M I D W E S T

Site-Specific Nutrient Management: Production Examples

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This article focuses on the usefulness of site-specific approaches in assessing crop requirements for nutrients. Two examples are provided, one from Illinois and one from Indiana.

Illinois grid-sampled example. A 90-acre central Illinois field was sampled on a 1-acre grid. The yield goal for corn was set at 200 bu/A, and the yield goal for soybeans was set at 60 bu/A. After many years of following field-average recommendations for "maintenance plus buildup" according to the University of Illinois Agronomy Handbook, the average potassium (K) soil test at 350 lb K/A required no further buildup application. So the recommendation called for "maintenance-only" on the whole field.

> Production agriculture is currently grappling with many issues related to site-specific nutrient management. Some of the more important topics are: obtaining accurate maps of soil test variability; evaluating the appropriateness of current recommendations when applied at smaller scales; and accuracy of variable nutrient applications.

Figure 1 shows the spatial distribution of the soil test results from the 1-acre grid sampling. When the 1-acre grid test results were interpreted for the same yield goals, 47 of the 90 acres showed a need for buildup fertilizer in addition to the maintenance application. Thirty acres required maintenance only (the same as the field-average recommendation), and 13 acres had soil K levels high enough that no fertilizer was required at all. **Two-thirds of the field was not properly assessed by the field-average approach.**

Zone-managed Indiana field. The second example is a 157-acre field in central Indiana. Three-year average corn yields varied by soil type (**Table 1**). Larger soil mapping units were subdivided into areas small enough for representative soil samples to be

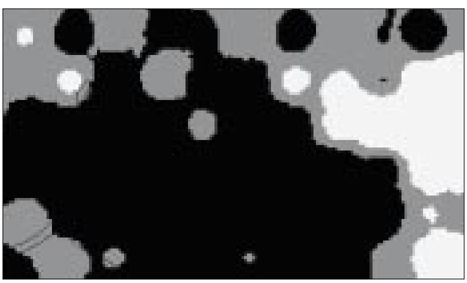

Figure 1. Fertilizer recommendations for 200 bu/A corn and 60 bu/A soybeans on a 90-acre central Illinois field.

Legend: Black areas: maintenance + buildup (47 acres); Gray areas: maintenance only (30 acres); White areas: no fertilizer needed (13 acres)

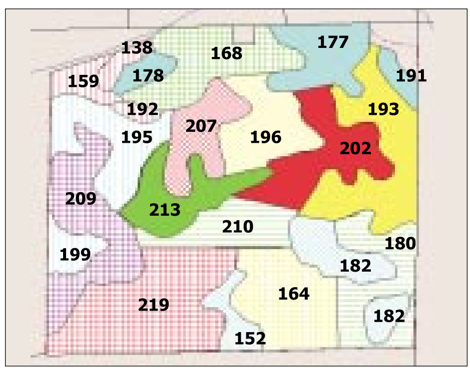

Figure 2. Yield goals for each management zone, determined from three-year averages for a 157-acre central Indiana field.

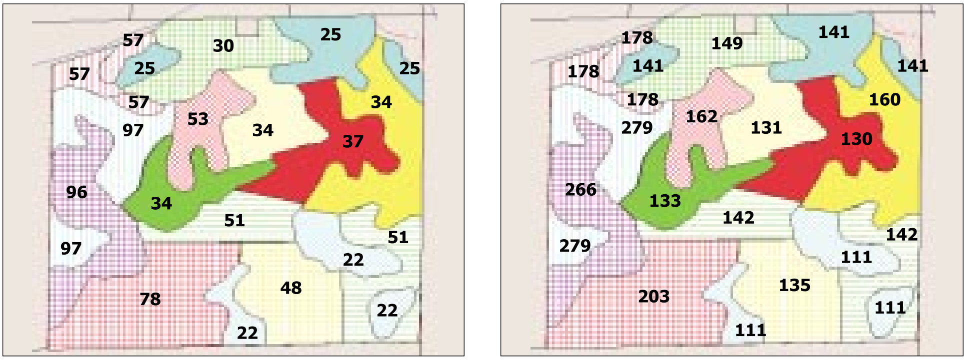

Figure 3. Bray P-1 soil test levels (on left) and Mehlich 3 K soil test levels (on right) for each management zone. Levels are in ppm.

collected. They ranged in size from 1 to 19 acres. All samples were composites of 20 to 30 individual soil cores, each geo-referenced and taken to a depth of 6 inches. These subdivisions in soil mapping units formed the basis for management zones.

Recommendations for phosphorus (P) and K were based on the Tri-State Fertilizer Recommendations (Vitosh, M.L., J.W. Johnson, and D.B Mengel. 1995. Tri-state fertilizer recommendations for corn, soybeans, wheat, and alfalfa. Ext. Bull. E-2567. Purdue Univ. Coop. Ext., Purdue University, West Lafayette, IN). Recommendations were calculated using yield goal, soil test level, cation exchange capacity (CEC), and soil buffer capacity. Three-year average corn grain yields were used as the yield goal for each zone, which ranged from 138 to 213 bu/A (**Figure 2**).

The Bray P-1 and Mehlich 3 K soil tests for each management zone are shown in

TABLE 1. Three-year average corn grain yields for a central Indiana field in a

Soil series	Abbreviation	3-yr. ave. grain yield, bu/A
Brookstone sil[1]	Bs	193
Crosby sil	Cs	187
Miami sil	Mi	159
Russell sil	Ru	192
Shoals sil	Sh	138

[1]Si = silt; l = loam

Figure 3. Soil test P and K ranged from 22 to 97 parts per million (ppm) and 111 to 279 ppm, respectively. Field average P and K soil test levels, calculated from zone soil tests using zone area as a weighting factor, were 52 and 170 ppm, respectively.

Recommendations based on calculated field average soil test levels would have called

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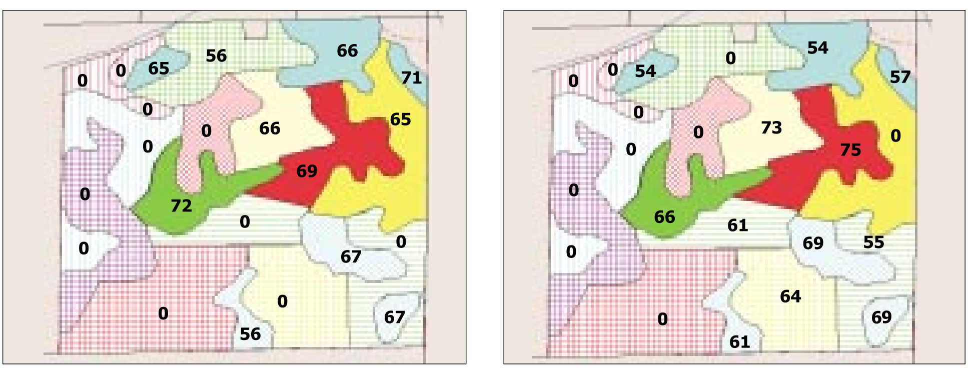

Figure 4. Nutrient recommendations for (on left) P (lb P_2O_5/A) and (on right) K (lb K_2O/A) for each management zone.

estimated net return to fertilization was greatest with the application of 60 lb N/A and the 137 lb/A P_2O_5 rate. Over the three-year period, cumulative net profits were greatest with the total application of 110 lb N/A and 69 lb P_2O_5/A. At the 137 lb/A P_2O_5 rate, the highest net return was with the total application of 220 lb N/A in three years. Continued cropping of the plots for several more years would more than likely have resulted in the greatest net return being with the 137 lb/A P_2O_5 rate. **Figure 2** shows that the one time application of P fertilizer improved soil test P levels for several years, with the 137 lb/A P_2O_5 rate still testing in the medium range the third crop year after P fertilization.

Maximum grain yields declined with each additional year of continuous winter wheat production on the plot area used in this study. **Figure 3** shows the decline in maximum grain yield attained each crop year. Downy brome grass competition increased with each additional year of winter wheat and with N and P fertilization. However, the downy brome was chemically controlled the last crop year, so competition with the wheat was minimized. In addition to the downy brome problem, other factors such as phytotoxic or allelopathic effects of the wheat residues on the next wheat crop may have contributed to the declining wheat yields. These observations show the importance of crop rotation as well as a good fertility program in maintaining optimum crop yields.

Application of P not only improved grain yields, but also improved N use efficiency. The residual soil NO_3-N levels in the 0- to 4-ft. profile after harvest of the last crop were lower with than without P fertilization (**Figure 4**). Note the large increase in residual soil NO_3-N when N application rates exceeded those needed for optimum grain yield (application of 440 and 780 lb N/A in three crops). Soil testing to determine N and P fertilization needs before nutrient application is important to optimizing yields and nutrient use efficiency and for protecting the environment from excess nutrient application. BC

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Site-Specific Nutrient Management... *(continued from page 13)*

for no supplemental P or K. However, with more intensive sampling and yield goal assessment, approximately 73 acres (46 percent) were identified as needing additional P, and 76 acres (48 percent) required additional K. The recommended rates per acre for each management zone are shown in **Figure 4**.

Total field requirements of 4,740 lb of P_2O_5 and 4,895 lb of K_2O were identified by the zone management plan, but were missed by whole field sampling and yield goal determination.

These two examples demonstrate the possibilities of precision agriculture in refining nutrient management. How often such disparities exist between whole-field and site-specific nutrient management has not been well assessed in many regions. Fields with known "hotspots" or areas with very high soil test levels are currently considered good candidates. The range in soil test levels is also important. Variability occurring at levels higher than those requiring additional nutrients is not cost-effective for site-specific nutrient management. However, wide ranges that include soil test levels requiring additional nutrients are thought to benefit from more refined approaches. BC

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