NITROGEN USE: IT'S NOT YOUR GRANDFATHER'S CORN

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Adequate plant available nitrogen (N) is a requirement for high yielding corn. Nitrogen fertilizer or manure is applied to supplement N supplied by the soil system. Fertilization rates are derived from on-farm research trials, and in Iowa suggested economic optimum N rates [Maximum Return To Nitrogen (MRTN) and most profitable N rate range] are provided through the online Corn Nitrogen Rate Calculator and the Iowa State University Extension and Outreach publication "Nitrogen Use in Iowa Corn Production".

Corn yields have increased substantially in Iowa over time, from around 40 bu/acre through 1940 to now around 200 bu/acre (statewide averages). As yield goals were used for a long time to determine N applications (ex. yield goal bu/acre times a factor), many people still expect the current high corn yields to require concurrent high N fertilizer application rates. However, suggested MRTN rates provided by the Corn Nitrogen Rate Calculator are not based on yield goals, but instead recent research trials that measure yield increase to applied N. Not using yield level (goal) in N rate determination leads many people to believe that rate guidelines are too low to support the current high yields.

What is not widely accepted is that corn N fertilization requirements have been relatively constant for a long time. A two-year study near Ames Iowa that looked at N use by popular hybrids from ten-year periods (1960, 1970, 1980, 1990, and 2000 eras planted at the same time and same environment) showed that yields were highest, N response greater, and N use efficiency higher in the most recent era hybrids; however, grain and plant N concentrations were lower which tempered plant N demand in the most recent era hybrids. That is, grain and plant N content (amount) did not follow directly the higher yields across time. For example, in Table 1 where the 1960 and 2000 era hybrids are compared, the 2000 hybrids had 67% higher yield, but only 19% more total plant N and only 22% more grain N than the 1960 era hybrids. The per bushel grain N was 0.76 lb N/bu for the 1960 era hybrids, but only 0.58 lb N/bu for the 2000 era hybrids (a 24% lower N concentration). In several studies conducted across Iowa in recent years, the average grain N was 0.53 lb N/bu at economic optimum N rates. This means, harvested grain N removal, even at high yields, is less than suggested MRTN application rates from the Corn Nitrogen Rate Calculator (especially for continuous corn) – likely opposite of what many would expect. Also, the internal plant N use efficiency (bu produced per lb total plant N) was 40% higher for the 2000 era hybrids than the 1960 era hybrids (which is a very good trait). Nitrogen use efficiency can vary with different years, environmental conditions and yield levels, and plant use efficiency helps explain why current yield levels do not match optimal N fertilization rates.

Much progress has been made in corn yield improvement over time. It is helpful from an economic and environmental standpoint that higher N applications have not been needed to allow those yield improvements to be realized. However, on a regional basis as grain N removal compared to N application rate has remained similar over time (an example is the ratio of estimated grain N removal from statewide corn yields and fertilizer N applied to corn in Iowa),

nitrate-N movement to water systems has also remained similar. Increasing N applications in reaction to high corn yields would only reduce profitability and worsen environmental issues such as nitrous oxide release to the atmosphere and nitrate-N in water systems.

Table 1. Comparison of 1960 and 2000 era hybrids.

	Era	
Plant Measurement	1960	2000
Grain Yield (bu/acre)	134b	224a
Total N uptake at maturity (lb/acre)	159b	190a
Grain N (lb/acre)	113b	138a
Grain N Harvest Index	0.71a	0.73a
Grain Harvest Index (%)	49a	53a
Grain (bu/lb of total plant N)	0.84b	1.18a
Grain N Concentration (% DM basis)	1.61a	1.23b
Grain N (lb N/bu at 15.5%)	0.76a	0.58b

Letters indicate statistical difference in measurement between eras ($P \leq 0.10$).
K.P. Woli, M.J. Boyer, Roger W. Elmore, J.E. Sawyer, L.J. Abendroth, and D.W. Barker. 2016. Iowa State University.

Footnote:
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