Improving Corn Yield Potential with Banded Phosphorus Fertilizer

Tryston A. Beyrer and Fred E. Below

Crop Physiology Laboratory, Department of Crop Sciences, University of Illinois at Urbana-Champaign

Introduction:

- Increasing environmental concerns dictate alternative methods of applying fertilizers in order to decrease nutrient loss and promote increased fertilizer efficiency even when soil test levels are high.[1]
- Many areas of the corn belt have observed decreases in median Phosphorus (P) soil test levels; where, between 2005 and 2010, Illinois Bray 1 P levels decreased 10 ppm.[2]
- Recent advances in fertilizer banding capabilities and GPS technology allow for more accurate fertilizer applications.[3]
- Current P fertilizer recommendations based on past soil testing recommendations may not be adequate for the higher yield levels from modern corn hybrids and management practices.[4]

References

1. Bundy, L.G. 2001. Management practice effects on phosphorus losses in runoff in corn production systems. J. Environ. Qual. 30:1822.
2. Fixen, P.E., T.W. Bruulsema, T.L. Jensen, R. Mikkelsen, T.S. Murrell, S.B. Phillips, Q. Rund and W.M. Stewart. 2010. The fertility of North American Soils, 2010. Better Crops 94:6-8.
3. Vyn, T.J. 2008. Tillage and fertility placement aspects of root zone optimization for corn. p. 70-74. *In* 2008 Illinois crop protection technology conference proceedings.
4. Bender, R.R., J.W. Haegele, M.L. Ruffo and F.E. Below. 2013. Modern corn hybrids' nutrient uptake patterns. Better Crops 97:7-10.

Research Approach:

- Field experiments were conducted in 2013 at Champaign, Illinois on a Drummer-Flanagan silty clay loam and in Harrisburg, Illinois on a Harco silt loam. Plots were planted in Champaign on May 19th and in Harrisburg on May 30th to achieve a final stand of 88,920 plants ha^{-1} (36,000 plants ac^{-1}).
- Fertilizer parameters were selected to evaluate the effect of fertilizer management:
  - **P Source:** Directly prior to planting, Mono-ammonium Phosphate (MAP, 11-52-0) or a premium P fertilizer MicroEssentials® SZ™ (MESZ, 12-40-0-10S-1Zn) was applied.
  - **P Rate:** 0, 56, 112 and 168 kg P_2O_5 ha^{-1}.
  - **P Placement:** Broadcast and lightly incorporated vs. banding 10-15 cm directly under the row using RTK guidance.
- Five plants were sampled at V8 growth stage to determine dry weight at Champaign.
- All values are expressed on a dry weight (0% moisture) basis.

Question: *Do new fertilizer technologies increase yield in modern crop production systems?*

Objective: *Determine whether banding of phosphorus fertilizers has the potential to increase yield beyond standard production practices.*

Increased Early Season Growth:

- **Early season growth responses from banded P fertilizer occurred in soils testing high in P (45 ppm Mehlich III extraction), suggesting that P fertilizer may be beneficial to young plants even when additional fertilizer is not recommended based on soil tests (Figure 1).**
- **Banded P fertilizer increased vegetative biomass by 26% when compared to broadcast fertilizer (Figure 2).**
- **Additional increments of P fertilizer increased vegetative growth and was more pronounced with banded fertility.**
- **Lower fertilizer rates of banded P fertilizer produced larger plants than the highest rate of broadcast fertilizer.**

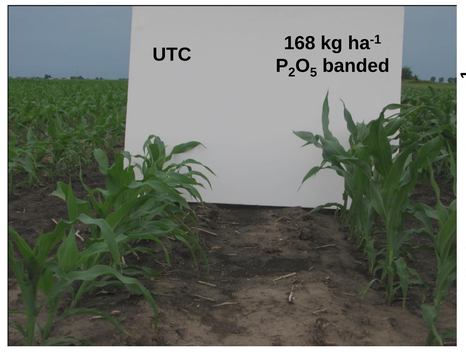


Figure 1. Early season growth responses between a UTC (0 kg P_2O_5 ha^{-1}, left) and a treatment that received banded fertilizer (168 kg P_2O_5 ha^{-1} MESZ, right) in soils testing high in phosphorus.

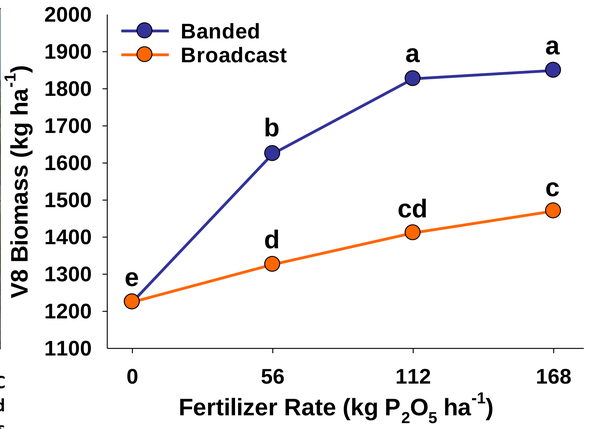
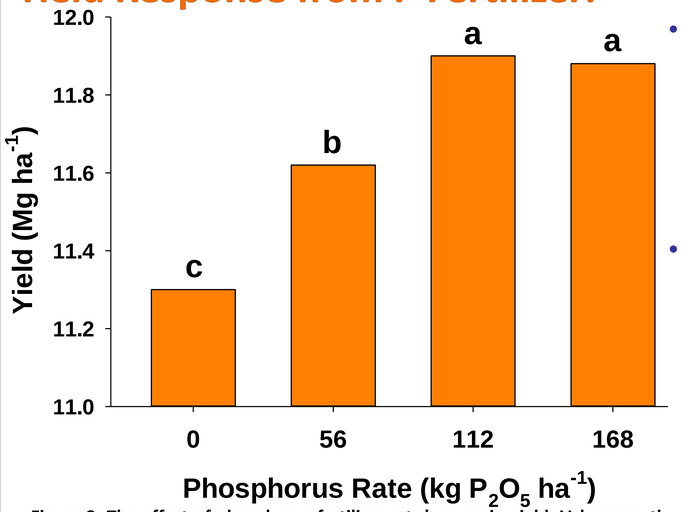


Figure 2. The effect of application technology† and P rate on early season biomass (V8) measured at Champaign, IL. during 2013. Plant biomass was averaged over both P sources.
† Values for P rate and application type with different letters differ (*P≤ 0.1*)

Yield Response from P Fertilizer:



- **Grain yield was increased with P fertilizer and was maximized with 112 kg P_2O_5 per hectare (Figure 3).**
- **Despite the early season growth advantages, banded fertility did not result in greater grain yield increases than broadcast fertilizer (Figure 4).**

Figure 3. The effect of phosphorus fertilizer rate† on grain yield. Values are the average of two locations (Champaign and Harrisburg, IL.) in 2013 and fertilizer rates were averaged across both P sources and placement technologies.
† Values with different letters differ (*P ≤ 0.1*)

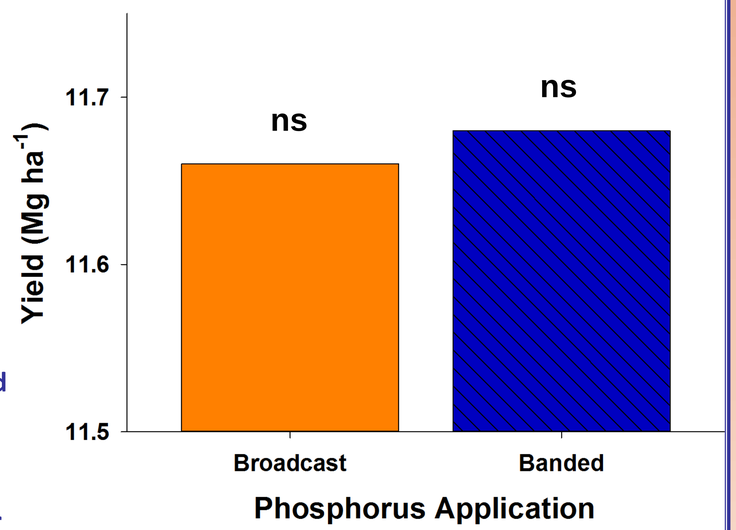


Figure 4. The effect of broadcast and banded P applications† on grain yield. Values are the average of two locations (Champaign and Harrisburg, IL.) in 2013 and application techniques were averaged across all added P rates and sources.

Increased Yield Potential:

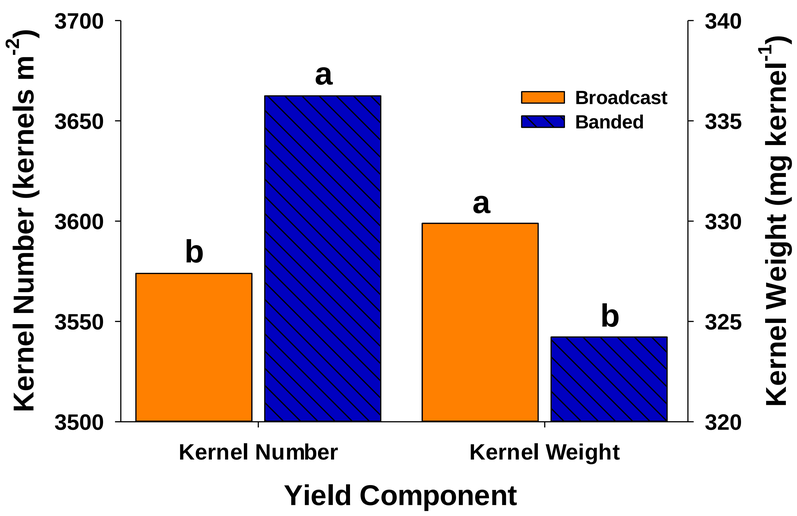


Figure 5. The effect of P application method on the yield components† kernel number and kernel weight. Values were averaged across two locations (Champaign and Harrisburg, IL.) and application techniques were averaged across both P sources and added P fertilizer rates during 2013 from a subsample of grain harvested at maturity.
† Values for each yield component with different letters differ (*P ≤ 0.1*)

- **Early season growth responses from banded P fertilizer corresponded with an increase in kernel number (Figure 5).**
- **Decreased kernel weight occurred via yield component compensation where plants with banded fertility were not able to sustain the fill rate required for the greater number of kernels.**
- **Dry conditions during grain filling in 2013 likely hindered the crops ability to realize the higher yield potential that was achieved with banded fertility.**

Conclusions:

1. Are growth increases from P fertilizer possible on high P soils?

✓ **Yes, Both banded and broadcast fertilizer applications had grain yield increases from added P fertilizer, while early season plant growth increased with banded fertilizer applications.**

2. Do early season growth responses guarantee increases in final grain yield?

X **No, Yield was not significantly improved with additions of P fertilizer due to unpredictable late season environmental effects despite a trend for higher grain yields when early season visual differences were detected.**

3. Does banded P fertilizer set the potential for higher grain yields?

✓ **Yes, Banded P fertilizer set the potential for higher grain yields through increased kernel number, and if the plant can be managed all season long to prevent additional stress, additional yield gains may be realized.**

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