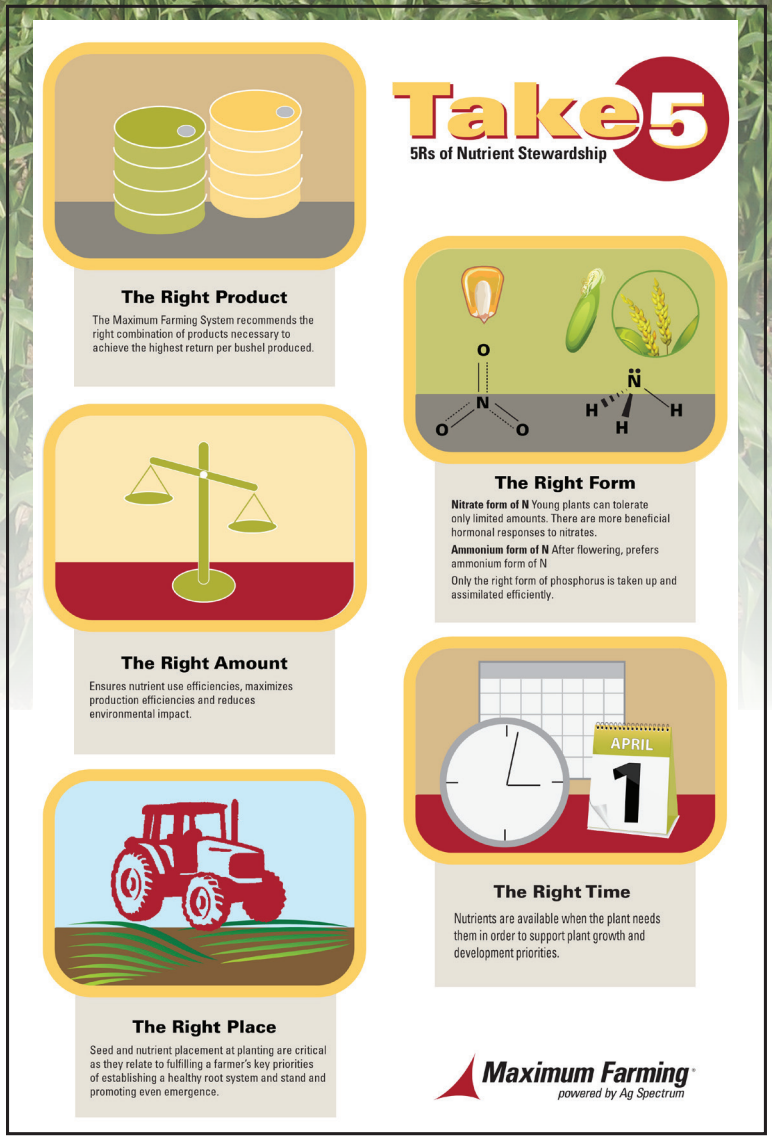
The Edge®
An Ag Spectrum Company Publication for Ag Professionals

OPTIMIZING NITROGEN USE



by Brian Gardener, Ph.D

Nitrogen fertilizers are critical inputs for optimizing grain productivity. Most farmers understand that increasing rates of N fertilizers will tend to increase yields to a point after which the return on investment is drastically reduced. This conventional thinking has led to solid gains in crop productivity over the years, but it still often fails to deliver more than 50% fertilizer nitrogen use efficiency (NUE).

Why does conventional nitrogen management, which relies so heavily on applied field research, fall short so consistently? In conventional thinking, aggregate data from many farms and soil types are used to determine optimal rates based on the assumptions that the details of soil type and management matter very little. But that applied science approach does not provide guidance tailored to individual farms.

Basic science has shown that optimal fertilizer N use depends on a soil's capacity to yield. That capacity depends largely on knowledge of a farm's soil types and its managers' abilities. Thus, to truly optimize NUE, one needs to understand and act on the basic science behind the 5Rs of nutrient management.

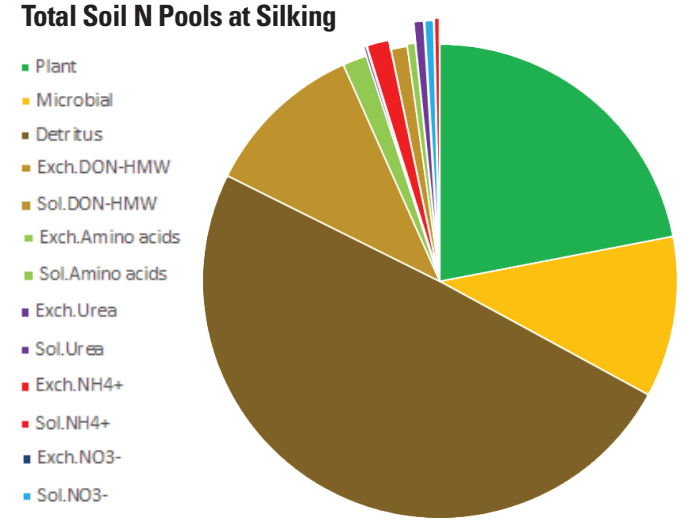


Figure 1: Fertilizer N represents a small fraction of the total N present in a corn field. Soluble and exchangeable organic N pools are just as large or larger than those applied by farmers. Detritus, composed microbial and plant decomposition products, represents the largest fraction and is constantly being cycled into and out of the smaller soluble pools by microbial activities.

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RATE

Optimal nitrogen fertilizer rates are based on crop demand, prevailing soil conditions, and late season water availability, all of which contribute to achievable yield goals. All soils have ample amounts of nitrogen locked up in residue and various organic matter pools (Figure 1). Those pools cycle rather quickly with much of the N going in and out of solution multiple times throughout the growing season.

Providing fertilizer N to supplement natural cycling is critical to boosting yield potential, particularly when soils are excessively cool early in the spring. That is why the Maximum Farming System provides about half of supplemental fertilizer nitrogen at planting in the furrow and as a nearby banded application.

TIMING

Optimal timing is based on crop demand. Typically, corn will take up 5% by V6, 30% by V12, and between 50% and 80% of its total nitrogen load by V18/Silking (Figure 2). Research supported by Ag Spectrum in the early 1990's and conducted by Drs. Tsai and Huber at Purdue University showed that hybrid responses to N differed substantially. Older "workhorse" (Type 1) hybrids would take up 80% or more of their N before silking, but newer "racehorse" (Type 3) hybrids could readily take up the majority of their N after silking and pollination.

More recent research presented by Michigan State's Dr. Addie Thompson at the 2022 National Dealer Seminar and Maximum Farming Club Conference showed yield responses to side dress nitrogen applications can differ substantially by hybrid type and growing season (Figure 3). Such basic science affirms our guidance to properly split nitrogen fertilizer applications based on hybrid N response types.

PLACEMENT

Fertilizer nitrogen placed below the soil surface prevents predictable and avoidable losses. At planting, the in furrow starter nitrogen (present in CleanStart®) is placed at or below the seed so it contacts soil moisture. Likewise, the banded UAN should contact soil moisture at about seeding depth so it can diffuse downward and outward, flowing into the path of the growing seminal and nodal roots.

Because the rates of the banded and side dress N are substantial, care must be taken to ensure they are placed sufficiently far from the growing seedling so it doesn't experience ammonium toxicity stress. Placement of the initial

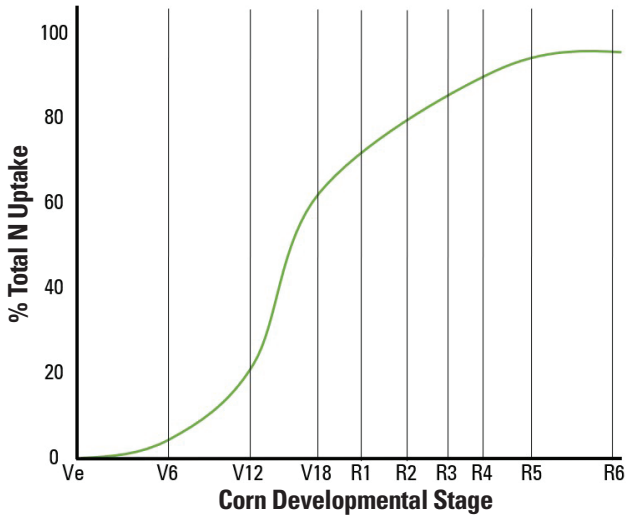

Figure 2: Optimal N fertilizer use aims to supplement soil N pools so that the growing plant has enough soluble N to draw from as it goes through its lifecycle. Providing too much N too early will significantly reduce NUE.

band should be 4 to 6 inches from the furrow. The side dress band is best placed below the surface and centered between adjacent rows.

FORM

Urea, amino acids, ammonium, and nitrate can all be taken up and processed by roots and soil microbes. However, biasing applications to certain forms during certain developmental stages can improve crop yields.

Young plants want nitrate N because that form stimulates cytokinin activity and new root growth. In the case of corn, nitrate can also help improve kernel set by stimulating zein deposition in the ear as it forms during the early vegetative stages. Later, as soils warm and the plants get larger, higher concentrations of ammonium are tolerated and can stimulate auxin activity that expands leaf growth.

PRODUCT

Often overlooked, product formulations can have a significant impact on NUE. In the furrow, optimal NUE is obtained only in the presence of a complete macro-, meso- and micronutrient package, like the one present in our formulations.

As soils warm and plants begin rapid growth, supplementing banded UAN with some fertilizer K and/or S can further improve NUE of a crop's "second" feeding. While the primary benefits of our foliar program are to deliver micronutrients and stimulate post-pollination root growth, the PT21 carrier includes a urea-form nitrogen that both improves leaf penetration and stimulates plant metabolism so that the micronutrients and biochemical signals are taken up efficiently.

In a year when nitrogen prices are sky high, it is more important than ever to optimize fertilizer N use efficiencies. Following the 5Rs for nitrogen fertilization will yield greater returns by improving overall nitrogen use efficiency. By using basic science to guide our decisions, we are able to better improve our customers' success.

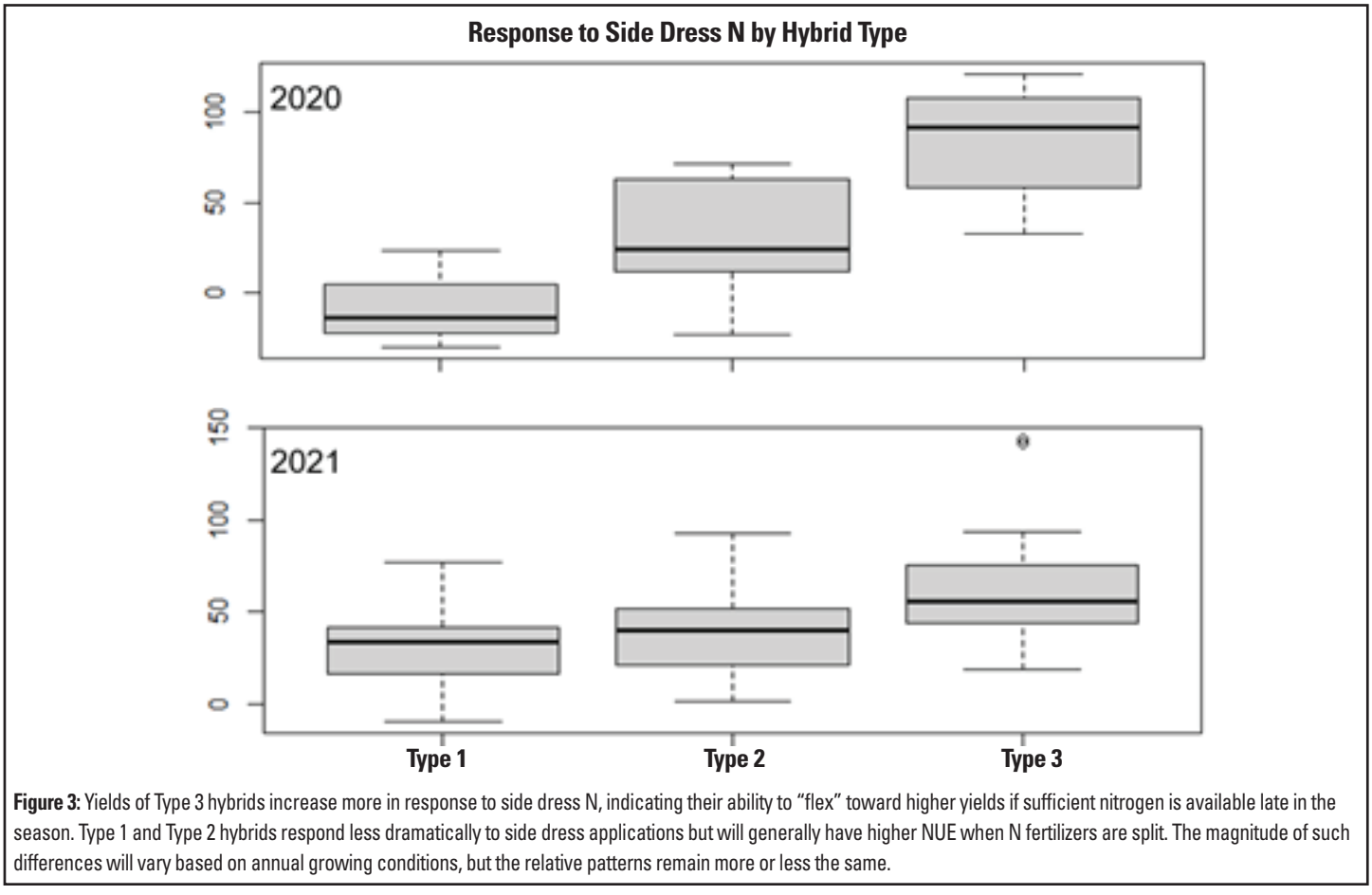

Figure 3: Yields of Type 3 hybrids increase more in response to side dress N, indicating their ability to "flex" toward higher yields if sufficient nitrogen is available late in the season. Type 1 and Type 2 hybrids respond less dramatically to side dress applications but will generally have higher NUE when N fertilizers are split. The magnitude of such differences will vary based on annual growing conditions, but the relative patterns remain more or less the same.

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