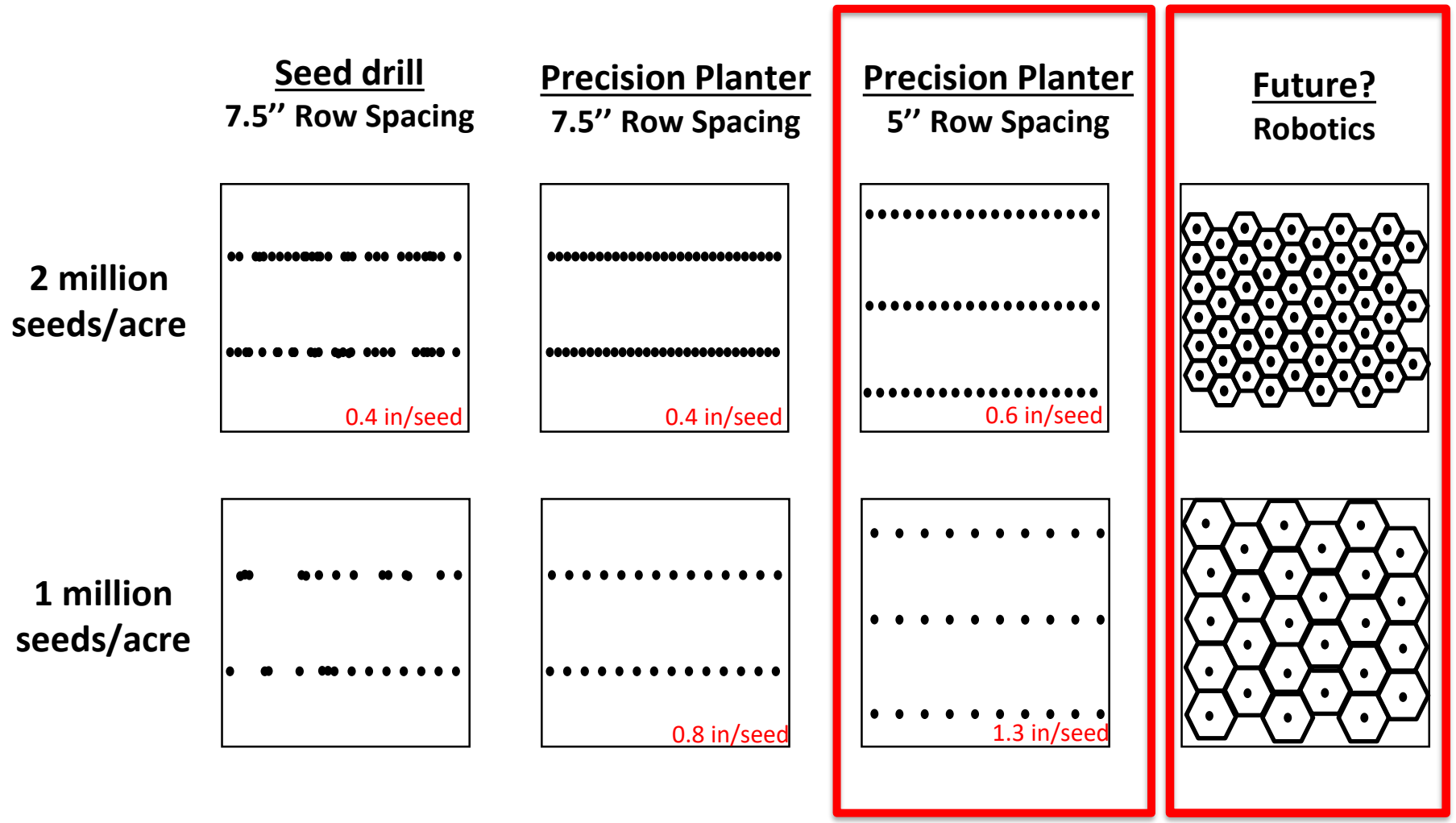
Seed is dispensed via pressurized air flow to seed distribution to row units with singulation discs that use centrifugal force for singulation

Advantages: Seed is dropped one at a time to singulate placement in the row. One pass system- seedbed preparation, fertilizer, and planting. Singulation and seeding depth accuracy is good to excellent. Planter can be set up to plant wheat and soybeans.

Disadvantages: Seed must be sized, cost is higher than drill, prototype- not yet available in the U.S.

Where headed?

Precision Planting-current and Future?



- Bill Widdicombe
- Chris Difonzo
- Eric Olson
- Samuel Martin
- Katlin Fusilier
- Harkirat Kaur
- Tom Siler
- Kelly Ish
- Madeline Yaek
- Lucas Para

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Thanks!

Questions?

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