Site-Specific Management of Nitrogen and Phosphorus in a Corn/Soybean Rotation

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Varying N and P together provided the greatest opportunities for yield and profit improvement, compared to a uniform nutrient management strategy in a Midwest study.

It is well known that N and P needs vary within a field. Multi-year, on-farm studies examining N and P interactions at a sub-field scale are not widely available.

A study was established in 1996 on a 30-acre farmer's field near Windom, Minnesota, and continued for 5 years (3 years of corn and 2 years of soybeans). The field had been in a corn/soybean rotation for the last 20 years, with no manure applied.

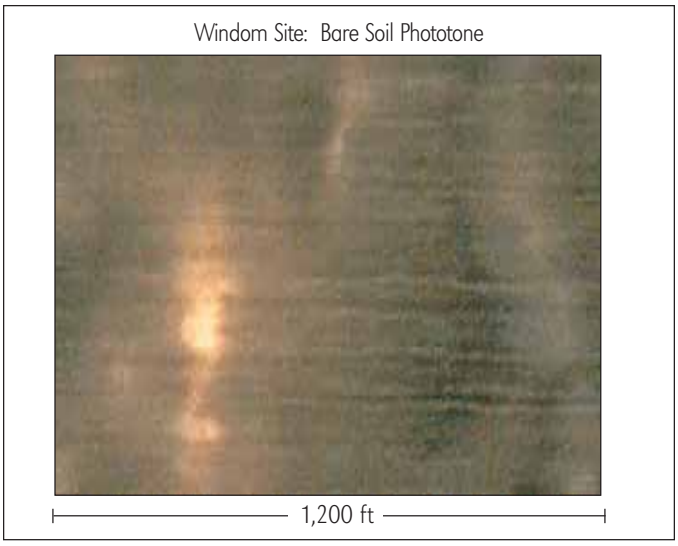
The site was extensively grid sampled in the fall of 1996. Soil organic matter ranged from less than 2% up to 10%. Phosphorus soil tests ranged from very low (less than 5 ppm) to very high (greater than 15 ppm). Soil pH ranged from 6 to 8. The dominant soils were Aquolls and Udolls: 1) a Jeffers clay loam, 2) Clarion-Swanlake clay loams, and 3) Webster-Delft clay loams.

The study examined corn and soybean responses to combinations of N and P rates. Phosphorus was applied at rates of 0, 50, and 100 lb P_2O_5/A in wider strips that ran the length of the field. Within each of these strips, five rates of N (0, 60, 100, 140, and 180 lb N/A) were applied in narrower strips. Both N and P were applied in the fall prior to the corn growing season. Treatments were replicated three times. During harvest, the plot combine was stopped every 50 ft. and the position of the harvester georeferenced. The combine was equipped with a ground distance monitor and a computerized weigh cell.

Partial budgets examined crop responses to N and P rate combinations. Profitability was evaluated for three scenarios: 1) variable N and P, 2) variable N, but uniform P, and 3) uniform N and variable P. When a variable nutrient rate was examined, profitability was based on the economically optimum rate for a particular area in the field. Consequently, the economics of variable nutrient applications are a "best case" scenario and assume that the optimum rate could have been selected before application. Profitability of uniform rates was determined using currently recommended university Extension nutrient rates and back calculating the predicted yield response.

Table 1. Yields of N and P management strategies.

Year	Crop	Yield of uniform N and P rates, bu/A	Yield as a percent of the yield of uniform N and P rates: Variable N and P	Variable P, uniform N	Uniform P, variable N
			%		
1997	Corn	127	104	100	97
1998	Soybean	44	102	102	100
1999	Corn	152	105	101	104
2000	Soybean	41	102	102	100
2001	Corn	117	107	101	101



This bare soil image of the experimental site in Minnesota shows variability of soils over a 1,200 ft. distance.

Average market prices (1997 through 2001) were used for corn and soybean in Cottonwood County, Minnesota ($2.00/bu corn and $4.76/bu soybean). Nutrient costs were $0.17/lb for N and $0.26/lb for P_2O_5. Variable and uniform nutrient applications were $5.35 and $4.00/A, respectively. Map-making and creation of management zones was assessed at $2.96/map. Intensive soil sampling and analysis costs were assumed to be $5.50/A. These costs were reduced to $0.33/A for uniform nutrient management, assuming one composite sample was taken from the field. Costs of mapping, soil sampling, and soil testing were charged in the 1997 year only and assumed to have value for 4 years.

Two years (1997 and 2001) had exceptionally adverse early season weather conditions (**Table 1**). In 1997, late spring snowfall and cold, wet conditions just before planting caused relatively low yields in parts of the field. In 2001, the early part of the growing season was again very wet, causing many zero or near zero yields where drainage was poor.

Corn response to N and P and soybean response to P varied spatially and temporally. Response patterns for N were less stable over time than for P. Economically optimum N rates were generally higher than

Abbreviations and notes for this article: N = nitrogen; P = phosphorus; ppm = parts per million, A = acre.

Table 2. Cash flow and net present value of N and P management strategies.

Year	Crop	Cash flow of uniform N and P rates, $/A	Increase or decrease in cash flow, compared to cash flow of uniform N and P rates		
			Variable N and P	Variable P, uniform N	Uniform P, variable N
			$/A		
1997	Corn	174.89	-5.09	-8.82	-9.85
1998	Soybean	182.90	4.00	3.90	0.00
1999	Corn	187.94	3.34	0.60	2.70
2000	Soybean	147.30	3.28	2.71	0.00
2001	Corn	117.00	5.96	1.70	-0.87
Net present value:		810.03	11.49	0.10	-8.02

university-recommended whole-field rates. On average, university recommended P rates were close to the economically optimum P rates for this field, ignoring any residual value at the end of the study.

Corn and soybean yields from a variable N and P program, assuming optimum rates could be applied in each area of the field, exceeded those of a uniform rate program in all years of the study (**Table 1**). Varying only one nutrient, rather than both, decreased the opportunities for yield improvements.

Net present value (cash flow minus initial investments) for the variable N and P program exceeded that of a uniform N and P program by approximately $11.50/A (**Table 2**), a significant increase. Uniform N applications combined with variable P rates did not produce significantly higher profit margins.

Returns to a variable N/uniform P strategy were significantly less than the completely uniform approach, indicating that spatial management of N over multiple growing seasons was more difficult than spatial management of P in this field. BC

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For further reading

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Dr. Paul E. Fixen Elected Fellow of AAAS

The American Association for the Advancement of Science (AAAS) recently awarded the distinction of Fellow to **Dr. Paul E. Fixen**, IPNI Senior Vice President, Americas Group Coordinator, and Director of Research. In making the announcement, AAAS explained that individuals are elevated to this rank because of their efforts toward advancing science applications that are deemed scientifically or socially distinguished. New Fellows will be presented with an official certificate and rosette pin at a forum during February in San Francisco.

Dr. Fixen was elected under the AAAS Section on Agriculture, Food, and Renewable Resources: For outstanding contributions to the science of crop nutrient management, particularly for chloride nutrition and for use of advanced technologies in improving nutrient use effectiveness. AAAS, founded in 1848, is the world's largest general scientific society and publisher of the journal *Science*. BC

International Plant Nutrition Institute Announces the "IPNI Science Award"

IPNI President Dr. Terry L. Roberts recently announced a new program to recognize outstanding achievement in the field of plant nutrition.

"The IPNI Science Award is to be presented each year to one agronomic scientist. Private or public sector agronomists, crop scientists, and soil scientists from all countries are eligible for nomination," Dr. Roberts explained.

The recipient will receive a plaque and a monetary award of US$5,000 (five-thousand dollars). The award recognizes outstanding achievements in research, extension, or education which focus on efficient and effective management of plant nutrients and their positive interaction in fully integrated crop production that enhance yield potential. The purpose of the award is to acknowledge and promote distinguished contributions by scientists involved with ecological crop intensification where productivity is increased and the environment is improved.

For 2007, nominations for the IPNI Science Award must be received by September 30; winner of the award will be announced December 31. To learn more about this program and to obtain a nomination form, visit the IPNI website at >**www.ipni.net/awards**<. BC