Dr. Gyles Randall

# Managing Nitrogen With Five-dollar Gas

Escalating natural gas prices with little possibility of low-cost nitrogen returning, strongly encourages growers to fine-tune management practices or jeopardize profits.

***Summary:*** *Sound nitrogen (N) fertilizer management practices include applying proper N rates, proper timing, diagnostic tools to assess soil N and plant N status, and the use of nitrifi cation and urease inhibitors, as well as controlled-release N fertilizers.*

The price of N is of concern to many growers because it is one of the highest variable input costs corn farmers encounter. Natural gas, a basic feedstock in the production of N fertilizers, has seen a substantial price escalation within the U.S. in the last few years. Thus the cost of N fertilizer has risen dramatically, giving heightened interest and economic concern to U.S. corn producers.

How can N fertilizer be managed more intensely to gain increased efficiency and "greater return for the buck" to American farmers? The following will describe management practices that can be employed now or can likely be used in the future to fine-tune N management, bringing greater return to the grower's pocketbook. These practices generally include applying the correct rate of N, applying N at the proper time to maximize availability and minimize loss, using nitrification and urease inhibitors and controlled release N fertilizer sources if appropriate, and using diagnostic assessment tools to help arrive at the proper N rate (soil N tests, remote sensing, etc.).

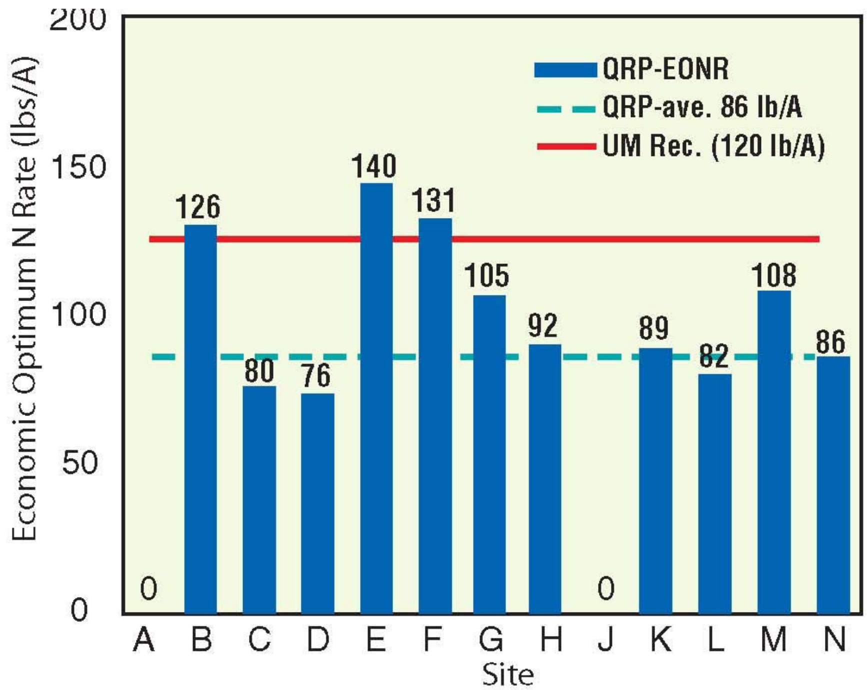


**Figure 1.** Economical optimum N rate (EONR) for 13 small plot sizes in growers' fields in southern Minnesota

### Proper rate

From 1989 through 2001, our recommendations for corn after soybeans were tested on farmers' fields to develop data for validating current recommendations and changing recommendations if needed. Best management practices were used at all sites and are considered essential for efficient N use.

*Small plots.* Thirteen studies conducted from 1989 through 1999 were equally divided between the loess soils (silt loam) of southeastern Minnesota and the glacial till soils (clay loam) of southcentral Minnesota. The plots were 10 to 15 feet wide and 40 to 60 feet long and were replicated four to six times at each site. The farmers tilled, planted, applied pesticides, cultivated, and selected hybrids and planting rates. University scientists applied N fertilizer, hand-harvested the yields, and collected other appropriate field data (weather, past cropping, nutrient history, etc.). N was applied in 30-lb increments at rates from 0 to 180 lbs/A at seven sites and 0 to 150 lbs/A at six sites. Urea was spring preplant applied at 11 sites, and anhydrous ammonia was sidedressed at two sites. The economical optimal N rate (EONR) for each of the sites ranged from a low of 0 to a high of 140 lbs/A of N (Figure 1). The EONR averaged across the sites was 86 lbs/A of N while the yield at the EONR (YEONR) was 173 bu/A.

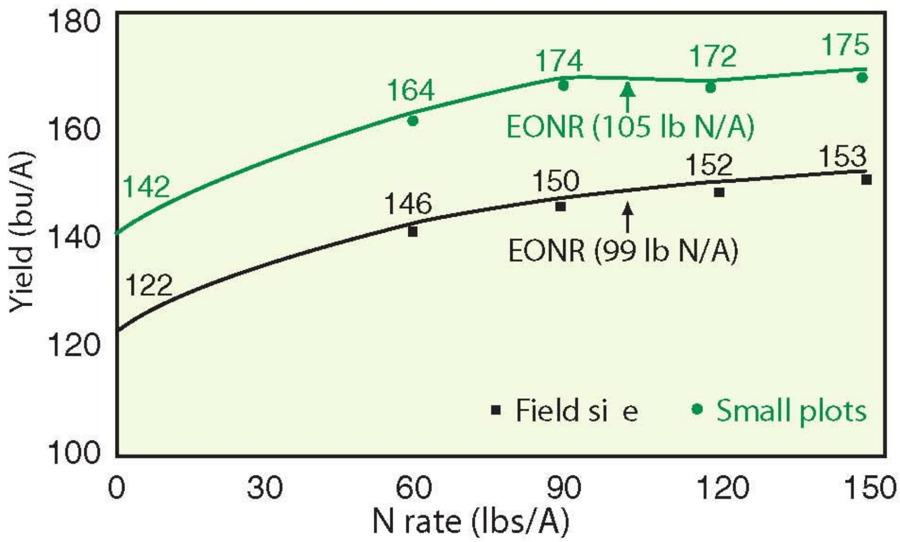


**Figure 2.** Effect of fertilizer N rate on average corn yield and EONR from 13 small plot field-size strip studies in Minnesota.

**Table 1.** Corn yield, apparent N recovery by corn, economic return to fertilizer N and N-serve, and nitrate-N loss to subsurface drainage as affected by time of N application and N-Serve.

| | | 7-year avg. | | | |
|---|---|---|---|---|---|
| Treatment | N-Serve | Grain yield | N recovery | Economic return | Nitrate-N loss in drainage |
| | | bu/A | % | $/A | lb/A/inch |
| Fall | No | 131 | 31 | 67 | 3.8 |
| Fall | Yes | 139 | 37 | 78 | 3.1 |
| Spring | No | 139 | 40 | 85 | 3.1 |
| Split | No | 145 | 44 | 97 | 3.3 |

The optimal N rate data in Figure 1 also show the variability among sites. University scientists usually set their recommendations slightly higher than the response data suggest. This cushions the farmer from risk of yield and profit loss under unforeseen conditions. In this case, an N recommendation of 120 lbs/A was actually more than was needed for optimal yields at 10 of 13 sites. Based on these yield responses to N in small-plot studies, the 120-lb N rate (recommended by the University of Minnesota for 150 to 174 bu/A corn grown on these soils) was enough to optimize yield and profit at 10 of 13 sites. In fact, the yield maximum at 7 of 13 sites was reached at an N rate of less than 90 lbs/A.

*Field-size strip studies.* Spring or sidedress application was used at 10 sites and fall anhydrous ammonia plus N-Serve was used at 3. N was applied at rates of 0, 60, 90, 120, and 150 lbs/A at 10 sites and included 180 lbs/A at 3 sites. N was applied by the dealer or farmer in strips matching the applicator width (30 to 60 ft). Strip length ranged from about 400 to more than 1200 feet.

At each field strip site, tillage, planting, pesticide application, and hybrid and planting rate selection were performed by the farmers. All yield data were collected by the farmer and/or consultant.

EONR ranged from 55 to 169 lbs/A and averaged 100 lbs/A for the 13 field-size strip studies. YEONR was 151 bu/A. As with the small-plot studies, these field-size experiments demonstrate the site-to-site variability when finding an optimal N rate for corn. But in total, a 120-lb/A N rate was enough to optimize corn yield and profit at 11 of 13 sites. On 4 sites, yield and profit were maximized at N rates of 90 lbs/A and less.

*Small plots vs. field-size strip.* Corn yields for N rates of 0, 60, 90, 120, and 150 lbs/A were pooled for all 13 small-plot studies to find the EONR for all 13 sites. The same yield pooling procedure was used for the field-size studies. Although the procedures were different for these two types of field studies, the results were remarkably similar (Figure 2). EONRs for the small plots and field size were 105 and 99 lbs/A of N, respectively. The YEONR was greater in the small plots (173 bu/A) than in the field-size strips (151 bu/A) due to very high yields in the small plots in southeastern Minnesota in 1989, 1998, and 1999 when field-size strip studies were not performed. This shows that plot size used in N rate calibration trials does not affect N fertilizer rate recommendations.

Primary conclusions from these 26 site-years on-farm studies:

- EONRs averaged across small plots and field-size strips were 86 and 100 lbs/A, respectively. When yield data were pooled, EONRs were 105 and 99 lbs/A, respectively. Yields were 173 and 151 bu/A, respectively.
- Although yield variability among the sites was significant, it was not nearly as dramatic as the variability among EONRs across the sites. EONR ranged from 0 to 140 lbs/A in small plots and from 55 to 169 lbs/A in field-size strips.
- Plot size used in N rate calibration research did not affect N fertilizer rate recommendations.
- N rate recommended by the University of Minnesota achieves

optimal corn yield and may be greater than needed for maximum profitability in many fields.

**Proper timing**

A field experiment (1988 to 1994) was conducted on a poorly drained soil at the University's Southern Research and Outreach Center at Waseca to determine the effect of time of N and N-Serve applications on corn yield, profitability, N efficiency, and N losses to subsurface drainage in a corn/ soybean rotation.

Seven-year average corn grain yields were lowest with fall N without N-Serve, intermediate and equal for fall N + N-Serve and spring preplant N, and highest for split N treatment (Table 1). Apparent N recovery and economic return to the fertilizer and N-Serve were ranked in decreasing order: split N > Spring > Fall + N-Serve > Fall N. Nitrate–N losses expressed on a "per inch of drainage" basis were greatest for fall N, intermediate for split N, and lowest for fall N + N-Serve and spring preplant N (Table 1). These results clearly show yield, profitability and N efficiency advantages for the split N treatment. However, slightly more nitrate-N was lost in the drainage water from the split N treatment, due primarily to increased loss of N in the spring of the following year (soybeans), compared to the spring preplant and fall N + N-Serve treatments. These findings are contrary to common perception but are similar to other studies reported in the literature.

---

*Dr. Randall is soil scientist and professor at the Southern Research and Outreach Center at the University of Minnesota.*