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Ecologically Intensify Your Corn Nutrition

"*Major scientific breakthroughs must occur in basic plant physiology, ecophysiology, agroecology, and soil science to achieve the ecological intensification that is needed to meet the expected increase in food demand.*"

LONG BEFORE the current biofuels boom, Dr. Kenneth G. Cassman concluded a 1999 National Academy of Sciences paper with this statement. The need for ecological intensification is all the more pressing today. And managing the nutrition of your corn crop is a big part of it.

Ecological intensification has several levels of meaning. First, it means growing more on less land, to preserve natural ecosystems. Second, it means growing those higher yields with less impact on surrounding ecosystems, meaning minimal losses of sediment, nutrients, and agro-chemicals. But the third level is probably the most challenging: applying the principles of ecology to make cropping systems more productive.

The first principle of ecology is that each living organism has an ongoing and continual relationship with every other element that makes up its environment. Managing crop nutrients ecologically, therefore, means that more than just the crop is affected by the nutrients you apply. You need to consider the longer-term effects on the cropping system and the soil ecology as well.

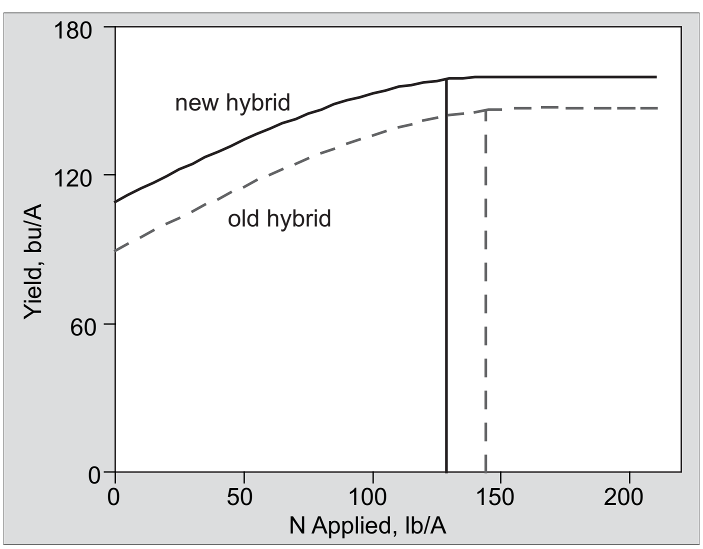

Figure 1. A new hybrid yields more with less N, compared to one popular 20 years ago. Mean of 4 years' data (Below, 2007).

Dr. Tom W. Bruulsema
Northeast Director
International Plant Nutrition Institute (IPNI)
18 Maplewood Drive
Guelph, Ontario, Canada N1G 1L8
Phone: (519) 821-5519
Fax: (519) 821-6302
E-mail: tom.bruulsema@ipni.net
Website: www.ipni.net

Healthy ecosystems are productive. Ecologists and crop producers therefore have similar goals in enhancing primary productivity – the capture of sunlight and its conversion to plant material.

Natural ecosystems waste little in the way of nutrients. A diversity of plants takes up nutrients as they are made available. Ecological crop nutrition also strives to match nutrient supply to crop demand. How it's best done is constantly changing. New genetics change crop demand, and new technologies change the ways in which the demand can be met. And the list of ecosystem impacts to be considered continues to grow as well.

New Genetics

As breeders select for yield across a range of environments, new hybrids increase their resistance to stresses. Physiological studies show that today's corn plant keeps its leaves active and keeps taking up N later in the season. As a result, more of the N mineralized from the soil's organic matter is taken up.

Dr. Fred Below, Professor of Crop Physiology at the University of Illinois, recently pointed out that new hybrids respond differently to N. The general trend is shown in **Figure 1**, comparing a hybrid of the early 1980s to one that is grown today in central Illinois. The new hybrid yields more with less N — though the gain in yield per unit applied doesn't really differ. The major difference is capture of N from the soil. This historical change was also evident in Dr. Matthijs Tollenaar's studies comparing hybrids from the 1960s and 1990s in Ontario.

More recent work by Dr. Below shows a possibility that the Bt-rootworm trait may have further altered response

Abbreviations and notes for this article: N = nitrogen; P = phosphorus; K = potassium; S = sulfur.

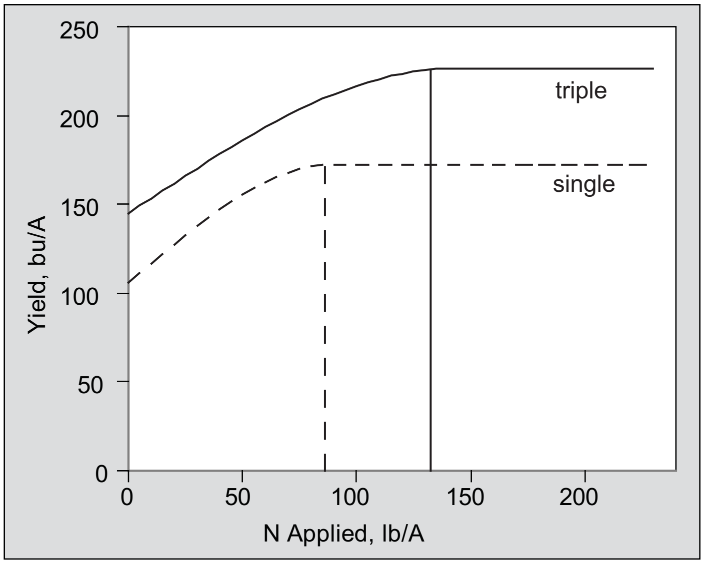

Figure 2. A "triple-stack" Bt-rootworm hybrid responds differently than one with a single herbicide resistance trait (2006 data; Below, 2007).

to N. At a single site in 2006, a "triple-stack" hybrid including the Bt-rootworm trait showed a large increase in both yield and optimum N rate (**Figure 2**). The increased yield without N indicates again greater capture from the soil. Is the new trait extending the life of the root system? Will this hybrid show the same difference next year? More testing will be needed before we can make any general conclusion on the effect of this genetic trait on N use efficiency.

It is encouraging to see that—so far—the direction of genetic change seems consistent with ecological intensification. These changes in rooting and nutrient capture have implications for other nutrients as well. Uptake of P, K, and S may increase in linkage with yield, and may come from different soil depths than in the past.

New Technologies

One of the keys to minimizing waste is to ensure the timing of supply matches that of plant demand. Many new N products are moving to market: some polymer-coated, some chemically stabilized, some with inhibitors of urease and/or nitrification, and some with combinations of these.

Are these products better than split application? Not necessarily everywhere, but for many soils and conditions, split application entails risks. Soil may be too wet at side-dress time to get on to the field. In 2007, many soils were so dry that side-dressed N—even fluids—didn't get to the roots. Controlled-release products can potentially be more reliable and more convenient. But weather and many other soils factors can influence the rate of release, so it's important to evaluate these products to find which performs best in your own specific growing conditions. On-farm testing is key.

Ecosystem Impacts

Soil ecology depends on organic matter. Soil organic matter needs inputs of roots and crop residues. Higher corn yields supported by optimum N management have been shown to contribute toward building soil organic matter. Crop rotations that include wheat undersown to forage legumes also contribute toward this goal — and they need to be integrated with livestock.

Are new genetics keeping corn roots alive longer to capture more soil N?

Nitrogen management affects not only the yield of the crop, but also the environment. Risks of nitrate in drainage water, ammonia gas transfer to forests and a possible contribution to smog, and nitrous oxide emissions related to greenhouse gases and ozone depletion all need to be considered. Each of these processes has different controls. Limiting one process can increase another.

Can you cost-effectively manage to control each of these loss processes? Owing to their complexity, not likely. The best you can do is improve N use efficiency to a level that gives you optimum effectiveness. Ecological corn nutrition depends on using time-tested best management practices to ensure the **right source is applied at the right rate, time, and place**.

Key best management practices for N include:

- Crediting previous crops and applied manure.
- Determining yield goals from reliable information.
- Maintaining non-limiting levels of other nutrients.
- Crop management and hybrid selection for maximum economic yield.
- Timing supply to match plant need, by either controlling release or split application.
- Placement below the soil surface, or incorporated where possible.
- Placing a balanced starter fertilizer close to the seed.
- Maintaining and calibrating application equipment.
- Designing the crop rotation to capture surplus N.
- Evaluating success using on-farm trials and soil and stalk nitrate tests.

Global demand for food and fuel has returned profitability to crop production. This is the opportune time to test technologies to sustain those profits, using best management practices that enhance productivity, increase sustainability and improve environmental health as well. Doing so intensifies your corn nutrition ecologically. ■

References

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Cassman, K.G. 1999. Ecological intensification of cereal production systems: Yield potential, soil quality, and precision agriculture. Proc. Natl. Acad. Sci. USA Vol. 96:5952–5959.