Yield response to P & K fertilizers over landscapes

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Objective:
The objective of this project is to measure grain crop yield response to P and K over landscapes and identify factors that favor response. Soil tests are currently used as nearly the only tool to predict response, but we know that many other factors are involved.

Accomplishments for 2010:
- We set up on-farm, field-scale P and K response tests with producers in three different regions of Missouri.
  - All tests involved spring-applied treatments since funding began in February 2010.
  - This was feasible because fall 2009 field conditions prevented P & K applications in most fields.
  - Spring 2010 field conditions were also wet, making it difficult to get field work done and causing one producer to withdraw from the study.
  - This report will report on the other two fields, and will also report on the field that we studied as a pilot project in 2009.
  - Field locations are shown in Figure 1.
Mississippi County field

- The smoothed yield map with the treatment areas overlaid is shown in Figure 2 for this 108-acre field.
  - The squares show areas where no P or K was applied.
  - The rest of the field received a broadcast variable-rate P & K application based on grid soil sampling.
  - Yield effect of P & K application was estimated by calculating the average yield for each full square, then comparing it with the average yield for the same-size square immediately to the south.
  - Each square is approximately six combine passes wide.
- Spatial variability in yield was wide in this field (Figure 2), leading to wide variability in estimated yield response to P & K.
- Yield response was seen mostly in the middle of the south strip. Soil in this location appears to be a Malden loamy fine sand. Soils in other parts of the field are Dundee silt loam and Sharkey silty clay loam.
- We have not completed Geographic Information Systems analysis of soil effects on yield response. This analysis will give us better information about the possibility that the yield response is located mainly in the Malden soil.
- The Malden soil map unit makes up much of the high-yield zone in this field.
- Regression analysis shows that high yields when P and K were applied predicts large yield responses ($R^2 = 0.64$). This should be interpreted cautiously, since yield response is calculated from yield with P & K applied. However, it’s possible that the high-yielding areas have greater response to P & K due to increased demand.
- We have not yet received soil-test data for this field, but we did receive rate recommendations for P and K for each square (Figure 2) based on grid soil sampling. These rates are inversely related to soil test values (higher soil test gives lower rate recommendation). There was no relationship between yield response to P/K and recommended P rate, nor between yield response and recommended K rate. This suggests that there would also be no relationship between yield response and soil test P or K. It appears that factors other than soil test levels controlled yield response to P and K in this field.
- We will also use GIS to test the relationship between color of bare-soil aerial photos and:
  - yield response to P & K
  - yield
  - these photos may reflect soil variability and boundaries better than the soil map
- The overall average yield response to P and K in this field is only 3 bushels.

Figure 2. Squares (black outline) show locations of test strips receiving no P or K in the Mississippi County field. Colors show the smoothed corn yield map for this field. Response to P and K was estimated by calculating average yield for each full square, then subtracting it from the average yield for a square of the same size immediately to its south.
The area of large positive yield response in the middle of the south strip is counter-balanced by large negative ‘yield response’ values at the east end of the south strip and the west-central part of the north strip.

The negative values are not believable as a yield penalty to P and K.

Therefore they must reflect factors other than P & K that created yield differences between adjacent squares. This is not too surprising, since soils can vary widely over short distances in Mississippi County.

Some of the large positive ‘yield responses’ in the center of the south strip may also be due to yield-controlling factors other than P & K.

Lewis County field

- The unfertilized strips in this field are shown as strips 2 and 5 overlaid on the corn yield map (Figure 3).
- The remainder of the field received a uniform application of 25-120-100 broadcast in the spring of 2010 before planting.
  - Strips 1 and 3 received this application and are used for comparison to strip 2.
  - Strips 4 and 6 received this application and are used for comparison to strip 5.
- Yield response to P & K was calculated from these comparisons.
  - For each rectangle in strip 2, we averaged the yield of the adjacent rectangles in strips 1 and 3, then subtracted the yield from strip 2.
  - For each rectangle in strip 5, we averaged the yield of the adjacent rectangles in strips 4 and 6, then subtracted the yield from strip 5.
- Yield response to P & K for this field is shown in Figure 4.
- More than half (36 of 57) of the rectangles had a yield response of less than 10 bushels per acre.
- Average yield response to P & K over the entire test area was 7.5 bushels/acre.
- The greatest yield response to P and K was seen at the south end of the western strip. This was one of the highest-yielding areas in the field. However, the statistical connection between high yield and high yield response to P & K is weak when analyzed over the whole field.

Figure 3. Strips 2 and 5 in this Lewis County field did not receive any P or K for the 2010 season. Strips 1, 3, 4, and 6 received an application of 25-120-100 in spring 2010. Comparisons of yields from these strips was used to map yield response to P and K. Corn yields for 2010 are indicated by color for yield monitor data.
○ This area is mapped mostly as an eroded Armstrong loam, with Westerville silt loam mapped at the southern end.
○ Neither of these soils is represented elsewhere in the test strip area, so it’s possible that something about these soils makes them more P- and K-responsive than other soils in the field.
○ Again, we need to follow up with GIS analysis to clarify how well this idea holds up.

- In the east strip, a good yield response is seen near the north end approximately where the strips cross some eroded Keswick clay loam soil. We will check how well these line up using GIS analysis. Other than that, there are only a smattering of locations in this strip with good yield response.
- This field was grid soil sampled within the past year or two. However, we do not yet have the soil test data from this sampling. When we do, we will analyze the relationship between soil test value and yield response.

Vernon County field
- In this field, P and K were placed in a subsoil band in February, but four strips were left with no P or K (Figure 5). Colored areas show where P & K were applied, and the four white strips are the ones left without P & K. Strips were 16 rows wide. Corn yields in this field were excellent for Vernon County, averaging over 160 bushels/acre.

Figure 4. Yield response to P and K is color coded in the rectangles of strips 2 and 5. See Figure 3 for a description of how yield response was calculated. Response is greatest at the south end of the western strip, which is a high yielding area with an Armstrong loam soil.
• By subtracting yield with P & K from yield in the adjacent strip(s) without P & K, we measured yield response to P & K. Numbers on the field map indicate corn yield response to P & K (in bushels/acre).
• Responsive areas at the north end of the field were not different in yield, pH, or soil test P or K from non-responsive areas.
• A soils map shows that the soils in the responsive areas were derived from sandstone, while soils in the rest of the field were derived from shale.
• An area in the southeastern part of the field with higher cation exchange capacity (CEC), as shown in the grid soil samples, was also relatively responsive.
• Yield, soil test P, and soil test K levels were not significant predictors of yield response to P & K in this field, nor was soil pH.
• Soil drainage class was the best single predictor of yield response, with well-drained soils giving the largest response.

![Figure 5. White strips in this field were left unfertilized during a February strip-till and variable-rate fertilizer injection operation. Yield response was greatest at the north end of each test strip. These locations were mapped as sandstone-derived Barco soils, while the rest of the field is made up of soils derived from shale.]

**Budget request for 2011:**

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Request for 2011: **$15,000**