Site-Specific Management Impacts P and K Use and Productivity

By Paul E. Fixen

Soil variability can cut crop yields and profitability. More intensive soil sampling coupled with modern technology has the potential to improve fertilizer recommendations, increase nutrient use efficiency, increase yields and boost profits while maintaining environmental protection.

THE VARIABILITY of some fields is readily apparent. Other fields may appear uniform. Detailed soil sampling often reveals hidden variability that can rob farmers of yields and profitability. Multiple limiting factors frequently reduce yields in significant portions of fields that, on the average, test high or very high in phosphorus (P), potassium (K) and other nutrients. See the article titled "Soil Test Level Variability in Southern Minnesota" on page 24 of this issue.

Today's technology has the potential to unleash the true yield potential of soils and at the same time accommodate the application of nutrients only where they are needed.

Grid soil sampling is the key that unlocks hidden yield potential. This is a method of soil sampling in which several soil cores are collected at each point in a grid that divides a field into small, more uniform areas. The interval between grid points changes, depending on field variability and other factors, but is usually in the 200 to 440-foot range.

Impacts on Recommendations

The impact of grid sampling on total P and K recommended may not be the same in all regions. However, results from Minnesota and Ontario indicate that gridding will increase the total P and K recommended for fields having high variability that average near the soil test level where the recommendation drops to 0. To illustrate the effect of grid sampling on the total amount of P recommended, a simulation was conducted on 140 grid sampled fields in western Minnesota. Phosphorus recommendations were calculated based on the field average soil test level to simulate a conventional sampling approach. This recommended rate was then compared to the average of recommendations

BOTH dry and fluid applicators can vary fertilizer rate based on a grid map and other factors.

Table 1. Field average soil test level and variability influence the increase in P recommended due to grid sampling.

Soil test category[1] Olsen P, ppm	Field soil test variability[2] Low (<6)	Med. (6-10)	High (>10)
	Increase, lb P_2O_5/A		
<12 (L,M)	1	6	17
12-19 (H,VH)	5	14	25
>19 (VH)	0	3	16

Based on MN-ND-SD tri-state university recommendation for 140 bu/A corn which drops to zero at 16 parts per million (ppm). Data source: Agvise Labs
[1]Low, Medium, High, and Very high.
[2]Value in parentheses is standard deviation in ppm.

Dr. Fixen is PPI Northcentral Director, located in Brookings, SD.

based on individual grid points from the same field. Grid sampling increased the P rate recommended by an average of 51 percent. **Table 1** shows how the average soil test level for the field and field variability influenced the magnitude of the difference between these soil sampling approaches. For these 140 fields:

- Grid sampling **never** decreased the amount of P recommended.
- The largest increase occurred when the field average soil test was near the level where the recommendation dropped to zero (between high and very high).
- As field variability increased, the increase in P recommended due to gridding increased.

Ontario research indicates that a similar recommendation/gridding relationship may exist for K. Their studies show that field variability increases the optimum K rate compared to standard recommendations developed from uniform small plot calibration. The increase in K rates becomes larger as field variability increases and as the average soil test level for the field approaches the point where the recommendation drops to zero. Refer to the article on page 20 of this issue.

Gridding and Yield Potentials

How does grid sampling reveal hidden yield potential? Table 2 shows the results of a grid-sampled field from central Iowa where the data are summarized by soil mapping unit. Even though past yields varied little among mapping units, soil test levels were quite variable. Soil test calibration data for pH, P and K suggest that some soils were yielding at only 73 percent of their potential and that the field as a whole was at 88 percent of its potential. These limiting factors could not be identified without a site-specific management approach based on grid sampling.

The field average soil test levels that would be measured with conventional soil sampling are shown at the bottom of **Table 2**. Calculating the field yield potential from these average soil test levels suggests that the field is currently at 96 percent of its potential rather than 88 percent as shown in **Table 2**. Unrealized yield potential is hidden by the averaging effect of conventional soil sampling.

Table 2. Soil test levels and relative yields in a central Iowa corn field.

Soil	pH	Current levels P,ppm	Current levels K,ppm	Relative yield,%
Clarion	5.5	16	95	78
Nicollet	5.2	22	91	73
Canisteo	7.4	17	168	97
Webster	6.3	37	134	98
Field averages	6.5	20	134	88

USDA Soil Tilth Laboratory

Yield records collected by soil type can be combined with the relative yields from **Table 2** to generate an estimate of the true yield potential for the field, as shown in **Table 3**. In this case, the field yield potential is estimated to be 173 bu/A if pH, P and K are removed as limiting factors using site-specific management techniques. This represents an increase of 16 bu/A over conventional methods, based on field average soil test levels (151 bu/A ÷ 0.96 = 157; 173-157=16).

Soil fertility is often more variable than expected. For example, a private consulting firm reports in the article on pages 24 and 25 of this issue of *Better Crops* that 86 percent of nearly 400 grid sampled fields in southern Minnesota had 4 or 5 soil test P categories present in the field; 61 percent had 4 or 5 soil test K categories present (categories were very low, low, medium, high, very high). The monetary benefit of recognizing that kind of variability in management programs can be substantial.

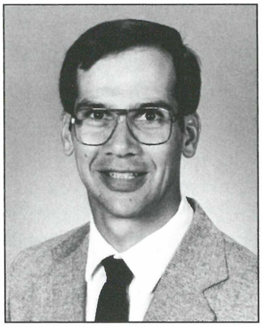
Table 3. Estimated corn yield potentials after soil test correction.

Soil	Past yield, bu/A	Relative yield,%	Yield potential, bu/A
Clarion	145	78	187
Nicollet	151	73	208
Canisteo	154	97	159
Webster	147	98	151
Field	151	88	173

USDA Soil Tilth Laboratory

PPI Announces T.W. Bruulsema as Director for Eastern Canada and Northeast U.S.

DR. THOMAS W. BRUULSEMA is joining the staff of PPI as Eastern Canada and Northeast U.S. Director. He will be responsible for the agronomic research and education programs of the Institute in the region, beginning in December 1994.



Dr. T.W. Bruulsema

"We are proud to welcome Tom Bruulsema to the organization," said Dr. David W. Dibb, President of PPI. "He has excellent credentials as an agronomic scientist and proven skills in working with people."

A native of Ontario, Dr. Bruulsema was active in the operation and management of his home farm for several years during high school. In 1983, he graduated with distinction from the University of Guelph with a B.Sc. in agriculture, then completed his M.Sc. in crop science in 1985.

From 1986 to 1990, Dr. Bruulsema and his wife, Elizabeth Anne, worked as volunteers in Bangladesh . . . he as a research agronomist, she as a family nutrition advisor.

After returning to North America, Dr. Bruulsema studied and conducted research from 1991 to early 1994 at Cornell University. Following completion of requirements for his Ph.D., he moved to the University of Minnesota. As a Research Associate studying fertility management of soil spatial variability, he worked with Dr. Gary Malzer.

In his new responsibility, Dr. Bruulsema will direct PPI programs in the Canadian provinces of Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland. His region will also include Pennsylvania, New Jersey, New York and the New England states.

Dr. Bruulsema will be located at Guelph, Ontario. He and his wife have two young children. ■

Site-Specific Management . . .

Site-Specific Management of P and K Offers Many Benefits

Its easy to get excited about appropriate, site-specific approaches to P and K management. Clearly, the benefits will be greater for some landscapes and crop rotations than others and all the questions have not yet been answered on how to optimize the benefits. However, this new style of management offers great promise to the future of crop production.

Farmers benefit through greater profits and improved efficiency of all inputs. Properly *managing* variability instead of ignoring it means more profit. Higher yields from the acres that were being underfertilized and reduced input costs from the acres that were being overfertilized translate into profit potential. The more variable the fields, the greater the profit increase will be.

Fertilizer dealers benefit by marketing more services and sometimes even more fertilizer.

Rural communities benefit from circulation of additional dollars and from the creation of new jobs in this intensive approach to crop management.

General public benefits from a more efficient food production system that has a reduced potential for surface and groundwater impacts. ■