P and K Placement Methods for Corn and Soybean

An Iowa Perspective

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Plant Roots and P - K Uptake

- P and K don't move much. Main uptake mechanism is slow diffusion to roots through less than 1/10 of an inch.
- A large root system and large surface of fine roots are keys for P and K uptake.
- Small root system and limited root growth may limit P and K uptake:
  - cold, dry, compacted, or loose soil
  - diseases and pruning by insects

Why Not Just Broadcast P & K?

- Some soils may retain P and K tight when fertilizer is incorporated.
- Apply some P and K in the root zone when root growth is restricted.
- Banding localizes fertilizer, and also slows down the change of soluble forms to less soluble forms.
- Under these conditions, banding can increase P and K uptake and efficiency.

Soil P and K Retention or Fixation

- P and K are retained by soil, but seldom means "fixation" in most soils of Iowa and the Corn Belt
- Strong retention (some "fixation"):
  - For both: very heavy textured soils and some clay types
  - For P: high Fe oxide concentration, very acid, highly calcareous
- Significant losses through crop removal, erosion, and surface runoff

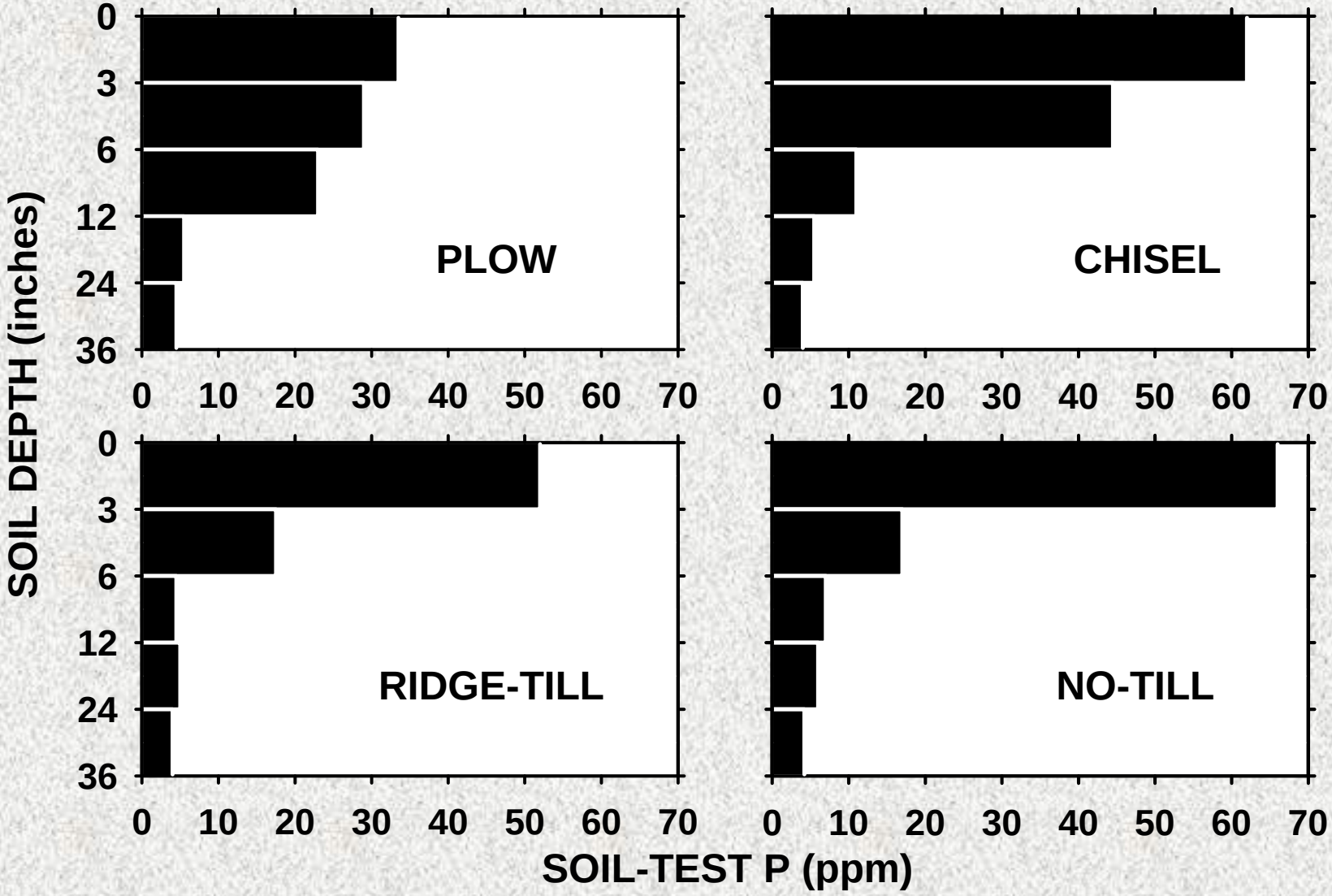
Residues on the Soil Surface

- Colder and wetter soil in early spring that may limit early plant growth, P and K diffusion to roots, and uptake.
- Increased water infiltration and reduced soil moisture loss in summer improves nutrient uptake efficiency of both deep and shallow roots.
- Very variable effects depending on the specific soil and climate conditions.

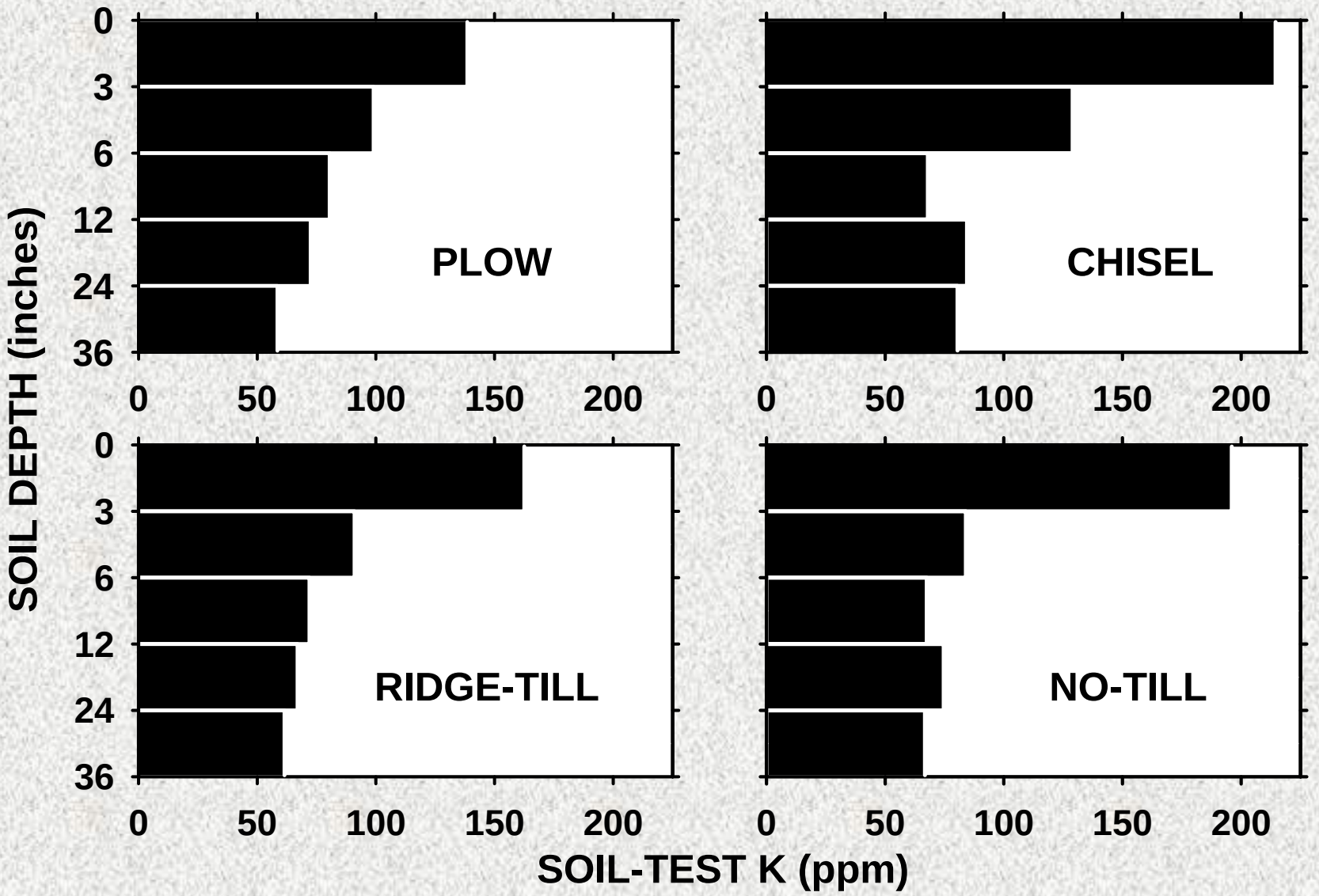
Tillage and Placement Interactions

- Agronomic issues
  - mix of P and K with soil or not, stratification near the soil surface
  - residue cover, temperature, moisture
  - early plant growth and nutrient uptake
  - P and K placement method
- Water quality issues
  - not an issue for K
  - P loss from fields with soil erosion and surface runoff

Tillage and Soil P Stratification



Tillage and Soil K Stratification



Banding and Starter: Confusion

- **What does “starter” mean?**
  - ***A small amount of fertilizer in the root zone to supplement primary fertilizers when needed, necessarily a band*.**
- **Fertilizer can be banded with planter attachments or other tools. Cannot apply high rates in-furrow due to salt effect or ammonia toxicity.**
- **Banding in the furrow or in the root zone may have a starter effect.**

Iowa Placement Methods Research

- Dry fertilizers, corn-soybean rotations.
- Five long-term trials:
  - 2 tillage systems: no-till, chisel-plow
  - 3 placement methods
    - broadcast or deep-band: annual rates of 0, 28, 56 lb P_2O_5/a or 0, 35, 70 lb K_2O/acre; twice the high bi-annually
    - Planter bands 2x2”, 28 and 56 lb P_2O_5/acre or 35 and 70 lb K_2O/acre
- 60 short-term trials, no-till and ridge-till


Deep band in the fall, 5 to 7” depth,
30" width spacing, planting on top,
every year or every two years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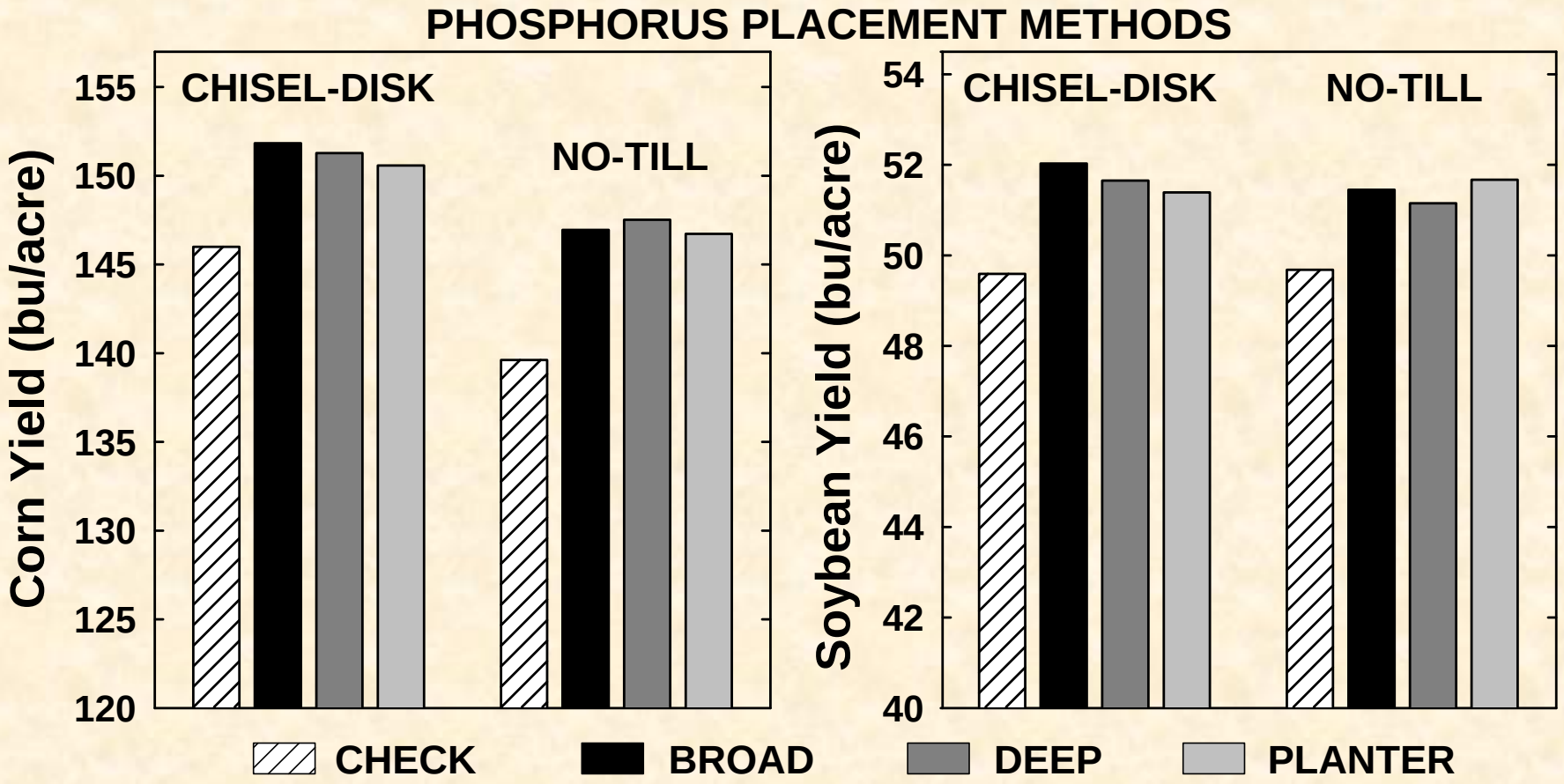
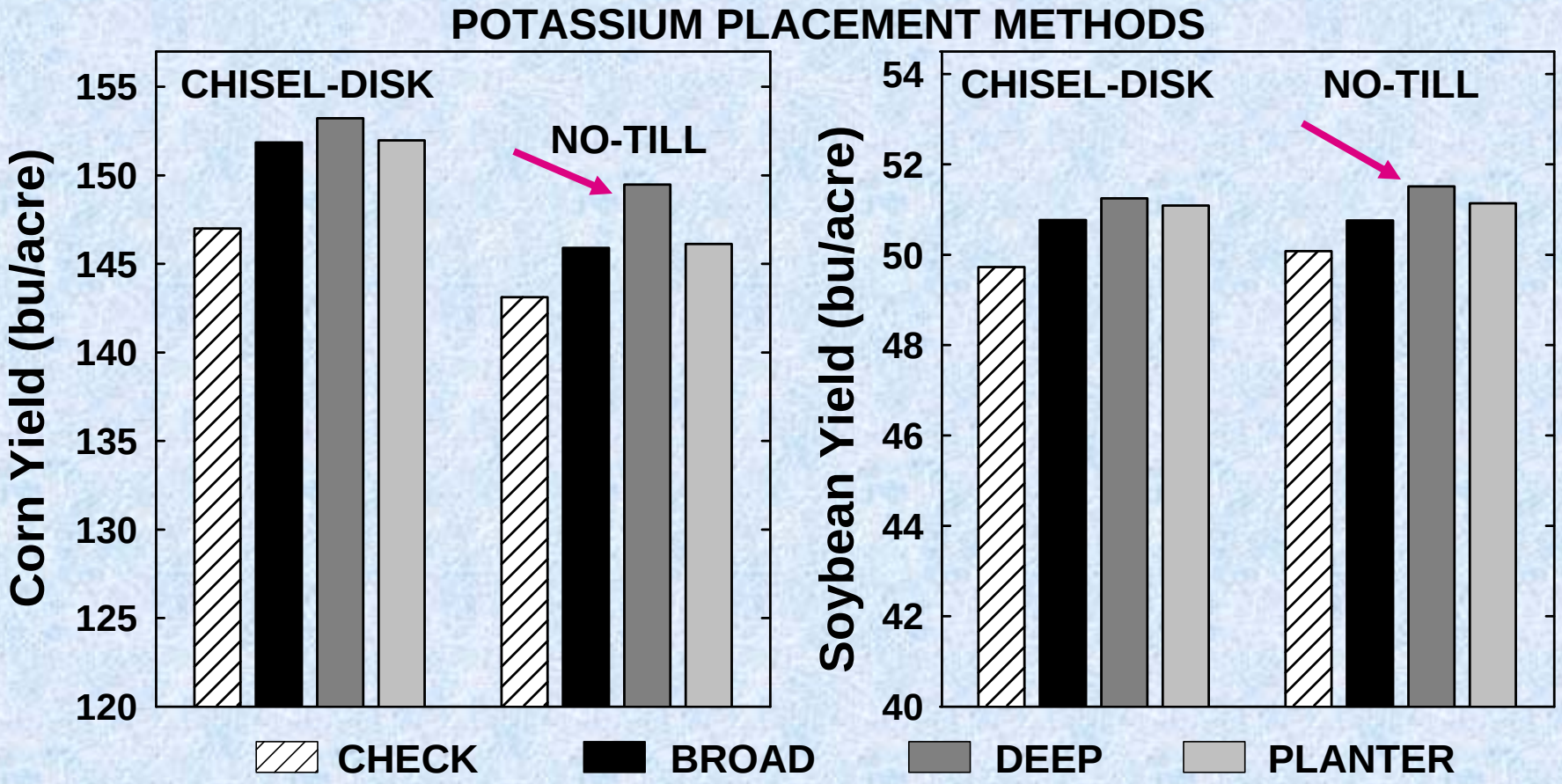
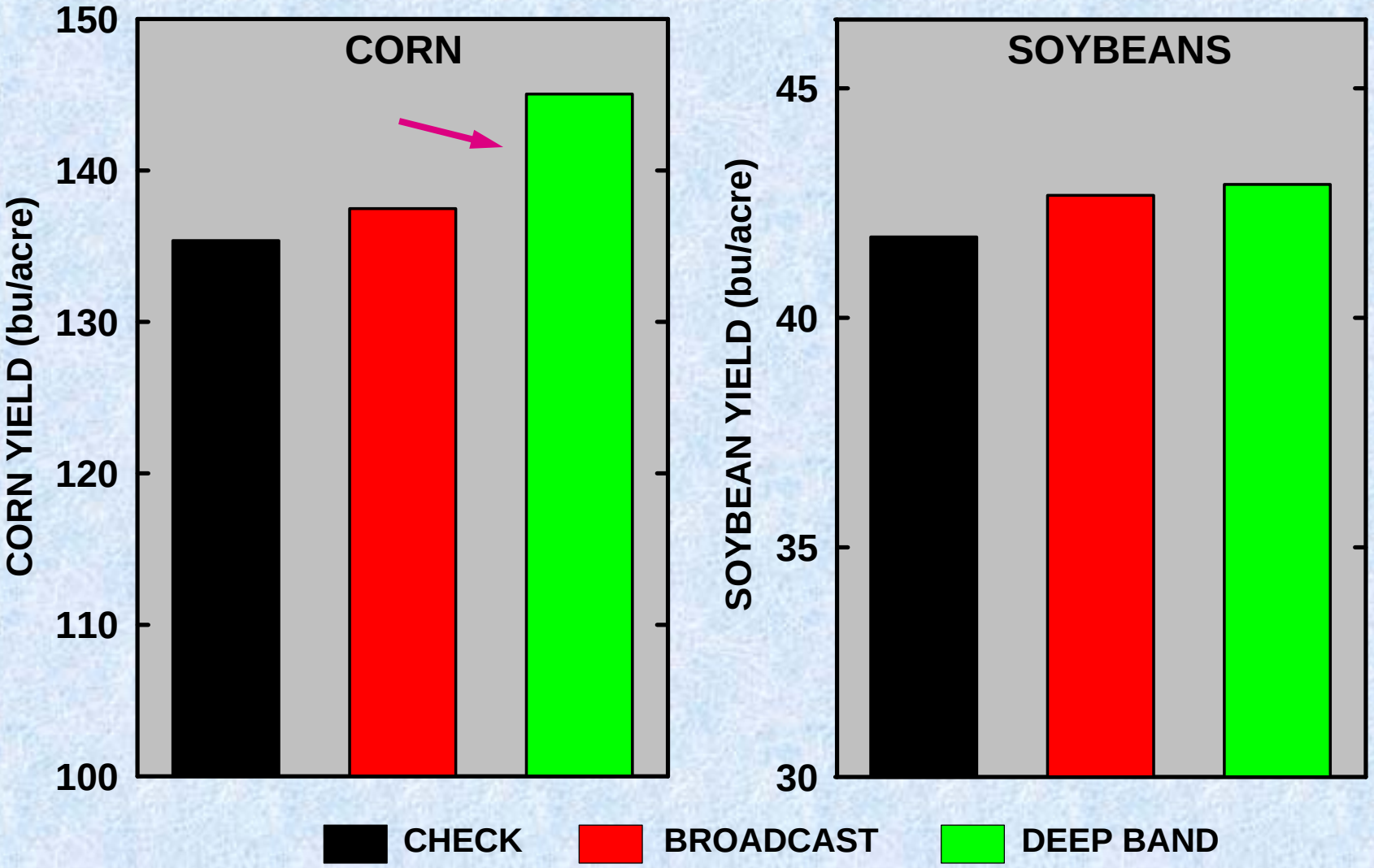
P Placement Methods in Iowa



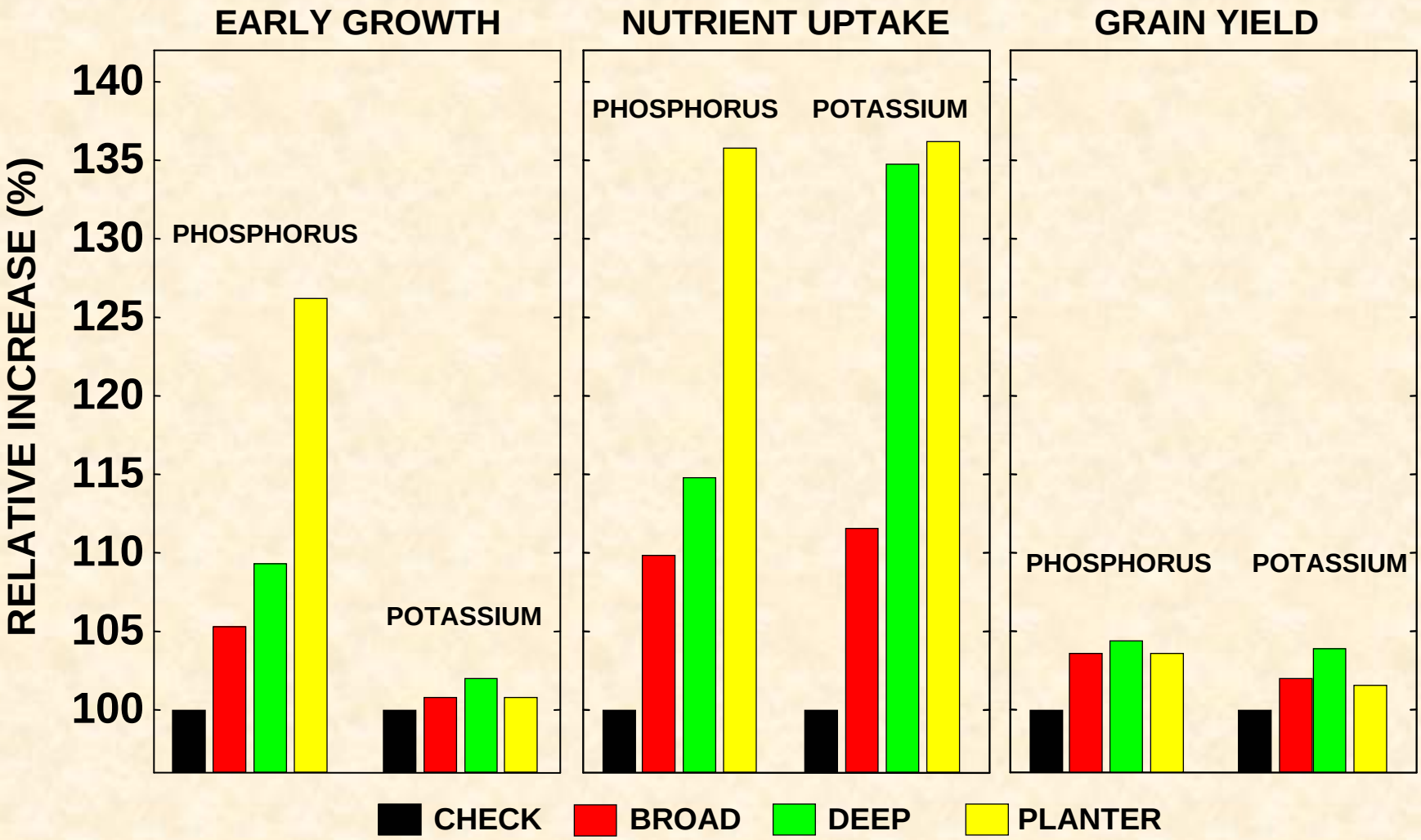
K Placement Methods in Iowa



Need Deep K for Ridge-Till Corn



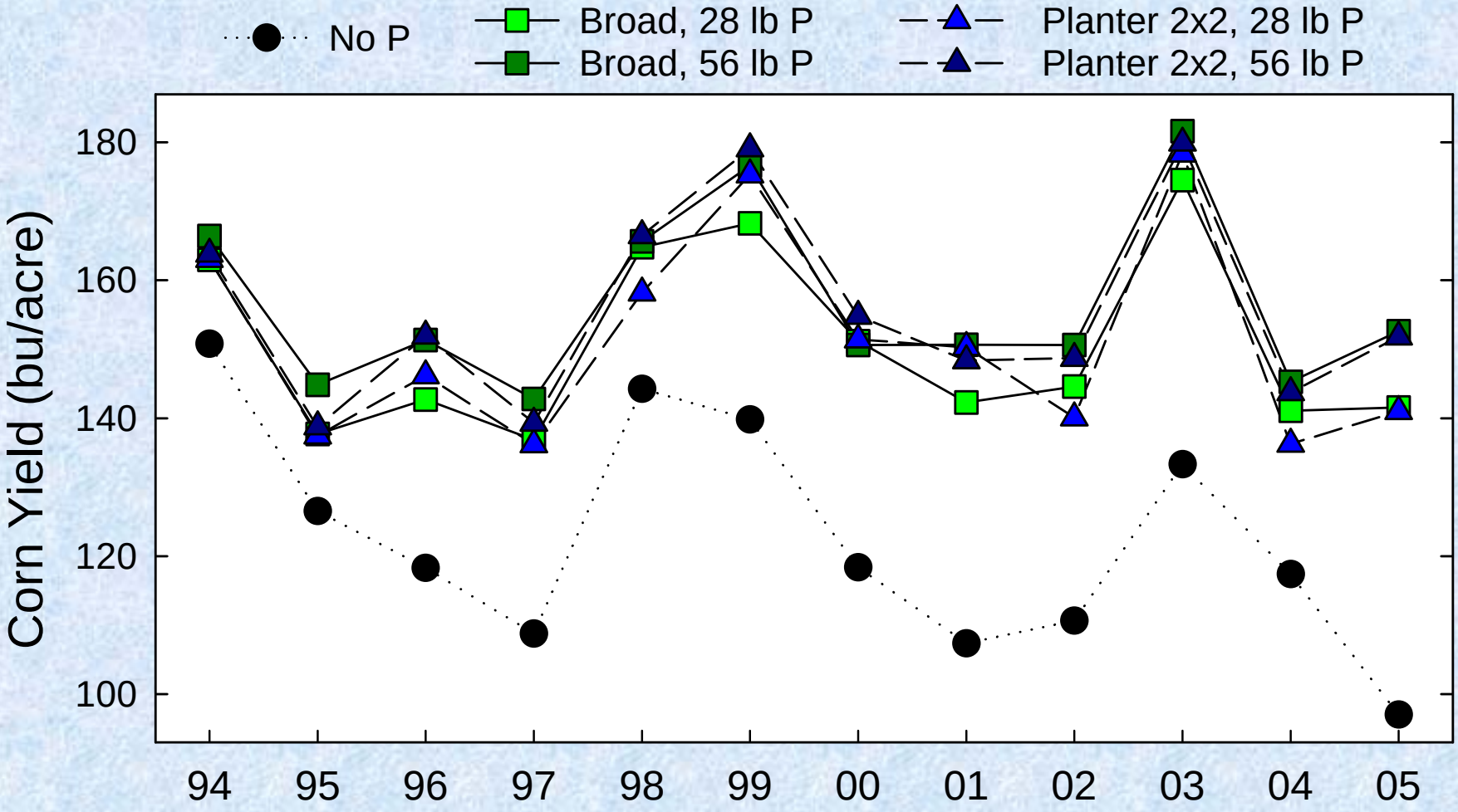
P & K Placement for No-Till Corn



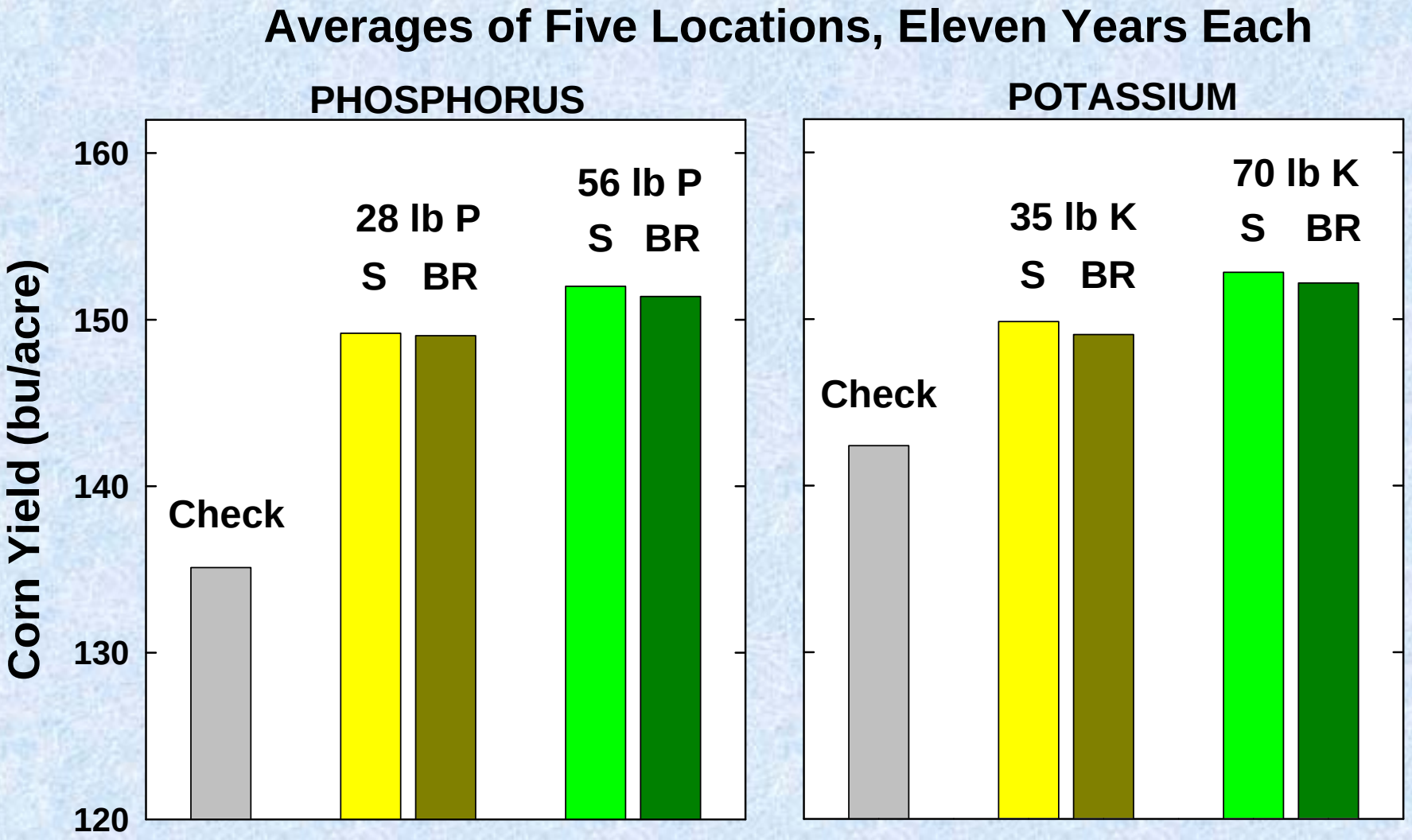
Other Relevant Placement Results

- No consistent difference between annual or bi-annual application before corn or soybean, broadcast or deep.
- Response to deep K was in addition to any physical knife/coulter effects.
- Placement differences were similar for all P and K rates: Can't cut the rate by banding. But banding could be better in other soils and with very low rates.

No Long-Term P Placement Effect



Rate & Placement Effects



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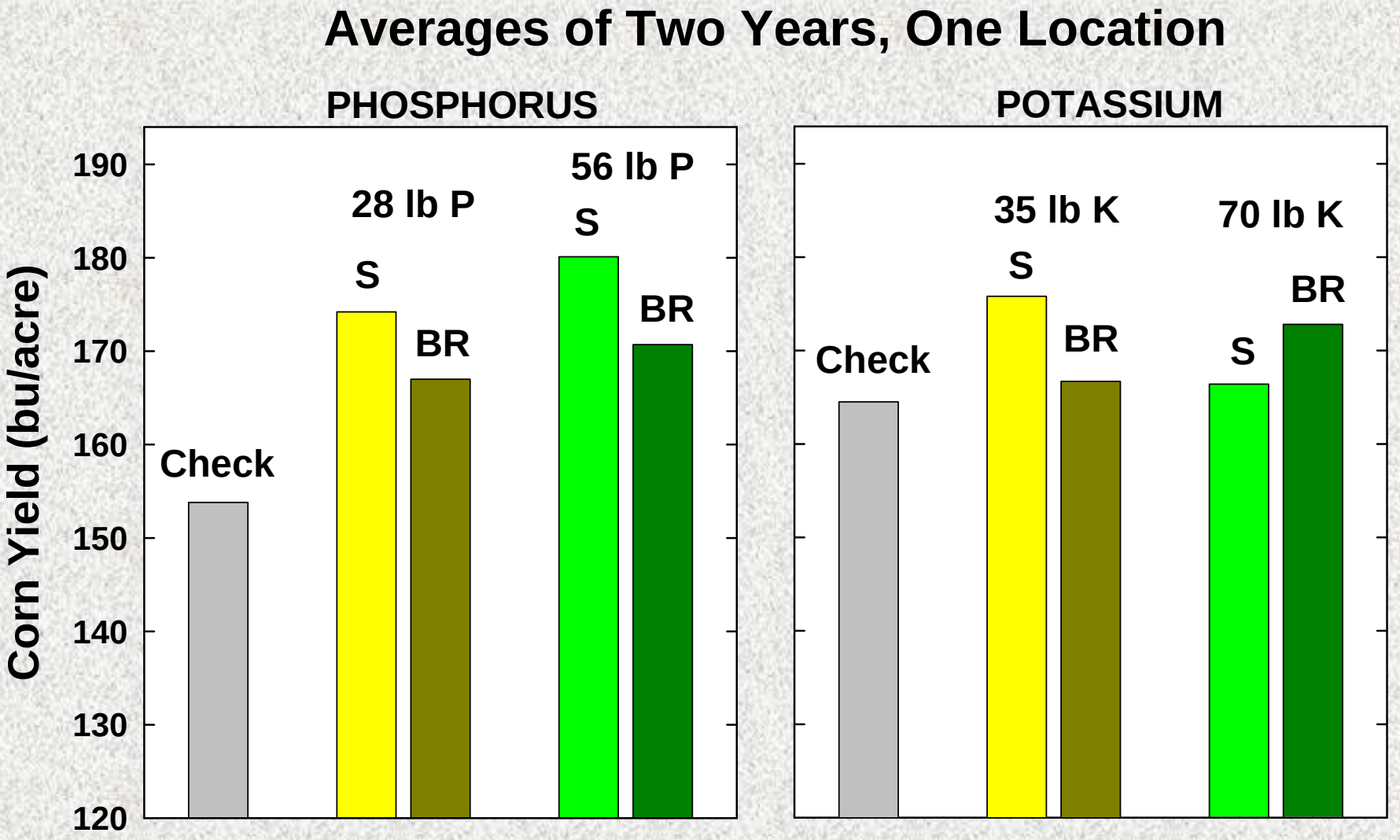
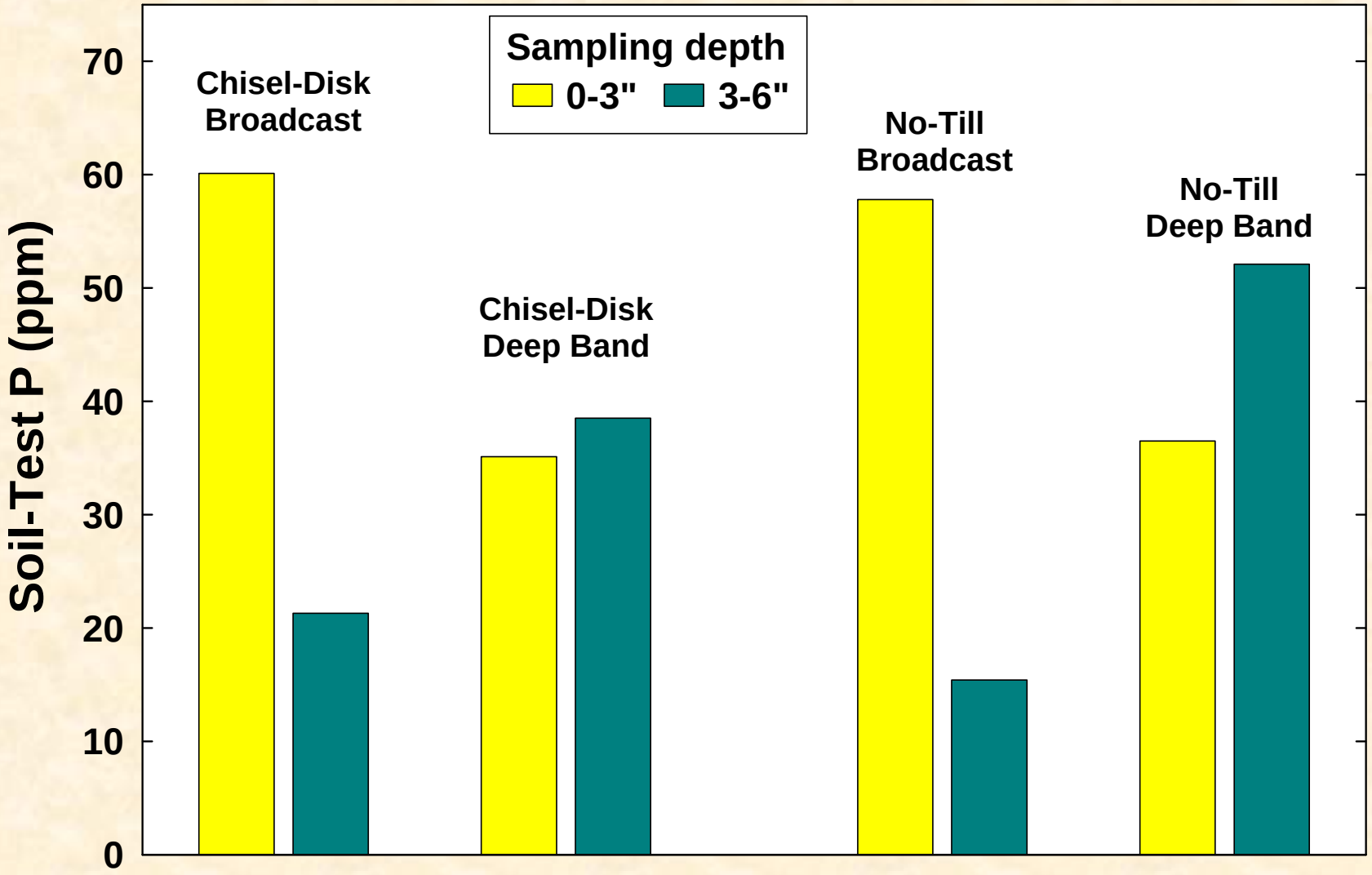


What? Band P Wasn't Better?

- Banded P always was better for corn early growth but seldom for grain yield:
  - soils not extremely low in P
  - P retention, not fixation
  - Humid region, good root growth
  - Broadcast P long before planting.
  - Uptake/translocation adjustments
- Banding may be better in other soils with very low soil P and lower P rates

Deep Banding Reduces Stratification



Soil Sampling Depth Issues

- Bands deeper than 6" complicate soil sampling and increase costs.
- Sampling the band area is clearly better only with permanent ridges.
- Shallow sampling with broadcast P and no-till isn't better than a 6" depth.
- Don't trust soil testing too much when banding P and K rates higher than common starter rates!

Incorporating or Injecting Manure

- No consistent crop response to deep P and K in Iowa using fertilizer or manure, but isn't bad.
- Manure incorporation or injection is good because it reduces
  - N volatilization losses
  - Odor problems
  - Runoff P loss when soil erosion and surface runoff are controlled

Liquid Starter Fertilizer for Corn

Mainly in-furrow. The 2x2" attachments are disappearing in Iowa

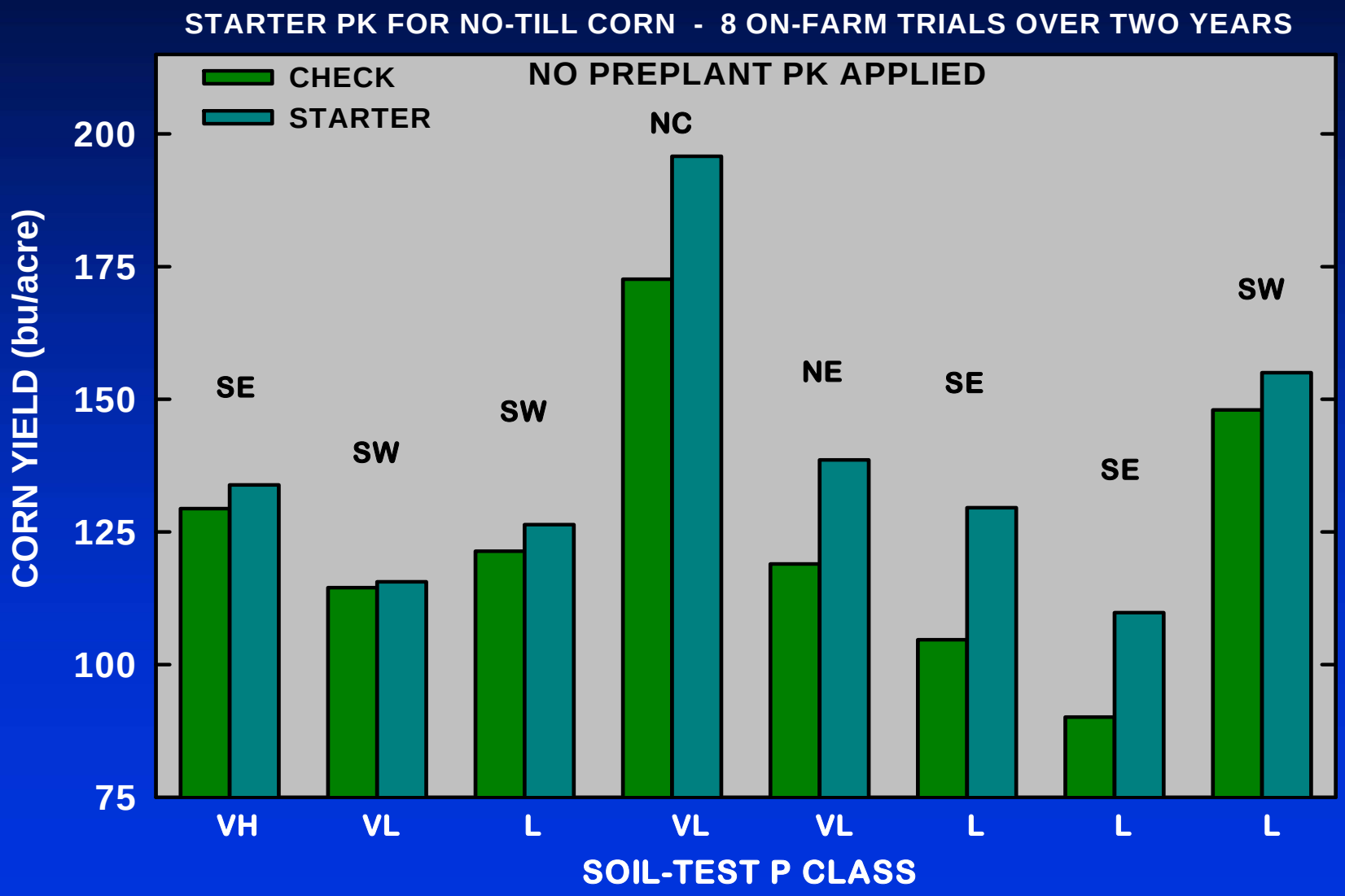
Why Would Starter be Needed?

- When an early growth delay cannot be offset during the season
- Applied nutrients aren't in the seedlings root zone (in topsoil or too deep).
- Cold and wet soil limit early root growth and nutrient uptake
  - reduced P & K diffusion through soil
  - reduced root activity impairs uptake
- Too late corn planting dates (WI work)

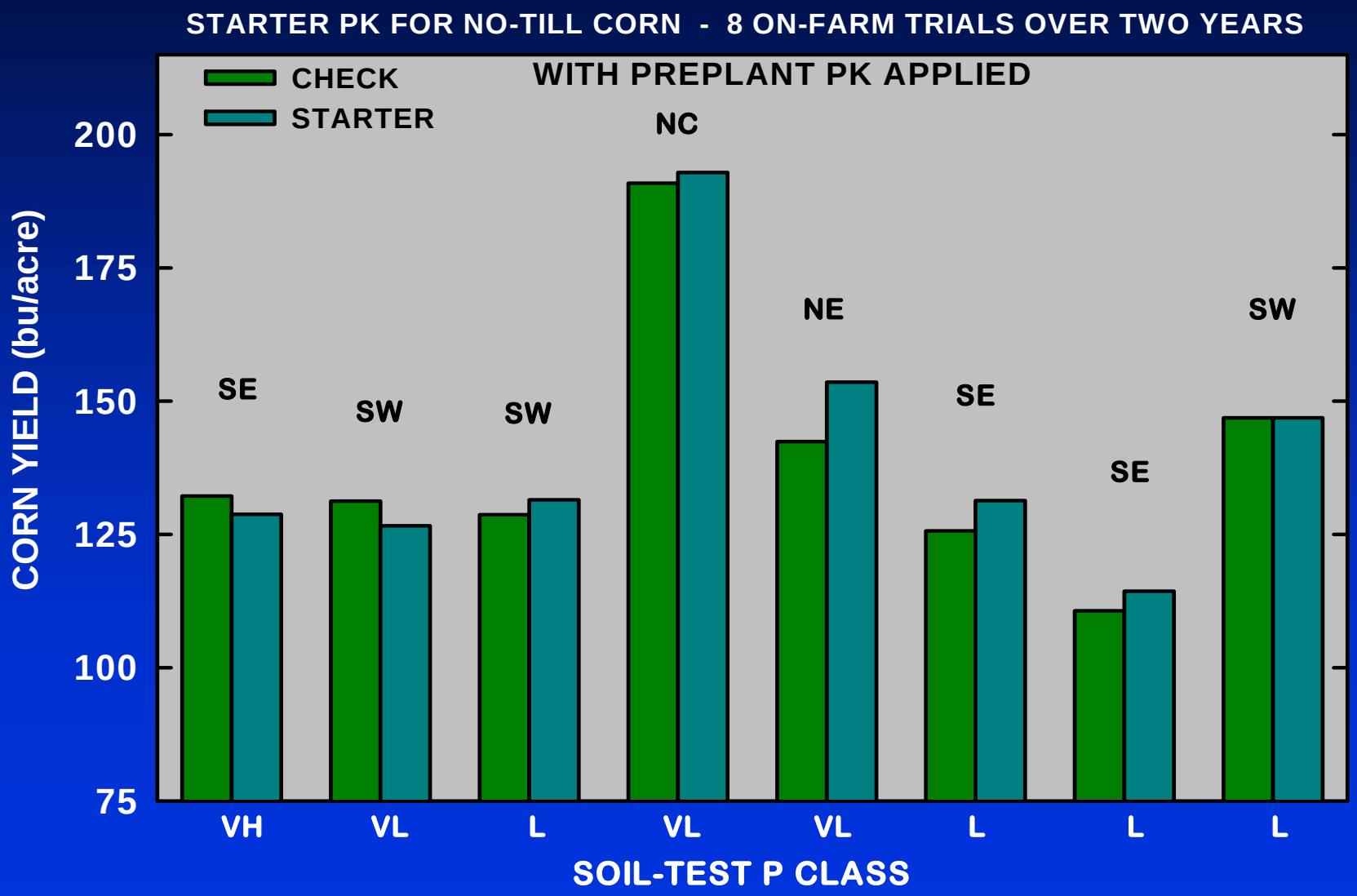
Liquid Starter Research for Corn

- Liquid P-K starter alone or with 2-year broadcast rates for corn-soybean
  - 3-18-18, 6-18-6, 7-21-7, or 9-18-9
  - 5 to 25 lb P_2O_5 and K_2O/acre
  - In-furrow or with 2x2" attachments
- No-till response to starter N or P-K
  - All high-testing soils
  - 2x2" planter attachments
  - Starter N alone or N-P-K

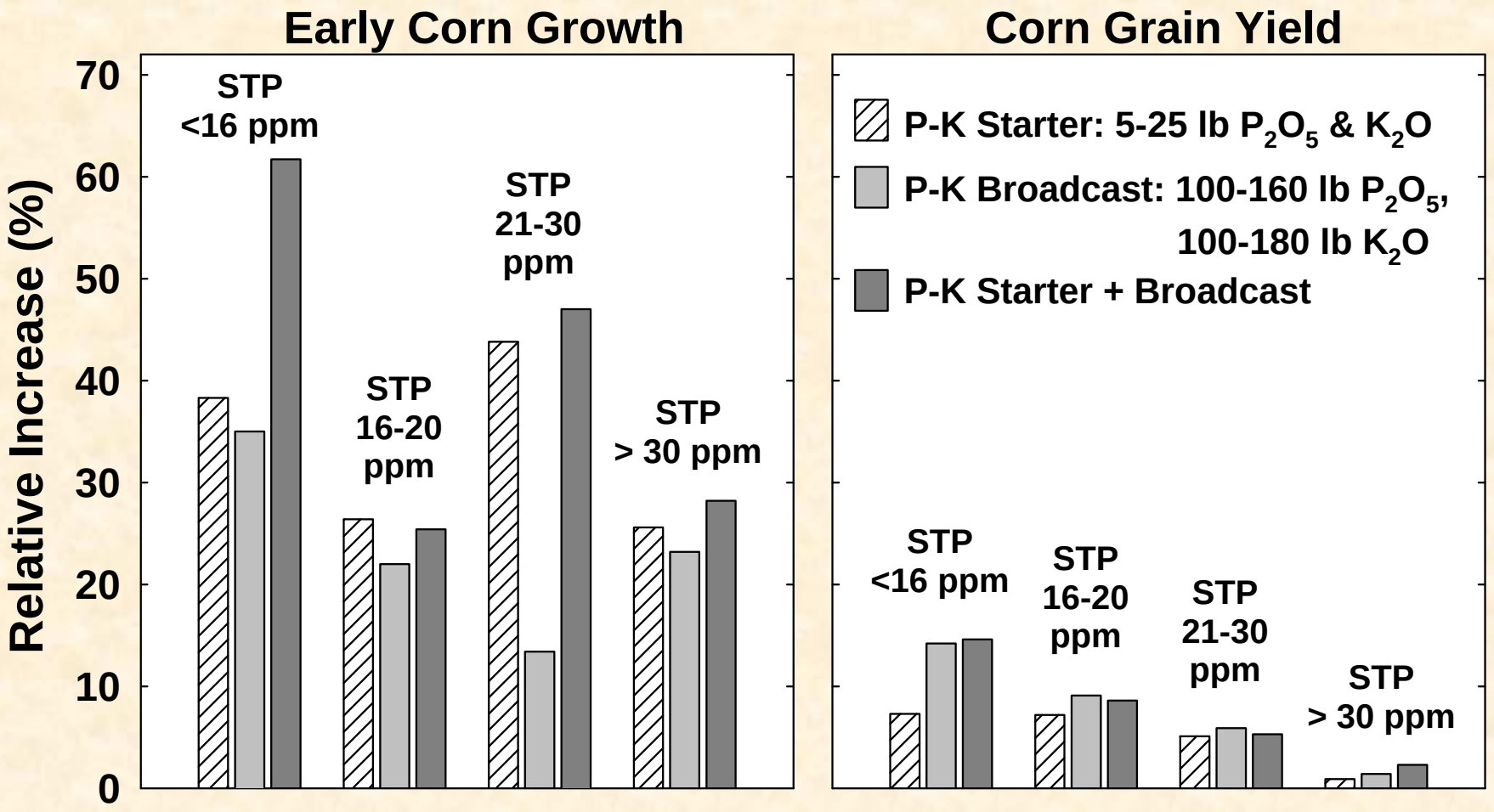
Response to Starter P-K Alone



Response to Starter After Broadcast



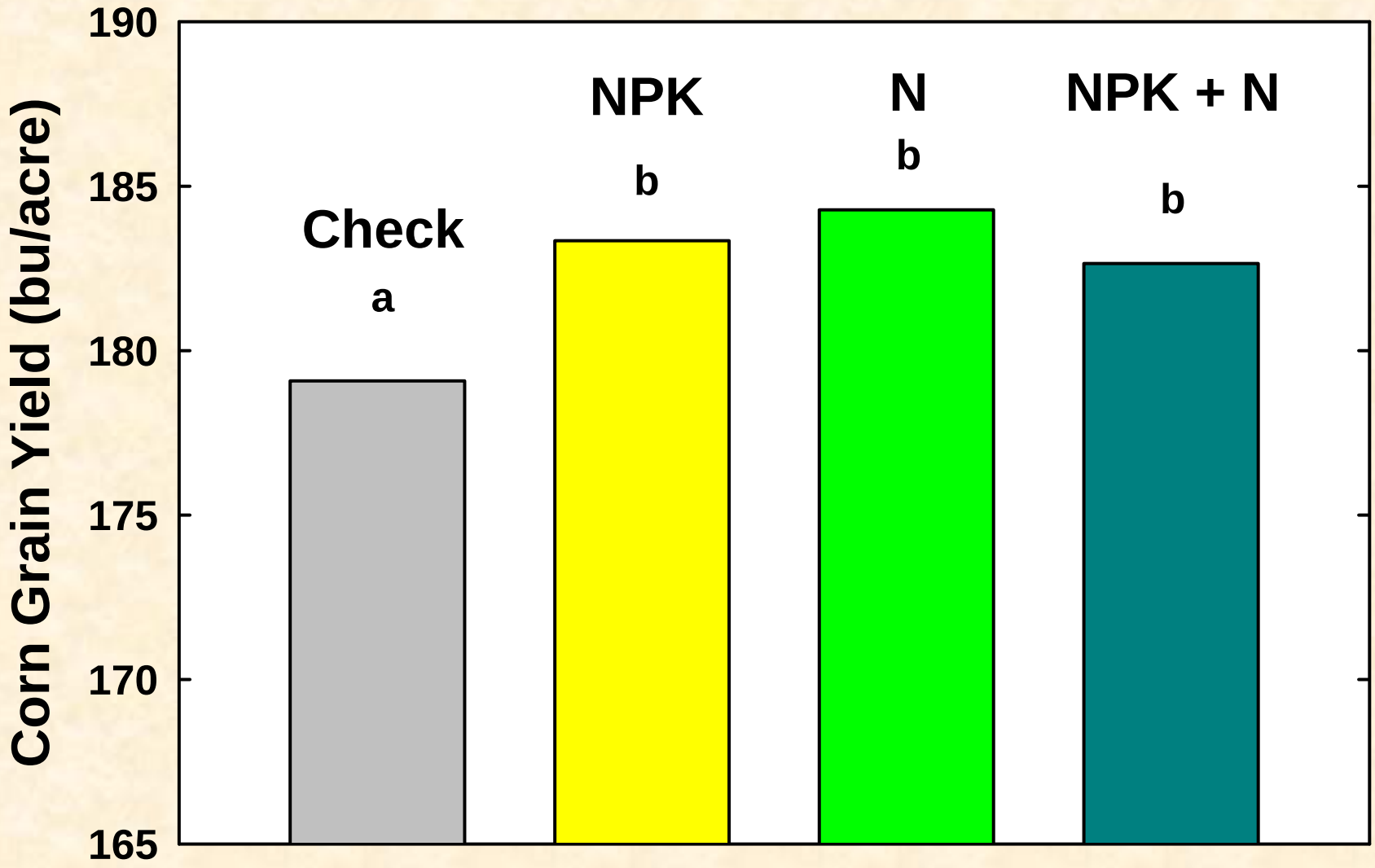
Starter and Broadcast P



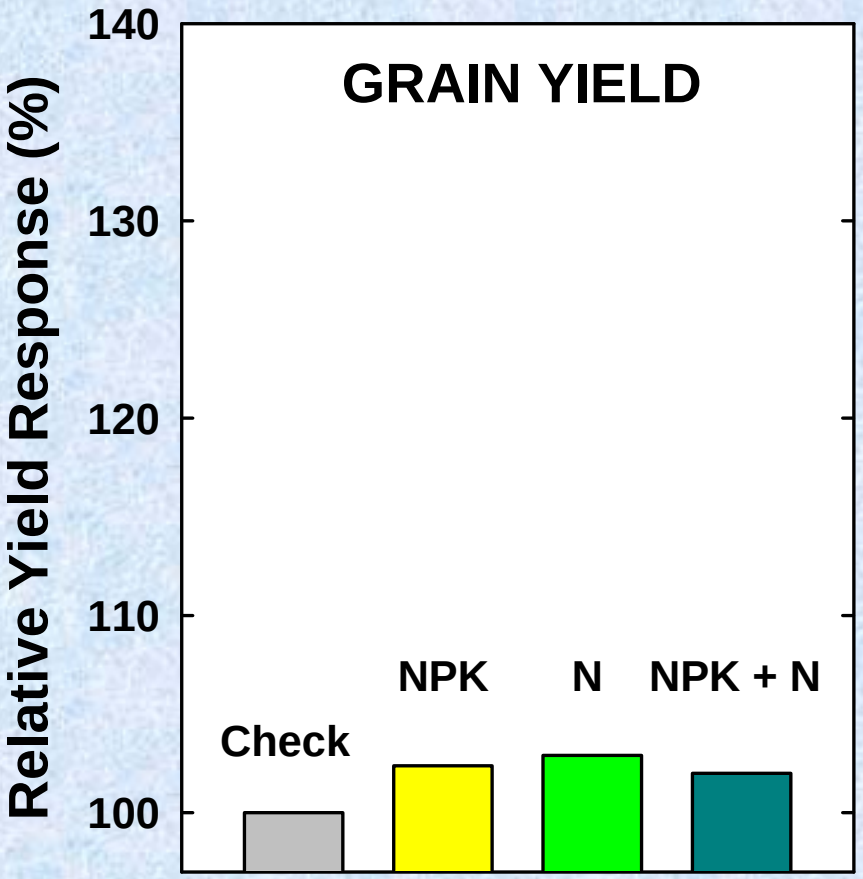
Starter in High-Testing Soils

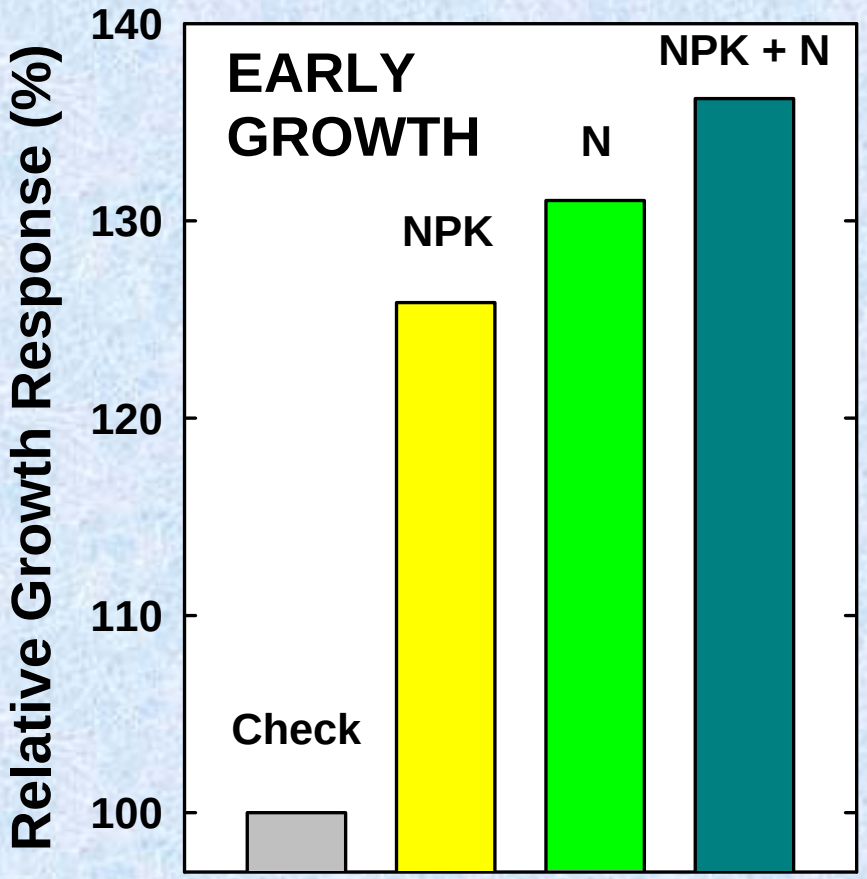
- We see occasional corn response to starter in soils testing high in P and K.
- Most frequent with no-till management and corn on corn.
- Usually attributed to response to N or P in the starter, seldom to K.
- Investigated this issue in 8 high-testing producers' fields using 2 x 2 planter attachments.

Starter in High-Testing Fields: Yield



Yield and Early Growth Response





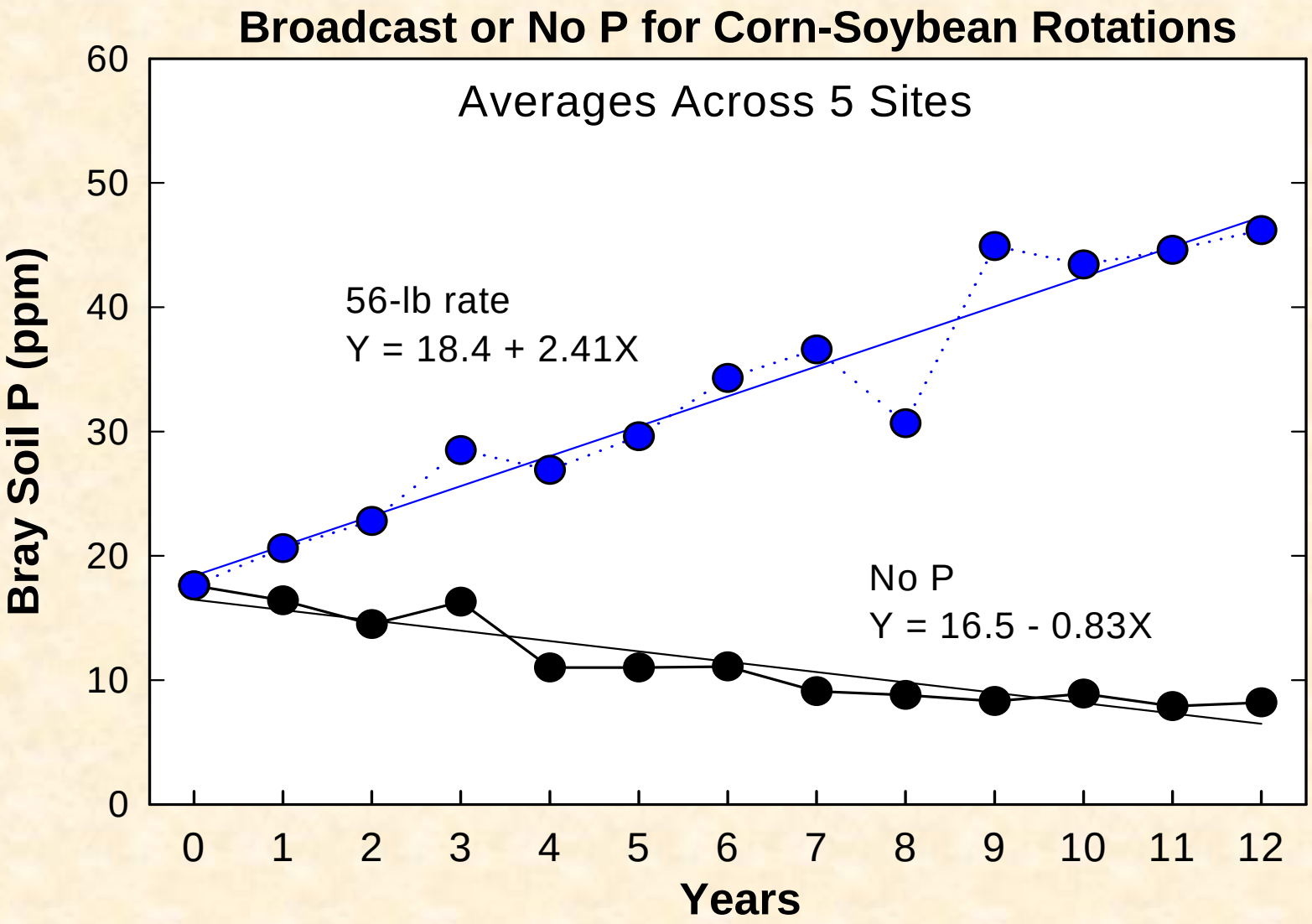
Starter in Low Testing Soils

- Crop response in low-testing soils is very likely and broadcast fertilization is a safe investment.
- Starter alone seldom is enough
- Very unlikely response to starter when 2-year rates are applied before corn
- Likely response to starter in some conditions when "one crop" or lower broadcast rates are applied

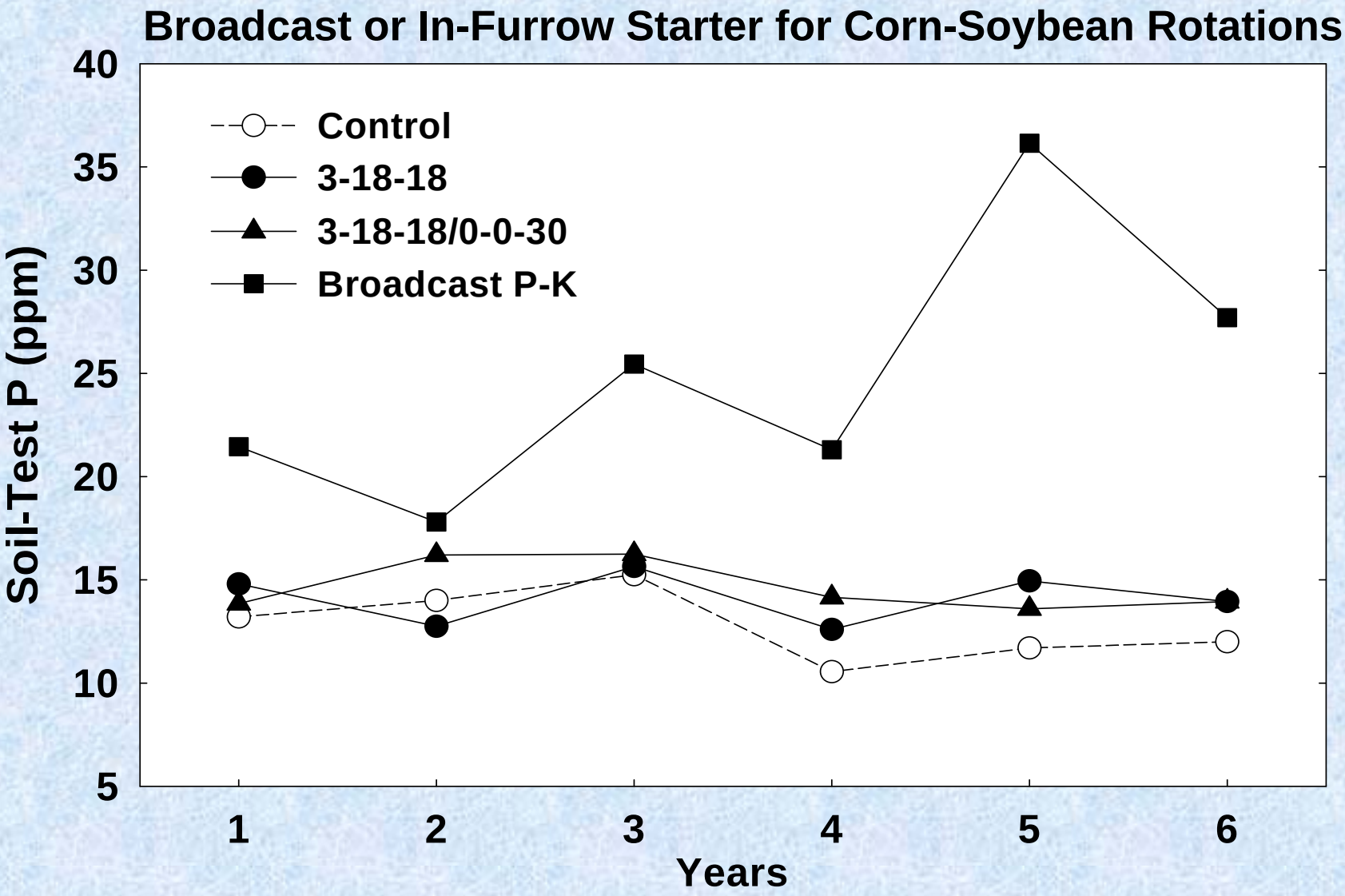
Starter in Optimum (Medium) Soils

- Low response probability, maintenance based on removal is recommended for long-term profitability and reduced risk.
- Flexibility, various options depending on prices, land tenure, and philosophy.
- Starter or low broadcast rates result in the same yield response and are more profitable in the short term, but will not maintain soil test levels over time.

But Soil Tests Change Gradually!



Soil Tests Decrease Gradually!



Placement Recommendations

- Deep placement: Deep K for ridge-till and maybe for no-till (cost tradeoff).
- Deep-banding P and K together for corn combined with strip tillage doesn't hurt.
- Deep band P is better for water quality.
- Starter N-P pays in some conditions.
- The 2x2" attachment is a great tool, much flexibility is lost without it.

Starter in High-Testing Soils

- Many farmers apply removal P and K rates to high-testing soils when it isn't needed.
- Small starter rates are enough to catch any unlikely small corn response.
- Starter is a lower-cost sleeping pill for high-testing soils and is much better for water quality.