

DEPARTMENT OF HORTICULTURE AND CROP SCIENCE

# Ohio Soybean and Wheat Research Report

2013-2016



**THE OHIO STATE UNIVERSITY**

COLLEGE OF FOOD, AGRICULTURAL,  
AND ENVIRONMENTAL SCIENCES



United States  
Department of  
Agriculture

National Institute  
of Food and  
Agriculture



To Ohio Farmers and Agricultural Industry Personnel:

The Soybean and Small Grain Crop Production Lab at The Ohio State University is pleased to present the first edition of the *Ohio Soybean and Wheat Research Report*. This publication contains the final reports of soybean and wheat research trials conducted between 2012 and 2015. All research findings were originally published in peer-reviewed journals. Here, we present our research findings of our most recently published research in a concise manner.

The goal of the Soybean and Small Grain Crop Production Lab is to maximize yield and profits while maintaining environmental sustainability.

This research was generously funded with check-off funds from the Ohio Soybean Council, Ohio Small Grains Marketing Program, and Michigan Wheat Program. We also wish to thank our cooperating-farmers and OARDC staff for helping establish, maintain, and harvest our research trials. Printing of this research report was funded by USDA NIFA (project number 2014-7000622507).

We look forward to continuously provide you with relevant and useful crop production research.

Sincerely,

Laura Lindsey  
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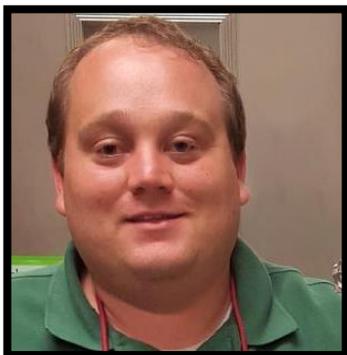
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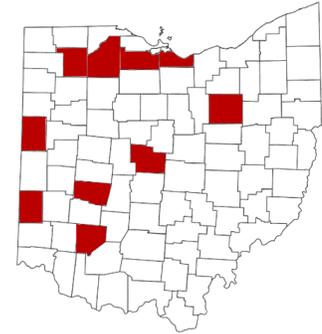
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## **High-Input Soybean Production: Soybean Yield Response to Rhizobia Inoculant, Gypsum, Manganese Fertilizer, Insecticide, and Fungicide**

**Grace M. (Bluck) Looker, Laura E. Lindsey, Anne E. Dorrance, and James D. Metzger**

From 2000 to 2013, the average soybean commodity price in the United States increased almost 300%, from an average price of \$4.35/bu to \$14.07/bu (NASS, 2016). Consequently, the rise in commodity price generated interest among farmers in agricultural inputs to maximize soybean grain yield. Inputs must be cost effective and associated yield gains need to withstand fluctuations in commodity prices as those observed in 2016, when the average soybean price dropped to \$7.50.

A study was conducted to evaluate five agronomic inputs: Rhizobia inoculant, pelletized gypsum, foliar manganese (Mn) fertilizer, foliar insecticide, and foliar fungicide. The study was conducted at 16 field trials in Ohio, nine of which were studied in 2013 and seven in 2014. Counties where the trial was established include Clark, Clinton, Delaware, Erie, Henry, Mercer, Preble, Sandusky, Wayne, and Wood.



### **QUICK TAKE-AWAY:**

- **There were limited effects of inoculant, gypsum, foliar manganese (Mn), foliar insecticide, and foliar fungicide on soybean grain yield. However, these fields had established corn-soybean rotations, no sulfur (S) or Mn deficiencies, and limited insect pressure.**
- **Foliar fungicide applied at the R3 growth stage was effective at reducing frogeye leaf spot and brown leaf spot disease severity. Soybean yield was influenced by fungicide application in 6 out of 16 site-years by 3.1 to 11.8 bu/acre.**
- **High rainfall in June and July created an environment that was favorable for development of brown leaf spot and frogeye leaf spot, and disease severity appeared to be the driving force in determination of yield response to fungicide.**
- **Crop scouting is a useful tool to identify fields where disease pressure levels are higher to determine when fungicide applications may be justified, as well as to scout for nutrient deficiencies and insect pressure to warrant the application of inoculant, gypsum, foliar Mn fertilizer, and foliar insecticide.**

**Methods.** An omission trial treatment structure was used to evaluate the effect of:

- Rhizobia inoculant: TagTeam LCO Liquid MultiAction Legume Fertility (Monsanto BioAg)
- Gypsum: NutraSoft Pelletized Gypsum (The Andersons) applied at 2 tons/acre
- Mn foliar fertilizer: EDTA Max-In Ultra Manganese (Winfield Solutions LLC) applied at the label recommended rate during the R3 soybean growth stage.
- Foliar insecticide: Warrior II with Zeon Technology (Syngenta) at the label recommended rate during the R3 soybean growth stage.
- Foliar fungicide: Headline (BASF) at the label recommended rate during the R3 soybean growth stage.



**Former graduate student, Grace (Bluck) Looker, applying foliar treatments using a backpack sprayer.**

In an omission trial, two treatment controls are used, with one control having every input factor applied (enhanced production system) and the other control having none of the input factors applied (traditional production system) (Table 1).

**Table 1. Omission trial design, treatment name, list of inputs applied, and estimated cost per acre (product + application).**

	Treatment name	Inoculant	Gypsum	Mn	Insecticide	Fungicide	Cost/acre
1	Enhanced (E)	YES	YES	YES	YES	YES	\$61
2	E – inoculant	NO	YES	YES	YES	YES	\$56
3	E – gypsum	YES	NO	YES	YES	YES	\$41
4	E – Mn	YES	YES	NO	YES	YES	\$51
5	E – insecticide	YES	YES	YES	NO	YES	\$57
6	E – fungicide	YES	YES	YES	YES	NO	\$44
7	Traditional (T)	NO	NO	NO	NO	NO	\$0
8	T + inoculant	YES	NO	NO	NO	NO	\$4
9	T + gypsum	NO	YES	NO	NO	NO	\$20
10	T + Mn	NO	NO	YES	NO	NO	\$16
11	T + insecticide	NO	NO	NO	YES	NO	\$10
12	T + fungicide	NO	NO	NO	NO	YES	\$24

Planting dates ranged from May 15 to June 3. Soybeans, ‘Asgrow 3231’ (maturity group 3.2), were planted in 15-inch rows. The previous crop was corn at all locations. All sites were no-till except for the 2013 Clinton County site which was minimally tilled.

**Enhanced vs. Traditional Production System Results.** There was very limited soybean yield response when comparing the enhanced production system (all inputs applied) to the traditional production system (no inputs applied). In only 2 out of 16 site-years was there a significant yield increase in the enhanced system compared to the traditional system (3.4 bu/acre increase at the 2013 Wood Co. location and 6.5 bu/acre increase at the Mercer Co. location). A yield increase of at least 8.1 bu/acre would be required to breakeven using the 2016 soybean price of \$7.50/bu.

**Rhizobia Inoculant Results.** Omission of inoculant from the enhanced production system and addition of inoculant to the traditional system did not result in any significant yield changes at all site years. Lack of yield response from inoculant is likely attributed to all site-years being in a corn-soybean rotation for several years. These findings correspond to other studies where yield response due to inoculant was rare when soybean had been grown in a field within the previous 5 yr (Abel and Erdman, 1964; Boonkerd et al., 1978; De Bruin et al., 2010; Ham et al., 1971; Muldoon et al., 1980; Nelson et al., 1978).

**Gypsum Results.** Soybean yield was not positively influenced by gypsum application at any of the site-years. Ohio fertilizer guidelines recommend 0.21 to 0.40% S in the uppermost fully developed soybean trifoliolate at the R1 growth stage (Vitosh et al., 1995). Soybean trifoliate collected had S within the recommended range and no visual symptoms of S deficiency were observed.

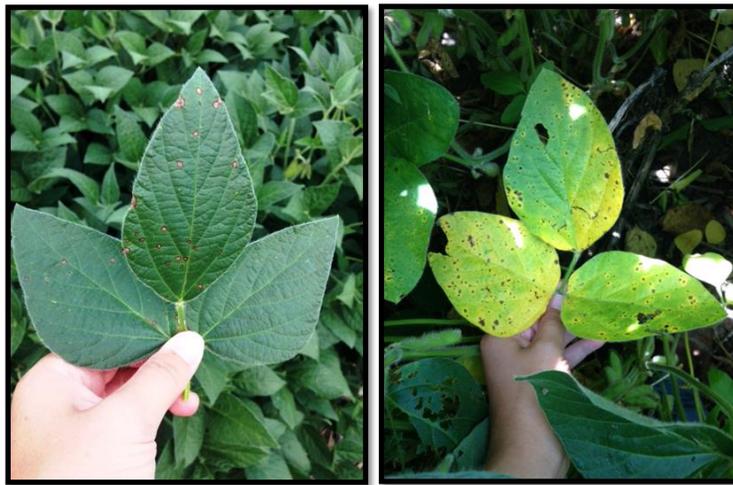
**Manganese Foliar Fertilizer Results.** Manganese foliar fertilizer application influenced soybean yield at 1 out of 16 site-years. Omission of the Mn foliar fertilizer from the enhanced production system was found to significantly reduce yield by 8.0 bu/acre at the Sandusky Co. location in 2014. Although the leaf samples collected at the Sandusky Co. location were within the recommended sufficiency range of 21 to 100 ppm of Mn and did not exhibit visual deficiency symptoms, the soil at this site-year had a large concentration of sand (63%). Due to the high sand content, the soil was very likely dry and may have lost moisture easily. In dry soil, Mn can be converted to form that is unavailable for plant uptake.



**Manganese deficiency symptoms include interveinal chlorosis.**

**Foliar Insecticide Results.** There was a yield response to foliar insecticide at 1 out of 16 site-years. A significant yield reduction of 4.8 bu/acre occurred at the Wayne County location in 2014 due to the omission of insecticide from the enhanced production system. At the Wayne Co. location in 2014, soybean aphid and bean leaf beetle were noted. Overall limited response due to insecticide may be attributed to low insect pressure and low defoliation severity. In general, trifoliolate defoliation in the mid- to upper canopy was <15%.

**Foliar Fungicide Results.** Omission of fungicide from the enhanced production system resulted in significant yield decreases of 3.1 to 11.8 bu/acre in 5 out of 16 site-years. The addition of fungicide to the traditional production system resulted in a yield increase of 7.0 bu/acre at 1 out of 16 site-years. Site-years where there was a yield response to fungicide (either a yield loss when fungicide was omitted in the enhanced system or a yield increase when fungicide was applied in the traditional system) had an average of 11 inches of rainfall in June and July. Site-years that were unresponsive to fungicide application had an average of 9 inches of rainfall in June and July (excluding two locations that experienced an intense rainfall event in July that caused standing water for 24 h). Brown leaf spot and frogeye leaf spot are favored by wet conditions and heavy rainfall, as rain splashes the fungus upward in the plant canopy, spreading the disease. Greater disease pressure created by wet growing conditions may have resulted in the yield responses from the fungicide input.



**Frogeye leaf spot (left) and brown spot (right).**

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#### ***Acknowledgements:***

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# Effect of Soybean Planting Date and Starter Fertilizer on Soybean Grain Yield

Matthew W. Hankinson, Laura E. Lindsey, and Steven W. Culman

A trial was established at the Western Agricultural Research Station (WARS) in South Charleston, Ohio and at the Northwest Agricultural Research Station (NWARS) in Custer, Ohio to evaluate the effect of starter fertilizer on soybean grain yield across several soybean planting dates.

## QUICK TAKE-AWAY:

- Nitrogen (N) and phosphorus (P) starter fertilizer did not increase soybean grain yield. However, all three site-years had soil P levels greater than the critical level of 15 ppm (Bray P).
- Soybeans planted on May 1 at the South Charleston, Ohio location yielded 94 bu/acre. Even at high yields, there was no yield response to starter N or P fertilizer.
- Soybean yield decreased by 0.6 bu/acre/day when soybeans were planted after the first planting date at the South Charleston location in both years.
- Timely planting is much more critical for maximizing soybean yield than use of starter fertilizer.

**Methods.** The trial was established in 2013 and 2014 at WARS and 2014 at NWARS. The soil series was Kokomo silty clay loam at WARS and Hoytville clay at NWARS. At all research locations, the previous crop was corn. The WARS location was minimally tilled in the fall, and the NWARS location was minimally tilled in the fall and spring. Soybeans were planted in 30-inch rows to facilitate starter fertilizer application. Soybeans, Asgrow 3231 (3.2 relative maturity), treated with Acceleron were planted at 145,000 seeds/acre.



Three to four planting dates were evaluated at each location ranging from May 1 through July 2 (Table 1). Starter fertilizer treatments were applied in a band 2 inches beside and 2 inches below the seed at planting. Starter fertilizer evaluated included:

- None (control)
- Urea at 30 lb N/acre
- Triple super phosphate (TSP) at 40 lb P<sub>2</sub>O<sub>5</sub>/acre
- Urea + TSP at 30 lb N/acre and 40 lb P<sub>2</sub>O<sub>5</sub>/acre
- Diammonium phosphate (DAP) at 40 lb P<sub>2</sub>O<sub>5</sub>/acre and 16 lb N/acre

Prior to planting, a soil sample was collected at 0 to 8 inch depth for nutrient analysis. Soil P (Bray P) was 33 ppm, 38 ppm, and 84 ppm at the WARS 2013, WARS 2014, and NWARS 2014 locations, respectively. Soil P was not limiting at any of the trial locations.

**Table 1. Planting date and harvesting date for soybean at the Western Agricultural Research Station (WARS) and Northwest Agricultural Research Station (NWARS) in 2013 and 2014.**

Location, Year	Planting Date	Soil Temperature at Planting from 2-inch depth (°F)	Harvesting Date
<b>WARS, 2013</b>	May 1	59	Sept. 25
	May 20	68	Oct. 1
	June 12	73	Oct. 14
	July 2	73	Nov. 6
<b>WARS, 2014</b>	May 21	64	Oct. 2
	June 3	73	Nov. 3
	June 16	73	Nov. 3
	July 1	77	Nov. 3
<b>NWARS, 2014</b>	May 8	62	Sept. 25
	May 27	72	Oct. 27
	June 18	76	Oct. 27

**Effect of Starter Fertilizer on Soybean Grain Yield.** Starter fertilizer had no effect on soybean grain yield at any of the locations (Table 2). The soil P level at all three site-years was >15 ppm which is the established P critical level for Ohio (Vitosh et al., 1995). If the soil P levels were <15 ppm, a yield response to P starter fertilizer would have been much more likely to occur. In previously conducted studies, soybean yield response to N application in soybean was variable and generally occurred under high-yielding conditions when biological N fixation and soil residual N did not supply sufficient N to meet crop demand (Salvagiotti et al., 2008). Soil organic matter was 3.6 to 4.0% for the three site-years, which may have resulted in sufficient N mineralization to meet crop demand causing the lack of yield response to starter N fertilizer (Sawyer et al., 2006). At the WARS location in 2013, soybean yield was 94 bu/acre when planted on May 1; however, starter N fertilizer did not increase soybean yield, indicating that biological N fixation and soil residual N were adequate.

**Table 2. Starter fertilizer did not significantly affect soybean grain yield at all three site-years ( $\alpha = 0.10$ ).**

WARS, 2013	Grain yield (bu/acre)
<b>None</b>	73.6 A
<b>Urea</b>	76.1 A
<b>TSP</b>	77.2 A
<b>Urea + TSP</b>	74.8 A
<b>DAP</b>	77.2 A
WARS, 2014	
<b>None</b>	58.0 A
<b>Urea</b>	59.5 A
<b>TSP</b>	60.1 A
<b>Urea + TSP</b>	61.8 A
<b>DAP</b>	62.1 A
NWARS, 2014	
<b>None</b>	54.0 A
<b>Urea</b>	53.9 A
<b>TSP</b>	53.8 A
<b>Urea + TSP</b>	53.8 A
<b>DAP</b>	53.9 A

**Effect of Planting Date on Soybean Grain Yield.** Soybean grain yield was influenced by planting date at the WARS location, but not the NWARS location. Soybean grain yield decreased by 0.6 bu/acre/day at the WARS location both years when soybeans were planted after the first planting date (Figure 1). Soybean grain yield was not affected by planting date at the NWARS location.

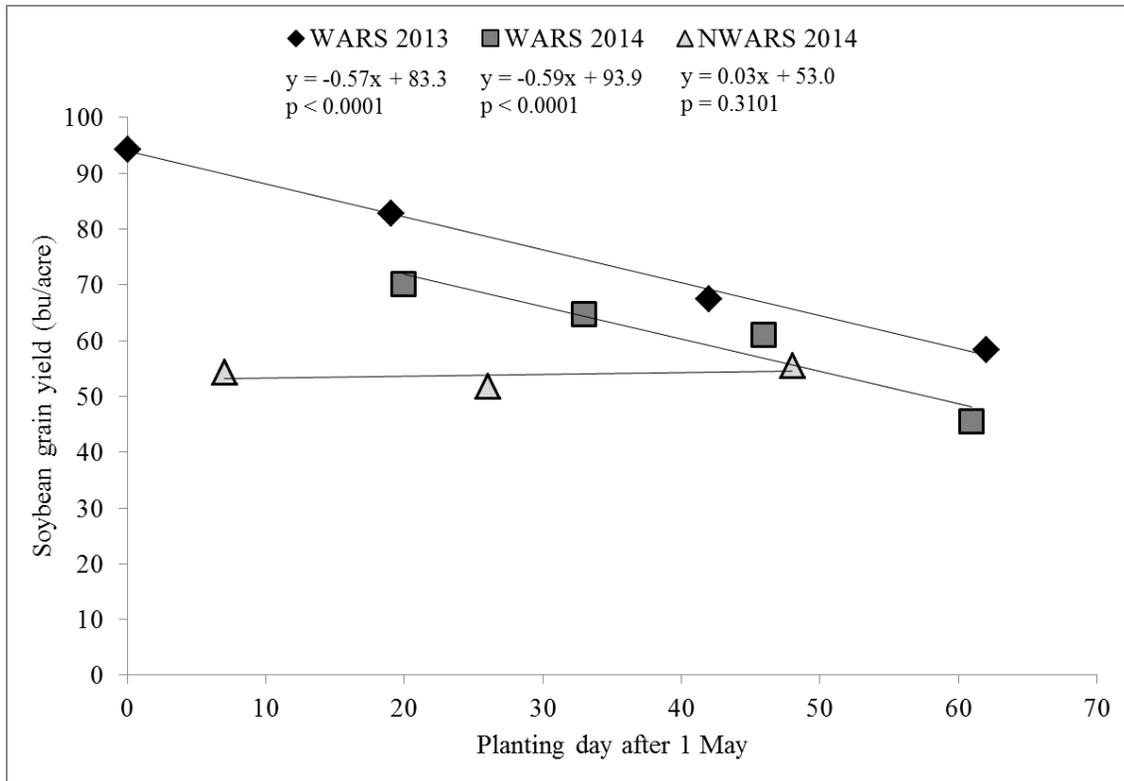


Figure 1. Effect of soybean planting date on soybean grain yield at the Western Agricultural Research Station (WARS) in 2013 and 2014 and the Northwest Agricultural Research Station (NWARS) in 2014.

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## Row Width Influences Wheat Yield, But Has Little Effect on Wheat Quality

Laura E. Lindsey, Edwin Lentz, and Byung-Kee Baik

Farmers are interested in wide-row wheat production due to reductions in equipment inventory (lack of grain drill) and to allow intercropping of soybean into wheat. A trial was established during the 2012-2013 and 2013-2014 growing seasons in Wayne Co. and Wood Co., Ohio to evaluate the effect of row width and cultivar on soft red winter wheat grain yield and quality.

### QUICK TAKE-AWAY:

- In 3 out of 4 site-years, wheat yield was reduced by 2 to 15% when grown in wide rows compared with narrow rows. At one site-year, grain yield was the same regardless of row width.
- Yield response to row width was similar among the four cultivars evaluated in this study.
- Differences in wheat quality were small and unlikely to be significant to the soft red winter wheat baking industry.

**Methods.** A field study was established during the 2012-2013 and 2013-2014 growing seasons at the Ohio Agricultural Research and Development Center (OARDC) in Wayne Co. and the Northwest Agricultural Research Station (NWARS) in Wood Co. Two row widths were evaluated: 7.5-inch and 15-inch. Four wheat cultivars were evaluated: Rupp 935, Rupp 972, Syngenta SY483, and Syngenta W1104.



The previous crop was soybean. The soil series in Wayne Co. was Canfield silt loam, and the soil series was Hoytville clay in Wood Co. Soil phosphorus, potassium, and pH were adequate for wheat according to state recommendations (Vitosh et al., 1995). Wheat was planted at 25 seeds/ft row regardless of row width, which is equal to 1,700,000 seeds/acre at 7.5-inch row width and 850,000 seeds/acre at 15-inch row width (Beuerline, 2002). Each year, 30 lb N/acre was applied at planting and an additional 100 lb N/acre was applied in the spring at green-up.

***Effect of Row Width and Cultivar on Grain Yield.*** Overall, reductions in grain yield at wide row width compared with narrow row width ranged from 0 to 15% with an average reduction of 7%. Averaged across all site-years, there were 20% more wheat heads produced when wheat was grown in 15-inch row width compared with 7.5-inch row width. The increased number of wheat heads may explain the relatively small yield reduction associated with growing wheat in wide row width compared with narrow row width.



**Wheat grown in 15-inch row width (left) and 7.5-inch row width (right).**

***Effect of Row Width and Cultivar on Wheat Quality.*** Wheat cultivar influenced grain test weight, flour yield, flour softness, and flour protein. However, there were very limited effects of row width on wheat grain quality.

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## On-Farm Investigation of Seeding Rate for Wide-Row Wheat Production in Northwest Ohio

Eric Richer and Laura E. Lindsey

Previously conducted row width and seeding rate studies have indicated that approximately 871,000 seeds/acre is optimum when planting in 15-inch row widths (Lee and Herbek, 2012). However, many farmers were concerned that a seeding rate of 871,000 seeds/acre was too low for wheat grown in northwest Ohio, where the standard practice is to seed 2.0-2.5 million seeds/acre in 7.5-inch row widths. On-farm trials were conducted to evaluate wheat grown using the standard practice of 7.5-inch row width at 2.0 million seeds/acre compared with wheat grown in 15-inch row width at 1.0 and 1.5 million seeds/acre.

### QUICK TAKE-AWAY:

- Yield was reduced by 15% when wheat was grown in 15-inch row widths compared to 7.5-inch row widths.
- When wheat was grown in 15-inch row widths, there was no difference in yield whether wheat was seeded at 1.0 or 1.5 million seeds/acre.
- If wheat is grown in 15-inch row widths, it is not necessary to plant over 1.0 million seeds/acre to maximize yield when planting within 20 days of the Hessian fly-safe date in northwest Ohio.

**Methods.** Three on-farm trials were established during the 2013-2014 growing season, and one trial was established during the 2014-2015 growing season in Fulton Co., Ohio. The trials consisted of three treatments: 1.) the standard practice of seeding wheat in a 7.5-inch row width at 2.0 million seeds/acre, 2.) seeding wheat in 15-inch row width at 1.0 million seeds/acre, and 3.) seeding wheat in a 15-inch row width at 1.5 million seeds/acre.

**Results.** Averaged across the four site-years, wheat grain yield was 81.7 bu/acre when grown in the standard practice of 7.5-inch row width at 2.0 million seeds/acre (Figure 1). Compared to the standard practice, yield was reduced by 15% when wheat was grown in 15-inch row widths across seeding rates. There was no difference in yield when wheat was grown in 15-inch row widths whether wheat was seeded at 1.0 or 1.5 million seeds/acre.



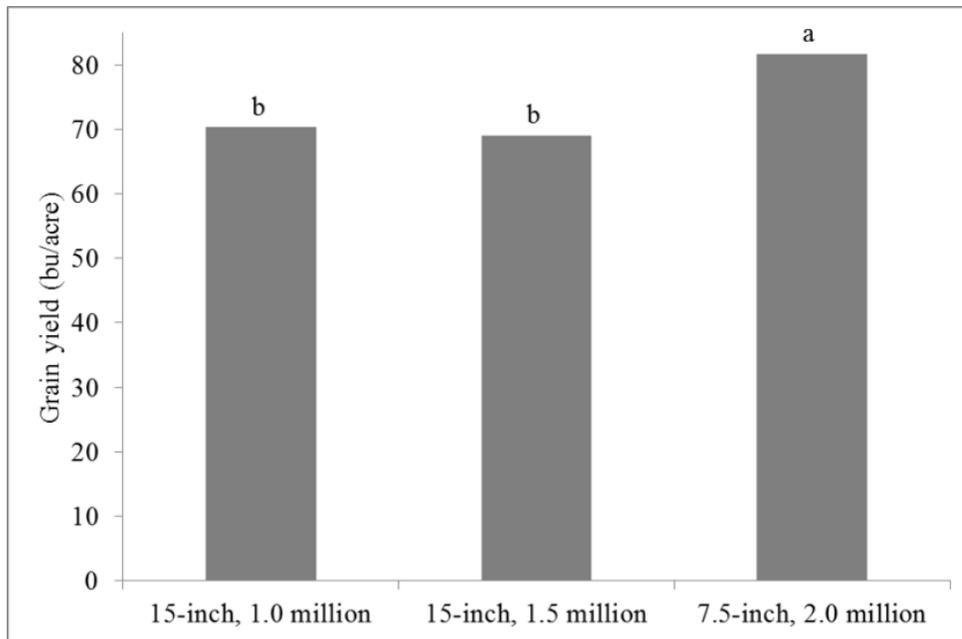


Figure 1. Wheat grain yield averaged across four site-years for wheat grown in 15-inch row width at 1.0 million seeds/acre, 15-inch row width at 1.5 million seeds/acre, and 7.5-inch row width at 2.0 million seeds/acre. Same letters indicate no statistically significant difference at  $\alpha = 0.10$ .

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### *Acknowledgements:*

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# COMING SOON!



## Is tank-mixing fungicide and insecticide beneficial?

Graduate student, Sin Joe Ng, is wrapping-up her final year of research investigating tank-mix applications of foliar fungicide and insecticide at the R3 soybean growth stage.



**What is the status of soil fertility in Ohio?**



**What is the optimum wheat seeding rate?**



**How susceptible is winter wheat to late spring freezes?**



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