



Nitrogen fertilizers contribute substantially to the cost of corn production. In Illinois, for example, the annual investment is about \$500 million and relies extensively on yield-based N fertilizer recommendations developed in the 1970s. These recommendations are called into question by a new study published in the January–February 2006 issue of the *Soil Science Society of America Journal* (SSSAJ), which offers a soil-based alternative that will benefit crop yields, the environment, and the bottom line for farmers.

“We evaluated the proven-yield (PY) method on a site-by-site basis for 102 on-farm N-response trials conducted throughout Illinois in six growing seasons from 1990 to 2003,” explains the study’s lead author Richard Mulvaney, professor of soil fertility at the University of Illinois. “It was disturbing to see how poorly this method performed, considering that it has been so widely advocated for the past three decades. In fact, on average, the error itself was greater than the economically optimum N rate.”

Top: There was no visible difference between 0 and 235 kg N ha⁻¹ when corn was grown on this Illinois soil. Grain yields were slightly lower for the check plot on the left, but there was no significant difference between 34 and 235 kg N ha⁻¹. Increasing the population from 20,000 (middle) to 40,000 (bottom) plants acre⁻¹ led to lighter-colored plants when corn was grown at equidistant spacing on an irrigated Illinois prairie soil without N fertilization and reduced yield from 7.6 to 5.6 Mg ha⁻¹.

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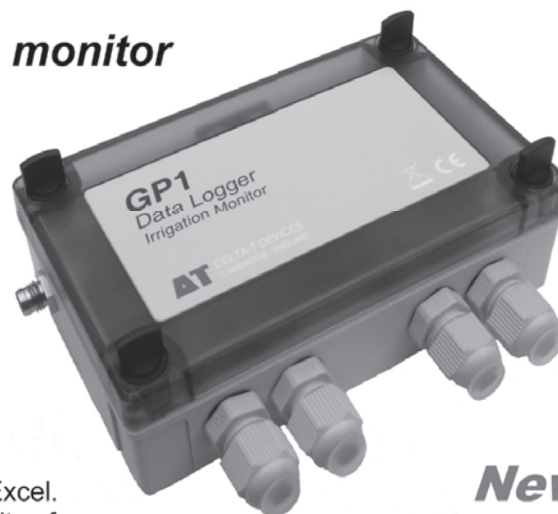
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The PY method was developed in an era when N fertilizer was relatively inexpensive and environmental concerns were less pressing, and has often been advocated as insurance against a yield limitation due to N deficiency. Yet even with an increasingly unrealistic corn-to-N price ratio of 10:1, the insurance policy failed to avoid underfertilization about one time out of six, by 46 kg ha⁻¹ on average and mostly when corn followed soybean.

"These findings are not that surprising when you consider the 'one-size-fits-all' philosophy behind the PY method," said Saeed Khan, co-author and research specialist at the University of Illinois. "Besides invoking standardized credits to account for N derived from legumes or manure, it assumes a constant fertilizer efficiency, regardless of timing, formulation, and method of application; weather conditions; landscape position; soil type; planting rate; and perhaps most importantly, the inherent differences that exist in soil N-supplying power."

Those differences have a crucial effect on the need for supplemental N fertilization, according to new insight provided by the Illinois soil N test (ISNT), a simple Mason-jar technique developed to identify sites where corn does not respond to N fertilization. There were 33 such sites reported in the SSSAJ study, and all except two were predicted correctly, assuming a critical test level of 230 mg kg⁻¹ as originally established. This level was less effective in identifying 50 of the 69 responsive sites, but the remaining 19 have important implications for fertilizer N management

with the ISNT. In some of these cases, drought or soil acidity likely limited the microbial activity that converts organic to inorganic soil N, thereby reducing plant N availability. In others, a deficiency of P or K would have decreased the efficiency for crop utilization of available soil N. More commonly, the critical level proved inadequate in applying the ISNT to sites where corn followed soybean with high plant populations. Not only would crop N demand have been increased by the presence of more plants, so would the input of C in the resulting residues, thereby promoting microbial competition for available soil N.

Yields were greatest when high planting rates were combined with N fertilization for sites that tested high by the ISNT, suggesting that this test has potential applications for variable-rate planting as well as site-specific N management.

"The ISNT can help us find areas within a field where N rates can be reduced without sacrificing yield, or where productivity can instead be increased by growing more plants," noted Tim Ellsworth, co-author and associate professor of soil physics at the University of Illinois. "Either option should be good for the environment."

Mulvaney, R.L., S.A. Khan, and T.R. Ellsworth. 2006. Need for a soil-based approach in managing nitrogen fertilizers for profitable corn production. Soil Sci. Soc. Am. J. 70:172-182. View the full article online at <http://soil.scijournals.org/content/vol70/issue1/>