The Complicated Pursuit of Simultaneous Improvements in Corn Productivity and Nitrogen Use Efficiencies

Monumental quantities of scientific outcomes regarding crop response to nutrient management in the context of changing varieties, environments, and management systems are continuously published in *Crop Science* and other journals, but deeper investigations and syntheses of previously documented results are rare. Seed companies are making major investments in breeding corn hybrids with improved nitrogen use efficiency (NUE) without necessarily clearly understanding how corn plant NUE, and its numerous sub-components, have changed in previous decades as both genotypes and management systems have evolved.

To better understand the history of corn yield dependency on whole-plant N uptake, Purdue University researchers Ignacio Ciampitti and Tony Vyn looked at all available N use studies (100 worldwide investigations) that reported at least grain yields, N rates applied, whole-plant N uptake at maturity, and corn plant density. They divided these research studies into two time periods for comparison purposes—1940–1990 (“Old Era”) versus 1991–2011 (“New Era”). That large data source (~2,900 observations) became the basis for two review papers.

In the first review paper (Ciampitti and Vyn, 2012), the researchers investigated whether any changes in NUE over time were simply associated with improved yields, differences in mean N fertilizer rates applied, or other factors. They primarily found that modern hybrids take up more total N per acre during the growing season than they did before and that hybrids from the New Era produced approximately 13% more grain per pound of N accumulated in corn plants than was the case for Old Era hybrids. This reflected a dramatic gain in the N internal efficiency in more modern hybrids. Maximum individual plant N uptake stayed exactly the same despite the average gain of 6,000 plants per acre (i.e., from 22,800 to 28,900 from Old to New Eras, respectively). However, improvement in NUE came at the expense of lower grain N concentrations in a relatively stable grain N harvest index (~63%), the researchers wondered if pursuing further NUE improvements would be sustainable.

With that concept in mind, they undertook the second review paper, published in the March–April 2013 issue of *Crop Science*, to better understand the proportional grain N sources coming from (a) reproductive (after flowering) plant N uptake, (b) remobilized N from the leaf and stem structures during senescence, and (c) the N taken up prior to flowering. Identification of the potential changes over time in the grain N sources can provide a deeper understanding for future corn NUE improvements. The researchers used subsets of the original data source with the required additional data (e.g., whole-plant N uptake at maturity).