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 2011:
- We set up four on-farm, field-scale P and K response tests with producers for 2011
  - Three tests were in northwest Missouri, the only quadrant of the state where we had not previously had one of these tests.
  - One test was in southwest Missouri.
  - We do not yet have the yield maps associated with any of these tests. We know that yields were low in the southwest Missouri test due to drought stress.
  - Outcomes of these tests will be analyzed during the winter.
  - Additional analyses have been completed during 2011 on 2010 fields and are presented in this report.
- Locations of field-scale P and K response tests to date are shown on the map below.

Figure 1. Locations of field-scale trials to measure yield response to P and K over landscapes.

Mississippi County field

- Additional analyses of the results from this field were completed during 2011.
- Geographic Information Systems analysis of soil effects on corn yield response was completed during 2011.
  - This analysis showed that yield response to P and K depended strongly on soil type.
  - There was a 41 bushel/acre yield response to P and K on the Malden loamy fine sand in the middle of the field (Figure 2). Statistical confidence in this yield response is 99.6%.
  - Average yield response to P and K on the Dundee silt loam was -12 bushels/acre. There is no plausible mechanism for the P and K application to reduce yield, so I attribute this result to soil variability other than nutrients causing the yield difference.
  - Average yield response to P and K on the Sharkey silty clay loam was -1 bushels/acre.
  - The Malden fine sandy loam was also the highest-yielding soil in this field, with an average yield of 190 bushels/acre with P and K applied. This yield was higher than the yield obtained with P and K on the other two soils with 93% confidence.
    - Average yield on the Sharkey soil was 169 bushels/acre and on the Dundee soil was 164 bushels/acre.
  - Because the three soils in this field fall into three different drainage classes, yield response to P and K was also strongly related to drainage class.
    - The Malden soil, where a large yield response to P and K was seen, is excessively well-drained.
    - The Dundee soil is somewhat poorly-drained, and the Sharkey soil is poorly-drained.
    - This result is similar to what we reported for the Vernon County test in last year's report, where the largest yield response to P and K was seen on well-drained soils.

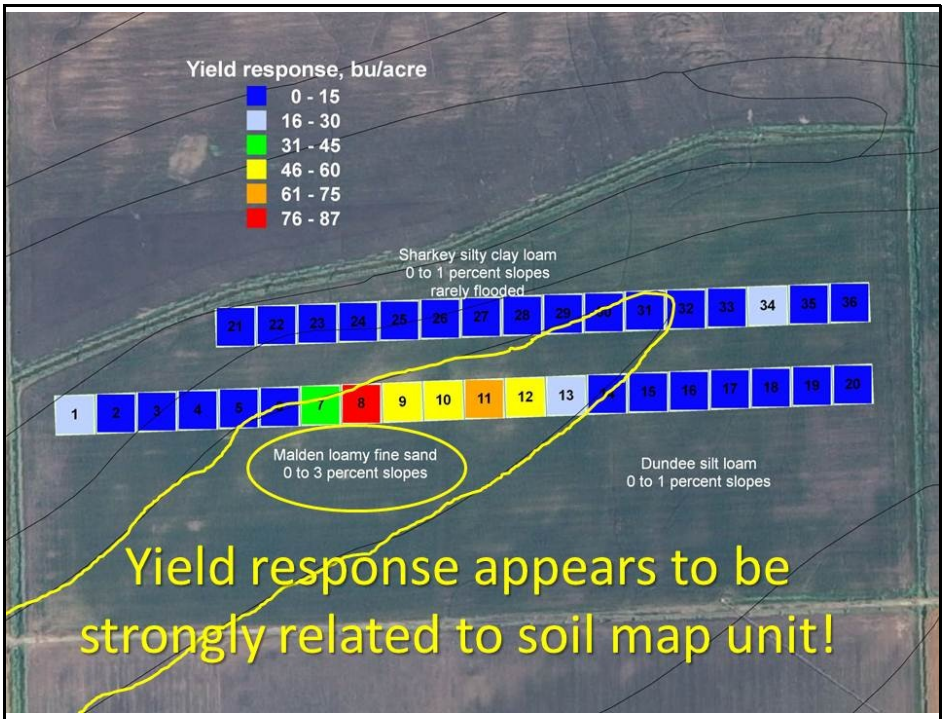

Figure 2. Yield response to P and K in the Mississippi County test overlaid on the soil map for the field.

- We also received and analyzed grid-sampled soil test data for this field during 2011.
  - These analyses showed that soil test value was not a useful predictor of where yield response to P and K was seen (Figure 3).
  - If anything, soil test values were higher in the areas where yield response was largest.
  - It appears that factors other than soil test levels controlled yield response to P and K in this field.

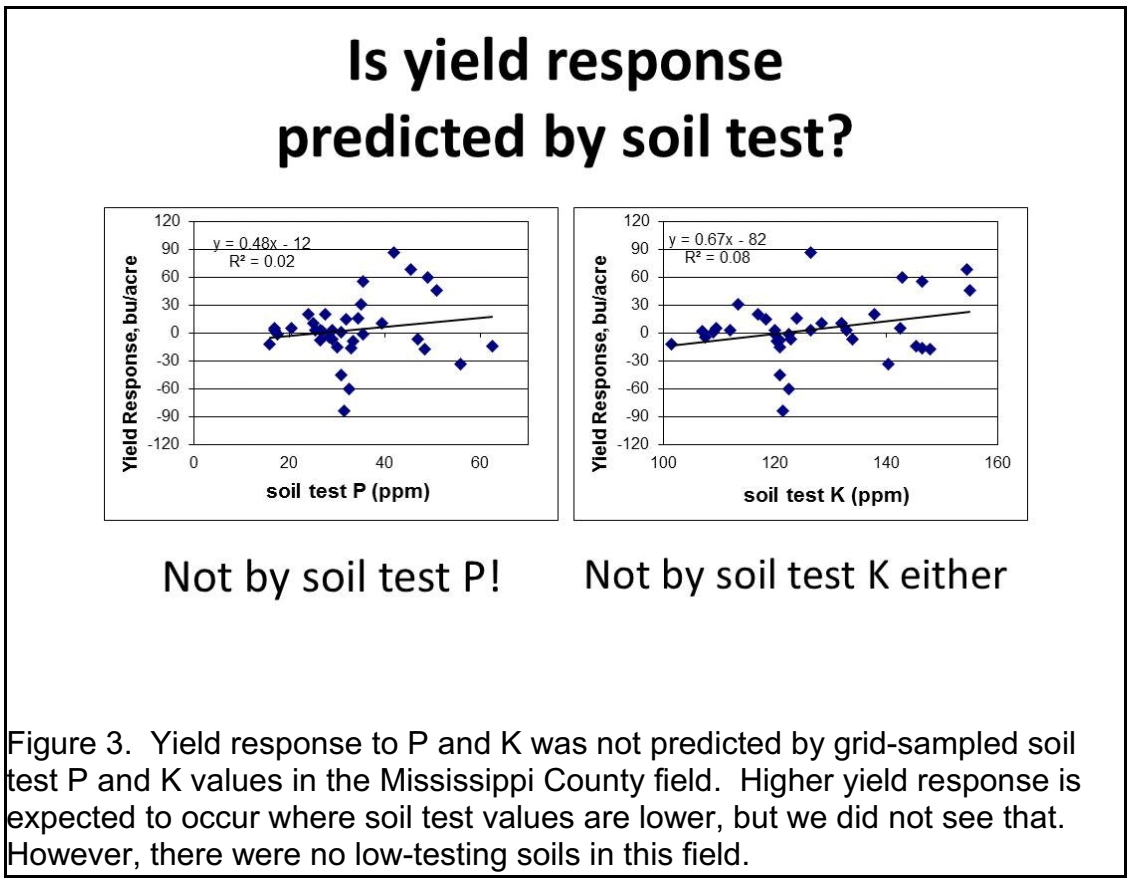

Figure 3. Yield response to P and K was not predicted by grid-sampled soil test P and K values in the Mississippi County field. Higher yield response is expected to occur where soil test values are lower, but we did not see that. However, there were no low-testing soils in this field.

- Summary for the Mississippi County P and K response test:
  - P and K targeted to the Malden soil were highly profitable.
  - P and K targeted to the other soils were not.
  - P and K applied over the whole field was not profitable; average yield response over the whole test area was 3 bushels/acre.
  - Soil test values were of no value in predicting the location where response would occur.
  - Soil map unit was a useful indicator of where response would occur, with a large yield response in the Malden soil and none in the other soils.
  - This would need to be confirmed with further tests before it would be a reasonable management strategy to target Malden soils for higher P and K rates than other soils.
  - The agreement between this field and the Vernon County field that the largest yield responses were on the best-drained soils suggests the possibility that soil drainage class could become a useful indicator for P and K management decisions.
  - This concept needs further testing.

Lewis County field

- Additional analyses of this 2010 field were completed during 2011 as well.
- As with the Vernon and Mississippi County fields, yield response to P and K differed between soil map units.
- The largest yield response to P and K was seen on the Armstrong loam soil. This yield response was 24 bushels/acre (99.9% statistical confidence that this was a true yield response).
- A yield response was also seen on the Keswick clay loam, 12 bushels/acre with 97% confidence that the response was real.
- No yield response to P and K was seen on the Kilwinning or Goring soils.
- As with the Mississippi County field, the largest yield response was on the soil that produced the highest yield. Average yields for the four soils in the test area were:
  - Armstrong 123
  - Gorin 110
  - Keswick 108
  - Kilwinning 93
- Unlike the Mississippi and Vernon County fields, the soil with the largest P and K response was not the best-drained soil. However, we did see a statistically significant yield response to P and K on the best-drained soil (Keswick, moderately well-drained).
- This is the only field in this project where we have found a relationship between soil test values and yield response. It is also the field with, by far, the lowest soil test values.
- For each grid sample point within the test area, we related the soil test value from that grid point to the yield response that we measured.

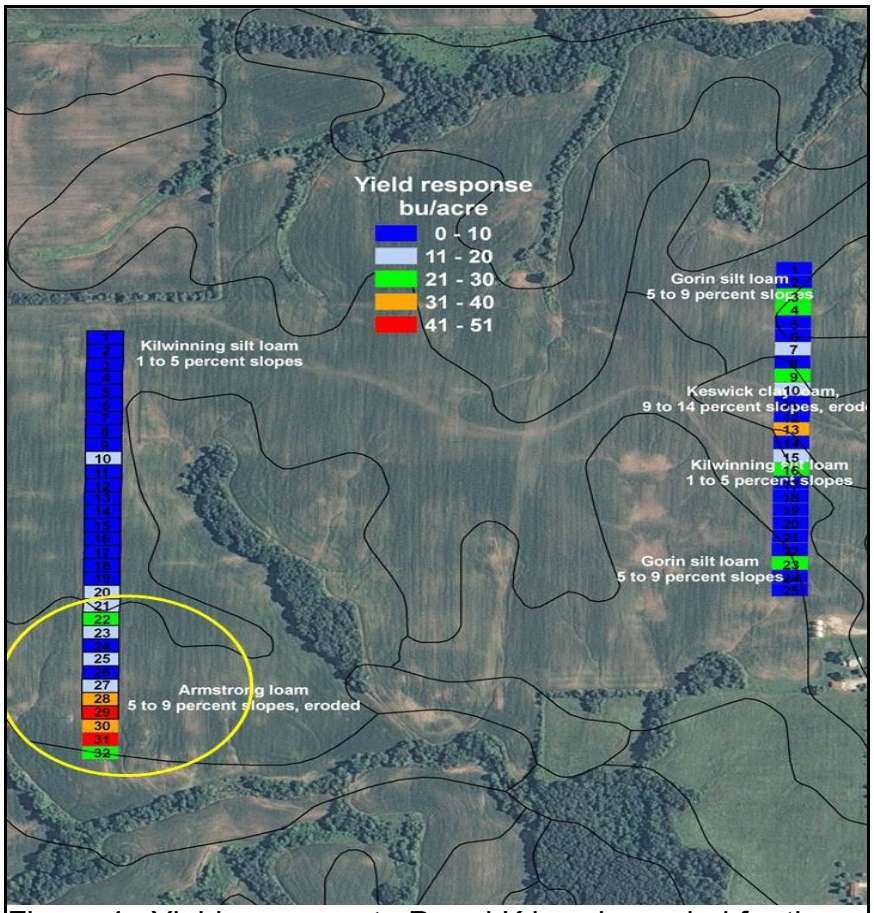

Figure 4. Yield response to P and K is color coded for the Lewis County field and overlaid on the soil map and an aerial photo. Yield response was 24 bushels/acre on the Armstrong soil, 12 bushels/acre on the Keswick soil, and zero on the Gorin and Kilwinning soils. The Armstrong soil also produced higher yields than the other soils in the field.

- When soil test P (Bray-1) was 1 to 4 ppm, average yield response to P and K was 16 bushels/acre. At soil test P of 5 and above, no yield response to P and K was seen. Of the 18 soil samples taken within the test area, 7 had soil test P values between 5 and 7 ppm,

which is very low, and still had no yield response to P and K fertilizer. It was unexpected to see no response with soil test values this low, and shows the value of testing on-farm where responses are occurring.
- When soil test K was below 80 ppm, average yield response to P and K was 23 bushels/acre. The larger yield response at low soil test K values than at low soil test P values suggests that K was more yield-limiting in this field than P. When soil test K was above 80 ppm, no yield response to P and K was seen.

SUMMARY

- Yield response to P and K was concentrated in one or two soils in each field that we have analyzed.
- There is a tendency for the most responsive soil to also be:
  - The highest yielding soil
  - The best-drained soil
- Soil test values had no relationship to yield response to P and K in 2 of the 3 fields that we have completed our analyses on.
- In the third field, soil test values for both P and K were low, and yield responses were seen in areas with soil test P below 5 ppm or soil test K below 80 ppm. No yield response was seen in this field with soil test P of 5 ppm or greater, or soil test K of 80 ppm or greater.
- Strip trials to measure yield response to P and K are a practical and fairly simple way for producers to better understand how to optimize P and K management on their own farm.