Site-Specific Management Guidelines

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SSMG-23

Getting Specific with Site-Specific Nutrient Management

Summary

Oversimplification of site-specific nutrient management can lead to reduced profits and production. Currently, site-specific nutrient management typically involves applying a definite set of recommendations to different areas in a field, based upon a few factors, such as soil test levels and yield goals. However, if these recommendations do not consider other site-specific factors that influence response to nutrient application, substantial opportunities to increase profits and production may be lost. Standard university recommendations for nitrogen (N) and phosphorus (P) were evaluated for profitability potential within a field and compared to actual crop response needs. Site-specific university recommendations produced an average net return of $75/A, while actual crop response suggested that a return of $100/A was possible with the right nutrient management decisions. Yield and crop response at this location were impacted by drainage and compaction. Proper evaluation of these yield-limiting factors and appropriate management changes based on readily available information could make site-specific nutrient management more profitable.

Introduction

Nutrient management is often considered to be a rather straightforward process. One collects some data (soil test information), opens up a university nutrient recommendation guide, reads a table or consults a computer program, and determines how much fertilizer to apply. To many, this part of farm management is thought to carry the least amount of risk and require the least amount of thought. In reality, oversimplification of nutrient management can lead to increased economic and environmental risk. It is important to remember that university recommendations are created as well-researched suggestions and are collected over many years and geographic locations. Not every factor that influences crop response to a particular nutrient is included. Fertilizer recommendations are usually based on factors such as soil test level, yield goal, previous crop, and organic matter content. Factors that also influence how a crop will respond to fertilizer application include weeds, insects, diseases, rainfall, drainage, competition, and many other stress factors. To increase nutrient management profitability, other factors that influence crop response may need to be incorporated. Combining university suggestions with field experience and solid agronomic training can create nutrient management strategies with the lowest economic, agronomic, and environmental risks.

Research Methods and Results

An on-going study was started in the fall of 1996 to test the ability of soil test recommendations to optimize crop response in site-specific nutrient applications. The 30-acre experimental site located in southwest Minnesota has been in a corn and soybean rotation for the past 20 years. Thirteen fertilizer treatment combinations were applied as uniform strips (1,200 ft. long), replicated three times, utilizing a split block design with P rate as the main block. The treatments included a modified factorial arrangement of five N rates (0, 60, 100, 140, and 180 lb N/A) and three P rates (0, 50, and 100 lb P_2O_5/A). Both nutrients were applied in the fall of 1996, prior to the corn year. No fertilizer was applied in the subsequent soybean year. Each replication was subdivided into 50 ft. long plots and harvested separately with a small plot combine. Each of these small plots was also soil sampled in the fall of 1996 and every year thereafter. Crop response yield functions based on fertilizer rates were determined using regression techniques of side-by-side comparisons of fertilizer treatments. Economic optimum rates were calculated from yield functions using a $1 fertilizer product cost: $1 yield income return. The optimum rates reflect the impact of all of the factors that influenced yield in a particular year and therefore provide a good test of the annual accuracy of models incorporated into current university recommendations.

Proper N and P fertilization was profitable for both years in the crop rotation. The profitability of N and P applications at optimum rates are shown in **Figure 1** for

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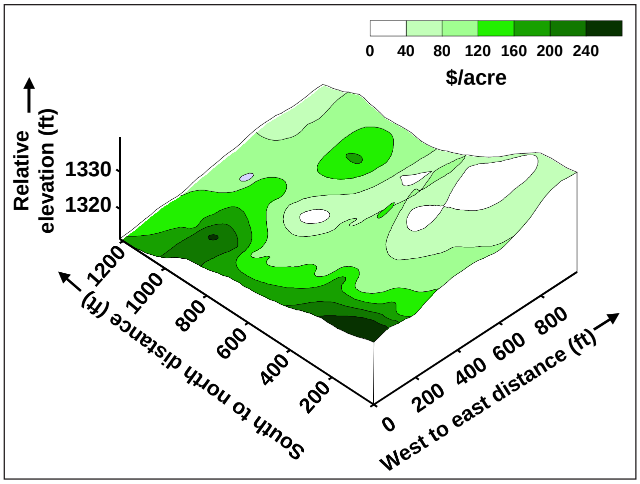

Figure 1. Net return ($/A) to optimum N and P rates for the corn year.

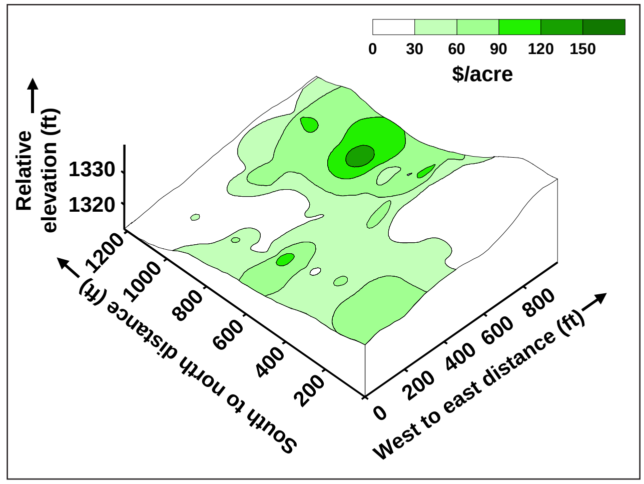

Figure 2. Net return ($/A) to optimum residual P rates for the soybean year.

the corn year and in **Figure 2** for the soybean year. The southeast and north central portions of the field had high soil test P levels and exhibited little if any crop response. Optimum N and P rates produced net returns ranging from $8 to $246/A. Response from residual P during the soybean year produced net returns of $0 to $146/A. These data demonstrate the importance of making proper management decisions in various areas of the field to maximize returns.

Recommendations that over-estimate or under-estimate crop need reduce net returns. University recommendations were determined using average yield goals and grid soil sample results. Expected yields were calculated from response equations generated from actual yield measurements. Predicted returns generated from the recommendations were subtracted from returns possible from optimum fertilization. **Figures 3-5** show how these two approaches compared across the field for both the corn and soybean years.

University recommendations for the corn/soybean rotation were a uniform application of 80 lb N/A during the corn year and a variable application of 10 to 85 lb P_2O_5/A. Based upon measured crop response, economic optimum fertilizer rates ranged from 0 to 180 lb N/A and 0 to 100 lb P_2O_5/A during the corn year, while P response during the soybean year ranged from 0 to 100 lb P_2O_5/A. The university N recommendation did well on the eastern two-thirds of the field for corn (**Figure 3**), but it substantially underestimated the crop need on the western one-third. Corn responded to P application, and the average site-specific rate was similar to university recommended rates. However, better distribution of fertilizer P within the field could have returned an average of $13/A more than existing recommendations (**Figure 4**).

Soybean response to previously applied P suggests that relatively high rates of P should have been applied in the two-year rotation. Optimum P rates for soybeans ranged from 0 to 100 lb P_2O_5/A and in general were higher than current recommendations. Fertilizing at optimum rates had the potential, during the soybean year, to increase profits by approximately $20/A (**Figure 5**).

The optimum P application rate maps for the corn and

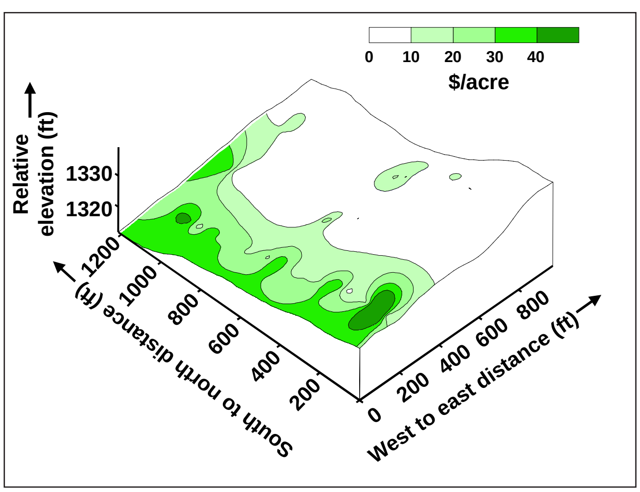

Figure 3. Potential increased returns ($/A) from optimum, site-specific N management in the corn year (optimum net returns–university net returns).

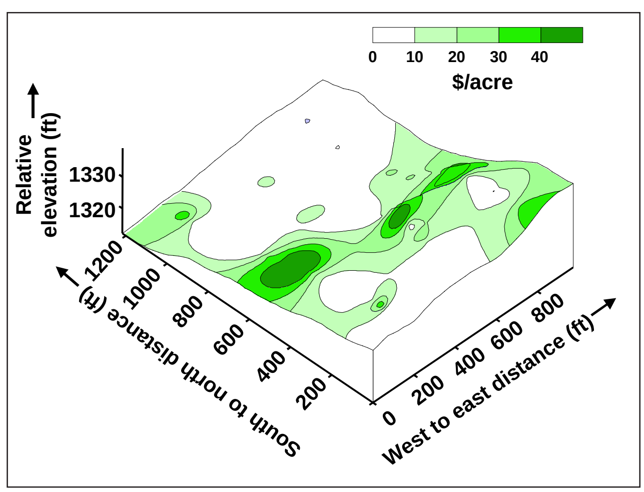

Figure 4. Potential increased returns ($/A) from optimum, site-specific P management in the corn year (optimum net returns–university net returns).

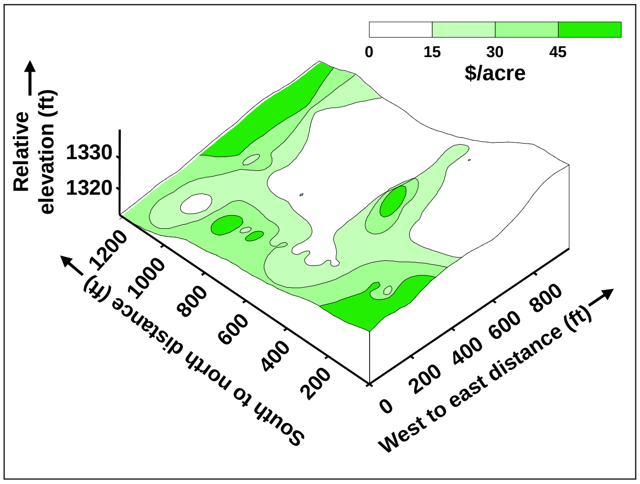

Figure 5. **Potential increased returns ($/A) from optimum, site-specific P management in the soybean year (optimum net returns–university net returns).**

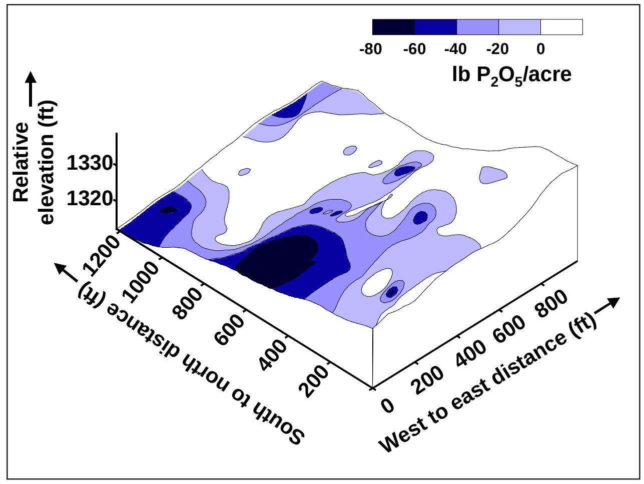

Figure 6. **Difference (lb P_2O_5/A) in university recommended P rates and optimum P rates for the corn year (optimum rate–university recommendation).**

soybean years, **Figures 6 and 7** respectively, were quite different. This disparity suggests that a different P management strategy may have been more appropriate. Perhaps broadcasting P before the soybean crop and using starter fertilizer containing P during the corn year may have been more profitable.

Soil test results were useful during both years for predicting areas of the field where no P response was anticipated (high soil test P). In areas testing medium or below, recommendations were inadequate for predicting the amount of P needed to optimize crop response. This does not mean that soil tests in this range are unreliable indicators of response. Rather, it suggests that consideration of other factors in addition to soil fertility may have improved crop response. Many of the areas that responded to higher rates of N and P were also areas that had compaction and drainage problems. These poor conditions for root growth resulted in poor yields and a higher dependence on fertilizer inputs.

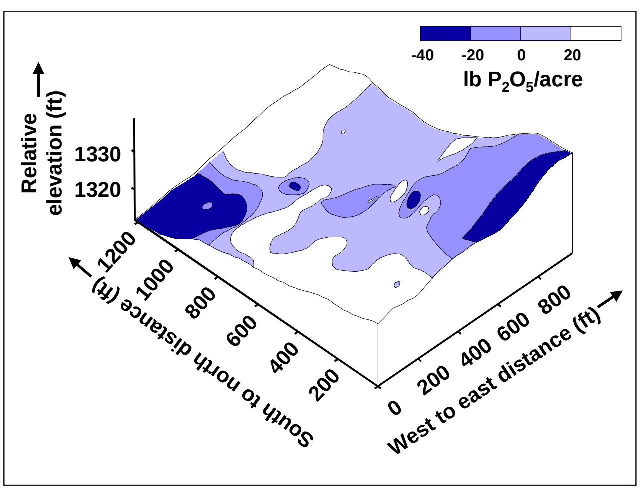

Figure 7. **Difference (lb P_2O_5/A) in university recommended P rates and optimum P rates for the soybean year (optimum rate–university recommendation).**

Being able to address problem situations by better managing nutrients is critical to improving farmer profitability. Response to additional N and P fertilizer was somewhat predictable at this site. Crop requirements for additional nutrient inputs under compacted and poorly-drained conditions are well-known (see further reading, listed at end). What was not known until data had been collected was the magnitude and extent of the responses. In the field used in this study, a farmer armed with better knowledge of nutrient/compaction/drainage relationships and the extent of compaction could have made better nutrient management decisions that would have allowed him or her to capitalize on at least part of the potential profitability.

Yields obtained and crop response to applied P at this location were poor predictors of nutrient need. Yield response to applied P was very high in some areas and low in others, regardless of yield level. Many of the responsive areas did not require high P application rates. Likewise, many areas where higher rates were economically justified did not produce the largest overall returns. This suggests differential crop use efficiency of applied P. Failure to account for this variability led to reduced economic returns. These data also suggest that setting lower yield goals for the lower-yielding areas of the field would have resulted in under-fertilization if university recommendations had been followed. Thus it is important to consider not only current production levels, but also responsiveness to nutrient inputs. Farmers can begin to quantify responsiveness in their fields by establishing test strips. Comparing the yields of test strips where one nutrient is omitted to adjacent test strips where the nutrient is applied provides an indication of crop response.

Practical Implications

The economic benefits associated with making a site-specific nutrient recommendation will not be uniform across a given field. Better management in those areas where a large response is anticipated will add to the bottom line. Likewise, incorrect management decisions may cost the producer money. Making a wrong decision on the low responding areas of the field would not have been costly. Wrong decisions on the highly responsive areas would have reduced gross returns considerably. It is critical to identify highly responsive areas and manage them correctly. This research demonstrates that increased return associated with university recommendations may be enhanced with additional site-specific knowledge. This means including other factors beyond yield goals and soil test levels. Care must be taken to interpret additional variability correctly. Local data used for changing nutrient management practices must be based on sound agronomic principles and wise interpretations of field observations to lower risk in nutrient management.

It must be remembered that university recommendations were created as long-term best management practices, averaged over variability encountered across many sites and years. Care must be exercised in the evaluation of economics from this short-term experiment with recommendations that were developed for long-term average conditions. Continuance of this research for many years will be the only means of testing the overall effectiveness of current recommendations at this site or other field locations. ■

Further Reading

For selected on-line discussions and recommendations on the interaction of nutrients and compaction see:

Griffith, B. 1999. Phosphorus. Efficient Fertilizer Use Manual. 4th ed. IMC Global. (Available on-line with updates at http://www.imc-agrico.com/fertilizer/education/efumanual.).

Potash & Phosphate Institute, 1999. Important factors affecting crop response to phosphorus. Better Crops 83(1):16-19. Potash & Phosphate Institute, Norcross, GA. (Available on-line with updates at http://www.ppi-far.org/PPIArea/periodicals/bc/index.htm.)

Swan, J.B., J.F. Moncrief, and W.B. Voorhees. 1994. Soil compaction: causes, effects, and control. University of Minnesota Extension Service Bulletin BU-3115-GO. University of Minnesota, St. Paul, MN. (Available on-line with updates at http://www.extension.umn.edu/Documents/D/C/DC3115.html.)

University of Minnesota Extension Service. 1997. Flooding shouldn't affect phosphorus availability for crops. News Information. May 6, 1997. University of Minnesota, St. Paul, MN. (Available on-line with updates at http://www.extension.umn.edu/Documents/J/N/JN1135.html.)

To access on-line university extension publications via the internet, see the state extension service home page of the United States Department of Agriculture: http://www.esusda.gov

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