Better Maize Response to Optimal Fertilizer Placement

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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]
- Fertilizer application technologies such as banding can reduce nutrient loss of phosphorus when compared to broadcast fertilizer applications.[2]
- Recent advances in fertilizer banding capabilities and GPS technology allow for more accurate fertilizer applications.[3]
- Current P fertilizer recommendations based on soil test thresholds 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. Kimmell, R.J., G.M. Pierzynski, K.A. Janssen, and P.L. Barnes. 2001. Effects of Tillage and Phosphorus Placement on Phosphorus Runoff Losses in a Grain Sorghum–Soybean Rotation. J. Environ. Qual. 30:4
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 2014 at Champaign, Illinois on a Drummer-Flanagan silty clay loam. Eight replications were planted in Champaign on June 15th to achieve a final stand of 74,100 and 111,150 plants ha^{-1} (30,000 and 45,000 plants ac^{-1})**.

Directly prior to planting, 112 kg P_2O_5 ha^{-1} MicroEssentials® SZ™ (MESZ, 12-40-0-10S-1Zn) was applied.

P Placement: Broadcast and lightly incorporated vs. bands placed 15 cm deep and 0, 8, 15, 23, 30, or 38 cm parallel to the crop row using RTK guidance.

Four plants were sampled per plot from 6 replications at the V6 growth stage to determine root and vegetative dry weight (0 % moisture) and nutrient composition.

**No significant interactions were found between final plant stand and fertilizer distance, so data were averaged over both plant populations.

Question: ***Where should P fertilizer be applied to maximize corn plant use and minimize loss?***

Objective: ***Determine the optimal P fertilizer placement to increase growth and yield in corn.***

Increased Early Season Growth:

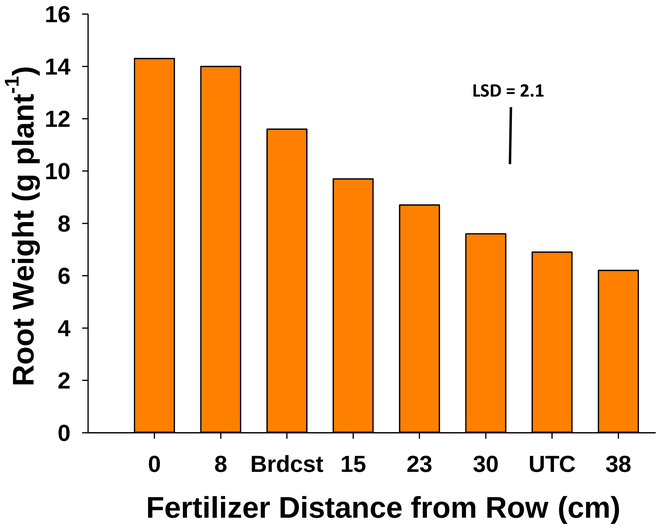

Figure 1. The effect of phosphorus fertilizer placement on V6 root size.
† Values differing more than LSD line length are significant ($P \leq 0.1$)

Root size increased with fertilizer placed in closer proximity to the plants (or roots), presumably due to increased root interception of nutrients at the early growth stages (Figure 1).

Early season growth responses from banded P fertilizer occurred in soils testing high in P (60 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 2).

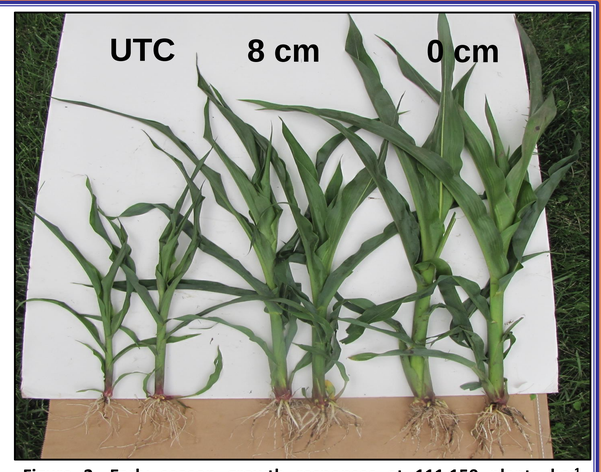

Figure 2. Early season growth responses at 111,150 plants ha^{-1} between a untreated check (UTC, 0 kg P_2O_5 ha^{-1}, left), and treatments that received banded fertilizer (112 kg P_2O_5 ha^{-1} MESZ) 15 cm (center) and 0 cm (right) distance from the crop row in a soil testing high in phosphorus.

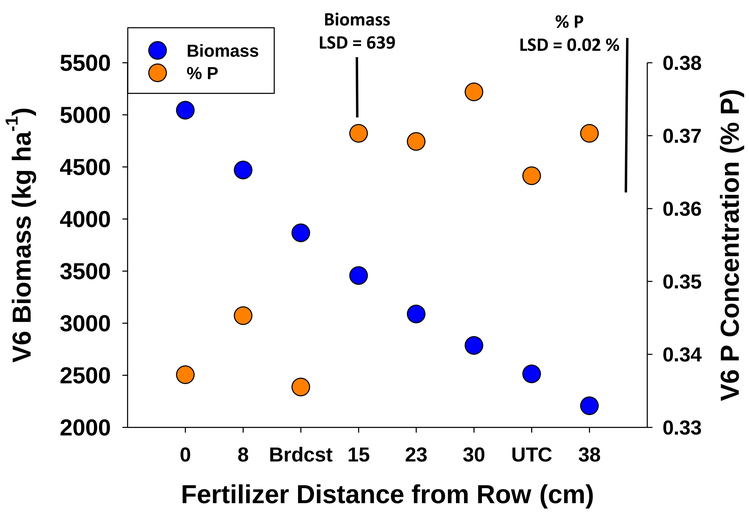

Figure 3. Early season biomass yield and phosphorus nutrient concentrations resulting from various fertilizer placement treatments.
† Values differing more than LSD line length are significant ($P \leq 0.1$)

Total plant P uptake at V6 was increased with fertilizer placed closer to the row (P<0.0001), (Figure 4) which was primarily due to an enhancement in early season growth.

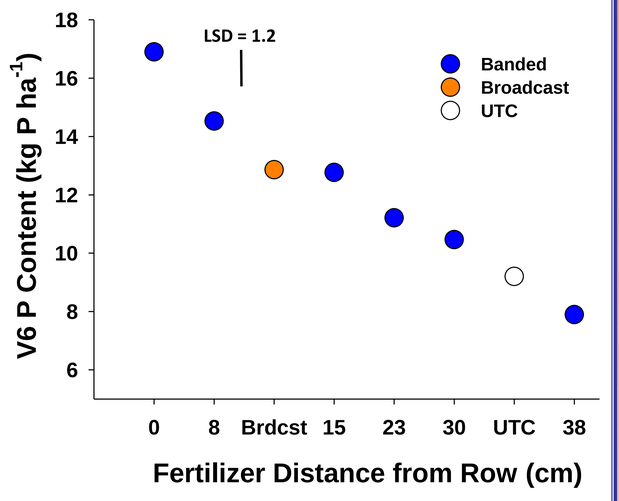

Figure 4. Early season above-ground phosphorus uptake (kg P ha^{-1}) compared to fertilizer placement.
† Values differing more than LSD line length are significant ($P \leq 0.1$)

Banding P fertilizer directly beneath the row (0 cm) increased vegetative biomass by 103% over the UTC and 29% when compared to broadcast fertilizer (Figure 3).

Banding fertilizer in a concentrated zone closer to the plant resulted in a lower plant P concentration due to greater plant biomass (Figure 3).

Yield Response from P Fertilizer:

Phosphorus fertility banded directly beneath the row resulted in a 1.42 Mg per hectare (12%, 23 bu ac^{-1}) grain yield increase over the UTC, and 0.46 Mg per hectare increase over broadcast fertilizer application (Figure 5).

Fertilizer placed 15 cm or less from the crop row resulted in higher grain yields than the UTC, but banded fertility 8 cm and less from the row produced higher yields than broadcast fertilizer.

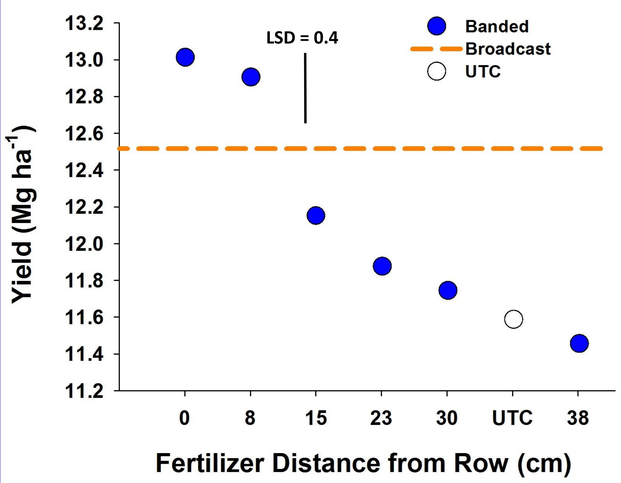

Figure 5. Final grain yield of treatments comparing broadcast and multiple distances of banded fertilizer from the row.
† Yield values differing more than LSD line length are significant ($P \leq 0.1$)

Increased grain yield was positively correlated with greater vegetative V6 biomass (r=0.78, P<0.0001), suggesting that a critical yield-establishing period likely occurred around this growth stage.

Increases in yield due to fertilizer placed closer to the plant corresponded with an increase in kernel number (Figure 6), but had little effect on kernel weight (data not shown).

Kernel number per square meter was increased over the UTC when fertilizer was placed within 15 cm from the row (P<0.0001).

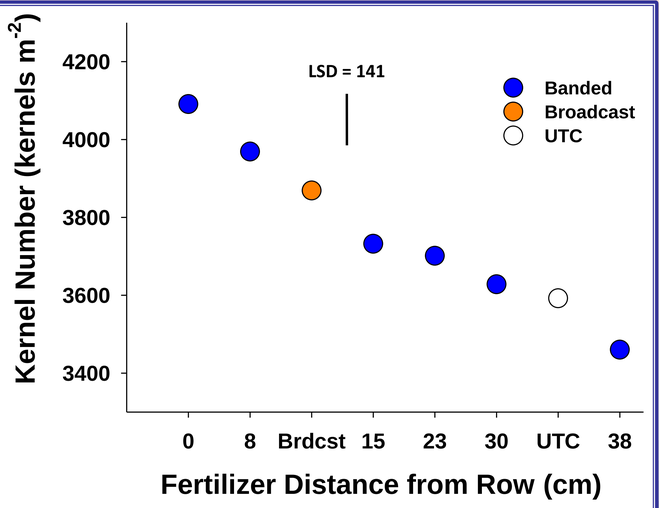

Figure 6. The effect of fertilizer placement distance on kernel number per meter squared. †Values differing more than LSD line length are significant ($P \leq 0.1$)

Conclusions:

1. What is the optimal placement of fertilizer for greater corn growth and yields?

- Fertilizer banded up to 15 cm from the row could translate into greater yields than no fertilizer; however, bands should be placed within 8 cm of the row to benefit over broadcast fertilizer applications.

2. Does fertilizer placed closer to plants result in greater P accumulation?

- ✓ Yes, Adequately placed fertilizer can increase early plant biomass which increases P accumulation despite having lower P concentrations.

3. Does better fertilizer placement set the potential for higher grain yields?

- ✓ Yes, Banded P fertilizer set the potential for higher grain yields when placed within 15 cm from the crop row, primarily by increased kernel number.