

# Study reveals that nitrogen fertilizers deplete soil organic carbon

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The common practice of adding nitrogen fertilizer is believed to benefit the soil by building organic carbon, but four University of Illinois soil scientists dispute this view based on analyses of soil samples from the Morrow Plots that date back to before the current practice began.

The research, also drawing upon data from other long-term trials throughout the world, was conducted by U of I soil scientists Saeed Khan, Richard Mulvaney, Tim Ellsworth, and Charlie Boast. Their paper "The Myth of Nitrogen Fertilization for Soil Carbon Sequestration" is published in the November/December 2007 issue of the *Journal of Environmental Quality*.

"It is truly fortunate that researchers over the past 100 years have been diligent in collecting and storing samples from the U of I Morrow Plots in order to check how management practices have affected soil properties," said Khan. The Morrow Plots are America's oldest experimental field. "We were intrigued that corn growth and yields had been about 20 percent lower during the past 50 years for the north (continuous corn) than for the south (corn-oats-hay) end of the Morrow Plots, despite considerably greater inputs of fertilizer nitrogen and residues."

To understand why yields were lower for plots that received the most nitrogen, Khan and his colleagues analyzed samples for organic carbon in the soil to identify changes that have occurred since the onset of synthetic nitrogen fertilization in 1955. "What we learned is that after

five decades of massive inputs of residue carbon ranging from 90 to 124 tons per acre, all of the residue carbon had disappeared, and there had been a net decrease in soil organic carbon that averaged 4.9 tons per acre. Regardless of the crop rotation, the decline became much greater with the higher nitrogen rate," said Khan.

Mulvaney says that the findings have troubling implications for corn production due to the widespread use of yield-based nitrogen recommendations since the 1970s. "The one-size-fits-all approach was intended to minimize the risk of nitrogen deficiency as insurance for high yields. Unfortunately, the usual result is over-fertilization because of the assumption that the fertilizer supplies more nitrogen than the soil. The opposite is true in most cases, and especially for the highly productive soils of the Corn Belt that receive the highest nitrogen rates." Added Khan, "The rates have been progressively inflated over the years by yield increases from agricultural advances such as better varieties and higher populations."

Their findings for the Morrow Plots are confirmed in published literature from field studies that included initial soil organic carbon data. "In numerous publications spanning more than 100 years and a wide variety of cropping and tillage practices," said Boast, "we found consistent evidence of an organic carbon decline for fertilized soils throughout the world and including much of the Corn Belt besides Illinois."

"We don't question the importance of nitrogen fertilizers for crop production," said Ellsworth. "But, excessive application rates cut profits and are bad for soils and the environment. The loss of soil carbon has many adverse consequences for productivity, one of which is to decrease water storage. There are also adverse implications for air and water quality, since carbon dioxide will be released into the air, while excessive nitrogen contributes to the nitrate pollution problem."

Because soils differ in their capacities to supply nitrogen, Khan and his colleagues stress the need for soil testing, ideally on a site-specific basis, as a prerequisite to soil-based nitrogen management that optimizes fertilizer rates.

In comparing USDA data for Iowa and Illinois, the two states that rank highest in corn production, they found that from 1994 to 2001, annual grain yields in Iowa averaged 1.7 billion bushels with 740 thousand tons of nitrogen, as compared to an average of 1.5 billion bushels produced in Illinois with 847 thousand tons of nitrogen. The difference, Khan said, translates into lower fertilizer efficiency that cost Illinois farmers 68 million dollars per year.

Source: University of Illinois at Urbana-Champaign

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