

Impacts of Placement and Timing of P and K Fertilization on Crop Yield An Iowa Perspective

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Major Placement Questions for P and K

- Is banding more effective than broadcasting and can I reduce the P or K rate by banding?
- If so, for what
 - Soils?
 - Crops?
 - Tillage systems?
 - Soil/weather conditions?
 - Need to band the primary P and K rate or does a low starter rate complements broadcasting?

Plant Roots and P or K Uptake

- P and K are less mobile in soils than nitrate, stratification of applied P or K
- Reach the roots surface by diffusion from a short distance
 - Faster diffusion of K than P BUT need higher K amounts
- Actively growing large root systems with fine roots is key for P and K uptake
 - P is especially key for early growth and development
- What can limit root growth and uptake?
 - Cold, dry, compacted, or too loose soil
 - Root/crown diseases or insects

Physiological/Root Growth Effects

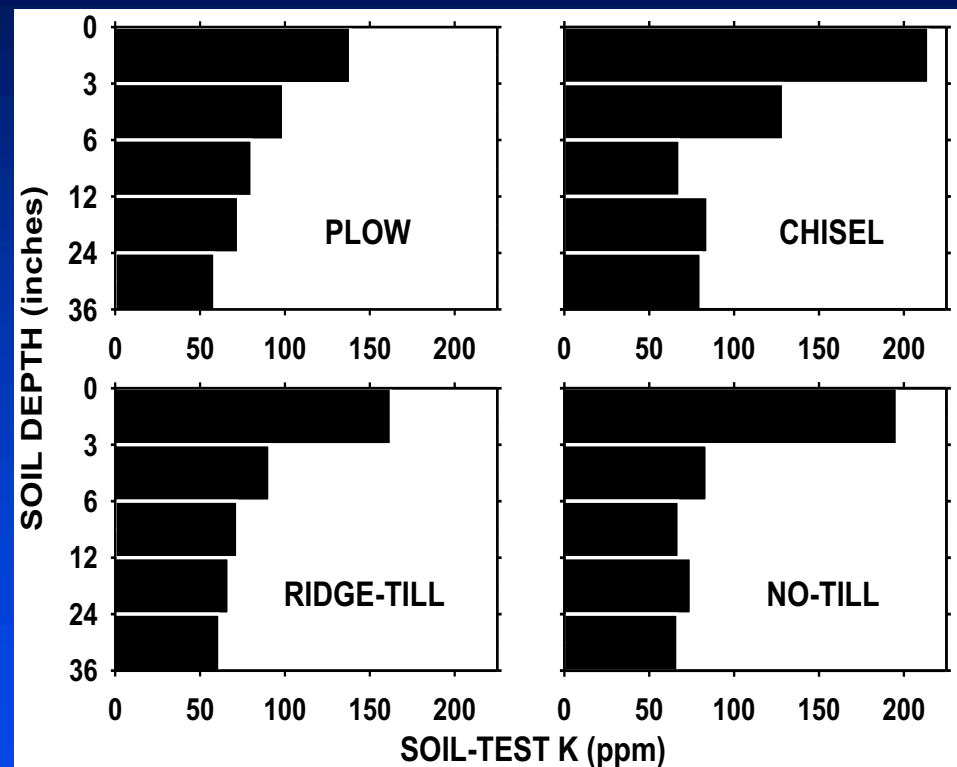
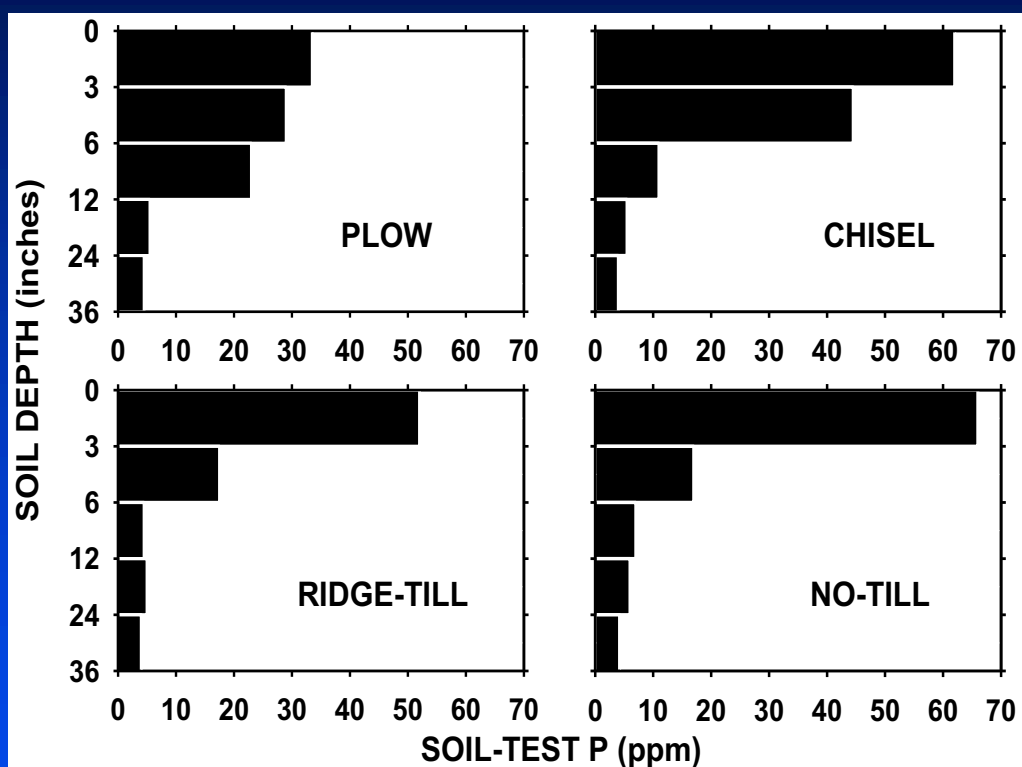
- Fertilizing a fraction of the root zone may create problems mainly for early growth
 - Salt damage to seedlings with most K sources and some P sources with N
 - Banded P can increase root growth and uptake per unit root surface and root proliferation in the band zone, but there is an upper limit for uptake rate
- Row crops may not get enough P or K when much of the root system isn't in the band

No-Till and P-K Management

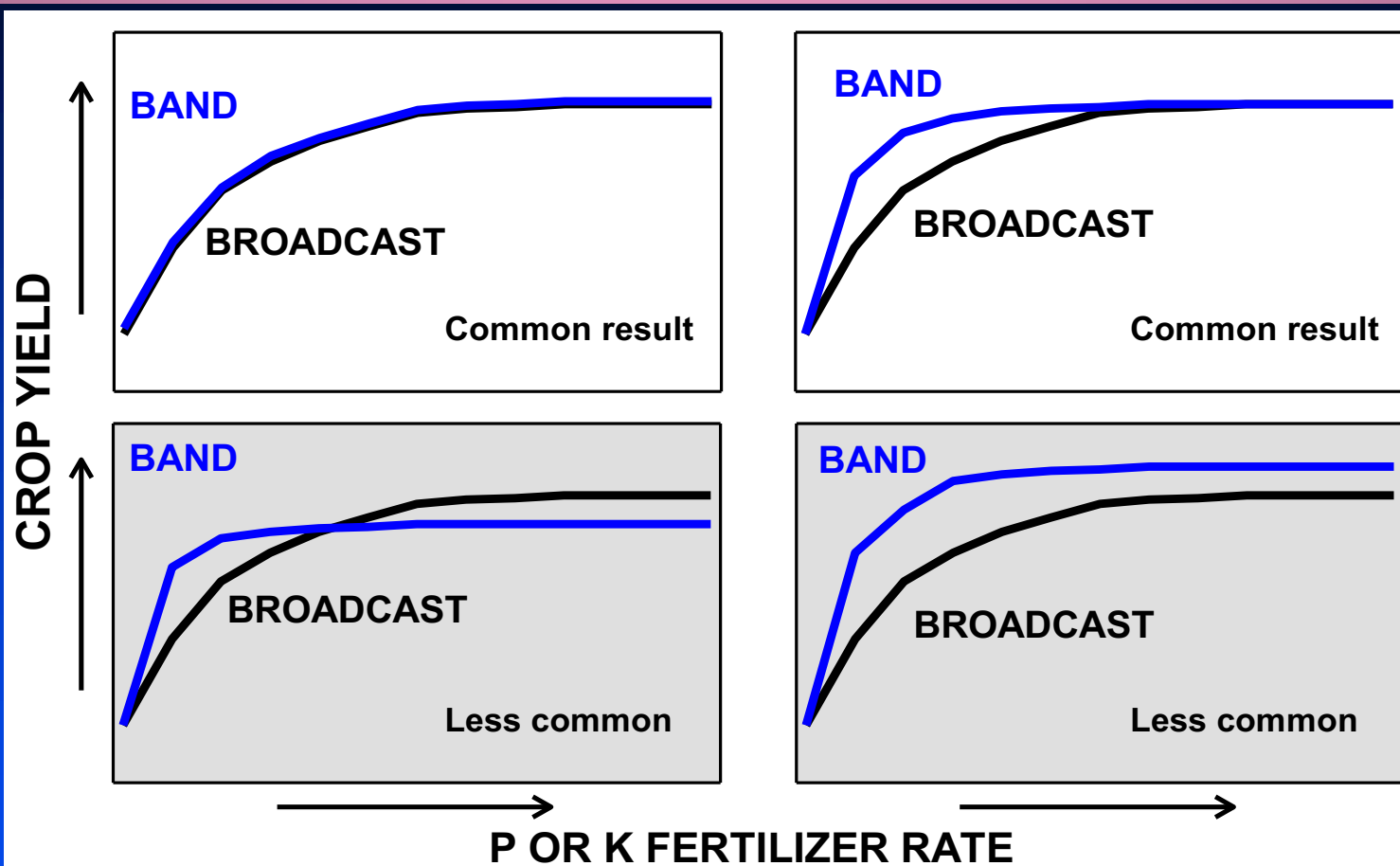
- **Increased residue cover**
 - Colder and wetter soil in early spring may limit root growth and P-K diffusion
 - But in summer, increased water infiltration and cover increase soil moisture and both shallow and deep roots efficiency
- **Broadcasting is a horizontal band in no-till**
 - Limits P-K reaction with soil
 - Increases surface OM, reduces P "fixation"
 - But deficient subsurface layers may limit uptake and total root growth

Tillage and Soil P or K Stratification

Old Long-Term Trial – Northeast Research Farm



Possible Placement Results Found in the US



P and K Placement Research in Iowa

- 1950s and 60s corn with tillage, no difference between broadcast and planter bands
- Numerous short-term or long-term trials with corn and soybean since 1994
 - No-till, Strip-till, Ridge-till, Chisel plow/disk
- Primary rate placement with dry fertilizers
 - At research farms or on-farm with strips, GPS
- Starter fertilization for corn
 - N, P, or K alone, and N-P-K
 - Dry, liquid, 2x2, in-furrow

Long-Term P and K Placement Research

- 24-year trials, 5 for P and 5 for K, granulated fertilizers, corn-soybean rotations at five research farms
- Tillage treatments: No-till and chisel-plow/disk
- Placement methods
 - 1994-2001: fall broadcast, Fall deep-band, planter bands (2x2")
 - In 2002 discontinued the deep band
- Rates
 - Annual: 0, 28, 56 lb P_2O_5 /a or 0, 35, 70 lb K_2O /acre
 - For broadcast and deep-band, also double the highest rate applied every other year before corn or soybean

Broadcast vs Deep Band for No-Till & Strip Till

At 5 Research Farms and Several Farmers' Fields

Fall deep band/strip tillage, 5-6" depth, planting on top, annual or every 2 years



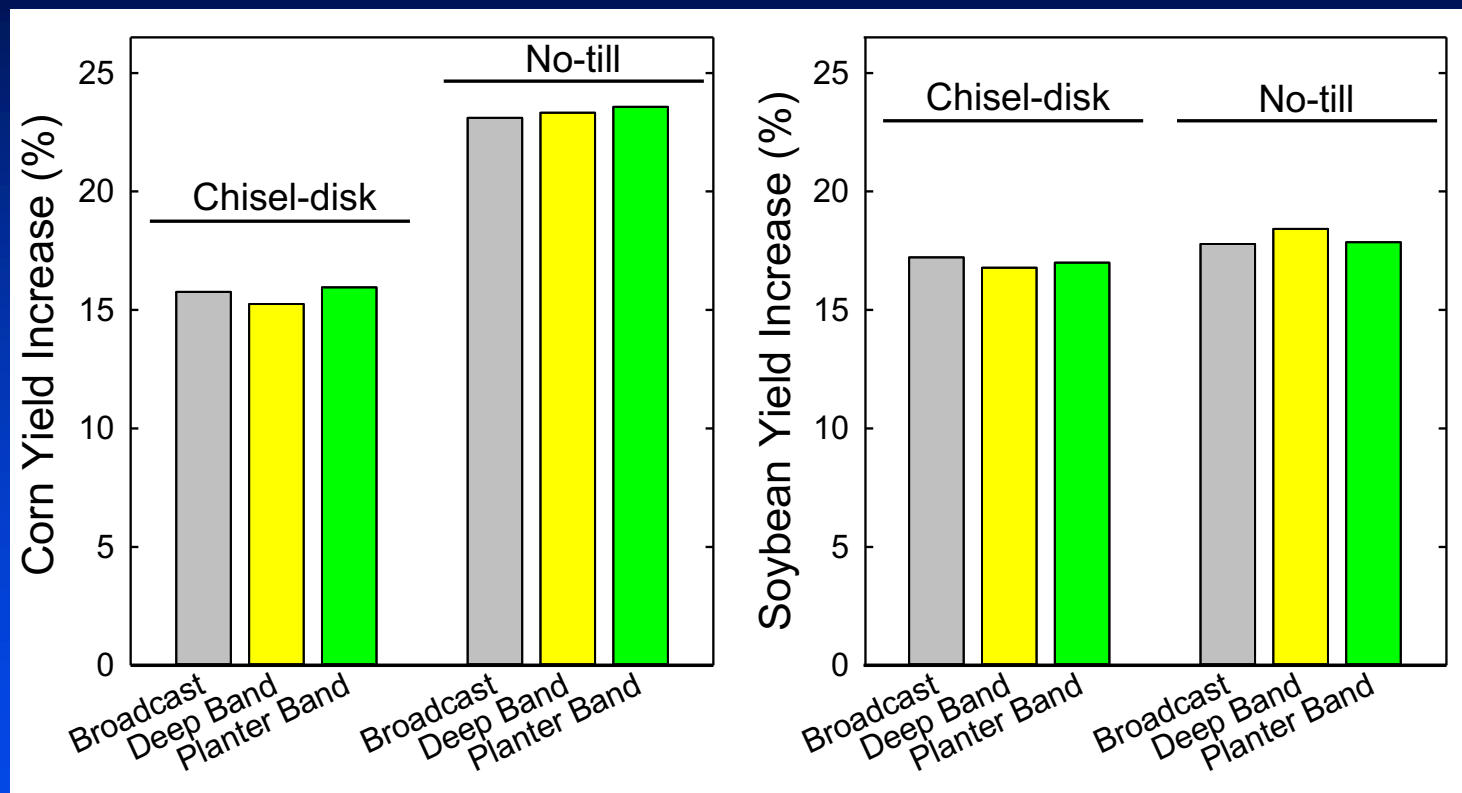
Plots Layout Example: Northeast Farm



P Deep Band & Broadcast Placement Methods

Long-Term Trials at Five Research Farms, 8 years

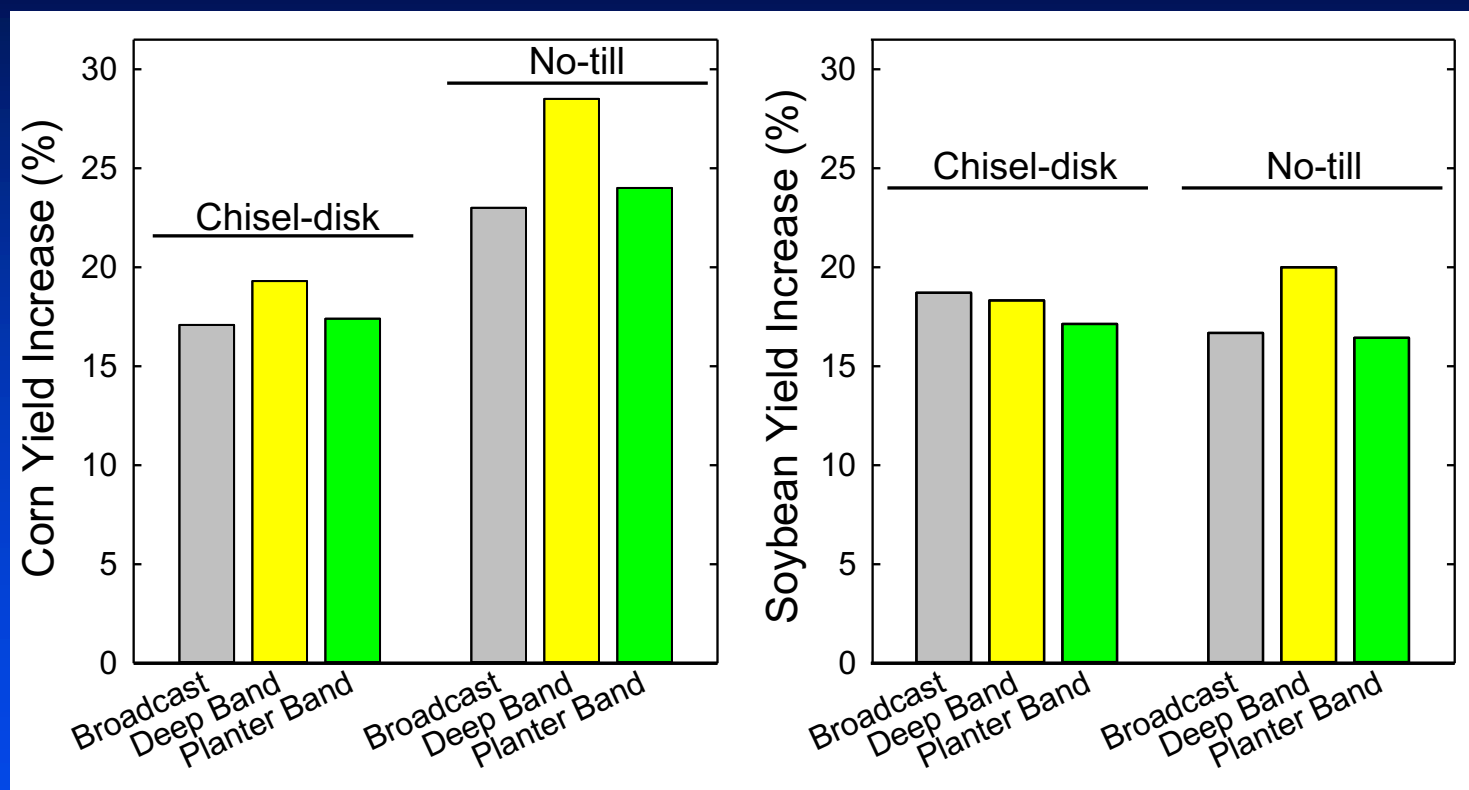
- Control with knife or strip-till but no P or K applied
- 0 and 2 annual rates and 2X before either crop
- No placement differences between rates



K Deep Band & Broadcast Placement Methods

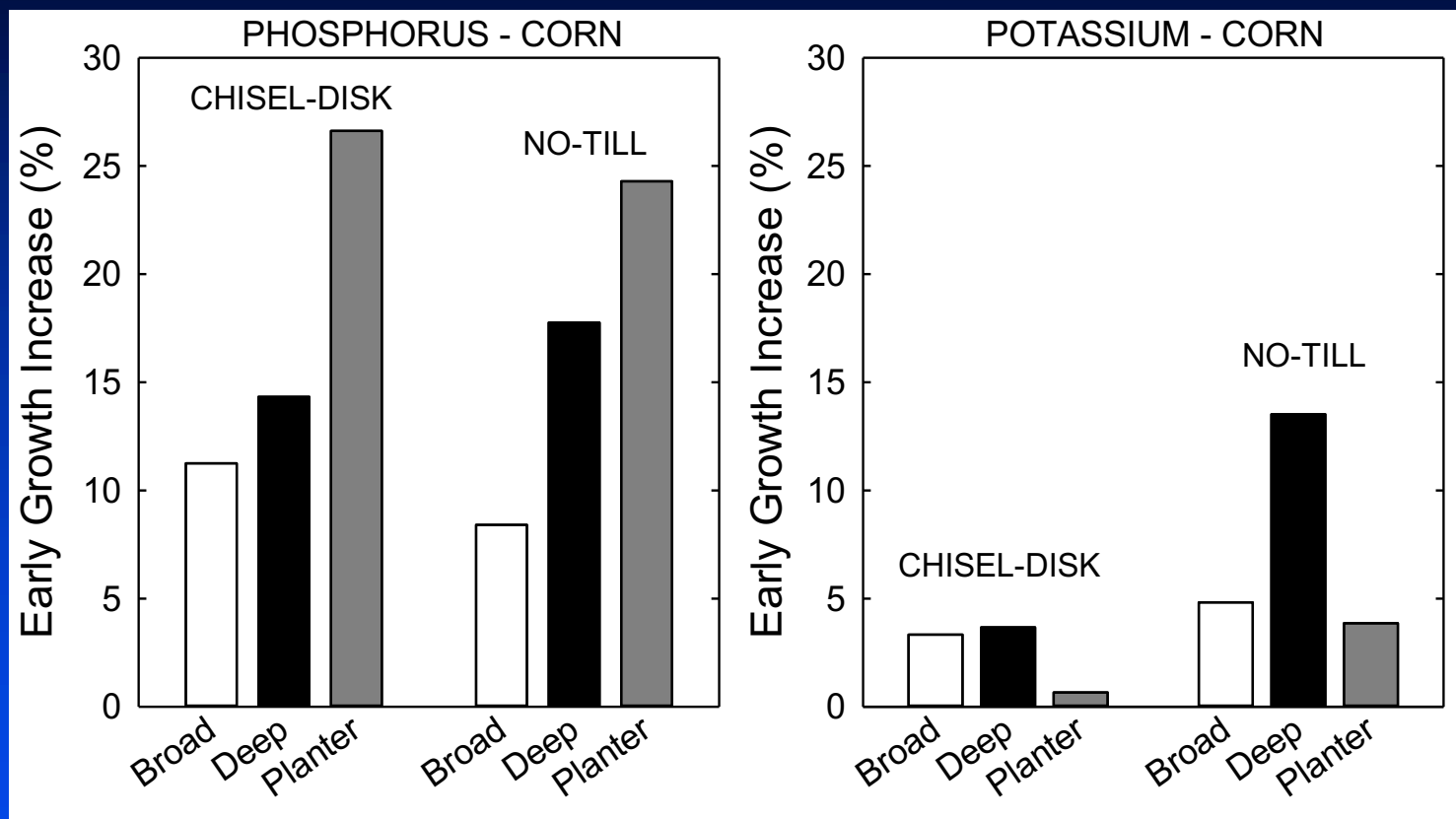
Long-Term Trials at Five Research Farms, 8 years

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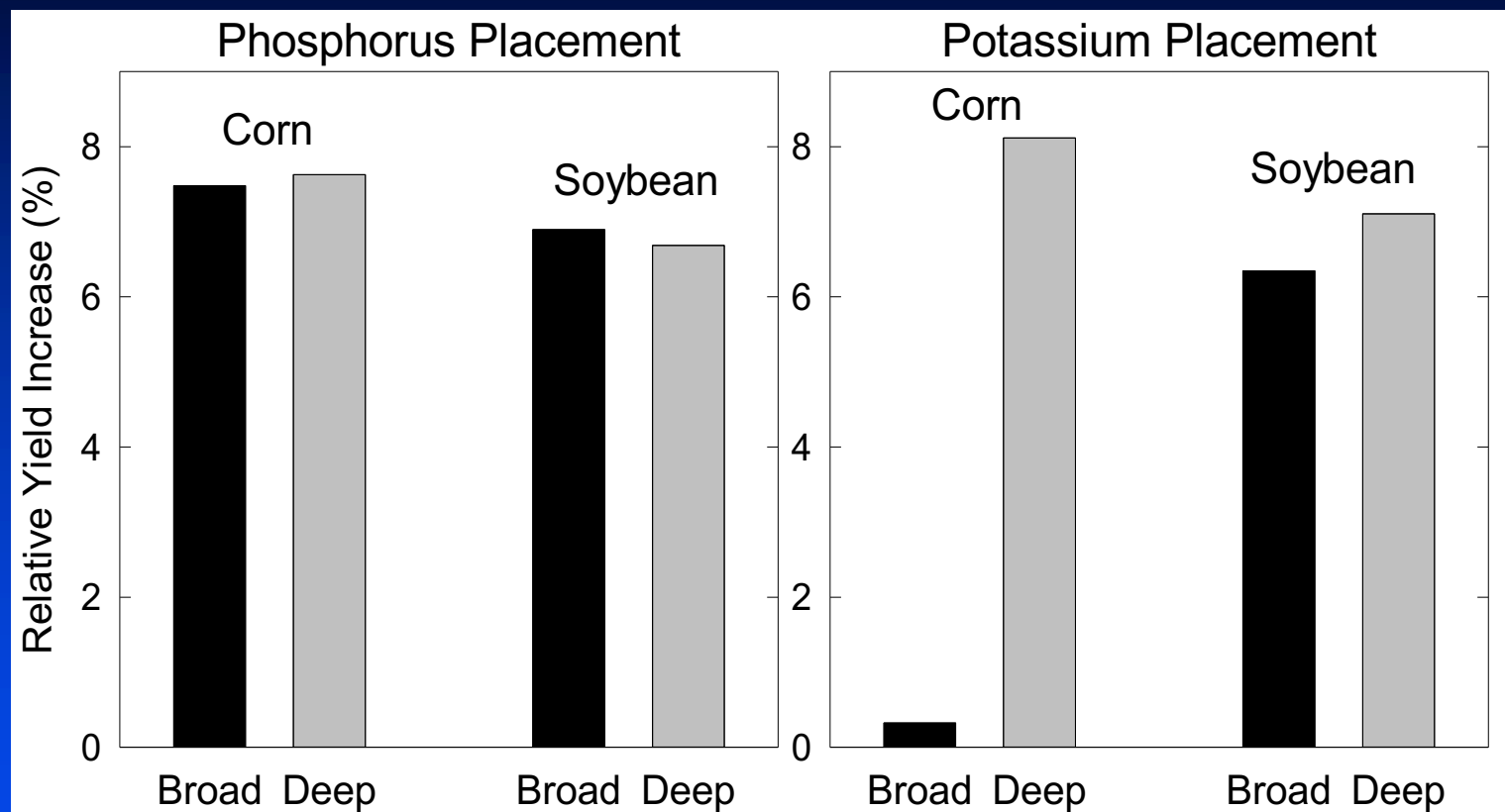
Placement Effect on Early Corn Growth

- Small plants sampled at the V5 to V6 growth stage
- Not shown for soybean, not much effect for either P or K



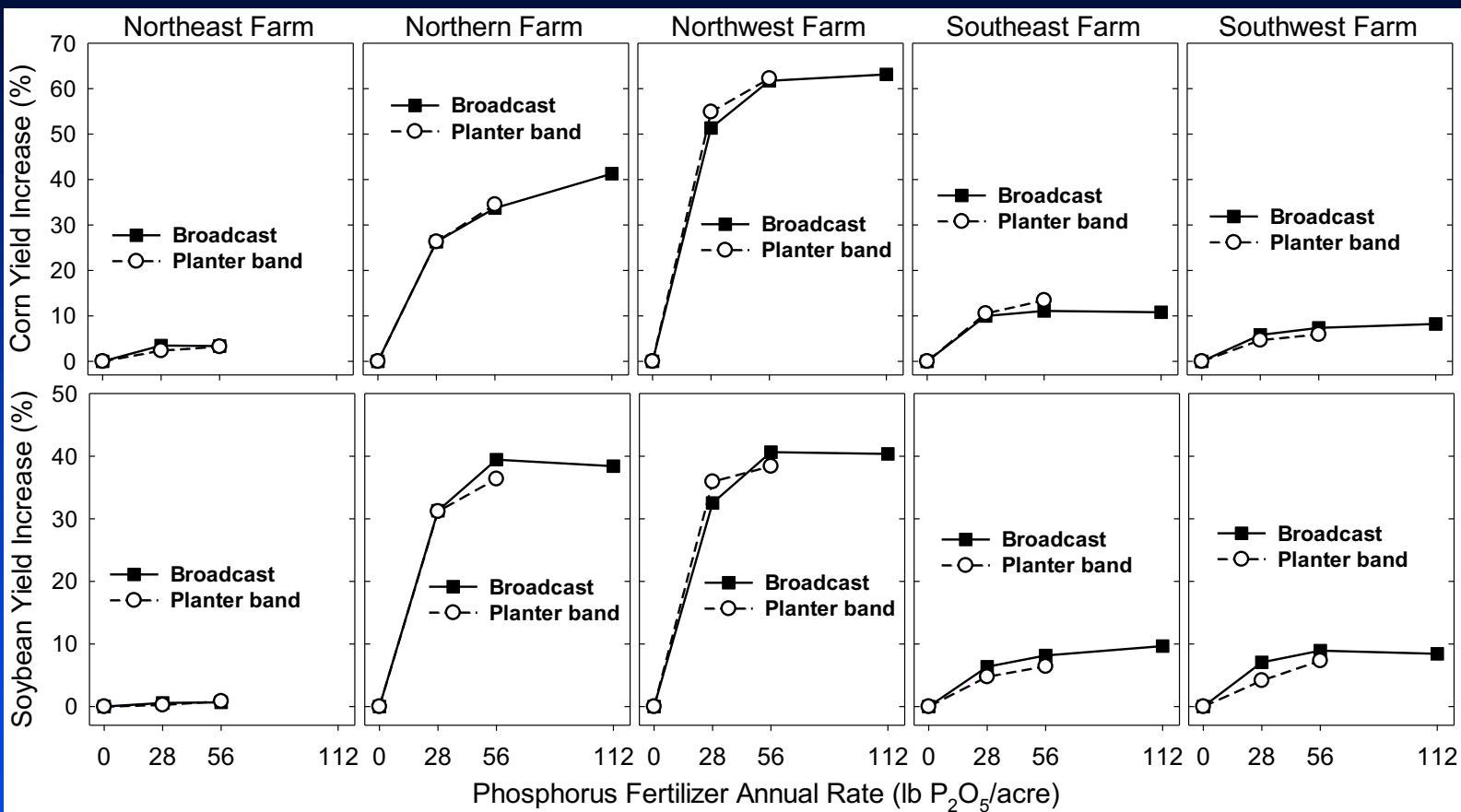
Ridge-Till Deep P banding or Broadcast

- Research at several farmers' fields
- Fall deep bands to the ridge core through the center or shoulders



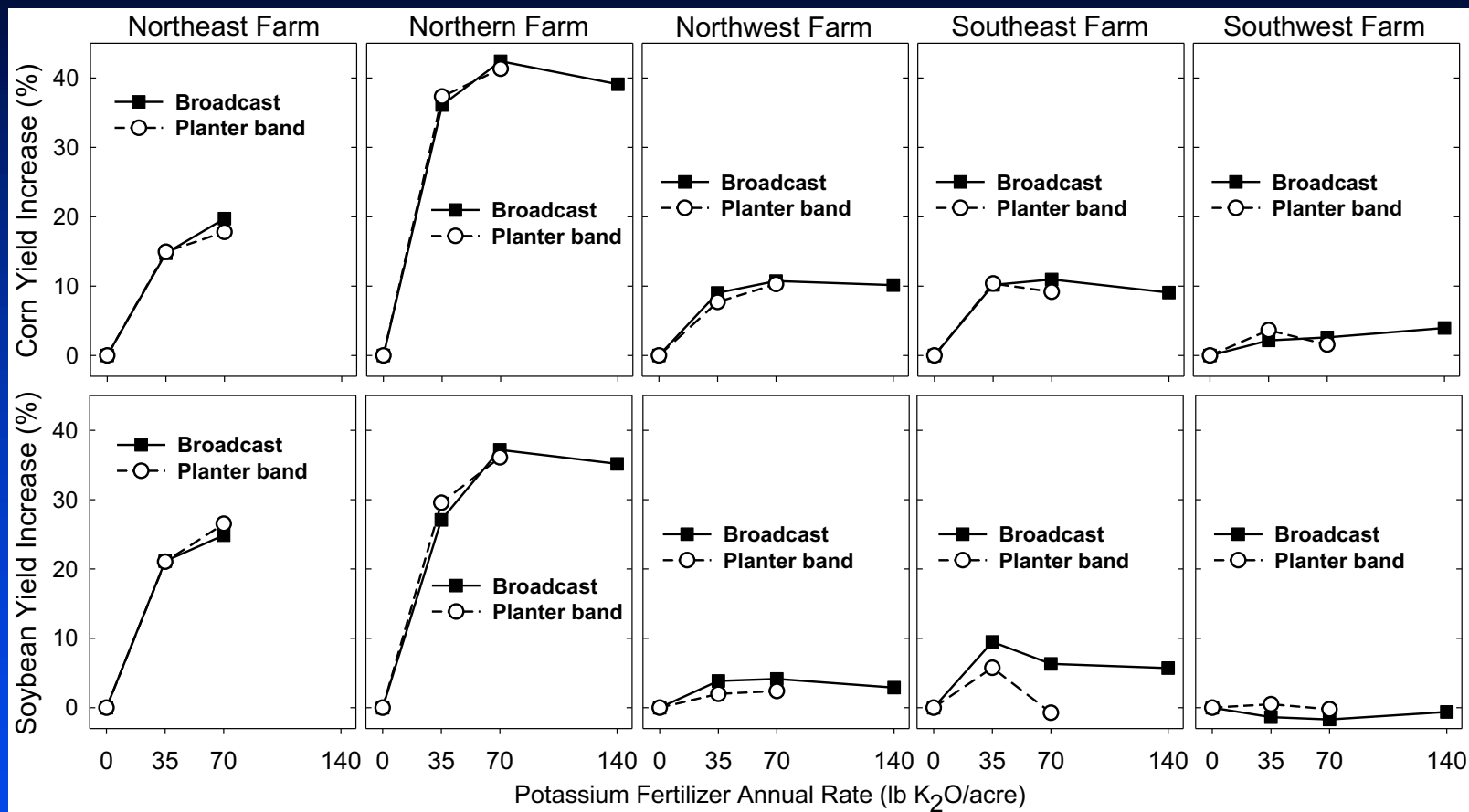
P Broadcast or Planter Band 2002-2014

No-Till Corn and Soybean



K Broadcast or Planter Band 2002-2014

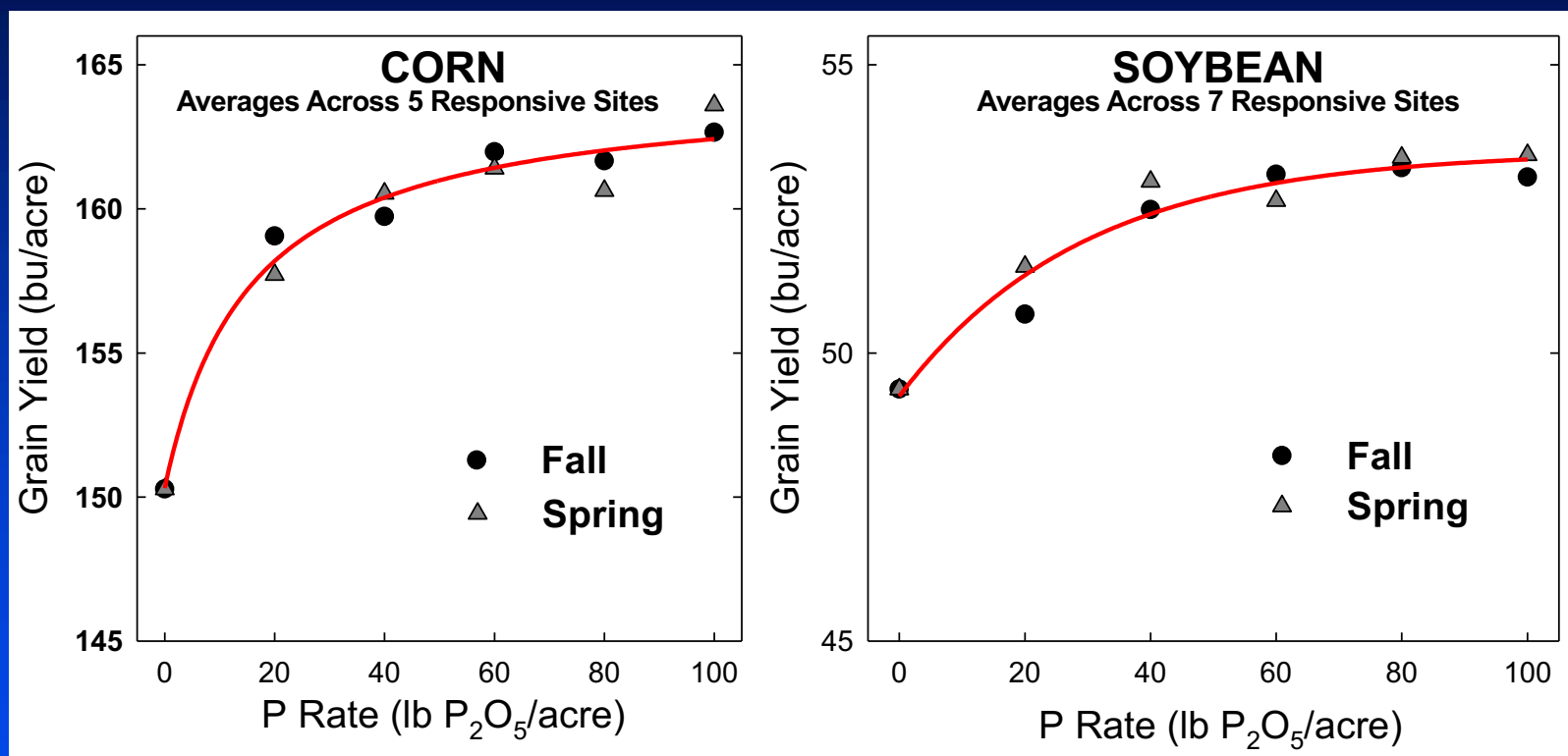
No-Till Corn and Soybean



Timing of Broadcast P Fertilization

Research at 10 Corn Sites and 10 Soybean Sites (2005, 2006, 2007)

Mallarino, Barcos, Prater and Wittry, SSSAJ 2009



Why Banding P or K Isn't Better in No-Till?

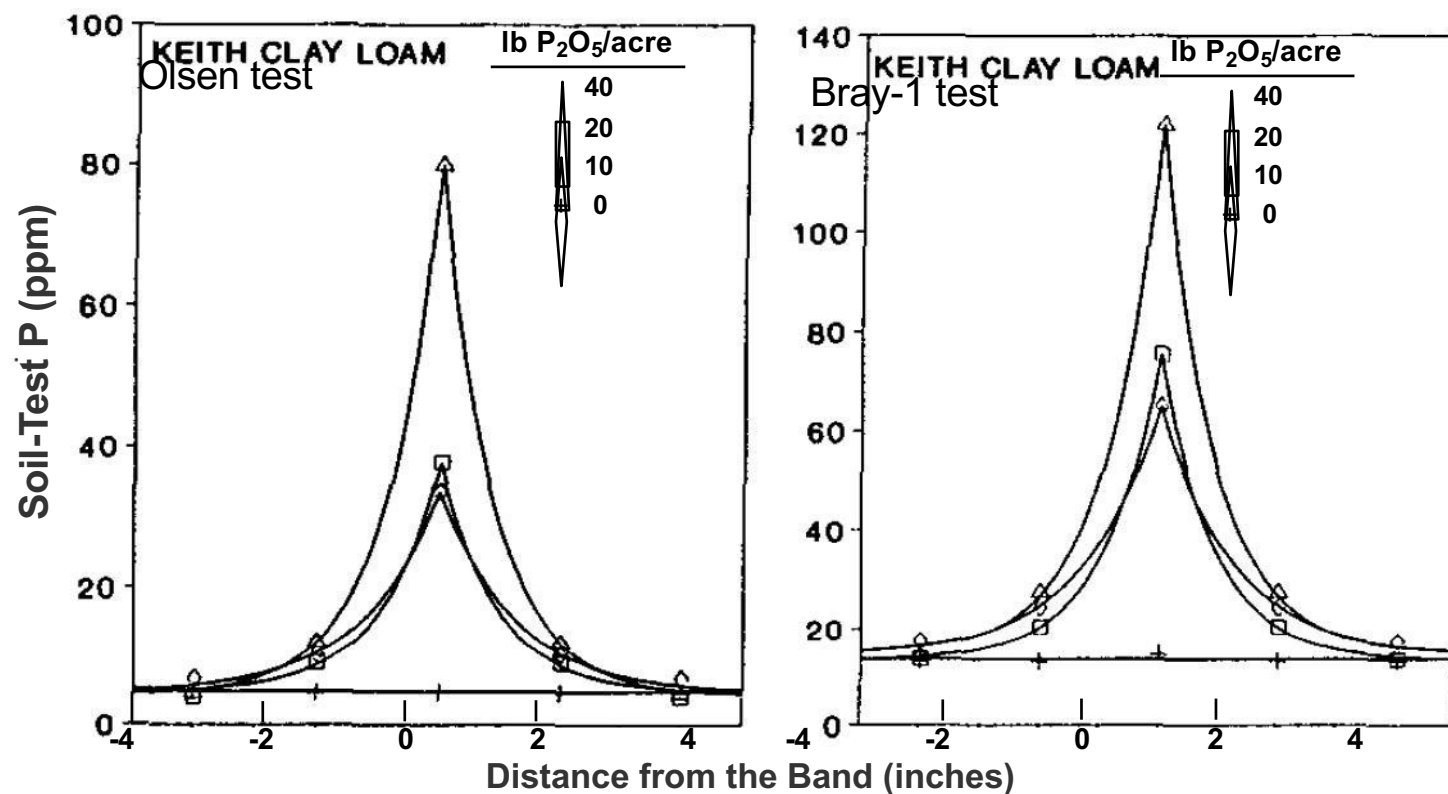
- Little or no P or K “fixation” in Iowa soils and usually humid spring weather
- No-till increases residue cover, decrease evaporation from soil surface surface soils, and increase surface organic matter and shallow roots function
- Slower early crop growth doesn't necessarily reduce grain yield with recommended planting dates and weed control
- Why large deep K effect with ridge-till only?
 - Ridge core always was low in K AND larger needs than for P
- Still, low-cost starter P may help corn in some conditions

Problematic Sampling with Banding

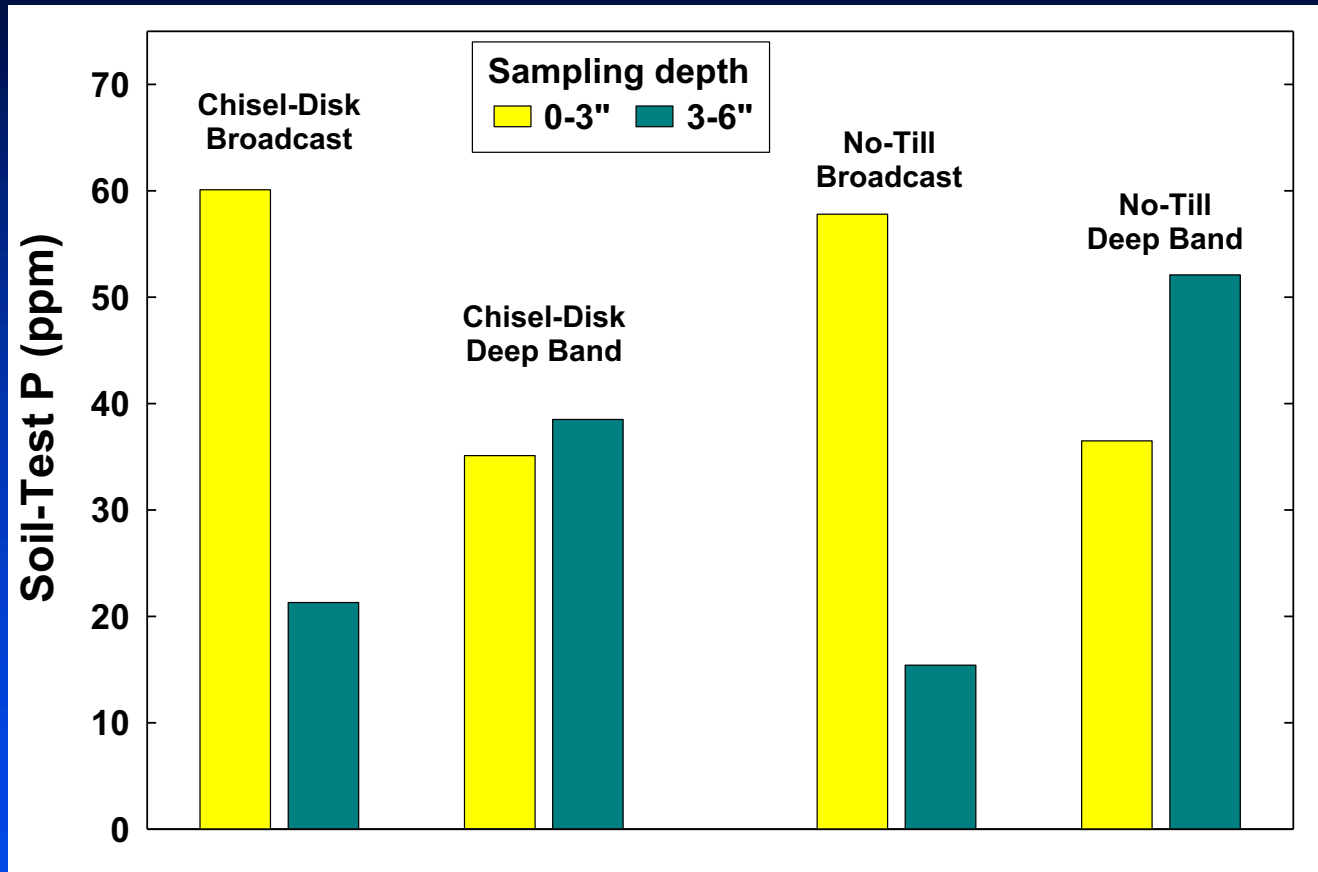
- **A nightmare with high banded P and K rates without tillage, very high small-scale variation!**
- **But common starter P and K rates are not a problem**
- **No proof is needed EXCEPT for deep K in ridge-till**
- **Soil-test calibrations with sampling depth shallower or deeper than 6 inches ARE NOT BETTER for any tillage system**
- **Sampling depth SHOULD be the same used for research of STP and STK calibrations with yield response!**

Soil P Lateral Variation after Banding

Kitchen et al., 1990, MO. P banded at 3-inch depth, 6-inch sampling depth

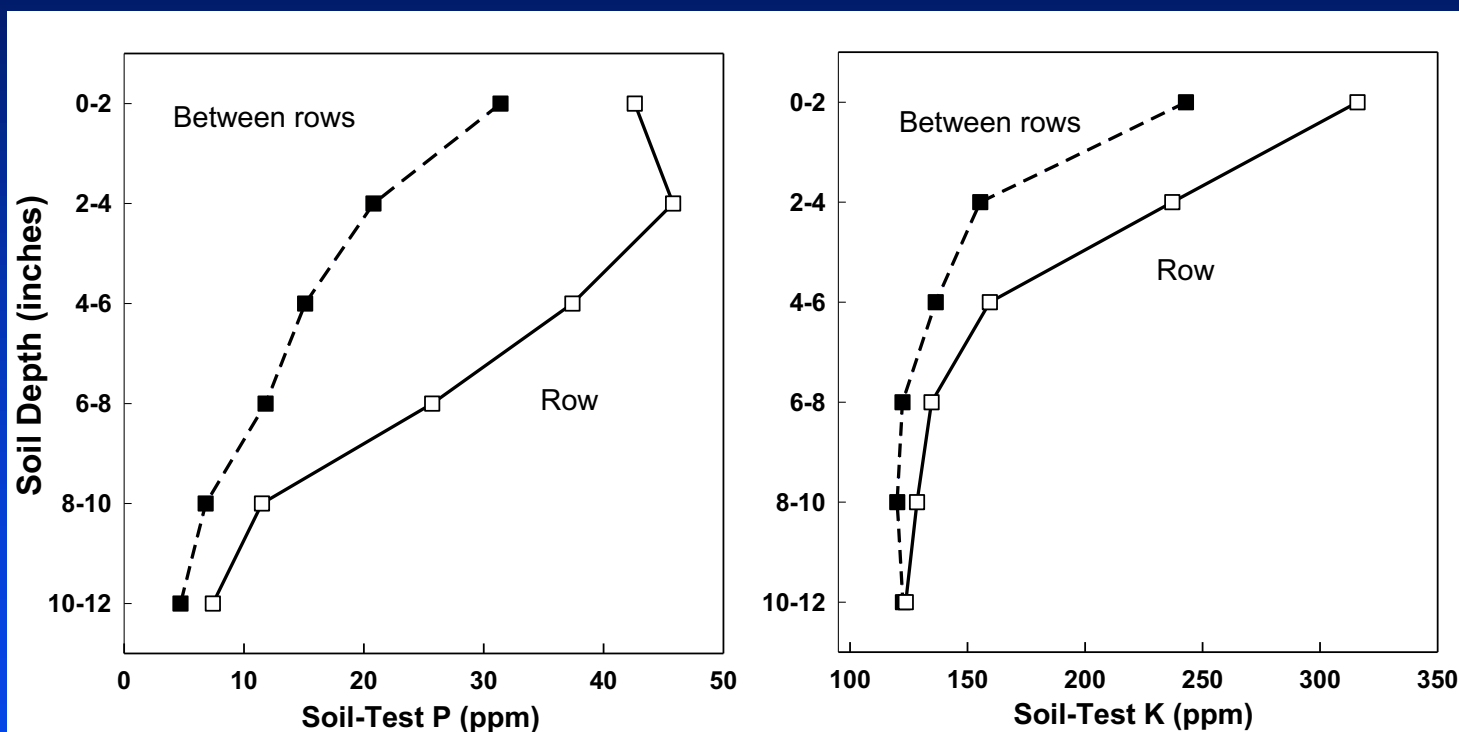


Deep Banding Reduces Stratification

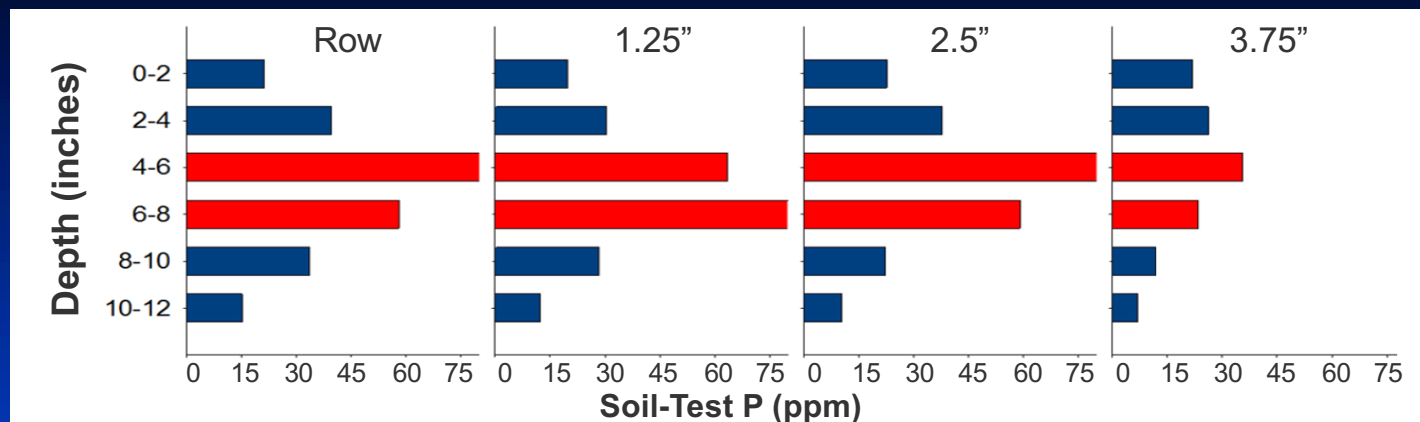


Strip-Till with Deep Banding - Iowa

Borges and Mallarino, 2005, Iowa, corn-soybean rotation, averages of 5 sites, banded every year (5-6 inches depth)

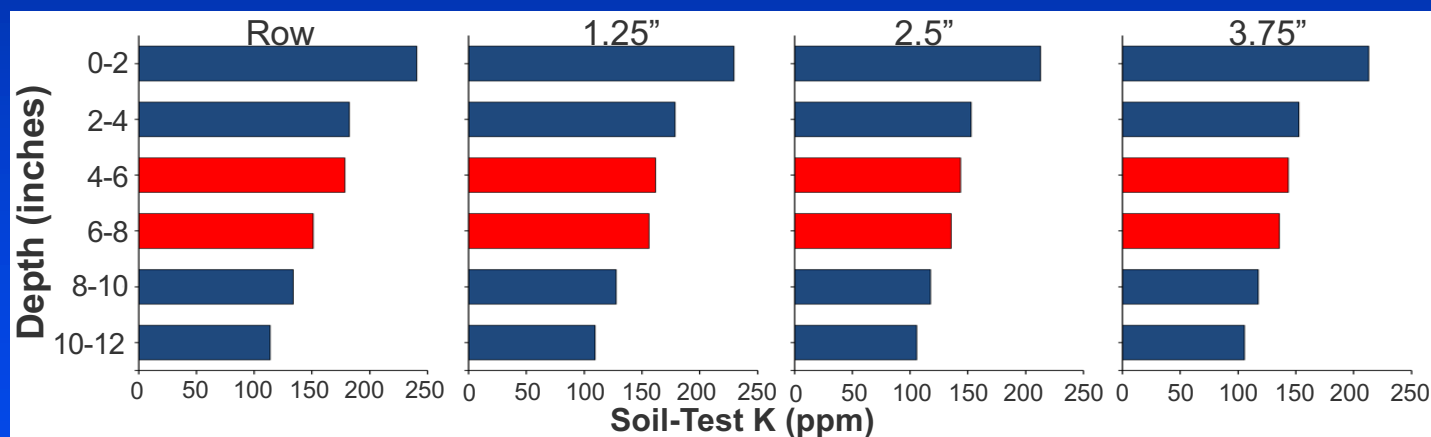


Strip-Till with P-K Deep Banded – Illinois



Courtesy of
Fabian Fernandez

Now at the University
of Minnesota



Similar Conclusions from IA and IL

- Adequate soil P-K levels and rates are more important than the placement method
- Tillage systems affect corn yield but the P or K placement method seldom does
- Can't reduce P and K rates by banding
- Banding primary P or K rates complicates soil testing
 - Need MANY more composite samples and CORES/SAMPLE!
 - Fabian (IL) suggested taking 2-3 cores away from the band for each core taken from the band area
 - Antonio (IA) didn't find one way works across all fields, take random cores or as many from band and inter-band areas

Sidedressing Fluid K Fertilizer

5 initial broadcast KCl rates before corn, injected potassium acetate (0-0-24), 0 or 45 lb K₂O between rows, reapplied sidedress for second-year soybean

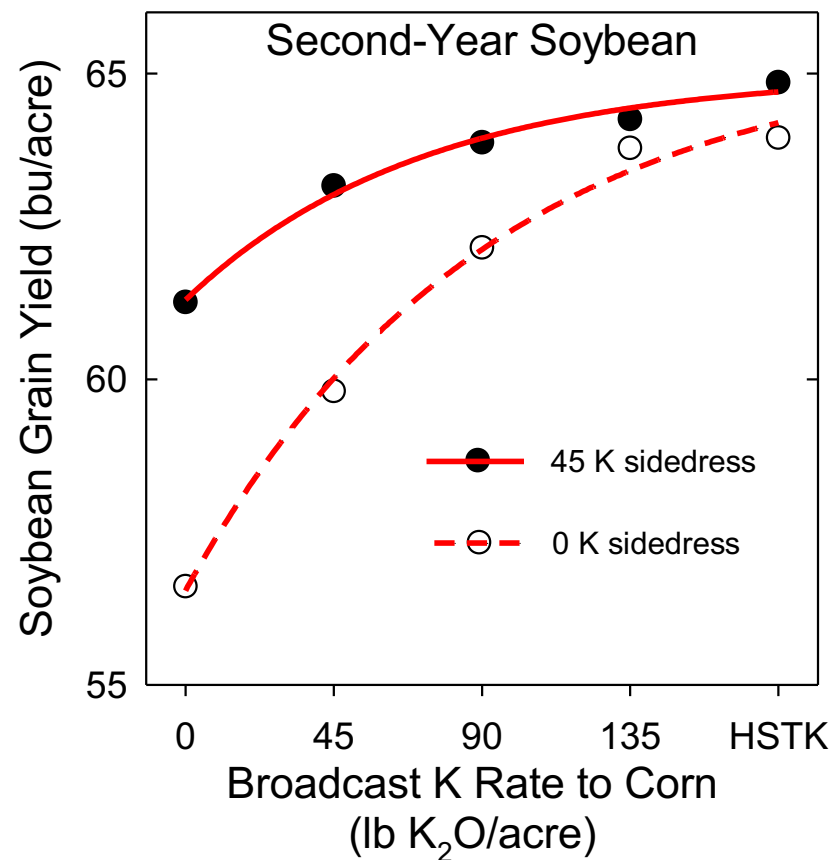
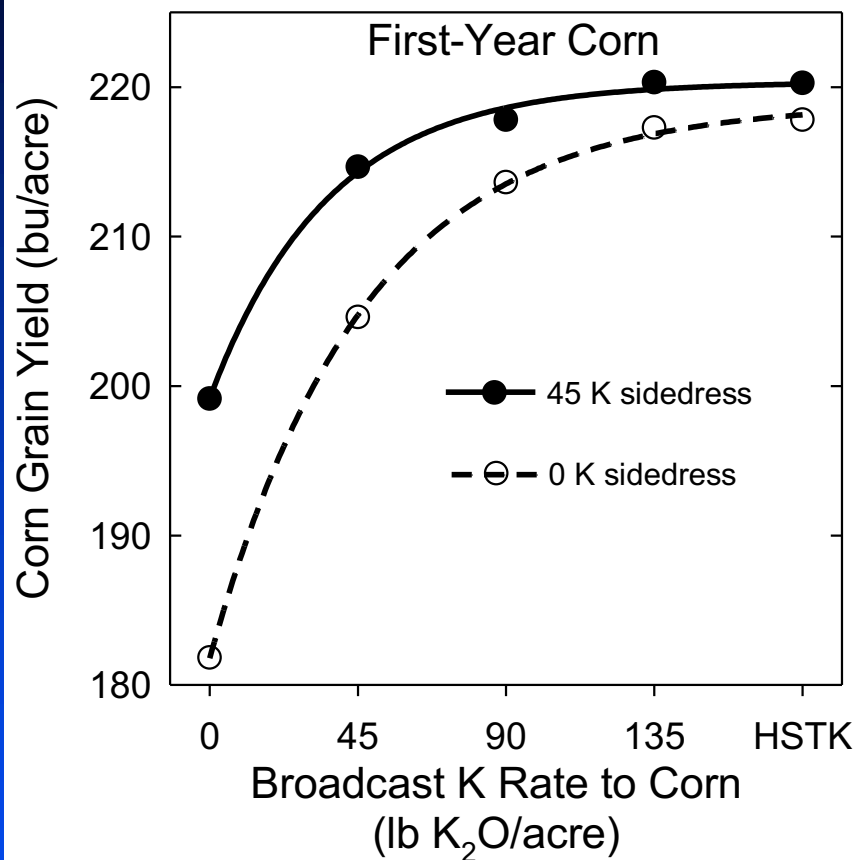
Corn low-testing fields, 6 in 2017, 6 in 2018



Reapplication to Second-Year Soybean



Sidedressing Fluid K – Averages Across 12 Sites



Primary P-K Rates Placement Guidelines in Iowa

- No differences among P or K broadcast and shallow or deep band placement methods with few exceptions (online publication PM 1688):
- Phosphorus
 - Potential benefits from starter N-P in very few conditions
- Potassium
 - Ridge-till: Deep banding is essential for corn (to the ridge core)
 - No-till or Strip-till: Small and occasional benefits from deep banding often may not offset increased costs
- Soil sampling guidelines in online publication CROP 3108

Starter for Corn General Guidelines

- **“True” starter effect exists for N and P, not for K**
- **Early corn growth always is slower in no-till than with strip-till or tillage**
- **Starter P always increase early growth BUT not necessarily grain yield or gets drier grain at harvest**
- **Unlikely response to P-K starter with the 2-broadcast rate or in high-testing soils**
- **Unlikely response to starter N in corn after soybean with spring preplant N**

Best Way of Save Money in P and K?

- **Do good and frequent soil testing and don't fertilize high-testing soils!**
- **Farmers owning land may afford maintaining a high level with low prices, but it won't pay**
- **With rented land, uncertain tenure, and low prices farmers shouldn't fertilize high-testing soils and landowners should not require it**
- **Starter fertilizer averts unlikely and small yield responses in high-testing soils and is an environmentally friendly sleeping pill**

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