Bill Lohry

Fertility Management A Must For High-Profit Yields

All-encompassing strategy must be developed and implemented to overcome obstacles that can drain profits from high-yielding reduced-till crops.

The practice of banding, stripping, or knifing fluid fertilizers has proved the superior method of application in almost all cases—especially in reduced-till operations—when compared with conventional broadcast methods. Research conducted over the years on banding, stripping, knifing of fluid fertilizers to produce high yields could fill more than one good-sized pickup. Trials on wheat, barley, corn, sorghum, soybeans, pastures—to name just a few crops—have been conducted to compare depths, band widths, and formulations. The trials are so numerous and varied that, owing to editorial space restrictions, only the more important implications of banding fluid fertilizers can be summarized. Reviewed will be the components of an all-encompassing strategy you can employ to overcome obstacles that often slice into profits of high-yield reduced-till farm operations.

Stratification

PROBLEM: In the Corn Belt, nutrients often are not distributed uniformly throughout the profile of many soils. Principal causes are several:

Broadcasting. The most common reason for soil stratification is the practice of applying fertilizer on the surface, followed by shallow incorporation.

Residue decay. Nutrients are also stratified because of decay of crop residues. Phosphorus, potassium, sulfur, and zinc thus tend to accumulate on the surface.

Reduced tillage. Different tillage methods have contributed to stratification of nutrients when they are surface applied. Typical is an Iowa State University study. Note how phosphorus and potassium are more concentrated in the upper root zone and more deficient in the lower root zone in no-till, when compared to the other tillage methods (Table 1). Another good example of stratification is shown in Table 2. This western Iowa soil had been minimum tilled for approximately 14 years. Phosphorus, potassium, and sulfur had accumulated in the upper three inches. Because of stratification near the surface, these nutrients were not available to the crop in July and August when needed most.

ANSWER: Stratification can be remedied by root zone banding fluid fertilizers, injecting them into the 3- to 12-inch soil profile where roots can proliferate. This can be accomplished during tilling, using chisel plows or field cultivators, or can be applied with knife machines and dual application units where ammonia and mixed liquids are applied simultaneously. This is a simple concept, yet a logical approach to correcting stratified soils.

Soil sampling

PROBLEM: Meaningful soil sampling is difficult in stratified soils, especially on eroded or heavily cropped fields, or on soils that have been minimum tilled. The standard 0 to 6-inch probe just doesn't give the true picture of root zone fertility level.

For example, a potassium, sulfur, or zinc problem would not have been discovered on the test analysis in Table 2 if the soil had been sampled with a standard probe. Soil sampling technique must be modified to get a true picture.

ANSWER: Meaningful sampling can be accomplished by using what we call the ABC system. Here the soil is divided into three zones. A soil analysis is made on each zone separately and listed as shown in Table 2. Complete analyses are usually made on zones A and B while only a nitrate analysis is made on zone C.

Interpretation

PROBLEM: Today's interpretations of soil tests are inadequate for high profit yields. As just noted, soils that are sampled with a standard 0 to 6-inch probe often provide misleading information and distort the soil test analysis. Stratification of phosphorus in the Sharpsburg soil (Figure 1) is quite serious, and an ordinary soil probe would not give true indications of the fertility level in the B or C root zones. The vertical dotted lines show the sufficiency level for a particular yield goal. Note how the 3- to 12-inch zone is below this sufficiency level in both phosphorus and potassium.

Debates have taken place between

agronomists about how to interpret soil tests. Some agronomists believe in replacement of nutrients withdrawn by crops. Others believe in maintaining a sufficiency level, or the level of nutrients required to achieve a certain yield goal. My opinion is that both these philosophies have problems.

Replacement. While replacement of nutrients has merit as a basis of maintaining fertility levels, it is more important to build soil fertility to a level that will support higher populations, thus increasing yield and profits for the farmer.

Recommending a nutrient replacement program can be a double-edged sword. First, a nutrient that is already adequate in the soil profile may be recommended. Second, simple replacement won't *build* fertility. At best, it will maintain it. Compounding this further are inherent nutrient losses in the soil (e.g., denitrification), which the grower seldom realizes.

The strategy of nutrient replacment or maintaining fertility is a regressive approach to high-yield crop production. The success of U.S. agriculture has been a continual increasing of yields and reducing costs per bushel via a continual *buildup* of soil productivity.

Sufficiency. The strategy of sufficiency should also be approached with caution. Sufficiency of each nutrient needs to be defined for each set of conditions including: hybrid, proposed population, grower management ability, climate, and yield goal. What are the sufficiency levels for NPK to raise 250 bushels of corn per acre? Answers can be extremely complex.

The biggest problem with sufficiency, however, is in defining the levels of nutrients for a stratified soil. Shouldn't the sufficiency level be high enough in the 3- to 12-inch zone to support the more extensive root mass of the higher population required to produce a high, profitable yield? It is my opinion that nutrients should be at a high level throughout the soil profile to support and encourage this deep root growth.

There is considerable evidence from research that concentration of nutrients in the soil solution should be higher as plant populations increase. Theory is: as plant populations increase, root mass becomes more and more restricted. Demand for nutrients by each plant rapidly depletes the soil solution. An adequate reserve must be available to replenish the extra nutrients withdrawn

Table 1. Example of stratified nutrients in soils with different tillage methods, Nicollet soil, Iowa State University.

Depth	Moldboard	Chisel	No-till
	Phosphorus (ppm)		
Zone A (0-3")	29	55	62
Zone B (3-12")	25	30	17
	Potassium (ppm)		
Zone A	130	235	240
Zone B	120	125	120

Table 2. Example of stratification on a western Iowa dryland, clay loam soil.

Depth	Organic Matter	NO_3-N	Ppm P	K	S	Zn
A (0-3")	2.8%	23	84	231	8.0	4.6
B (3-12")	1.7%	7	15	135	0.1	2.0
C (12-24")	2.2%	6	9	146	0.1	2.0

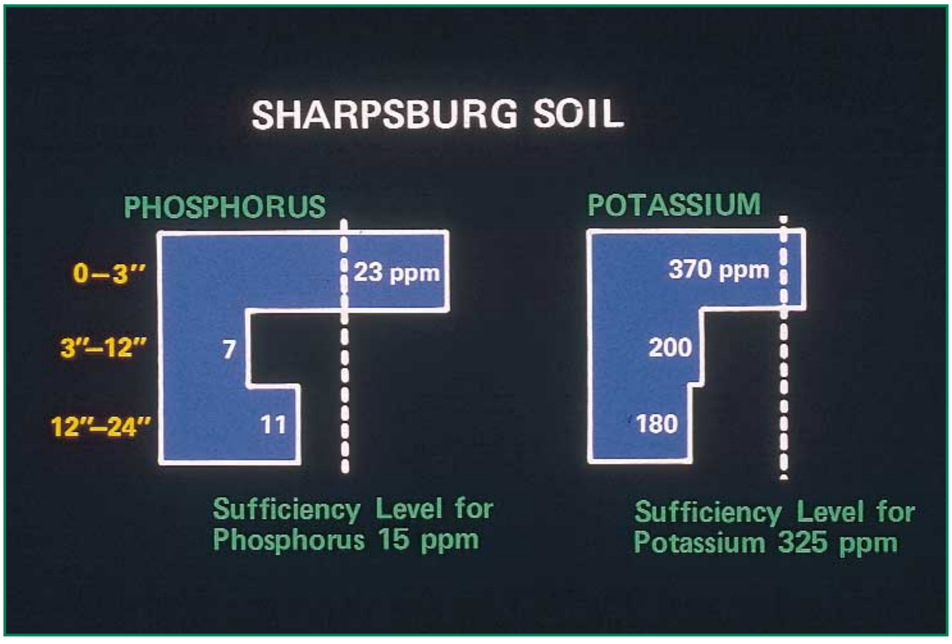

Figure 1. Stratification of phosphorus and potassium in a Sharpsburg soil, University of Nebraska.

by the root mass. The concentration in the soil must be maintained at a high level.

As phosphorus is withdrawn from the soil solution, there must be an ample reserve to replace that phosphorus that is absorbed by the roots. As populations increase, the old "sufficiency" levels of phosphorus may be "insufficient" or too low. Therefore, so-called sufficiency levels of phosphorus should be increased far beyond what some agronomists suggest if plant populations are being increased to levels needed to produce high yields.

It is interesting to note that corn will absorb no more nutrients per bushel from a 250-bu/A crop than from a lower-yielding crop. Yet, to reach 250 bu/A, the concentration of nutrients may have to be higher than sufficiency levels suggested.

ANSWER: The solution to simplifying soil test interpretation is to soil sample using the ABC system described earlier. Recommendations based on placing sufficient fertilizer where the greatest uptake occurs can then be made. Ignoring the fertility levels in the B and C zones and making recommendations from shallow soil samples is like flying a plane in a fog without using instruments.

Rainfall

PROBLEM: Limited rain and snow is a major obstacle to high yields in the western Corn Belt. One obvious remedy is irrigation but irrigation water is expensive. Under dryland conditions, moisture conservation can mean the difference between a good crop and crop failure.

ANSWER: There are many ways to improve water-use efficiency, including weed control, insect control, narrow rows, contour farming, conservation tillage, and so the list goes on. But one of the most effective ways to increase water-use efficiency is again through root zone banding or deep placement of fertilizer. Many times deeper root systems will carry the plant through periods of stress that occur at critical moments, thus increasing yields substantially.

Use the ballpoint pen measure on the grower sometime. Ask whether he would like to grow a crop in six inches (the length of the pen) or in 12 inches of soil in a dry year. You'll get no argument from most growers. They'll say, "Give me the deep-rooted crop when the weather is dry."

Absorption zone critical

PROBLEM: Assuming we have the right climate, hybrid, pest control, population level, high nutrient levels, we still need a deep soil profile to allow plant roots to proliferate. If populations are to increase we need to increase the soil volume available to the root system. If corn is planted in 30-inch rows at 18,000 plants/A and fertility is six inches deep, roots have an absorption zone of only nine gallons. Increase population to 28,000 plants/A, the zone shrinks to six gallons! The roots become restricted, compacted, crowded, and nutrients are less available.

ANSWER: Build a bigger box! The problem of restricted root volume can be solved by increasing the depth of fertility. Suppose we develop a soil with fertility and tilth 12 inches deep. Now the absorption zone available to each plant is 12 gallons! Under these conditions, 28,000 plants/A will produce a healthy plant with very little size reduction. Super high yields are possible. Production of 250-bu/A corn can be accomplished with 35,000 ears/A weighing a half pound each.

Tilth

PROBLEM: A common mistake is to underestimate the importance of tilth, viewing instead the importance of fertilization for high yield levels as primary. Fertility is easy to correct. Tilth, on the other hand, takes several years of skillful management to improve. Fertility is a small problem compared to tilth. Tilth is that magical combination of soil properties that distinguishes a soil by its physical and chemical characteristics. Tilth makes a soil crumbly, increases water-holding capacity, and improves aeration necessary for fertilizer uptake. Organic matter—a fragile group of organic compounds made up of carbon, nitrogen, phosphorus, and other essential nutrients—is the key to producing tilth. It's easy to destroy and difficult to maintain or produce.

ANSWER: Tilth in modern farming can be achieved by a combination of residue management, deep tillage, and, finally, deep fertilizer placement. Residues can be incorporated into the soil with sufficient nutrients to provide a favorable environment for the production of organic matter. Deep tillage can incorporate some of this residue into the deeper profile. The payoff is *profitable high yields* for the grower who achieves high soil productivity!

Lohry is chairman of Nutra-Flo Company in Sioux City, IA. ❏