Scientists identify link between plant nitrogen uptake and reduction in greenhouse gas emissions

July 4 2017, by Shari Finnell

Credit: Purdue University

Purdue University scientists released research findings that indicate corn management processes contributing to optimal levels of plant nitrogen

uptake could result in fewer nitrous oxide emissions, long identified as one of the most potent greenhouse gases.

The research, which revealed a strong relationship between actual nitrogen recovery and nitrous oxide emissions, was recently published in *Frontiers in Plant Science*.

"Previous internationally accepted estimates were that for every pound of nitrogen fertilizer applied in grain crop production, there is a loss of 1 percent as nitrous oxide to the atmosphere," said Tony Vyn, Purdue professor of agronomy. "We found that when it comes to North American corn production, nitrous oxide emissions are more of a function of two things—nitrogen balance and nitrogen recovery efficiency—than simply nitrogen rate alone. Moderate N rates cause less concern for nitrous oxide emissions, but when high rates of nitrogen fertilizer exceed optimal plant nitrogen requirements, then we will get higher nitrous oxide emissions."

He said the study's findings should be used to guide any agronomic research about the impact of agricultural production on nitrous oxide emissions.

"Our models indicated that a careful selection of appropriate nitrogen rate applied at the right time can both increase nitrogen recovery efficiency, lower the nitrogen balance left in the field, and reduce nitrous oxide emissions," Vyn said. "If you're going to measure greenhouse gas emissions, you must also measure the whole plant nitrogen uptake for each nitrogen fertilizer management program being tested."

Purdue research scientist Rex Omonode, who analyzed data from throughout the United States and Canada dating back to 2002, said the research was based on 1,375 plot-level observations. "It was exciting to

test a common but unproven hypothesis that an increase of plant nitrogen uptake and/or recovery efficiency will reduce nitrous oxide emission during crop production," Omonode said. Omonode and Vyn were helped in their analysis by research co-authors from the United States Department of Agriculture–Agricultural Research Service, and and Agriculture and Agri-Food Canada.

The link between crop production and nitrous oxide emissions has been the subject of numerous research studies, particularly throughout the United States, which is the No. 1 corn producer in the world. In 2016, 94 million acres of corn were planted throughout the country.

Many studies have either focused on greenhouse gas emissions in direct relation to fertilizer amounts applied or focused on efficiency of plant nutrient uptake without measuring greenhouse gases. "Too few researchers have looked at both simultaneously," Vyn said. "This study distinguished the proportion of fertilizer nitrogen applied that was taken into the plants and what actually went into the atmosphere during the growing season."

Vyn and Omonode said the research also provided insights on the impact of wide-scale education related to crop management. As a result of land-grant research and education programs, such as Extension programs, producers throughout the United States generally are maintaining management processes that have minimized potential nitrous oxide emissions, they said. For decades, research and education resulting from Extension programs have contributed to adoption of best management practices in crop production.

"North American maize production systems are currently at average total nitrogen application rates that are surprisingly good at limiting nitrous oxide emissions," Vyn said. Nitrous oxide emissions are also generally lower in irrigated corn systems.

Higher rates of emissions result when producers use more fertilizer than necessary, which can occur when producers are trying to guard against high nitrogen losses from soil when excessive rainfall occurs prior to plants locking up the plant-available mineral nitrogen with their roots. Nitrous oxide emissions climb steeply when a producer adds an extra 50 pounds of fertilizer per acre above the agronomic optimum nitrogen rates for their region, Omonode said.

With further studies of nitrous oxide losses, the research indicated, it is essential to gauge fertilizer recovery in all grain crops. "It doesn't matter if it's corn, wheat or other crops, it's important to look at nitrogen recovery when looking at greenhouse gas emissions," Omonode said.

More information: Rex A. Omonode et al. Achieving Lower Nitrogen Balance and Higher Nitrogen Recovery Efficiency Reduces Nitrous Oxide Emissions in North America's Maize Cropping Systems, *Frontiers in Plant Science* (2017). DOI: 10.3389/fpls.2017.01080

Provided by Purdue University